NEW AND RESTRUCTURED

POST-GRADUATE CURRICULA & SYLLABI

Biotechnology & Bioinformatics

Plant Molecular Biology & Biotechnology
Animal Biotechnology
Bioinformatics

Education Division
Indian Council of Agricultural Research
New Delhi

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Contents

EXECUTIVE SUMMARY

Plant Molecular Biology & Biotechnology

- In the last thirty years, a revolution has taken place that has put molecular biology and biotechnology at the heart of all the biological sciences with extensive applications in agriculture, health, industry and environment. Keeping these developments in view, the new course curriculum for PG program in 'Plant Molecular Biology and Biotechnology' has been developed
- The curriculum now includes courses on 'Plant Tissue Culture and Genetic Transformation', 'Molecular Breeding', 'Genomics and Proteomics', 'Bioinformatics', 'Nano-biotechnology', 'Biosafety, IPR and Bioethics', 'Biostatistics and Computers', 'Environmental Biotechnology', 'Immunology and Molecular Diagnostics', which have direct application in improving agriculture and industry.
- The curriculum also includes seven advanced courses (for Ph.D.) on Molecular Biology, 'Genetic Engineering', 'Microbial Biotechnology', 'Crop Biotechnology', 'Functional Genomics and Proteomics", "Commercial Plant Tissue Culture" and "Animal Biotechnology', which are meant to provide the latest developments in the respective fields of Biotechnology.
- The curriculum also includes two practical courses namely 'Techniques in Molecular Biology I and II' that includes exhaustive hands-on training on various techniques of molecular biology and genomics.
- Highly specialized faculty in different areas of Molecular Biology and Biotechnology, well-equipped laboratories and other resources shall be required for teaching of the courses and conducting practicals given in the new course curriculum. While teaching and research skills of the already employed faculty needs to be improved, new young faculty from advanced Institutes/Universities in India or abroad may be appointed. Exchange of faculty among the various Universities could also be a viable option.
- The new course curriculum shall provide ample opportunity to the students to specialize in several different areas of Biotechnology including 'Plant Tissue Culture', 'Genomics', 'Microbial Biotechnology', 'Animal Biotechnology', 'Molecular Breeding' and 'Genetic Transformation'.
- The proposed curriculum is now tuned with fast evolving area of 'Molecular Biology' and likely to generate qualified human resource at par with those from other elite National and International institutions.
- Training of the faculty is required to teach new courses.
- Approximately, Rs. 10 crores are required for building laboratories, equipment, furniture, etc. for effective implementation of both Ph. D. and M. Sc. Programmes.

Animal Biotechnology

- Opportunities in animal husbandry seek to improve product quality, production efficiency, and animal health & well-being, all while reducing the environmental impact of animal production.
- Animal biotechnology has long been source of innovation in production and processing, profoundly impacting the animal husbandry sector.
- Biotechnological research products, such as vaccines, diagnostics, *in vitro* fertilization, transgenic animals, stem cells, and a number of other therapeutic recombinant products are now commercially available.
- In view of the immense potential of biotechnology in the livestock and poultry sectors, the specialization in animal biotechnology has emerged as a distinct discipline.

- The PG programme in 'Animal Biotechnology' is aimed at providing cutting edge concepts, as well as practical applications of the exciting field of Animal Biotechnology.
- The revised course curriculum covers wide ranging topics including molecular genetics, molecular and cell biology, immunotechnology, transgenic animal technology, animal genomics, proteomics, reproductive biotechnology, molecular diagnostics, molecular forensics and vaccinology and bioprocess technology and bioinformatics.
- The course curriculum also explores the economic, social, legal, environmental safety, IPR, ethical issues and controversies associated with modern biology and biotechnology.
- Extensive laboratory exercises pertaining to analytic biochemistry, molecular biology, genetic engineering, immunology, molecular diagnostics, reproductive biotechniques, animal cell culture, animal genomics and proteomics tools have been included in course syllabi.
- Laboratory sessions will allow students to plan, implement and report on their results of laboratory and simulation experiments.
- The first part of animal biotechnology focuses on the basic sciences, allowing the student to gain a good understanding of the core subject areas, before moving on to study more specialist topics.
- The courses have been designed to encourage critical thinking, use of the scientific method, integration of technology, development of student leadership skills, and application of knowledge and skills related to practical questions and problems.
- In addition to a strong scientific knowledge, the students will also gain an understanding of entrepreneurship related Animal Biotechnology.
- Since, several new courses have been introduced; faculty training is required to teach new courses.
- Infrastructure commensurate to recent development also needs to be created. A separate building and 8000 squire foot covered area housing, Cloning and Expression Laboratory, Animal Cell Culture Laboratory, Embryo Biotechnology, Animal Genomics and Proteomics Laboratory, Molecular biology Teaching Laboratory, Molecular Forensics Laboratory, on Seminar room and lecture halls, department office, committee room, department library etc. Equipment, furniture etc are also required.
- Approximately Rs. 10 crores as one time grant and Rs. 50 lacs as recurring grant is required to effectively run Masters and Ph.D. programmes.

Bioinformatics

- Bioinformatics involves the integration of computers, software tools, and databases in an effort to understand biological systems.
- The emergence of new Internet technologies, new and more accurate algorithms and the development of High Performance Computing coupled with DNA sequencing, serial analysis of gene expression, microarrays, and new mass spectrometry has enabled bioinformatics to address the biological problems from several different angles. It is this change in paradigm that has led to the development of Bioinformatics as a separate skill-oriented discipline.

- The future of bioinformatics is integration of a wide variety of data sources such as GIS data, such as maps, weather systems, with crop health and genotype data, will allow us to predict successful outcomes of agriculture experiments.
- One of the biggest hurdles facing bioinformatics today is the small number of trained manpower and researchers in the field. This scenario needs to be addressed in changed perspective so that bioinformatics moves to the forefront of research.
- In order to produce trained manpower in the area of Bioinformatics, this curriculum has been prepared.
- The syllabus addresses modern concepts (of computing and Biology) and practices, and emphasizes the hands-on training.
- The basic subjects *viz.* Statistics, mathematics, Biological Chemistry, Genetics, Mathematics, Immunology, and computer Advanced courses such as Basic Molecular Biology, Pharmacogenomics & IPR.
- Bioinformatics Courses are Biological Databanks and Data Mining, Biomolecular Sequence and Analysis, Structural Genomics and Proteomics, Molecular modelling and drug design.
- The infrastructure (~ 2500 sq. ft. covered area) required to impart teaching according to present curriculum includes the provision of one high-end PC per student, two workstations, one server with 1 TB or more storage and an internet connectivity of 2 MBPS (for 15 students) or more.
- More emphasis should be on Open Source applications and OS.
- The faculty should be trained in advanced concepts of sequence analysis, systems biology, molecular modelling and data/text mining.
- Since it is new subject area, fresh recruitments should be made in this discipline. Approx. budget required is Rs. 5 crores.

BSMA Committee on Biotechnology & Bioinformatics

(Plant Biotechnology/Animal Biotechnology/Bioinformatics)

(Constituted by ICAR vide Office order No. F. No. 13 (1)/2007- EQR dated January 14, 2008)

Name	Address	Specialization
Dr. H.S. Nainawatee Ex. ADG (Edu) ICAR **Convener**	Ex. ADG(Edu), ICAR, New Delhi	Plant Biotech
Dr. P. Anand Kumar Project Director	NRC Plant Biotechnology, IARI, New Delhi	Plant Biotech
Dr. H.S. Chawla Professor	Department of Plant Breeding, GBPUAT, Pantnagar	Plant Biotech
Dr. R.G. Saini Retired Professor	Dept. Biotech., Genetics & Plant Breeding, PAU, Ludhiana	Plant Biotech
Dr. D.R. Sharma Director of Research	Dr. Y.S. Parmar University of Horticulture & Forestry, Solan	Plant Biotech
Dr. K. Kumanan Professor & Head	Department of Animal Biotechnology, TANUVASU, Chennai	Animal Biotechnology
Dr. Sudhir Kumar Associate Professor	Bioinformatics Section, CCS HAU, Hisar	Bioinformatics
Dr. Anant Rai Head	Division of Animal Biotech. IVRI, Izatnagar	Animal Biotechnology
Dr. Gaya Prasad Professor **Member Secretary**	Dept. Animal Biotech. CCS HAU, Hisar	Animal Biotechnology

PREAMBLE

Economic growth and development in India continues to be propelled by growth in agriculture and allied sectors. Since majority of our population is dependent on agriculture, it is pertinent to ensure their economic security under changing competitive globalized environment. This can only be done through technological advancements and competent human resource to serve the needs of highly receptive farming community. In past such efforts have led to green, white, yellow and blue revolutions to make the country self sufficient in food needs. However, over the time, changed circumstances, declining total factor productivity, rising unemployment, fast degrading natural resources etc., have led to declining agricultural growth. Agricultural production through most conventional science and technology innovations has reached a plateau. Therefore, there is need to break the plateau. Thus to put the country's agricultural growth on fast track, development of cutting edge technologies and competent human resource is the need of the hour.

Biotechnology and Bioinformatics are relatively newer cutting edge sciences which incorporate principles of biological, physical and chemical sciences. Biotechnology is based on techniques involving genes, genomes, nucleic acids and other related macro and micro bio-molecules. Bioinformatics apply computer based information technology for storage, retrieval and analysis of vast data bases being generated on genes, genomics and nucleic acids. Advances so far made in these disciplines have already found valuable applications in quality and quality of production and productivity, processing and value addition of produce of agriculture and allied sectors.

The tremendous impetus received for biotechnological research and education has been due to its direct impact on human and animal health, agricultural productivity and environment issues. Due to increasing acceptance of genetically modified foods and agricultural produce, big pharmaceutical and agribusiness companies are investing huge funds in the biotechnology R&D sector. At present in India the number of companies involved in R&D or product development or production related to biotechnology and life sciences products has grown close to 350. To sustain these efforts, biotechnology R&D as well as education sector needs high quality human resources for inventing and creating value added products through intervention of biotechnology. It is felt that the second green-blue-white revolution can be achieved only through sustained improvement in the genetic upliftment of native crops and livestock. Because of tremendous global interest in biotechnology in the last two decades, the genetic blue print of a number of organisms has been worked out, which has led to the accumulation of huge genetic data. This has created requirement of highly skilled manpower equipped with biotechnological as well as information technology skills to analyze, annotate and make use of the genetic information for genetic enhancement of breeds or developing new age drugs for personal medicine to name a few application. These two subjects have gained importance in the recent time not only from industrial point of view but also from basic and strategic future research.

Major interest and scope of Biotechnology has emerged from the techniques which permit manipulation of biological systems in a defined and deliberate manner for beneficial purposes. Both human genome and rice genome projects have demonstrated the tremendous power of biotechnology and bioinformatics tools and techniques and their enormous applications as a commercial activity which is anticipated to grow exponentially. In view of the fast expanding scope of Biotechnology and Bioinformatics, the post graduate programme, non- existent a few decades ago is now being offered in hundreds of public and private universities and institutes. Twenty seven agricultural universities offer Biotechnology programmes, some of which offer both Animal Biotechnology and Plant/Agricultural Biotechnology & Molecular Biology Programmes. Bioinformatics programme is offered only by CCS Haryana Agricultural University. Department of Biotechnology of Union Ministry of

Science & Technology supports PG Biotechnology programmes of ten agricultural universities.

The existing Biotechnology Departments of agricultural universities vary greatly in terms of infrastructure, facilities and human resources which at several places are inadequate for full realization of Biotechnology potential. Also in most cases, these Departments have been created by regrouping of willing and trained human resource form old well established disciplines like Biochemistry, Microbiology, Genetics, Plant Physiology, Plant Breeding etc. Biotechnology and Bioinformatics are fast developing disciplines in which scientific and technological advancements are taking place rapidly. There is strong need for continuous faculty competence improvement, for updating skill and knowledge of scientists through national and international human resource development activities and programmes.

The BSMA Committee has worked with the stakeholders of Biotechnology & Bioinformatics on issues concerning PG education. Curricula and Syllabi recommended by the ICAR and by the Department of Biotechnology of the Government of India, and some Agricultural Universities were considered in preparing the first draft of Curricula and Syllabi of Animal Biotechnology, Molecular Biology & Biotechnology and Bioinformatics. This was prepared by the concerned faculties of CCS Haryana Agricultural University, Hisar. The first draft was thoroughly discussed through e-mail exchanges among BSMAC Members and 64 stakeholders representing academia, biotech industries and government organizations. Curricula & Syllabi were further critically examined and thoroughly discussed in two BSMAC Meetings and a Stakeholders Workshop. All the suggestions and opinions received were properly considered in formulating the restructured Curricula & Syllabi.

The contents of most of the courses in all the three programmes have been revised keeping in view the advances in the respective subject area. Title of quite a few courses has been modified to make them contemporary. Following new courses have been included in the revised curricula:

Plant Molecular Biology & Biotechnology: Molecular Breeding; Nano-biotechnology; Biosafety, IPR and Bioethics; Immunology and Molecular Diagnostics; Crop Biotechnology; Plant Tissue Culture and Genetic Transformation, Environmental Biotechnology, Advances in Crop Biotechnology, Advances in Functional Genomics and Proteomics, Advances in Animal Biotechnology, Commercial Plant Tissue Culture.

Animal Biotechnology: Techniques in Molecular Biology & Genetic Engineering; Biodiversity, Biosafety & Bioethics; Molecular Forensics, Industrial Biotechnology; Animal Biotechnology; Functional Genomics & Proteomics; Gene Cloning and Expression; Trends in Vaccinology.

Bioinformatics: Basic Molecular Biology; Mathematics for Bioinformatics; Pharmacogenomics & IPR.

The new curricula and syllabi has increased practical component to provide hands on training and analytical skills to the students. The new courses such as Techniques in Molecular biology I & II, Techniques in Bioinformatics and Techniques in Molecular Biology & Genetic Engineering have been included with only practical format. The practical exercises have been distinctly out lined in the courses as these are to be conducted rather than in descriptive running text. Such courses are aimed at strengthening the practice/practical skills of the students to equip the students with modern research skills and knowledge to meet requirements of R&D organizations, private sector and global competitiveness for their employability.

ORGANIZATION OF COURSE CONTENTS
&
CREDIT REQUIREMENTS

Code Numbers

- All courses are divided into two series: 500-series courses pertain to Master's level, and 600-series to Doctoral level (corresponding Code nos. for Animal Biotechnology are 600- and 700-series).
- A Ph. D. student must take a minimum of two 600 series courses, but may also take 500-series courses if not studied during Master's programme. Credit seminar for Master's level is designated by code no. 591, and the two seminars for Doctoral level are coded as 691 and 692, respectively.
- Similarly, 599 and 699 codes have been given for Master's research and Doctoral research, respectively.

Course Contents

The contents of each course have been organized into:

- Objective – to elucidate the basic purpose.
- Theory units – to facilitate uniform coverage of syllabus for paper setting.
- Suggested Readings – to recommend some standard books as reference material. This does not unequivocally exclude other such reference material that may be recommended according to the advancements and local requirements.
- A list of journals pertaining to the discipline is provided at the end, which may be useful as study material for 600-series courses as well as research topics.
- E-Resources - for quick update on specific topics/events pertaining to the subject.
- Broad research topics provided at the end would facilitate the advisors for appropriate research directions to the PG students.

Minimum Credit Requirements

Subject	Master's programme	Doctoral programme
Major	20	15
Minor	09	08
Supporting	05	05
Seminar	01	02
Research	20	45
Total Credits	**55**	**75**
Compulsory Non Credit Courses	See relevant section	

Major subject: The subject (department) in which the students takes admission

Minor subject: The subject closely related to students major subject (e.g., if the major subject is Entomology, the appropriate minor subjects should be Plant Pathology or Nematology).

Supporting subject: The subject not related to the major subject. It could be any subject considered relevant for student's research work.

Non-Credit Compulsory Courses: Please see the relevant section for details. Six courses (PGS 501-PGS 506) are of general nature and are compulsory for Master's programme. Ph. D. students may be exempted from these courses if already studied during Master's degree.

PLANT MOLECULAR BIOLOGY AND BIOTECHNOLOGY

Course Structure – at a Glance

CODE	COURSE TITLE	CREDITS
MBB 501**	PRINCIPLES OF BIOTECHNOLOGY	2+1
MBB 502**	FUNDAMENTALS OF MOLECULAR BIOLOGY	3+0
MBB 503**	MOLECULAR CELL BIOLOGY	3+0
MBB 504	PLANT TISSUE CULTURE & GENETIC TRANSFORMATION	1+2
MBB 505**	TECHNIQUES IN MOLECULAR BIOLOGY I	0+3
MBB 506	MICROBIAL/ INDUSTRIAL BIOTECHNOLOGY	2+1
MBB 507	MOLECULAR BREEDING	2+0
MBB 508	GENOMICS & PROTEOMICS	2+0
MBB 509	TECHNIQUES IN MOLECULAR BIOLOGY II	0+3
MBB 510*	BIOSAFETY, IPR AND BIOETHICS	2+0
MBB 511*	ANIMAL BIOTECHNOLOGY	3+0
MBB 512*	IMMUNOLOGY AND MOLECULAR DIAGNOSTICS	2+1
MBB 513*	NANO-BIOTECHNOLOGY	3+0
MBB 551*	PRINCIPLES OF GENETICS	3+1
MBB 552*	GENERAL BIOCHEMISTRY	3+0
MBB 553*, **	BIOSTATISTICS AND COMPUTERS	2+1
MBB 554*	PRINCIPLES OF MICROBIOLOGY	3+1
MBB 555	INTRODUCTION TO BIOINFORMATICS	2+1
MBB 556	ENVIRONMENTAL BIOTECHNOLOGY	3+0
MBB 591	MASTER'S SEMINAR	1+0
MBB 599	MASTER'S RESEARCH	20
MBB 601	ADVANCES IN PLANT MOLECULAR BIOLOGY	3+0
MBB 602	ADVANCES IN GENETIC ENGINEERING	3+0
MBB 603	ADVANCES IN MICROBIAL BIOTECHNOLOGY	3+0
MBB 604	ADVANCES IN CROP BIOTECHNOLOGY	3+0
MBB 605	ADVANCES IN FUNCTIONAL GENOMICS AND PROTEOMICS	2+0
MBB 606	COMMERCIAL PLANT TISSUE CULTURE	2+0
MBB 607	ADVANCES IN ANIMAL BIOTECHNOLOGY	2+0
MBB 691	DOCTORAL SEMINAR I	1+0
MBB 692	DOCTORAL SEMINAR II	1+0
MBB 699	DOCTORAL RESEARCH	45

*May be taken as minor/supporting courses; **Compulsory for M.Sc. Programme

PLANT MOLECULAR BIOLOGY AND BIOTECHNOLOGY
Course Contents

MBB 501 PRINCIPLES OF BIOTECHNOLOGY 2+1

Objective

To familiarize the students with the fundamental principles of Biotechnology, various developments in Biotechnology and its potential applications.

Theory

UNIT I

History, scope and importance; DNA structure, function and metabolism.

UNIT II

DNA modifying enzymes and vectors; Methods of recombinant DNA technology; Nucleic acid hybridization; Gene libraries; PCR amplification; Plant and animal cell and tissue culture techniques and their applications.

UNIT III

Molecular markers and their applications; DNA sequencing; Applications of gene cloning in basic and applied research; Genetic engineering and transgenics; Genomics, transcriptomics and proteomics.

UNIT IV

General application of biotechnology in Agriculture, Medicine, Animal husbandry, Environmental remediation, Energy production and Forensics; Public perception of biotechnology; Bio-safety and bioethics issues; Intellectual property rights in biotechnology.

Practical

i. Isolation of genomic and plasmid DNA
ii. Gel electrophoresis techniques
iii. Restriction enzyme digestion, ligation, transformation and screening of transformants
iv. PCR and molecular marker analysis
v. Plant tissue culture: media preparation, cell and explant culture, regeneration and transformation.

Suggested Readings

Becker JM, Coldwell GA & Zachgo EA. 2007. *Biotechnology - a Laboratory Course*. Academic Press.

Brown CM, Campbell I & Priest FG. 2005. *Introduction to Biotechnology*. Panima Pub.

Brown TA. *Gene Cloning and DNA Analysis*. 5th Ed. Blackwell Publishing.

Dale JW & von Schantz M. 2002. *From Genes to Genomes: Concepts and Applications of DNA Technology*. John Wiley & Sons.

Gupta PK. 2004. *Biotechnology and Genomics*. Rastogi Publications.

Sambrook J, Fritsch T & Maniatis T. 2001. *Molecular Cloning - a Laboratory Manual*. 2nd Ed. Cold Spring Harbour Laboratory Press.

Singh BD. 2007. *Biotechnology Expanding Horiozon*. Kalyani Publishers.

MBB 502 FUNDAMENTALS OF MOLECULAR BIOLOGY 3+0

Objective

To familiarize the students with the basic cellular processes at molecular level.

Theory

UNIT I

Historical developments of molecular biology; Nucleic acids as genetic material; Chemistry, structure and properties of DNA and RNA.

UNIT II

Genome organization in prokaryotes and eukaryotes; Chromatin structure and function; DNA replication; DNA polymerases, topoisomerases, DNA ligase, etc; Molecular basis of mutations; DNA repair mechanisms.

UNIT III

Transcription process; RNA processing; Reverse transcriptase; RNA editing; Ribosomes structure and function; Organization of ribosomal proteins and RNA genes; Genetic code; Aminoacyl tRNA synthases.

UNIT IV

Translation and post-translational modifications; Operon concept; Attenuation of *trp* operon; important features of gene regulation in eukaryotes.

Suggested Readings

Lewin B. 2008. *Gene IX*. Peterson Publications/ Panima.

Malacinski GM & Freifelder D. 1998. *Essentials of Molecular Biology*. 3rd Ed. Jones & Bartlett Publishers.

Nelson DL & Cox MM. 2007. *Lehninger's Principles of Biochemistry*. W.H. Freeman & Co.

Primrose SB. 2001. *Molecular Biotechnology*. Panima.

Watson JD, Bakee TA, Bell SP, Gann A, Levine M & Losick R. 2008. *Molecular Biology of the Gene*. 6th Ed. Pearson Education International.

MBB 503 MOLECULAR CELL BIOLOGY 3+0

Objective

To familiarize the students with the cell biology at molecular level.

Theory

UNIT I

General structure and constituents of cell; Similarities and distinction between plant and animal cells; Cell wall, cell membrane, structure and composition of biomembranes, cell surface related functions.

UNIT II

Structure and function of major organelles: Nucleus, Chloroplasts, Mitochondria, Ribosomes, Lysosomes, Peroxisomes, Endoplasmic reticulum, Microbodies, Golgi apparatus, Vacuoles, etc.

UNIT III

Organellar genomes and their manipulation; Ribosomes in relation to cell growth and division; Cyto-skeletal elements.

UNIT IV

Cell division and regulation of cell cycle; Membrane transport; Transport of water, ion and biomolecules; Signal transduction mechanisms; Protein targeting.

Suggested Readings

Gupta PK. 2003. *Cell and Molecular Biology*. 2nd Ed. Rastogi Publ.

Lodish H. 2003. *Molecular Cell Biology*. 5th Ed. W.H. Freeman & Co.

Primrose SB. 2001. *Molecular Biotechnology*. Panima.

MBB 504 PLANT TISSUE CULTURE AND GENETIC TRANSFORMATION 1+2

Objective

To familiarize the students and provide hands on training on various techniques of plant tissue culture, genetic engineering and transformation.

Theory

UNIT I

History of plant cell and tissue culture; Culture media; Various types of culture; callus, suspension, nurse, root, meristem, etc.; *In vitro* differentiation: organogenesis and somatic embryogenesis; Plant growth regulators: mode of action, effects on *in vitro* culture and regeneration; Molecular basis of plant organ differentiation.

UNIT II

Micropropagation; Anther and microspore culture; Somaclonal variation; *In vitro* mutagenesis; *In vitro* fertilization; *In vitro* germplasm conservation; Production of secondary metabolites; Synthetic seeds.

UNIT III

Embryo rescue and wide hybridization; Protoplast culture and regeneration; Somatic hybridization: protoplast fusion, cybrids, asymmetric hybrids, etc.

UNIT IV

Methods of plant transformation; Vectors for plant transformation; Genetic and molecular analyses of transgenics; Target traits and transgenic crops; Biosafety issues, testing of transgenics, regulatory procedures for commercial approval.

Practical

i. Laboratory set-up.
ii. Preparation of nutrient media; handling and sterilization of plant material; inoculation, subculturing and plant regeneration.
iii. Anther and pollen culture.
iv. Embryo rescue.
v. Suspension cultures and production of secondary metabolites.
vi. Protoplast isolation, culture and fusion.
vii. Gene cloning and vector construction
viii. Gene transfer using different methods, reporter gene expression, selection of transformed tissues/plants, molecular analysis.

Suggested Readings

Bhojwani SS. 1983. *Plant Tissue Culture: Theory and Practice*. Elsevier.

Christou P & Klee H. 2004. *Handbook of Plant Biotechnology*. John Wiley & Sons.

Dixon RA. 2003. *Plant Cell Culture*. IRL Press.

George EF, Hall MA & De Klerk GJ. 2008. *Plant Propagation by Tissue Culture*. Agritech Publ.

Gupta PK. 2004. *Biotechnology and Genomics*. Rastogi Publ.

Herman EB. 2005-08. *Media and Techniques for Growth, Regeneration and Storage*. Agritech Publ.

Pena L. 2004. *Transgenic Plants: Methods and Protocols*. Humana Press.

Pierik RLM. 1997. *In vitro Culture of Higher Plants*. Kluwer.

Singh BD. 2007. *Biotechnology: Expanding Horiozon.* Kalyani.

MBB 505 TECHNIQUES IN MOLECULAR BIOLOGY-I 0+3

Objective

To provide hands on training on basic molecular biology techniques.

Practical

UNIT I

Good lab practices; Biochemical techniques: Preparation of buffers and reagents, Principle of centrifugation, Chromatographic techniques (TLC, Gel Filtration Chromatography, Ion exchange Chromatography, Affinity Chromatography).

UNIT II

Gel electrophoresis- agarose and PAGE (nucleic acids and proteins); Growth of bacterial culture and preparation of growth curve; Isolation of plasmid DNA from bacteria; Growth of lambda phage and isolation of phage DNA; Restriction digestion of plasmid and phage DNA; Isolation of high molecular weight DNA and analysis.

UNIT III

Gene cloning – Recombinant DNA construction, transformation and selection of transformants; PCR and optimization of factors affecting PCR.

UNIT IV

Dot blot analysis; Southern hybridization; Northern hybridization; Western blotting and ELISA; Radiation safety and non-radio isotopic procedure.

Suggested Readings

Ausubel FM, Brent R, Kingston RE, Moore DD, Seidman JG, Smith JA & Struhl K. 2002. *Short Protocols in Molecular Biology*. John Wiley.

Kun LY. 2006. *Microbial Biotechnology*. World Scientific.

Sambrook J, Russel DW & Maniatis T. 2001. *Molecular Cloning: a Laboratory Manual*. Cold Spring Harbour Laboratory Press.

MBB 506 MICROBIAL/ INDUSTRIAL BIOTECHNOLOGY 2+1

Objective

To familiarize about the various microbial processes/systems/activities, which have been used for the development of industrially important products/processes.

Theory

UNIT I

Introduction, scope and historical developments; Isolation, screening and genetic improvement (involving classical approaches) of industrially important organisms.

UNIT II

Primary metabolism products, production of industrial ethanol as a case study; Secondary metabolites, bacterial antibiotics and non ribosomal peptide antibiotics; Recombinant DNA technologies for microbial processes; Strategies for development of industrial microbial strains with scale up production capacities; Metabolic pathway engineering of microbes for production of novel product for industry.

UNIT III

Microbial enzymes, role in various industrial processes, production of fine chemicals for pharmaceutical industries; Bio-transformations, Bio-augmentation with production of vitamin C as a case study; Bioreactors,

their design and types; Immobilized enzymes based bioreactors; Microencapsulation technologies for immobilization of microbial enzymes.

UNIT IV

Industrial biotechnology for pollution control, treatment of industrial and other wastes, biomass production involving single cell protein; Bio-remediation of soil; Production of eco-friendly agricultural chemicals, bio-pesticides, bio-herbicides, bio-fertilizers, bio-fuels, etc.

Practical

i. Isolation of industrially important microorganisms, their maintenance and improvement.
ii. Production of industrial compounds such as alcohol, beer, citric acid, lactic acid and their recovery.
iii. Study of bio-reactors and their operations.
iv. Production of biofertilizers.
v. Experiments on microbial fermentation process, harvesting purification and recovery of end products.
vi. Immobilization of cells and enzymes, studies on its kinetic behavior, growth analysis and biomass estimation.
vii. Determination mass transfer co-efficients.

Suggested Readings

Huffnagle GB & Wernick S. 2007. *The Probiotics Revolution: The Definitive Guide to Safe, Natural Health*. Bantam Books.

Kun LY. 2006. *Microbial Biotechnology*. World Scientific.

Primrose SB. 2001. *Molecular Biotechnology*. Panima.

MBB 507 MOLECULAR BREEDING 2+0

Objective

To familiarize the students about the use of molecular biology tools in plant breeding.

Theory

UNIT I

Principles of plant breeding; Breeding methods for self and cross pollinated crops; Heterosis breeding; Limitations of conventional breeding; Aspects of molecular breeding.

UNIT II

Development of sequence based molecular markers - SSRs and SNPs; Advanced methods of genotyping; Mapping genes for qualitative and quantitative traits.

UNIT III

QTL mapping using structured populations; AB-QTL analysis; Association mapping of QTL; Fine mapping of genes/QTL; Map based gene/QTL isolation and development of gene based markers; Allele mining by TILLING and Eco-TILLING; Use of markers in plant breeding.

UNIT IV

Marker assisted selection (MAS) in backcross and heterosis breeding; Transgenic breeding; Foreground and background selection; MAS for gene introgression and pyramiding: MAS for specific traits with examples.

Suggested Readings

Chittaranjan K. 2006-07. *Genome Mapping and Molecular Breeding in Plants.* Vols. I-VII. Springer.

Newbury HJ. 2003. *Plant Molecular Breeding*. Blackwell Publ.
Weising K, Nybom H, Wolff K & Kahl G. 2005. *DNA Fingerprinting in Plants: Principles, Methods and Applications*. Taylor & Francis.

MBB 508 GENOMICS AND PROTEOMICS 2+0

Objective

To familiarize the students with recent tools used for genome analysis and their applications.

Theory

UNIT I

Structural genomics: Classical ways of genome analysis, large fragment genomic libraries; Physical mapping of genomes; Genome sequencing, sequence assembly and annotation; Comparative genomics, etc.

UNIT II

Functional genomics: DNA chips and their use in transcriptome analysis; Mutants and RNAi in functional genomics; Metabolomics and ionomics for elucidating metabolic pathways, etc.

UNIT III

Proteomics - Protein structure, function and purification; Introduction to basic proteomics technology; Bio-informatics in proteomics; Proteome analysis, etc.

UNIT IV

Applications of genomics and proteomics in agriculture, human health and industry.

Suggested Readings

Azuaje F & Dopazo J. 2005. *Data Analysis and Visualization in Genomics and Proteomics*. John Wiley & Sons.
Brown TA. 2007. *Genome III*. Garland Science Publ.
Campbell AM & Heyer L. 2004. *Discovery Genomics, Proteomics and Bioinformatics*. Pearson Education.
Gibson G & Muse SV. 2004. *A Primer of Genome Science*. Sinauer Associates.
Jollès P & Jörnvall H. 2000. *Proteomics in Functional Genomics: Protein Structure Analysis*. Birkhäuser.
Kamp RM. 2004. *Methods in Proteome and Protein Analysis*. Springer.
Primrose SB & Twyman RM. 2007. *Principles of Genome Analysis and Genomics*. Blackwell.
Sensen CW. 2005. *Handbook of Genome Research*. Vols. I, II. Wiley CVH.

MBB 509 TECHNIQUES IN MOLECULAR BIOLOGY-II 0+3

Objective

To provide hands on training on various molecular techniques used in molecular breeding and genomics.

Practical

UNIT I

Construction of gene libraries; Synthesis and cloning of cDNA and RT-PCR analysis; Real time PCR and interpretation of data.

UNIT II

Molecular markers (RAPD, SSR, AFLP etc) and their analysis; Case study of SSR markers (linkage map, QTL analysis etc); SNP identification and analysis; Microarray studies and use of relevant software.

UNIT III

Proteomics (2D gels, mass spectrometry, etc.); RNAi (right from designing of construct to the phenotyping of the plant); Yeast 1 and 2-hybrid interaction.

UNIT IV

Generation and screening of mutants; Transposon mediated mutagenesis.

Suggested Readings

Ausubel FM, Brent R, Kingston RE, Moore DD, Seidman JG, Smith JA & Struhl K. 2002. *Short Protocols in Molecular Biology*. Wiley.

Caldwell G, Williams SN & Caldwell K. 2006. *Integrated Genomics: A Discovery-Based Laboratory Course*. John Wiley.

Sambrook J, Russel DW & Maniatis T. 2001. *Molecular Cloning: a Laboratory Manual.* Cold Spring Harbour Laboratory Press.

MBB 510 BIOSAFETY, IPR AND BIOETHICS 2+0

Objective

To discuss about various aspects of biosafety regulations, IPR and bioethic concerns arising from the commercialization of biotech products.

Theory

UNIT I

Biosafety and risk assessment issues; Regulatory framework; National biosafety policies and law, The Cartagena protocol on biosafety, WTO and other international agreements related to biosafety, Cross border movement of germplasm; Risk management issues - containment.

UNIT II

General principles for the laboratory and environmental biosafety; Health aspects; toxicology, allergenicity, antibiotic resistance, etc; Impact on environment: gene flow in natural and artificial ecologies; Sources of gene escape, tolerance of target organisms, creation of superweeds/superviruses, etc.

UNIT III

Ecological aspects of GMOs and impact on biodiversity; Monitoring strategies and methods for detecting transgenics; Radiation safety and non-radio isotopic procedure; Benefits of transgenics to human health, society and the environment.

UNIT IV

The WTO and other international agreements; Intellectual properties, copyrights, trademarks, trade secrets, patents, geographical indications, etc; Protection of plant variety and farmers right act; Indian patent act and amendments, patent filing; Convention on biological diversity; Implications of intellectual property rights on the commercialization of biotechnology products.

Suggested Readings

Singh BD. 2007. *Biotechnology: Expanding Horizon*. Kalyani.

http://patentoffice.nic.in

www.wipo.org

www.dbtindia.nic.in

www.dbtbiosafety.nic.in

MBB 511 ANIMAL BIOTECHNOLOGY 3+0

Objective

Intended to provide an overview and current developments in different areas of animal biotechnology.

Theory

UNIT I

Structure of animal cell; History of animal cell culture; Cell culture media and reagents, culture of mammalian cells, tissues and organs, primary culture, secondary culture, continuous cell lines, suspension cultures, somatic cell cloning and hybridization, transfection and transformation of cells, commercial scale production of animal cells, application of animal cell culture for *in vitro* testing of drugs, testing of toxicity of environmental pollutants in cell culture, application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins.

UNIT II

Introduction to immune system, cellular and hormonal immune response, history of development of vaccines, introduction to the concept of vaccines, conventional methods of animal vaccine production, recombinant approaches to vaccine production, hybridoma technology, phage display technology for production of antibodies, antigen-antibody based diagnostic assays including radioimmunoassays and enzyme immunoassays, immunoblotting, nucleic acid based diagnostic methods, commercial scale production of diagnostic antigens and antisera, animal disease diagnostic kits, probiotics.

UNIT III

Structure of sperms and ovum, cryopreservation of sperms and ova of livestock, artificial insemination, super ovulation, *in vitro* fertilization, culture of embryos, cryopreservation of embryos, embryo transfer, embryo-spliting, embryo sexing, transgenic manipulation of animal embryos, different applications of transgenic animal technology, animal viral vectors, animal cloning basic concept, cloning from- embryonic cells and adult cells, cloning of different animals, cloning for conservation for conservation endangered species, ethical, social and moral issues related to cloning, *in situ* and *ex situ* preservation of germplasm, *in utero* testing of foetus for genetic defects, pregnancy diagnostic kits, anti-fertility animal vaccines, gene knock out technology and animal models for human genetic disorders.

UNIT IV

Introduction to different breeds of cattle, buffalo, sheep, goats, pigs, camels, horses, canines and poultry, genetic characterization of livestock breeds, marker assisted breeding of livestock, introduction to animal genomics, different methods for characterization of animal genomes, SNP, STR, QTL, RFLP, RAPD, genetic basis for disease resistance, Transgenic animal production and application in expression of therapeutic proteins. Immunological and nucleic acid based methods for identification of animal species, detection of meat adulteration using DNA based methods, detection food/feed adulteration with animal protein, identification of wild animal species using DNA based methods using different parts including

bones, hair, blood, skin and other parts confiscated by anti-poaching agencies.

Suggested Readings

Gordon I. 2005. *Reproductive Techniques in Farm Animals*. CABI.

Kindt TJ, Goldsby RA & Osbrne BA. 2007. *Kuby Immunology*. WH Freeman.

Kun LY. 2006. *Microbial Biotechnology*. World Scientific.

Levine MM, Kaper JB, Rappuoli R, Liu MA, Good MF. 2004. *New Generation Vaccines*. 3rd Ed. Informa Healthcare.

Lincoln PJ & Thomson J. 1998. *Forensic DNA Profiling Protocols*. Humana Press.

Portner R. 2007. *Animal Cell Biotechnology*. Humana Press.

Spinger TA. 1985. *Hybridoma Technology in Biosciences and Medicine*. Plenum Press.

Twyman RM. 2003. *Advanced Molecular Biology*. Bios Scientific.

MBB 512 IMMUNOLOGY AND MOLECULAR DIAGNOSTICS 2+1

Objective

To discuss the application of various immunological and molecular diagnostic tools.

Theory

UNIT I

History and scope of immunology; Components of immune system: organs, tissues and cells, Immunoglobulin chemistry, structure and functions; Molecular organization of immunoglobulins and classes of antibodies.

UNIT II

Antibody diversity; antigens, haptens, antigens- antibody interactions; immuno-regulation and tolerance; Allergies and hypersensitive response; Immunodeficiency; Vaccines; Immunological techniques.

UNIT III

Immunological application in plant science, monoclonal antibodies and their uses, molecular diagnostics. Introduction to the basic principles of molecular technology and techniques used in pathogen detection, Principles of ELISA and its applications in viral detection.

UNIT IV

Basics and procedures of PCR, Real time PCR, PCR based and hybridization based methods of detection, microarrays based detection, multiplexing etc, detection of soil borne and seed born infections, transgene detection in seed, planting material and processed food, molecular detection of varietal impurities and seed admixtures in commercial consignments.

Practical

i. Preparation of buffers and reagents.
ii. Immunoblotting, immunoelectrophoresis and fluorescent antibody test.
iii. Enzyme immunoassays including ELISA western blotting.
iv. Extraction and identification of DNA/RNA of pathogenic organisms.
v. Restriction hybridoma technique and production of monoclonal antibodies.

vi. Immunogenic proteins, expression and immunogenecity studies, purification of immunogenic protein and immunization of laboratory animals.

Suggested Readings

Bloom BR & Lambert P-H. 2002. *The Vaccine Book*. Academic Press.

Elles R & Mountford R. 2004. *Molecular Diagnosis of Genetic Disease*. Humana Press.

Kindt TJ, Goldsby RA & Osbrne BA. 2007. *Kuby's Immunology*. WH Freeman.

Levine MM, Kaper JB, Rappuoli R, Liu MA & Good MF. 2004. *New Generation Vaccines*. 3rd Ed. Informa Healthcare.

Lowrie DB & Whalen R. 2000. *DNA Vaccines*. Humana Press.

Male D, Brostoff J, Roth DB & Roitt I. 2006. *Immunology.* Elsevier.

Rao JR, Fleming CC & Moore JE. 2006. *Molecular Diagnostics*. Horizon Bioscience.

Robinson A & Cranage MP. 2003. *Vaccine Protocols*. 2nd Ed. Humana Press.

Spinger TA, 1985. *Hybridoma Technology in Biosciences and Medicine*. Plenum Press.

MBB 513 NANO-BIOTECHNOLOGY 3+0

Objective

Understanding the molecular techniques involved in structure and functions of nano-biomolecules in cells such as DNA, RNA and proteins.

Theory

UNIT I

Introduction to Biomacromolecules: The modern concepts to describe the conformation and dynamics of biological macromolecules: scattering techniques, micromanipulation techniques, drug delivery applications etc.

UNIT II

Cellular engineering: signal transduction in biological systems, feedback control signaling pathways, cell-cell interactions etc. Effects of physical, chemical and electrical stimuli on cell function and gene regulation.

UNIT III

Chemical, physical and biological properties of biomaterials and bioresponse: biomineralization, biosynthesis, and properties of natural materials (proteins, DNA, and polysaccharides), structure-property relationships in polymeric materials (synthetic polymers and structural proteins); Aerosol properties, application and dynamics; Statistical Mechanics in Biological Systems,

UNIT IV

Preparation and characterization of nanoparticles; Nanoparticular carrier systems; Micro- and Nano-fluidics; Drug and gene delivery system; Microfabrication, Biosensors, Chip technologies, Nano- imaging, Metabolic engineering and Gene therapy.

Suggested Readings

Nalwa HS. 2005. *Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology*. American Scientific Publ.

Niemeyer CM & Mirkin CA. 2005. *Nanobiotechnology*. Wiley Interscience.

MBB 551 PRINCIPLES OF GENETICS 2+1

Objective

This course is aimed at understanding the basic concepts of genetics, helping students to develop their analytical, quantitative and problem-solving skills from classical to molecular genetics.

Theory

UNIT I

Early concepts of inheritance; Discussion on Mendel's paper; Sex determination, differentiation and sex-linkage, Sex-influenced and sex-limited traits; Linkage, recombination and genetic mapping in eukaryotes, Somatic cell genetics.

UNIT II

Structural and numerical changes in chromosomes; Nature, structure and replication of the genetic material; Organization of DNA in chromosomes; Mutations and mutagenic agents.

UNIT III

Genetic code and protein biosynthesis; Gene regulation, Genes in development; Extra chromosomal inheritance, Male sterility and incompatibility; Recombination in bacteria, fungi and viruses, tetrad analysis.

UNIT IV

Inheritance of quantitative traits; Concepts in population genetics; Genes and behavior; Genetics and evolution; Recombinant DNA technology; Genetic fine structure analysis, Split genes, Transposable genetic elements, Overlapping genes, Pseudogenes, Oncogenes, Gene families; An overview of some recent discoveries in the field of genetics.

Practical

i. Laboratory exercises in probability and chi-square.
ii. Demonstration of genetic principles using laboratory organisms.
iii. Chromosome mapping using three point test cross.
iv. Tetrad analysis.
v. Induction and detection of mutations through genetic tests.
vi. Pedigree analysis in humans.
vii. Numerical problems on Hardy Weinberg Equilibrium, Quantitative inheritance and Molecular genetics.

Suggested Readings

Klug WS & Cummings MR. 2003 *Concepts of Genetics*. Peterson Education.

Lewin B. 2008. *Genes IX*. Jones & Bartlett Publ.

Russell PJ. 1998. *Genetics*. The Benzamin/Cummings Publ. Co.

Strickberger MW.1990. *Genetics*. Collier MacMillan.

Tamarin RH. 1999. *Principles of Genetics*. Wm. C. Brown Publs.

Uppal S, Yadav R, Subhadra & Saharan RP. 2005. *Practical Manual on Basic and Applied Genetics*. Dept. of Genetics, CCS HAU Hisar.

MBB 552 BASIC BIOCHEMISTRY 2+1

Objective

To provide elementary knowledge/overview of structure, functions and metabolism of biomolecules.

Theory

UNIT I

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 Waals forces; General introduction to physical techniques for determination of structure of biopolymers.

UNIT II

Classification, structure and function of carbohydrates, lipids and biomembranes, amino acids, proteins, and nucleic acids.

UNIT III

Structure and biological functions of vitamins, enzymes classification and mechanism of action; regulation, factors affecting enzyme action. Fundamentals of thermodynamic principles applicable to biological processes, Bioenergetics.

UNIT IV

Metabolism of carbohydrates, photosynthesis and respiration, oxidative phosphorylation, lipids, proteins and nucleic acids. DNA replication, transcription and translation; recombinant DNA technology, Nutritional aspects of carbohydrates, lipids, proteins and minerals.

Practical

i. Preparation of standard and buffer solutions.
ii. Extraction and estimation of sugars and amino acids.
iii. Estimation of proteins by Lowry's method.
iv. Estimation of DNA and RNA by Diphenyamine and orcinol methods.
v. Estimation of ascorbic acid.
vi. Separation of biomolecules by TLC and paper chromatography

Suggested Readings

Conn EE & Stumpf PK. 1987. *Outlines of Biochemistry*. John Wiley.

Metzler DE. ***Biochemistry.*** Vols. I, II. Wiley International.

Nelson DL & Cox MM. 2004. *Lehninger's Principles of Biochemistry*. MacMillan.

Voet D & Voet JG. *Biochemistry*. 3rd Ed. Wiley International.

MBB 553 BIOSTATISTICS AND COMPUTERS 2+1

Objective

This is the special course for M.Sc. students of Biotechnology. They are exposed to various statistical methods to analyze their experimental data.

Theory

UNIT I

Aims, scope and idea of elementary statistics; Measures of central tendency and dispersion, skewness and kurtosis.

UNIT II

Concept of probability and probability laws, mathematical expectation, moments, moments generating function; Standard probability distributions- Binomial, Poisson and Normal distributions.

UNIT III

Tests of significance based on Z, χ^2, t and F statistics; Correlation and regression, curve fitting by least squares methods.

UNIT IV

Basic principles, organization and operational aspects of computers, operating systems. Introduction to MS-Office, MS-Word, MS-Excel. Statistical Data analysis based on above topics through MS-Excel.

Practical

i. Data analysis using probability, test of significance
ii. Correlation and regression analysis
iii. Usage of MS-Windows
iv. Exercises on test processing, spreadsheet and DBMS
v. SPSS

Suggested Readings

Agarwal BL. 2003. *Basic Statistics*. New Age.
Gupta SP. 2004. *Statistical Methods*. S. Chand & Sons.
Dutta NK. 2002. *Fundamentals of Bio-Statistics*. Kanishka Publ.

MBB 554 PRINCIPLES OF MICROBIOLOGY 2+1

Objective

To acquaint the students with history, classification and role of microbiology in agriculture, food and environment.

Theory

UNIT I

Development of Microbiology in the 18^{th} and 19^{th} century. Morphology, structure and function of prokaryotic and eukaryotic cell. Archea. Classification of prokaryotes – Basic principles and techniques used in bacterial classification.

UNIT II

Evolutionary relationship among prokaryotes. Phylogenetic and numerical taxonomy. Use of DNA and r-RNA sequencing in classifications.

UNIT III

Study of major groups of bacteria belonging to Gracilicutes, Firmicutes, Tanericutes and Mendosicutes.

UNIT IV

Viruses – morphology, classification and replication of plant, animal and bacterial viruses. Cultivation methods of viruses. Immune response – specific and non-specific resistance. Normal microflora of human body; some common bacterial and viral diseases of humans and animals.

Practical

i. Methods of isolation, purification and maintenance of microorganisms from different environments (air, water, soil, milk and food).
ii. Enrichment culture technique – isolation of asymbiotic, symbiotic nitrogen fixing bacteria. Isolation of photosynthetic bacteria.
iii. Use of selective media, antibiotic resistance and isolation of antibiotic producing microorganisms.
iv. Morphological, physiological and biochemical characterization of bacteria.

Suggested Readings

Brock TD. 1961. *Milestones in Microbiology*. Infinity Books.
Pelczar ML Jr. 1997. *Microbiology*. Tata McGraw Hill.

Stainier RY, Ingraham JL, Wheelis ML & Painter PR. 2003. *General Microbiology*. MacMillan.

Tauro P, Kapoor KK & Yadav KS. 1996. *Introduction to Microbiology*. Wiley Eastern.

MBB 555 INTRODUCTION TO BIOINFORMATICS 2+1

Objective

To impart an introductory knowledge about the subject of bioinformatics to the students studying any discipline of science.

Theory

UNIT I

Introduction, biological databases – primary, secondary and structural, Protein and Gene Information Resources – PIR, SWISSPROT, PDB, genebank, DDBJ. Specialized genomic resources.

UNIT II

DNA sequence analysis, cDNA libraries and EST, EST analysis, pairwise alignment techniques, database searching, multiple sequence alignment.

UNIT III

Secondary database searching, building search protocol, computer aided drug design – basic principles, docking, QSAR.

UNIT IV

Analysis packages – commercial databases and packages, GPL software for Bioinformatics, web-based analysis tools.

Practical

i. Usage of NCBI resources
ii. Retrival of sequence/structure from databases
iii. Visualization of structures
iv. Docking of ligand receptors
v. BLAST exercises.

Suggested Readings

Attwood TK & Parry-Smith DJ. 2003. *Introduction to Bioinformatics*. Pearson Education.

Rastogi SC, Mendiratta N & Rastogi P. 2004. *Bioinformatics: Concepts, Skills and Applications*. CBS.

BMB 556 ENVIRONMENTAL BIOTECHNOLOGY 3+0

Objective

To apprise the students about the role of biotechnology in environment management for sustainable eco-system and human welfare.

Theory

UNIT I

Basic concepts and environmental issues; types of environmental pollution; problems arising from high-input agriculture; methodology of environmental management; air and water pollution and its control; waste water treatment - physical, chemical and biological processes; need for water and natural resource management.

UNIT II

Microbiology and use of micro-organisms in waste treatment; biodegradation; degradation of Xenobiotic, surfactants; bioremediation of soil & water contaminated with oils, pesticides & toxic chemicals,

detergents etc; aerobic processes (activated sludge, oxidation ditches, trickling filter, rotating drums, etc); anaerobic processes: digestion, filteration, etc.

UNIT III

Renewable and non-Renewable resources of energy; energy from solid waste; conventional fuels and their environmental impact; biogas; microbial hydrogen production; conversion of sugar to alcohol; gasohol; biodegradation of lignin and cellulose; biopesticides; biofertilizers; composting; vermiculture, etc.

UNIT IV

Treatment schemes of domestic waste and industrial effluents; food, feed and energy from solid waste; bioleaching; enrichment of ores by microorganisms; global environmental problems: ozone depletion, UV-B, greenhouse effects, and acid rain; biodiversity and its conservation; biotechnological approaches for the management environmental problems.

Suggested Readings

Evans GM & Furlong JC. 2002. *Environmental Biotechnology: Theory and Application*. Wiley International.

Jordening H-J & Winter J. 2006. *Environmental Biotechnology: Concepts and Applications*. Wiley-VCH Verlag.

MBB 601 ADVANCES IN PLANT MOLECULAR BIOLOGY 3+0

Objective

To discuss the specialized topics and recent advances in the field of plant molecular biology.

Theory

UNIT I

Arabidopsis in molecular biology, Forward and Reverse Genetic Approaches, Transcriptional and post-transcriptional regulation of gene expression, isolation of promoters and other regulatory elements.

UNIT II

RNA interference, Transcriptional gene silencing, Transcript and protein analysis, use of transcript profiling to study biological systems.

UNIT III

Hormone regulatory pathways: Ethylene, Cytokinin, Auxin and ABA, SA and JA; ABC Model of Floral Development, Molecular basis of self incompatibility, Regulation of flowering: photoperiod, vernalization, circadian rhythms.

UNIT IV

Molecular biology of abiotic stress responses: Cold, high temperature, sub-mergence, salinity and drought; Molecular Biology of plant-pathogen interactions, molecular biology of *Agrobacterium* Infection, Molecular biology of *Rhizobium* infection (molecular mechanisms in symbiosis), Programmed cell death in development and defense.

Suggested Readings

Buchanan B, Gruissen W & Jones R. 2000. *Biochemistry and Molecular Biology of Plants*. American Society of Plant Physiologists, USA.

Lewin B. 2008. *Gene IX*. Peterson Publications/ Panima.

Malacinski GM & Freifelder D. 1998. *Essentials of Molecular Biology*. 3rd Ed. Jones & Bartlett Publ.

Nelson DL & Cox MM. 2007. *Lehninger's Principles of Biochemistry*. WH Freeman & Co.
Watson JD, Bakee TA, Bell SP, Gann A, Levine M & Losick R. 2008. *Molecular Biology of the Gene.* 6th Ed. Pearson Education.

MBB 602 ADVANCES IN GENETIC ENGINEERING 3+0

Objective

To discuss the specialized topics and advances in field of genetic engineering and their application in plant improvement.

Theory

UNIT I

General overview of transgenic plants; Case studies: Genetic engineering of herbicide resistance, Transgenic plants resistant to insects/pests, Genetic engineering of abiotic stress tolerance, Engineering food crops for quality, Genetically engineered pollination control, Induction of male sterility in plants.

UNIT II

Molecular farming of plants for applications in veterinary and human medicine systems: Boosting heterologous protein production in transgenics, Rapid production of specific vaccines, High-yield production of therapeutic proteins in chloroplasts.

UNIT III

Recent developments in plant transformation strategies; Role of antisense and RNAi-based gene silencing in crop improvement; Regulated and tissue-specific expression of transgenes for crop improvement; Gene stacking; Pathway engineering; Marker-free transgenic development strategies; High throughput phenotyping of transgenic plants.

UNIT IV

Field studies with transgenic crops; Environmental issues associated with transgenic crops; Food and feed safety issues associated with transgenic crops; Risk assessment of transgenic food crops.

Suggested Readings

Christou P & Klee H. 2004. *Handbook of Plant Biotechnology*. John Wiley & Sons.
Specific journals mentioned later.

MBB 603 ADVANCES IN MICROBIAL BIOTECHNOLOGY 3+0

Objective

To discuss specialized topics about industrially important microorganisms.

Theory

UNIT I

Fermentative metabolism and development of bioprocessing technology, processing and production of recombinant products; isolation, preservation and improvement of industrially important microorganisms.

UNIT II

Immobilization of enzymes and cells; Batch, plug flow and chemostate cultures; Computer simulations; Fed-batch and mixed cultures; Scale-up principles; Down stream processing etc.

UNIT III

Current advances in production of antibiotics, vaccines, and biocides; Steroid transformation; Bioreactors; Bioprocess engineering; Production of non-microbial origin products by genetically engineered microorganisms.

UNIT IV

Concept of probiotics and applications of new tools of biotechnology for quality feed/food production; Microorganisms and proteins used in probiotics; Lactic acid bacteria as live vaccines; Factors affecting delignification; Bioconversion of substrates, anti-nutritional factors present in feeds; Microbial detoxification of aflatoxins; Single cell protein, Bioinsecticides; Biofertilizers; Recent advances in microbial biotechnology.

Suggested Readings

Specific journals and published references.

MBB 604 ADVANCES IN CROP BIOTECHNOLOGY 3+0

Objective

To discuss specialized topics on the application of molecular tools in breeding of specific crops.

Theory

UNIT I

Conventional versus non-conventional methods for crop improvement; Present status and recent developments on available molecular marker, transformation and genomic tools for crop improvement.

UNIT II

Genetic engineering for resistance against abiotic (drought, salinity, flooding, temperature, etc) and biotic (insect pests, fungal, viral and bacterial diseases, weeds, etc) stresses; Genetic Engineering for increasing crop productivity by manipulation of photosynthesis, nitrogen fixation and nutrient uptake efficiency; Genetic engineering for quality improvement (protein, essential amino acids, vitamins, mineral nutrients, etc); edible vaccines, etc.

UNIT III

Molecular breeding: constructing molecular maps; integrating genetic, physical and molecular maps; diversity assessment and phylogenetic analysis; molecular tagging of genes/traits; selected examples on marker-assisted selection of qualitative and quantitative traits.

UNIT IV

Discussion on application of molecular, transformation and genomic tools for the genetic enhancement in some major field crops such as rice, wheat, cotton, maize, soybean, oilseeds, sugarcane etc.

Suggested Readings

Specific journals and published references.

MBB 605 ADVANCES IN FUNCTIONAL GENOMICS AND PROTEOMICS 2+0

Objective

To discuss recent advances and applications of functional genomics and proteomics in agriculture, medicine and industry.

Theory

UNIT I

Genome sequencing and functional genomics; Human, animal, plant, bacterial and yeast genome projects; genome annotation; *ab initio* gene discovery; functional annotation and gene family clusters; etc.

UNIT II

Functional analysis of genes; RNA-mediated interference; gene knockoffs; Gene traps/ T-DNA insertion lines; homologous recombination; microarray profiling; SAGE; SNPs/variation; yeast-two hybrid screening; gene expression and transcript profiling; EST contigs; EcoTILLING; allele/gene mining; synteny and comparative genomics; Genome evolution, speciation and domestication etc.

UNIT II

Proteomics: protein annotation; protein separation and 2D PAGE; mass spectroscopy; protein microarrays; protein interactive maps; structural proteomics: protein structure determination, prediction and threading, software and data analysis/ management, etc.

UNIT IV

Discussion on selected papers on functional genomics, proteomics, integrative genomics etc.

Suggested Readings

Specific journals and published references.

MBB 606 COMMERCIAL PLANT TISSUE CULTURE 2+0

Objective

To discuss the commercial applications of plant tissue culture in agriculture, medicine and industry.

Theory

UNIT I

Micropropagation of commercially important plant species; plant multiplication, hardening, and transplantation; genetic fidelity; scaling up and cost reduction; bioreactors; synthetic seeds; management and marketing.

UNIT II

Production of useful compounds via biotransformation and secondary metabolite production: suspension cultures, immobilization, examples of chemicals being produced for use in pharmacy, medicine and industry.

UNIT III

Value-addition by transformation; development, production and release of transgenic plants; patent, bio-safety, regulatory, environmental and ethic issues; management and commercialization.

UNIT IV

Some case studies on success stories on commercial applications of plant tissue culture. Visits to some tissue culture based commercial units/industries.

Suggested Readings

Specific journals and published references.

MBB 607 ADVANCES IN ANIMAL BIOTECHNOLOGY 2+0

Objective

Intended to provide cutting edge knowledge on advances in different areas of animal biotechnology.

Theory

UNIT I

Advances in animal cell culture technology, suspension culture technology, advances in commercial scale productions of mammalian cells.

UNIT II

Advances in cell cloning and cell hybridization, advances in monoclonal antibody production technology, Advances in diagnostic technology, Computational vaccinology, reverse genetics based vaccines.

UNIT III

Advances in embryo manipulation, knock out and knock in technology, advances in animal cloning technology, stem cell technology, Advances in development of animal models for human diseases using transgenic animal technology.

UNIT IV

Advances in genetic basis for animal disease resistance, Molecular methods for animal forensics, Advances in animal genomics, proteomics,

Suggested Readings

Selected articles from journals.

PLANT MOLECULAR BIOLOGY & BIOTECHNOLOGY

List of Journals

- Advances in Botanical Research
- Advances in Enzyme Regulation
- Advances in Enzymology
- Advances in Genetics
- Agricultural and Biological Research
- Analytical Biochemistry
- Annals of Botany
- Archives of Biochemistry and Biophysics
- Archives of Microbiology
- Biochemical and Biophysical Research Communication
- Biochemical Genetics
- Biochemistry
- Biotechnology and Bioengineering
- Critical Reviews in Plant Sciences
- Crop Science
- EMBO Journal
- Euphytica
- Genetic and Plant Breeding
- Genome
- Indian Journal of Genetics and Plant Breeding
- Journal of Biotechnology
- Journal of Experimental Botany
- Journal of General Microbiology
- Journal of Heredity
- Journal of Plant Biochemistry and Biotechnology
- Journal of Plant Biology
- Molecular and Cellular Biochemistry
- Molecular Breeding
- Molecular Genetics and Genomics
- Nature
- Nature Biotechnology
- Plant Cell
- Plant Molecular Biology
- Plant Physiology
- Plant Physiology and Biochemistry
- Proceedings of The National Academy of Sciences (USA)
- Science
- Trends in Biochemical Sciences
- Trends in Biotechnology
- Trends in Cell Biology
- Trends in Food Science and Technology
- Trends in Genetics
- Trends in Microbiology
- Trends in Plant Sciences

e-Resources

- National Center for Biotechnology Information
  http://www.ncbi.nlm.nih.gov/
- The World Wide Web Virtual Library: Biotechnology.

http://www.cato.com/biotech/

- The Transgenic/Targeted Mutation Database (TBASE)
  http://www.bis.med.jhmi.edu/Dan/tbase/tbase.html
- Primer on Molecular Genetics
  http://www.bis.med.jhmi.edu/Dan/DOE/intro.html.
- Bioportal
  http://bioportal.gc.ca/english/BioPortalHome.asp
- Access Excellence
  http://www.gene.com/ae
- BioTech Biosources Database: Indiana University
  http://biotech.chem.indiana.edu/
- Information Systems for Biotechnology
  http://gophisb.biochem.vt.edu/
- All About The Human Genome Project (HGP)
  http://www.genome.gov/
- *Human Genome Project at the Sanger Institute*
  http://www.sanger.ac.uk/HGP/
- UCSC Genome Browser
  http://genome.ucsc.edu/
- Gramene
  www.gramene.org/
- The Institute for Genomic Research
  www.tigr.org

Suggested Broad Topics for Master's and Doctoral Research

- Micropropagation of important crop plants, cash crops, ornamentals, forest and horticultural trees, medicinal and aromatic plants.
- Development of transgenics in field crops for resistance against biotic and abiotic stresses, and to improve the nutritional quality, etc.
- DNA fingerprinting of important plant species and germplasm.
- Development of molecular markers (SNP, SSR, transposable elements, etc) and their utilization for genetic diversity and phylogenetic analysis.
- Molecular mapping and marker-assisted selection for major-gene traits in crop species.
- Value-addition including biopesticides, biofertilizers, biofuels, biodegradable plastics, secondary metabolites, etc.
- Genome sequencing and functional analysis of genes of important organisms.
- Allele mining, proteomics, genomics and metabolic engineering for crop improvement.
- Immobilization of enzymes/microorganisms.
- Protein engineering.
- To develop crops with improved mineral (Fe, Zn, Vitamin A, etc) bioavailbility.
- Biodiversity and conservation of endangered plant species.
- Bioprocess engineering and down stream processing.

ANIMAL BIOTECHNOLOGY
Course Structure – at a Glance

CODE	COURSE TITLE	CREDITS
ABT 601*	BASIC & APPLIED BIOTECHNOLOGY	3+0
ABT 602**	FUNDAMENTALS OF CELL & MOLECULAR BIOLOGY	3+0
ABT 603*	APPLIED MOLECULAR BIOLOGY	2+1
ABT 604**	ANIMAL CELL CULTURE: PRINCIPLES & APPLICATIONS	1+2
ABT 605**	MOLECULAR DIAGNOSTICS	1+2
ABT 606	VACCINE BIOTECHNOLOGY	2+0
ABT 607	IMMUNOLOGY APPLIED TO BIOTECHNOLOGY	1+1
ABT 608	INTRODUCTION TO BIOINFORMATICS	1+1
ABT 609**	ANIMAL GENOMICS	2+1
ABT 610**	REPRODUCTIVE BIOTECHNOLOGY	2+1
ABT 611**	TECHNIQUES IN MOLECULAR BIOLOGY & GENETIC ENGINEERING	0+3
ABT 612	BIODIVERSITY, BIOSAFETY & BIOETHICS	2+0
ABT 613	MOLECULAR FORENSICS	2+1
ABT 614	INDUSTRIAL BIOTECHNOLOGY	2+1
ABT 615*	PROBIOTICS & FEED BIOTECHNOLOGY	3+0
ABT 616	ANIMAL BIOTECHNOLOGY	3+0
ABT 691	MASTER'S SEMINAR	1+0
ABT 699	MASTER'S RESEARCH	20
ABT 701	GENE CLONING AND EXPRESSION	1+1
ABT 702*	FUNCTIONAL GENOMICS & PROTEOMICS	2+1
ABT 703	ADVANCES IN REPRODUCTIVE BIOTECHNOLOGY	2+1
ABT 704	TRENDS IN VACCINOLOGY	3+0
ABT 705	ADVANCES IN ANIMAL CELL CULTURE	2+1
ABT 706	TRANSGENIC ANIMAL TECHNOLOGY	2+0
ABT 791	DOCTORAL SEMINAR I	1+0
ABT 792	DOCTORAL SEMINAR II	1+0
ABT 799	DOCTORAL RESEARCH	45

* Courses may also be taken as Minor/Supporting
** Compulsory for Master's Programme

ANIMAL BIOTECHNOLOGY
Course Contents

ABT 601 BASIC AND APPLIED BIOTECHNOLOGY 3+0

Objective

Understanding the fundamental principles of biotechnology and its application in agriculture, veterinary sciences, medical sciences, industry and environment.

Theory

UNIT I

History of biotechnology, scope of biotechnology, introduction of genetic engineering, plant and animal tissue culture.

UNIT II

Fermentation technology, immobilized enzymes, vaccines, antibodies and hybridoma technology, diagnostics, embryo transfer technology, sexing of embryo, transgenics.

UNIT III

Genome, genome mapping, physical maps, genetic maps, different types of DNA markers and their applications.

UNIT IV

Application of biotechnology in agriculture, veterinary sciences, pharmaceutical industry, food industry, chemical industry and environment.

Suggested Readings

Becker JM, Cold Well GA & Zachgo EA. 2007. *Biotechnology a Laboratory Course*. Academic Press.

Brown CM, Campbell I & Priest FG. 2005. *Introduction to Biotechnology*. Panima.

Singh BD. 2006. *Biotechnology Expanding Horio*zon. Kalyani.

ABT 602 FUNDAMENTALS OF CELL & MOLECULAR BIOLOGY 3+0

Objective

Molecular structure and functions of cells and molecules such as DNA, RNA and proteins.

Theory

UNIT I

Evolution of cells, Introduction to molecular interactions, thermodynamics, and equilibrium in molecular recognition and biological functions. Energy production: Structure of mitochondria, and chloroplasts, respiratory chain, ATP synthesis, photosynthesis, genomes of mitochondria and chloroplasts , cellular compartments and intercellular sorting of proteins: endoplasmic reticulum, lysosome, peroxisomes, synthesis and shorting of proteins (lysosomal proteins, membrane proteins, secretary proteins, lipoproteins, glycolipids. Lipid synthesis and transport.

UNIT II

Cytoskeleton: Mechanism of muscle contraction, actin filaments and cell cortex, cilliary movements and cytoplasmic microtubules and intermediate filaments. Cell signaling: Endocrine, exocrine and synaptic signaling molecules, surface and intracellular receptors, G proteins and generation of secondary messengers, mode of action of cAMP and Ca^{++} calmodulin,

target cell adaptation. Cell growth and divisions: Cell cycle, cell division controls and transformation, growth factors, genes for social control of cell division, mechanism of cell division, cell adhesion, cell junctions and the extra cellular matrix, growth, development and differentiation.

UNIT III

History of molecular biology, nucleic acid as hereditary material, structure of DNA, chromatin, rRNA, tRNA and mRNA, proteins. DNA replication, transcription, translation, genetic code, operon, positive and negative control of gene expression, important enzymes such as RNA replicase, reverse transcriptase, ligase, polymerase, ribozyme, etc.

UNIT IV

Molecular mechanism of mutation. Molecular organization of cell, structure of genomes, synthetic chromosomes. RNA processing and alternative splicing, molecular biology of photosynthesis, nitrogen fixation and stress tolerance, development and differentiation and molecular evolution, RNAi and application.

Suggested Readings

Lewin B. 2008. *Gene IX*. Jones & Bartlett.

Primrose SB. 2001. *Molecular Biotechnology*. Panima.

Twyman RM. 2003. *Advanced Molecular Biology*. Bios Scientific.

ABT 603 APPLIED MOLECULAR BIOLOGY 2+1

Objective

Understanding the principle and application of recombinant DNA in biotechnology.

Theory

UNIT I

Enzymes used in molecular biology and recombinant DNA research, cloning and expression vectors, gene identification, construction of gene libraries, gene mapping and DNA structure analysis.

UNIT II

Methods of DNA sequencing, synthesis of double stranded DNA and complementary DNA, cDNA library identification and enrichment of recombinant clones.

UNIT III

Methods for transfer of cloned DNA, analysis and expression of recombinant DNA, site directed DNA alterations and gene manipulations, cloning in bacteria, yeast, plant and animal cells.

UNIT IV

Genetics of tumourogenic region of agrobacteria and its applications in agriculture, veterinary and medical sciences, biotechnology applications for production of high value and industrial products, safety aspects of genetic manipulations.

Practical

i. Extraction of DNA and RNA.
ii. Polyacrylamide gel electrophoresis (PAGE).
iii. Agarose gel electrophoresis.
iv. Restriction endonuclease analysis of DNA.
v. Isolation and purification of plasmid.
vi. Polymerase chain reaction.

vii. Cloning of gene.
viii. Expression of cloned gene.
ix. Purification of recombinant protein.
x. Blotting
xi. RFLP
xii. RAPD.

Suggested Readings

Kun LY. 2006. *Microbial Biotechnology*. World Scientific.

Sambrook J & Russel DW. 2001. *Molecular Cloning: a Laboratory Manual.* Cold Spring Harbour Lab. Press.

Twyman RM. 2003. *Advanced Molecular Biology*. Bios Scientific.

ABT 604 ANIMAL CELL CULTURE: PRINCIPLES AND APPLICATIONS 1+2

Objective

Understanding the principles of animal cell culture and its application.

Theory

UNIT I

Introduction, importance, history of cell culture development, different tissue culture techniques including primary and secondary culture, continuous cell lines, suspension culture, organ culture etc.

UNIT II

Different type of cell culture media, growth supplements, serum free media, balanced salt solution, other cell culture reagents, culture of different tissues and its application.

UNIT III

Behavior of cells in culture conditions, division, their growth pattern, metabolism of estimation of cell number.

UNIT IV

Development of cell lines, characterization and maintenance of cell lines, stem cells, cryopreservation, common cell culture contaminants.

Practical

i. Packing and sterilization of glass and plastic wares for cell culture.
ii. Preparation of reagents and media for cell culture.
iii. Primer culture technique chicken embryo fibroblast.
iv. Secondary culture of chicken embryo fibroblast.
v. Cultivation of continuous cell lines.
vi. Quantification of cells by trypan blue exclusion dye.
vii. Isolation of lymphocytes and cultivation of lymphocytes
viii. Study of effect of toxic chemicals on cultured mammalian cells
ix. Study of effect of virus on mammalian cells.
x. Suspension culture technique
xi. Cryopreservation of cell primary cultures and cell lines.
xii. Effect of viruses on cultured mammalian cells.

Suggested Readings

Freshney RI. 2005. *Culture of Animal Cells*. Wiley Liss.

Portner R. 2007. *Animal Cell Biotechnology*. Humana Press.

ABT 605 MOLECULAR DIAGNOSTICS 1+2

Objective

Understanding the molecular techniques involved in diagnosis of diseases.

Theory

UNIT I

Introduction, importance and historical perspective of development of molecular diagnostic technology, concept of development of group specific and strain specific nucleic acid based diagnostics, basis for selection of gene/nucleotide sequence of pathogenic organism to target for detection.

UNIT II

Application of restriction endonuclease analysis for identification of pathogens, principle of development of pathogen specific DNA probes, Southern and Northern hybridization.

UNIT III

Theoretical background of development of PCR and Real time PCR and its variations, application of PCR for diagnosis of infectious diseases of animals and poultry, nucleic acid sequence based diagnostics.

UNIT IV

Advancements in diagnostic technology including DNA array technology, biosensors and nanotechnology. OIE guidelines in development of diagnostics.

Practical

i. Preparations of buffers and reagents.
ii. Collection of clinical and environmental samples from animal and poultry farms for molecular detection of pathogens.
iii. Isolation of bacterial pathogens from the samples.
iv. Extraction of nucleic acids from bacteria and clinical specimens.
v. Restriction endonuclease digestion and analysis in agarose electrophoresis.
vi. Development of animal pathogen specific nucleic acid probes.
vii. Southern blotting for detection of pathogens.
viii. Polymerase chain reaction for detection of pathogens in blood and other animal tissues.
ix. RT-PCR for detection of RNA viruses.
x. Real time PCR for detection of pathogens in semen and other animal tissues.
xi. DNA fingerprinting for identification of animal species.
xii. PCR based detection of meat adulteration in processed and unprocessed meats.
xiii. Detection of food borne pathogenic organisms in vegetables and fruits using PCR technology.
xiv. PCR based detection of potential pathogens in milk, eggs and meat.

Suggested Readings

Elles R & Mountford R. 2004. *Molecular Diagnosis of Genetic Disease*. Humana Press.

Rao JR, Fleming CC & Moore JE. 2006. *Molecular Diagnostics*. Horizon Bioscience.

ABT 606 VACCINE BIOTECHNOLOGY 2+1

Objective

Understanding different approaches of vaccine development and production.

Theory

UNIT I

History of vaccinology, conventional approaches to vaccine development, live attenuated and killed vaccines, adjuvants, quality control, preservation and monitoring of microorganisms in seed lot systems.

UNIT II

Instruments related to monitoring of temperature, sterilization, environment, quality assurance and related areas. Production techniques, growing the microorganisms in maximum titre, preservation techniques to maintain good antigen quality, freeze drying.

UNIT III

Introduction to newer vaccine approaches namely sub-unit vaccines, synthetic vaccines, DNA vaccines, virus like particles, recombinant vaccines, edible vaccines, Nano particles in vaccine delivery systems, etc.

UNIT IV

Introduction to pharmacopeal requirement, disease security and biosecurity principles and OIE guidelines such as seed management, method of manufacture, in-Process control, batch control, tests on final product.

Practical

i. Inoculation of embryonated chicken eggs for cultivation of virus.
ii. Harvesting of virus from inoculated embryos.
iii. Inactivation of harvested viruses.
iv. Safety and sterility testing of inactivated vaccine.
v. Inoculation of tissue culture for propagation of virus.
vi. Harvesting and production of inactivated virus vaccine.
vii. Isolation and cloning of genes encoding immunogenic proteins.
viii. Expression of cloned gene.
ix. Purification of recombinant immunogenic protein.
x. Immunogenecity studies of recombinant protein
xi. Immunization of laboratory animals.
xii. Titration of antibodies against the recombinant protein.

Suggested Readings

Barry R Bloom, Paul-Henri Lambert 2002. *The Vaccine Book*. Academic Press.

Levine MM, Kaper JB, Rappuoli R, Liu MA, Good MF. 2004. *New Generation Vaccines*. 3rd Ed. Informa Healthcare.

Lowrie DB & Whalen R. 2000. *DNA Vaccines*. Humana Press.

Robinson A & Cranage MP. 2003. *Vaccine Protocols*. 2nd Ed. Humana Press.

ABT 607 IMMUNOLOGY APPLIED TO BIOTECHNOLOGY 1+1

Objective

Understanding the application of immunological techniques in biotechnology.

Theory

UNIT I

Introduction, principles of immunology, immune system, immune response, major histocompatibility complex, various techniques used in biotechnology.

UNIT II

Application of antibodies in purification, immunoblotting, expression of recombinant proteins and detection in different expression systems, industrial production of cytokines and interferon, expression of immunoglobulin genes in plants and production of antibodies.

UNIT III

Application of antibodies in chemiluminescence and florescence assay used for actions for recombinant genes, antibody based nucleic acid probes and their applications, immunoinformatics.

UNIT IV

Somatic cell hybridization, hybridoma technology, commercial production of antibodies using monoclonal antibodies.

Practical

i. Immunodiffusion.
ii. Immunoelectrophoresis.
iii. Fluorescent antibody test.
iv. Enzyme immunoassays including ELISA.
v. Immunoblotting.
vi. Affinity chromatography,
vii. Bioinformatics tools for immunological research.
viii. Cultivation of normal lymphocytes and myeloma cell line.
ix. Somatic cell hybridization and production of hybridoma.
x. Screening of hybrids for production of monoclonal antibodies.

Suggested Readings

Kindt TJ, Goldsby RA & Osbrne BA. 2007. *Kuby Immunology*. WH Freeman.

Male D, Brostoff J, Roth DB & Roitt I. 2006. *Immunology.* Elsevier.

Spinger TA. 1985. *Hybridoma Technology in Biosciences and Medicine*. Plenum Press.

ABT 608 INTRODUCTION TO BIOINFORMATICS 2+1

Objective

To impart an introductory knowledge about the subject of Bioinformatics to the students studying any discipline of science.

Theory

UNIT I

Introduction, biological databases – primary, secondary and structural, Protein and Gene Information Resources – PIR, SWISSPROT, PDB, genebank, DDBJ. Specialized genomic resources.

UNIT II

DNA sequence analysis, cDNA libraries and EST, EST analysis, pairwise alignment techniques, database searching, multiple sequence alignment.

UNIT III

Secondary database searching, building search protocol, computer aided drug design – basic principles, docking, QSAR.

UNIT IV

Analysis packages – commercial databases and packages, GPL software for Bioinformatics, web-based analysis tools.

Practical

i. Usage of NCBI resources
ii. Retrival of sequence/structure from databases
iii. Visualization of structures
iv. Docking of ligand receptors
v. BLAST exercises.

Suggested Readings

Attwood TK & Parry-Smith DJ. 2003. *Introduction to Bioinformatics*. Pearson Education.

Rastogi SC, Mendiratta N & Rastogi P. 2004. *Bioinformatics: Concepts, Skills and Applications*. CBS.

ABT 609 ANIMAL GENOMICS 2+1

Objective

Understanding structural, functional and comparative genomics of farm animals and its application for livestock improvement.

Theory

UNIT I

Historical perspective, genome organization in eukaryotes, satellite DNA including mini and microsatellites and their various families, long and short interspersed nucleotide elements, DNA markers- RAPD, STR, SSCP, RFLP, DNA fingerprinting, SNP, EST etc.

UNIT II

Importance of gene mapping in livestock, methods and techniques used for gene mapping, physical mapping, linkage analysis, cytogenetic techniques, FISH technique in gene mapping, somatic cell hybridization, radiation hybrid maps, *in-situ* hybridization, comparative gene mapping.

UNIT III

Genetic distance analysis, breed characterization on the basis of DNA markers, genetic markers for quantitative traits loci, marker assisted selection for incorporation of desirable traits DNA markers with economic traits, restriction fragment length polymorphism (RFLP) of different structural genes.

UNIT IV

Current status of gene maps of livestock, MHC and its relevance to disease resistance and immune response, genes influencing production traits, mitochondrial DNA of farm animals, evolutionary significance, applications of genome analysis of animals in breeding.

Practical

i. Chromosome preparation (normal karyotyping, different types of banding) in farm animals.
ii. Isolation and purification of animal genomic DNA from blood lymphocytes.
iii. Analysis of DNA by agarose or polyacrylamide gel electrophoresis.

iv. Checking the quality and quantity of genomic DNA.
v. Restriction digestion and analysis.
vi. Southern hybridization
vii. DNA fingerprinting.
viii. Techniques for revealing polymorphism-DNA fingerprinting, RFLP, SSCP, AFLP, STRP etc.
ix. Genomic DNA cloning or cDNA cloning.
x. Differentiation of tissues of different species by mitochondrial genome analysis.

Suggested Readings

Gibson G & Muse SV. 2004. *A Primer of Genome Science*. Sinauer Associates.

Primrose SB & Twyman RM. 2007. *Principles of Genome Analysis and Genomics*. Blackwell.

Sensen CW. 2005. *Handbook of Genome Research*. Vols. I, II. Wiley-CVH.

ABT 610 REPRODUCTIVE BIOTECHNOLOGY 2+1

Objective

Understanding *in-vitro* reproductive techniques for ovum and embryo manipulation.

Theory

UNIT I

History, importance of assisted reproductive biotechnology in man and animal, introduction to embryo biotechnology, endocrine therapeutics.

UNIT II

Biotechnological approaches to reproduction, methodology of super ovulation, *in vitro* fertilization, embryo culture and micromanipulation, preparation of sperm for IVF.

UNIT III

Different method of gene transfer and their limitations, embryo splitting, embryo sexing by different methods, production of transgenic livestock by nuclear transfer and its application, regulatory issues.

UNIT III

Cloning of domestic animals. Conservation of endangered species. Characterization of embryonic stem cells. Different applications of embryonic stem cells.

Practical

i. Synchronization and superovulation protocols.
ii. Collection of embryos using non-surgical procedures.
iii. Transferring embryos using non- surgical procedures.
iv. Embryo freezing protocols.
v. Oocyte collection and evaluation from slaughterhouse ovaries.
vi. In vitro fertilization protocols.
vii. Micromanipulation of early embryos.

Suggested Readings

Ball PJH & Peter AR. 2004. *Reproduction in Cattle*. Blackwell.

Gordon I. 2003. *Laboratory Production of Cattle Embryos*. CABI.

Gordon I. 2005. *Reproductive Techniques in Farm Animals*. CABI.

ABT 611 TECHNIQUES IN MOLECULAR BIOLOGY AND GENETIC ENGINEERING 0+3

Objective

To provide comprehensive hands-on training on techniques of molecular biology and genetic engineering.

Practical

UNIT I

Isolation of bacterial plasmids and chromosomal DNA. Isolation of DNA from mammalian cells. Isolation of mRNA/RNA. Quantitation of nucleic acids.

UNIT II

Plasmid minprep; Restriction endonuclease digestion of plasmid and chromosomal DNA. Agarose gel electrophoresis of RE digested DNA; Isolation of DNA; cDNA synthesis

UNIT III

Polymerase Chain Reaction using random primers as well as specific primers. Diiferent types of PCR, Real time polymerase chain reaction

UNIT IV

Cloning of bacterial and viral genes in to plasmid vectors. DNA ligation and transformation; Confirmation of insert by RE digestion and touch PCR; Transformation of yeast; Synthesis of nucleic acid probes; Nucleic acid hybridization

Suggested Readings

Kun LY. 2006. *Microbial Biotechnology*. World Scientific.

Sambrook J & Russel DW. 2001. *Molecular Cloning: a Laboratory Manual*. Cold Spring Harbour Lab. Press.

Twyman RM. 2003. *Advanced Molecular Biology*. Bios Scientific.

ABT 612 BIODIVERSITY, BIOSAFETY AND BIOETHICS 2+0

Objective

Understanding the basis of genetic diversity and its maintenance, biosafety procedures.

Theory

UNIT I

Historical and geographical causes of diversity, genetic diversity, molecular taxonomy, species and population biodiversity. Quantifying biodiversity, maintenance of ecological biodiversity, biodiversity and centres of origin of animals, biodiversity hotspots in India.

UNIT II

Collection and conservation of biodiversity, conservation of animal genetic resources, assessing, analyzing and documenting biodiversity. Morphological and molecular characterization of biodiversity, vulnerable and extinction of biodiversity, introduction to biodiversity database, global biodiversity information system, bioethics, CBD.

UNIT III

Biosafety and Risk assessment issues; Health aspects; toxicology, allergenicity; Ecological aspects; Regulations; National biosafety policy and law. The Cartagena Protocol on biosafety. The WTO and other international agreements; Cross border movement of germplasm; Risk management issues; Monitoring strategies and methods for detecting

transgenics; Risks, benefits and impacts of transgenics to human health, society and the environment.

UNIT IV

Bio-safety and bio-hazards; general principles for the laboratory and environmental bio-safety; Environment Impact Assessment; Gene flow in natural and artificial ecologies; Sources of gene escape; Ecological risks of genetically modified plants. Implications of intellectual property rights rights on the commercialization of biotechnology products.

Suggested Readings

Arya R. 2005. *Biodiversity*. Deep & Deep.

Gaston KJ. 2004. *Biodiversity: an Introduction*. Blackwell.

Kannaiyan S & Gopalam A. 2007. *Biodiversity in India: Issues and Concerns*. APC.

ABT 613 MOLECULAR FORENSICS 2+1

Objective

Understanding the application of DNA based techniques in animal forensics.

Theory

UNIT I

General history of forensic science, introduction to DNA forensics, scope and application of DNA forensics in animal and human criminal investigations in variety of situations.

UNIT II

Isolation methods and techniques such as DNA finger-printings, PCR, nucleic acid hybridization, restriction endo-nuclease analysis and sequencing, Individual Animal Identification using DNA fingerprinting

UNIT III

Animal species identification in religious disputes, adulteration of meat, theft of farm animals and pets etc., advantages, disadvantages and limitations of DNA forensics.

UNIT III

Mass spectroscopy, protein detections methods, immunological techniques including ELISA, immunoelectrophoresis and immunofluorence.

Practical

i. Collection of material for forensic analysis.
ii. Dispatch of material for forensic investigations.
iii. Storage and processing of forensics material.
iv. Preparation of different bio-reagents.
v. Isolation and extraction of nucleic acid from samples.
vi. Isolation and extraction of nucleic acid from wild animal scat.
vii. Isolation of nucleic acid from blood, skin, meat, milk, hair and cooked and putrefied meat.
viii. Designing of primers.
ix. Polymerase chain reaction (PCR).
x. Randomly amplified polymorphic DNA (RAPD)
xi. Restriction fragment length polymorphism (RFLP).
xii. Multiplex PCR for species identification.
xiii. Detection of adulteration in meat by PCR & nucleic acid hybridization assay.

Suggested Readings

Lincoln PJ & Thomson J. 1998. *Forensic DNA Profiling Protocols*. Humana Press.

Rudin N & Inman K. 2002. *An Introduction to Forensic DNA Analysis*. 2nd Ed. CRC Press.

ABT 614 INDUSTRIAL BIOTECHNOLOGY 2+1

Objective

Understanding the concept of bioprocessing of products and their production at commercial scale.

Theory

UNIT I

Introduction, scope and historical development; isolation, screening and genetic improvement of industrially important microorganisms, fermentation: introduction, historical perspective of development of bioprocessing technology.

UNIT II

Emerging new technologies for processing and production of recombinant products, isolation, preservation. Media designs, sterilization, down stream processing, important fermentation process.

UNIT III

Immobilization of enzymes and cells, and their application, growth rate analysis, estimation of biomass, batch and plug flow cultures, chemostate cultures. Production of vaccines and diagnostics.

UNIT IV

Fermented beverages, production of single cell protein, steroid transformation, silage production, waste water treatment. Industrial application of Nanobiotechnology. Computer simulations, energy requirement and product formation in microbial culture, fed-batch and mixed cultures, scale-up principles.

Practical

i. Isolation of industrially important microorganisms.
ii. Maintenance and improvement.
iii. Production of industrial compounds such as alcohol, beer, citric acid, lactic acid.
iv. Recovery of alcohol, beer, citric acid, lactic acid.
v. Study of bio-reactors and their operations.
vi. Production of biofertilizers.
vii. Experiments on microbial fermentation process.
viii. Harvesting purification and recovery of end products.
ix. Immobilization of cells and enzymes.
x. Studies on enzyme kinetic behavior, growth analysis, biomass estimation, determination of mass transfer co-efficients.

Suggested Readings

Alberghina L. 2000. *Protein Engineering for Industrial Biotechnology*. Routledge.

Kun LY. 2006. *Microbial Biotechnology*. World Scientific.

Singh, R & Ghosh SK. 2004. *Industrial Biotechnology*. Global Vision Publ. House.

Thomson J. 2006. *Your Guide to Industrial Biotechnology*. Abhishek Publ.

ABT 615 PROBIOTICS AND FEED BIOTECHNOLOGY 3+0

Objective

Understanding the concept of probiotics and applications of new tools of biotechnology for quality feed/food production.

Theory

UNIT I

Introduction, history of probiotics, normal microflora of GI tract, methods for analysis of intestinal microflora, microorganisms and proteins used in probiotics, genetic modification of intestinal lactobacilli and bifidobacteria, recombinant probiotics. Mechanism of action of probiotics, immune response to probiotics, anti-mutagenic and anti-tumor activities of lactic acid bacteria, probiotics and immune system, lactic acid bacteria as live vaccines.

UNIT II

Application of probiotics for humans, farm animals and poultry, probiotics and intestinal infections, lactose mal-digestion, probiotics regulatory issues. Symbiotics, traditional probiotic products, probiotics industrial perspectives, contradictions, precautions and adverse reactions.

UNIT III

Introduction, feed processing and preservation, microbial bioconversion of lignin and cellulose rich feeds, factors affecting delignification. Diversity of organisms involved, fermentation techniques, large scale bioconversion of substrates, pre-treatment of feeds, chemical vs. microbial treatment of feeds, anti-nutritional factors present in feeds, microbial detoxification of aflatoxins, mimosine and other anti-metabolites present.

UNIT IV

Genetic manipulation of organisms to enhance bioconversion ability, manipulation of rumen fermentation by selective removal of protozoa and fungi, effect of feed additives like antibiotics, methane inhibitors, genetic manipulation of rumen microflora to improve feed utilization, single cell protein as animal feed.

Suggested Readings

Fuller R. 1997. *Probiotics 2: Applications and Practical Aspects*. Springer.

Huffnagle GB & Wernick S. 2007. *The Probiotics Revolution: The Definitive Guide to Safe, Natural Health*. Bantam Books.

Kalidas S, Paliyath G, Pometto A & Levin RE. 2004. *Functional Foods and Biotechnology*. CRC Press.

Perdigón G & Fuller R. 2000. *Probiotics 3: Immunomodulation by the Gut Microflora and Probiotics.* Springer.

Roger A. 1989. *Food Biotechnology.* Cambridge Univ. Press.

Sambrook J & Russel DW. 2001. *Molecular Cloning: a Laboratory Manual*. Cold Spring Harbour Lab. Press.

Trenev N. 1998. *Probiotics: Nature's Internal Healers*. Avery.

ABT 616 ANIMAL BIOTECHNOLOGY 3+0

Objective

Intended to provide an overview and current developments in different areas of animal biotechnology.

Theory

UNIT I

Structure of animal cell, history of animal cell culture, cell culture media and reagents, culture of mammalian cells, tissues and organs, primary culture, secondary culture, continuous cell lines, suspension cultures, somatic cell cloning and hybridization, transfection and transformation of cells, commercial scale production of animal cells, application of animal cell culture for *in vitro* testing of drugs, testing of toxicity of environmental pollutants in cell culture, application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins.

UNIT II

Introduction to immune system, cellular and humoral immune response, history of development of vaccines, introduction to the concept of vaccines, conventional methods of animal vaccine production, recombinant approaches to vaccine production, hybridoma technology, phage display technology for production of antibodies, antigen-antibody based diagnostic assays including radioimmunoassays and enzyme immunoassays, immunoblotting, nucleic acid based diagnostic methods, commercial scale production of diagnostic antigens and antisera, animal disease diagnostic kits, probiotics.

UNIT III

Structure of sperms and ovum, cryopreservation of sperms and ova of livestock, artificial insemination, super ovulation, *in vitro* fertilization, culture of embryos, cryopreservation of embryos, embryo transfer, embryo-spliting, embryo sexing, transgenic manipulation of animal embryos, different applications of transgenic animal technology, animal viral vectors, animal cloning basic concept, cloning from- embryonic cells and adult cells, cloning of different animals, cloning for conservation for conservation endangered species, ethical, social and moral issues related to cloning, *in situ* and *ex situ* preservation of germplasm, *in utero* testing of foetus for genetic defects, pregnancy diagnostic kits, anti-fertility animal vaccines, gene knock out technology and animal models for human genetic disorders.

UNIT IV

Introduction to different breeds of cattle, buffalo, sheep, goats, pigs, camels, horses, canines and poultry, genetic characterization of livestock breeds, marker assisted breeding of livestock, introduction to animal genomics, different methods for characterization of animal genomes, SNP, STR, QTL, RFLP, RAPD, genetic basis for disease resistance, Transgenic animal production and application in expression of therapeutic proteins. Immunological and nucleic acid based methods for identification of animal species, detection of meat adulteration using DNA based methods, detection food/feed adulteration with animal protein, identification of wild animal species using DNA based methods using different parts including bones, hair, blood, skin and other parts confiscated by anti-poaching agencies.

Suggested Readings

Gordon I. 2005. *Reproductive Techniques in Farm Animals*. CABI.

Kindt TJ, Goldsby RA & Osbrne BA. 2007. *Kuby Immunology*. WH Freeman.
Kun LY. 2006. *Microbial Biotechnology*. World Scientific.
Levine MM, Kaper JB, Rappuoli R, Liu MA, Good MF. 2004. *New Generation Vaccines*. 3rd Ed. Informa Healthcare.
Lincoln PJ & Thomson J. 1998. *Forensic DNA Profiling Protocols*. Humana Press.
Portner R. 2007. *Animal Cell Biotechnology*. Humana Press.
Spinger TA. 1985. *Hybridoma Technology in Biosciences and Medicine*. Plenum Press.
Twyman RM. 2003. *Advanced Molecular Biology*. Bios Scientific.

ABT 701 GENE CLONING AND EXPRESSION 1+1

Objective

Understanding the concept of gene cloning and expression.

Theory

UNIT I

Cloning vectors- plasmids, phages, cosmids, BAC, YAC, expression vectors- viral, baculo and yeast vectors, shuttle vectors

UNIT II

Restriction, ligation, transformation and recombinant selection methods, construction of genomic and cDNA library, construction of full length cDNA.

UNIT III

Linkers, adapters and cassettes, screening the library.

UNIT IV

Expression of genes, prokaryotic and eukaryotic expression, identity of protein, purification of expressed protein.

Practical

i. Preparation of vector.
ii. Restriction enzyme digestion of vector.
iii. Purification of DNA.
iv. DNA ligation.
v. Transformation.
vi. Calculation of transformation efficiency.
vii. Preparation of electro competent cells.
viii. Screening by PCR.
ix. Cloning of PCR products in vectors.
x. Induction of expressed protein
xi. PAGE and western bloting.

Suggested Readings

Ausubel FM, Brent R, Kingston RE, Moore DD, Seidman JG, Smith JA & Struhl K. 2002. *Short Protocols in Molecular Biology*. Wiley.

ABT 702 FUNCTIONAL GENOMICS AND PROTEOMICS 2+1

Objective

Understanding gene expression at different conditions/organs.

Theory

UNIT I

Transcriptome and different methods to study gene expression, single gene analysis, northern blots, quantitative PCR, SAGE, MPSS and Microarray.

UNIT II

Introduction to basic micrroarray technology, Design of experiments, Types of microarray, nanoarray, Customised microarray design, Image processing and quantification, Normalization and filtering, Exploratory statistical analysis, gene expression databases.

UNIT III

SAGE and Microbeads, massive parallel signature sequencing, Microbial transcriptome. Role of functional genomics to study cancer and various clinical applications, Development, physiology, and behavior, evolutionary and ecology.

UNIT IV

Proteomics technology, identification and analysis of proteins by 2D analysis, mass spectrophotometery, NMR and X-ray crystallography, MALDI-TOF, Differential display proteomics, Protein -protein interaction, yeast two hybrid system and phage display.

Practical

i. Northern blotting
ii. Quantitative PCR.
iii. Design of microarray experiments.
iv. Microarray image processing.
v. Basic statistical methods.
vi. Clustering methods to study gene expression.
vii. Analytical software related to genomics and proteomics

Suggested Readings

Gibson G & Muse SV. 2004. *A Primer of Genome Science*. Sinauer Associates.

Primrose SB & Twyman RM. 2007. *Principles of Genome Analysis and Genomics.* Blackwell.

Sensen CW. 2005. *Handbook of Genome Research*. Vols. I, II Wiley-CVH.

ABT 703 ADVANCES IN REPRODUCTIVE BIOTECHNOLOGY 2+1

Objective

Understanding the new developments in reproductive technology.

Theory

UNIT I

Reproductive cloning, somatic cell nuclear transfer and transgenic animal production, cryopreservation of gametes.

UNIT II

Preimplantation genetic diagnosis (PGD), genomic imprinting and assisted reproduction, receptors of different hormones and their estimation.

UNIT III

Introduction to stem cells, types, identification, characterization and development of stem cells, transfection of gene in embryonic blastomeres.

UNIT IV

Stem cell therapeutics, social, ethical religious and regulatory issues.

Practical

i. Embryo micromanipulation.
ii. Microinjection.
iii. Intra-cytoplasmic sperm injection.
iv. ICSI Embryo biopsy for PGD and sexing.
v. Culture of embryonic stem cell.
vi. Characterization of embryonic stem cells.

Suggested Readings

Selected articles from journals.

ABT 704 TRENDS IN VACCINOLOGY 3+0

Objective

Understanding the latest developments in vaccine production technologies.

Theory

UNIT I

Molecular approaches to development of vaccines including: recombinant peptide vaccines, vectored vaccines, DNA vaccines, genetically manipulated live vaccines.

UNIT II

Plant expression system based vaccines, idiotype and synthetic peptide based vaccines, reverse genetic approach and computational vaccinology.

UNIT III

Immunomodulators including cytokines and new adjuvants, Immunomodulation, innovative methods of delivery of immunogens through liposomes, microspheres, ISCOMS, etc.

UNIT IV

Large scale production technology and quality control, regulatory issues, environmental concerns with the use of recombinant vaccines.

Practical

i. Preparation of gene construct for recombinant and nucleic acid vaccine.
ii. Expression of gene encoding immunogenic protein in prokaryotic/ yeast/ animal cell culture system.
iii. Study of immune response against recombinant vaccine.
iv. Protection and evaluation studies.
v. Use of modern adjuvants in vaccines.
vi. Vaccine delivery systems including use of nanoparticles

Suggested Readings

Selected articles from journals.

ABT 705 ADVANCES IN ANIMAL CELL CULTURE 2+1

Objective

Understanding the latest developments in cell culture techniques.

Theory

UNIT I

Development of cell lines, characterization of cell lines by morphology, chromosome analysis, DNA content, enzyme activity and antigenic markers, differentiation.

UNIT II

Cultivation requirements of different types of cells, flow cytometry, DNA transfer by calcium phosphate co-precipitation, lipofection, electroporation.

UNIT III

Expression of recombinant proteins in mammalian and avian cell lines.

UNIT IV

Up-scaling of cells for production of vaccines, diagnostic antigens and other pharmaceutical agents, up-stream and downstream processing, cell culture fermentors.

Practical

i. Primary and secondary mammalian cell culture.
ii. Development of transformed cell lines.
iii. Characterization of cell lines.
iv. Transfection of cells with recombinant DNA.
v. Expression of recombinant proteins.
vi. Scaling-up of cultures.

Suggested Readings

Selected articles from journals.

ABT 706 TRANSGENIC ANIMAL TECHNOLOGY 2+0

Objective

Understanding the latest developments in transgenic technology.

Theory

UNIT I

Concept of transgenics, techniques of gene transfer, microinjection of recombinant DNA into fertilized eggs/stem cells, transfection of DNA totipotent keratocarcinoma cells, electroporation, gene transfer into cultured cells.

UNIT II

Suitable promoters for expression of transgenes, eukaryotic expression vectors, detection of transgenes in the new born.

UNIT III

Principles of animal cloning, application of transgenic and cloning technologies for improvement of livestock. Transgenic animals as bioreactors.

UNIT IV

Social, ethical, religious, environmental and other regulatory issues related to transgenic animal technology.

Suggested Readings

Selected articles from journals.

ANIMAL BIOTECHNOLOGY
List of Journals

- Animal Biotechnology
- Animal Genetics
- Animal Reproduction
- Cellular and Molecular Probe
- Current Science
- Genome Research
- Indian journal of Microbiology
- Journal of Clinical Microbiology
- Journal of Dairy Science
- Journal of Reproduction and Fertility
- Methods in Virus Research
- Nature
- Nature Biotechnology
- Nature Genetics
- Nucleic Acid Research
- PNAS
- Reproduction in Domestic Animals
- Science
- Theriogenology
- Trends in Biotechnology
- Trends in Genetics
- Viral Research

e-Resources

- www.cls.casa.colostate.edu/TransgenicCrops/teacherlinks
- www.hpc.unm.edu/~aroberts/main/top5%25.htm
- www.isaaa.org
- www.ciat.cgiar.org/biotechnology/cbn/gines_mera_fund.htm
- www.scidev.net/en/agriculture-and-environment/agri-biotech/links/publications-and-information-services
- www.biotechinstitute.org/programs/t_leader_program.html
- www.sci-ed-ga.org/modules/dna/analogies.html
- www.accessexcellence.org/AE/AEPC/WWC/1993
- www.atschool.eduweb.co.uk/trinity/bio2.html
- www.pub.ac.za/resources/teach.html
- www.bio-link.org/biomaterial.htm
- www.biotechnology.gov.au/index.cfm?event=object.showContent&objectID=B35A914C-DE3D-1A59-79F89FAA26F54E44
- www.monsanto.com/products/techandsafety/technicalpubs/eduwebsites.asp
- www.ejbiotechnology.info/content/vol5/issue3/teaching/01/index.html
- www.ncbiotech.org/resource_center/for_educators/online_teaching_resources.html
- www.ias.ac.in/currsci/dec252006/1594
- www.cccoe.k12.ca.us/stsvcs/newteacher/rop/curr_rop_links2.html
- www.scielo.cl/scielo.php?pid=S0717-34582003000100004&script=sci_arttext
- www.sunysb.edu/ligase/Forstudents/BiotechTeachingCenter/biotechcenter.html

- www.ca.uky.edu/agc/pubs/brei/brei3tg/brei3tg.htm
- www.aggie-horticulture.tamu.edu/tisscult/biotech/biotechteach.html
- www.ejbiotechnology.info/content/vol6/issue2/issues/2/index.html
- http://science.nhmccd.edu/biol/bio1int.htm#dna
- http://nhscience.lonestar.edu/biol/bio1int.htm
- www.ingentaconnect.com/content/tandf/tsed/2000/00000022/00000009/art00007
- www.buildingbiotechnology.com/free.php
- www.biotechnologist2020.com/2008/04/teaching-jobs-in-bioinformatics.html
- www.eric.ed.gov/ERICWebPortal/recordDetail?accno=EJ613711
- www.uq.edu.au/teaching-learning/index.html?page=61920
- www.nature.com/nbt/journal/v18/n9/full/nbt0900_913b.html
- www.fotodyne.com/literature/datasheets/E10700
- www.biotethics.org/conferences/maastricht/partecipants.html
- www.brookes.ac.uk/studying/courses/postgraduate/2008/biotech
- www.bioweb.usc.edu/courses/2003-spring/documents/bisc406-notes_011603
- www.agen.ufl.edu/~chyn/age2062/lect/lect_09/lect_09.htm
- www.bioinformaticscourses.com/BIOL358/lectures.html
- www.isis.vt.edu/~nstone/LifeSci/lect5.html
- www.nwo.nl/nwohome.nsf/pages/NWOA_6Y2LGH_Eng
- www.soi.wide.ad.jp/class/20040016
- www.sciencetech.technomuses.ca/english/schoolzone/biotech.cfm
- www.freevideolectures.com/biotech.html
- www.agen.ufl.edu/~chyn/age4660/lect/lect_07/lect_07.htm
- www.web.mit.edu/cheme/news/frontiers_2005.html

Suggested Broad Topics for Master's and Doctoral Research

- Development of Vaccines against emerging pathogens
- Nucleic acid based diagnostics
- Molecular animal forensics
- Whole genome analysis of animal viruses
- Embryo manipulation
- Animal genomics
- Reproductive biotechnology
- Conservation of endangered animal species
- Animal breed characterization
- Genomic Diversity of animal viruses
- Mapping of disease resistance genes in livestock
- Proteomics

BIOINFORMATICS

Course Structure – at a Glance

CODE	COURSE TITLE	CREDITS
BIF 501*	INTRODUCTION TO BIOINFORMATICS	2+1
BIF 502*	ADVANCED BIOINFORMATICS	2+1
BIF 503*	TECHNIQUES IN BIOINFORMATICS	0+2
BIF 504**†	BIOLOGICAL CHEMISTRY	3+0
BIF 505**†	STATISTICS FOR BIOINFORMATICS	2+1
BIF 506	CONCEPTS IN COMPUTING	2+2
BIF 507**†	PROGRAMMING LANGUAGES FOR BIOINFORMATICS	2+2
BIF 508**†	BASIC MOLECULAR BIOLOGY	3+0
BIF 509**†	MATHEMATICS FOR BIOINFORMATICS	2+0
BIF 510**	GENETICS & IMMUNOLOGY	3+0
BIF 511	INTRODUCTION TO DATABASE SYSTEMS	2+1
BIF 512	COMPUTATIONAL & SYSTEM BIOLOGY	2+2
BIF 513	BIOMOLECULAR SEQUENCE ANALYSIS	1+1
BIF 514**†	DYNAMIC WEB-DESIGN	1+2
BIF 515	BIOLOGICAL DATABANKS & DATA MINING	1+2
BIF 516	MOLECULAR MODELLING & DRUG DESIGN	2+2
BIF 517	COMPARATIVE AND FUNCTIONAL GENOMICS	2+1
BIF 518	PHARMACOGENOMICS & IPR	2+1
BIF 591	MASTER'S SEMINAR	1+0
BIF 599	MASTER'S RESEARCH	20

* To be offered to the students other than those of M.Sc. Bioinformatics

** May be taken as Minor/Supporting course

† To be offered from respective departments. The syllabi are attached for reference only. Actual contents may be seen from the corresponding department(s).

BIOINFORMATICS

Course Contents

BIF 501 INTRODUCTION TO BIOINFORMATICS 2+1

Objective

To impart an introductory knowledge about the subject of Bioinformatics to the students studying any discipline of science.

Theory

UNIT I

Introduction, biological databases – primary, secondary and structural, Protein and Gene Information Resources – PIR, SWISSPROT, PDB, genebank, DDBJ. Specialized genomic resources.

UNIT II

DNA sequence analysis, cDNA libraries and EST, EST analysis, pairwise alignment techniques, database searching, multiple sequence alignment.

UNIT III

Secondary database searching, building search protocol, computer aided drug design – basic principles, docking, QSAR.

UNIT IV

Analysis packages – commercial databases and packages, GPL software for Bioinformatics, web-based analysis tools.

Practical

i. Usage of NCBI resources
ii. Retrieval of sequence/structure from databases
iii. Visualization of structures
iv. Docking of ligand receptors
v. BLAST exercises.

Suggested Readings

Attwood TK & Parry-Smith DJ. 2003. *Introduction to Bioinformatics*. Pearson Education.

Rastogi SC, Mendiratta N & Rastogi P. 2004. *Bioinformatics: Concepts, Skills and Applications*. CBS.

BIF 502 ADVANCED BIOINFORMATICS 2+1

Objective

To understand the usage of advanced techniques in Bioinformatics

Theory

UNIT I

Biological databases, database hierarchies, sequence and structure databases. Pairwise sequence alignment and database similarity searching: global and local alignments, matrices, gap penalties and statistical significance.

UNIT II

Multiple sequence alignment and phylogenetic analysis, Microarray technology: applications, analysis of data, clustering analysis. Pharmacogenomics: introduction, applications, Genome for medicine, current and future perspectives.

UNIT III

System modeling and metabolomics – concepts and principles. Nutrigenomics: system biology in nutrition and health arena.

UNIT IV

Genome annotation, EST clustering, protein modeling and design.

Practical

i. Development of small database
ii. Phylogenetic analysis
iii. Microarray data analysis (sample data from open sources).
iv. Other practical exercises based on above topics.

Suggested Readings

Baxevanis AD & Ouellettee BFF. 2001. *Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins*. Wiley Interscience.

Mount DW Cold. 2001. *Bioinformatics: Sequence and Genome Analysis*. Spring Harbor

Stekel D. 2003. *Microarray Bioinformatics*. Cambridge University Press.

Tomita M & Nishioka T. 2005. *Metabolomics: The Frontier of Systems Biology*. Springer Verlag.

Wong SHY. 2006. *Pharmacogenomics and Proteomics: Enabling the Practice of Personalized Medicine*. American Association for Clinical Chemistry.

BIF 503 TECHNIQUES IN BIOINFORMATICS 0+2

Objective

To explore the usage of various Open source software for Bioinformatics applications

Practical

UNIT I

Gene Information Resources: GenBank, EMBL, Protein Information Resources: Swiss-Prot, BLOCKS, Gene Prediction Tools: GENSCAN, GRAIL

UNIT II

Structural Databases: PDB, CSD, RELIBASE, REBASE, File Format Converter Tools: BABEL, ReadSeq, NCBI Resources

UNIT III

Visualization tools – RasMol, QMol, Swiss PDB, Pymol, Modelling Tools: MODELLER, SwissPDB, Geno3D, Docking Tools: Chimera, Dock, AutoDock, GRAMM, Hex, Argus Lab.

UNIT IV

Proteomics Tools: EXPASY, CDART, 3D-Structure Optimization Tools, Sequence Analysis Tools: BLAST, FASTA, EMBOSS, TCOFFEE, Phylogenetic Analysis Tools: Phylip, NTSYS, CLUSTALW/CLUSTALX, BIOEDIT

Suggested Readings

Software Manuals and Help files

BIF 504 BIOLOGICAL CHEMISTRY 3+0

Objective

This is intended to prepare the non-biology students for basic concepts of biological structures and functions as well as recapitulate the knowledge of biology students.

Theory

UNIT I

The molecular logic of living organisms; Cells and composition of living matter; Carbohydrates: monosaccharides, oligosaccharides, polysaccharides, proteoglycans and glycoproteins; Lipids: fatty acids, acylglycerols, phospholipids, sphingolipids, cholesterol and membranes.

UNIT II

Structure and function of Proteins and nucleic acids; Enzymes: details of enzyme nomenclature and classification; units of enzyme activity; coenzymes and metal cofactors; temperature and pH effects; Michaelis-Menten kinetics; Inhibitors and activators; active site and catalytic mechanisms; covalent and noncovalent regulations; isoenzymes.

UNIT III

Organization of metabolic systems: enzyme chains, multienzyme complexes and multifunctional enzymes; anaplerotic sequences and amphibolic pathways; pacemaker enzymes and feedback control of metabolic pathways; shuttle pathways; energy charge.

UNIT IV

Oxidation of glucose in cells: high energy bond, glycolysis, citric acid cycle and oxidative phosphorylation, metabolism of lipids, proteins and nucleic acids, signal transduction.

Suggested Readings

Geoffrey LZ, Michael Gregory E & Sitz T. 1997. *Biochemistry*. McGraw-Hill.

Nelson DL, Cox MM & Ocorr MOK. 2005. *Lehninger's Biochemistry*. WH Freeman & Co.

Voet D & Voet JG. 1997. *Biochemistry.* John Wiley & Sons.

BIF 505 STATISTICS FOR BIOINFORMATICS 2+1

Objective

To understand the basic principles of statistics and mathematics and their applications in relation to Biological system.

Theory

UNIT I

Introduction to Statistical Bioinformatics, Principles of sampling from a population; Random sampling

UNIT II

Frequency distributions: Graphical representations and Descriptive measures; Standard Probability Distributions; Correlation and regression analysis.

UNIT III

Hypothesis testing; Markov Models, Cluster Analysis: Hierarchical and Non-Hierarchical methods.

UNIT IV

Phylogenetic Analysis Tools: Maximum Likelihood, Parsimony methods.

Practical

i. Computational exercises on Random Sampling
ii. Construction and representation of frequency distributions
iii. Descriptive measures
iv. Probability distribution.

Suggested Readings

Gupta SC & Kapoor VK. 2000. *Fundamentals of Mathematical Statistics: A Modern Approach*. S. Chand & Co.

Warren JE & Gregory RG. 2005. *Statistical Methods in Bioinformatics*. Springer.

BIF 506 CONCEPTS IN COMPUTING 2+2

Objective

The objective of this course is to introduce the basic concepts of computing with introduction to OS, graphics, networking and client-server technologies.

Theory

UNIT I

Fundamentals of Computing; Introduction to Operating Systems: WINDOWS, UNIX/Linux operating systems; Computer Security (hacking, cracking), Computer Viruses.

UNIT II

Computer Graphics**:** Visualization techniques - Software and Hardware, Interactive Graphics; Viewing in three dimension; Raster algorithms; Rendering; Animation; Image Processing with emphasis on biological systems.

UNIT III

Computer Networking, Security of the network, Fire-walls, Network Goals, Applications Network, Network architecture, Hierarchical networks, Ethernet and TCP/IP family of protocols

UNIT IV

Use of INTERNET and WWW, Internet services.

Practical

i. MS-Windows
ii. Linux, UNIX
iii. Network design
iv. Internet search
v. Graphics and animation.

Suggested Readings

David FR. 1997. *Procedural Elements for Computer Graphics*. WCB/McGraw-Hill.

Foley JD & Van Dam A. 1982. *Fundamentals of Interactive Computer Graphics*. Addison-Wesley.

James FK & Keith WR. 2006. *Computer Networking: A Top-Down Approach Featuring the Internet*. Prentice Hall.

Siever E. 2005. *Linux in a Nutshell*. O'Reilly.

BIF 507 PROGRAMMING LANGUAGES FOR BIOINFORMATICS 2+2

Objective

Programming is a very significant area for bioinformatics and this course gives an understanding for logics of programming and command-line and graphical GDIs.

Theory

UNIT I

Programming in C*:* Pointers, pointers to functions, macro programming in C, graphs, data structure - linked list, stack, queue, binary trees, threaded binary trees.

UNIT II

File and exception handling in C, Programming in Visual Basic*:* Introduction to Application Development using Visual Basic; Working with Code and Forms.

UNIT III

Variables, Procedures and Controlling Program Executor; Standard Controls; Data Access Using Data Control; Connecting to Database using VB.

UNIT IV

Introduction to JAVA, variables, constants, control structures, input output, classes. Jar and Java applets.

Practical

i. Programming in C and Visual basic with special reference to database linking.
ii. Small Java applets

Suggested Readings

Brian WK & Ritchie DM. 1988. *C Programming Language*. Prentice Hall.

Kanetkar. 2002. *Let us C*. BPB Publications.

Microsoft Developers Network (MSDN Digital Library).2006. Microsoft.

BIF 508 BASIC MOLECULAR BIOLOGY 3+0

Objective

To understand the basic concepts of molecular biology in order to relate to the structure and functions of biomolecules and to have an insight of chemical aspects of life.

Theory

UNIT I

Nucleic acids as hereditary material, Genome organization in prokaryotes and eukaryotes.

UNIT II

DNA replication, semi-conservative model, mechanism of replication in *E. coli*, differences in pro- and eukaryotic DNA replication.

UNIT II

Reverse transcription, Transcription in pro- and eukaryotes, post-transcriptional changes; Ribozymes, anti-sense RNA, micro-RNAs

UNIT IV

Genetic code and translation; differences in translation process in pro-and eukaryotes; Gene regulation in prokaryotes and eukaryotes.

Suggested Readings

Gupta PK. 2003. *Cell and Molecular Biology*. 2nd Ed. Rastogi Publications.

Lodish H. 2003. *Molecular Cell Biology*. 5th Ed. W.H. Freeman & Co.

Zhang MQ & Jiang T. 2002. *Current Topics in Computational Molecular Biology*. MIT Press.

BIF 509 MATHEMATICS FOR BIOINFORMATICS 2+0

Objective

To understand and apply fundamental concepts of mathematics as applicable in Biology and to acquaint about theoretical concepts of algebra and geometry and numerical methods.

Theory

UNIT I

Coordinate geometry with basic concepts of 2D and 3D geometry, Vector algebra – Addition and subtraction of vectors, Dot and cross product, Scalar triple product.

UNIT II

Matrix algebra: basic definitions, matrix operations, transpose of a matrix, inverse of matrix, eigen values, Boolean algebra. Geometric and Arithmetic Progression.

UNIT III

Solution of equation by bisection method, Iteration method, Newton Raphson method, numerical differentiation.

UNIT IV

Numerical integration- Trapezoidal rule, Simpson's 1/3 and 3/8 rules, Runga Kutta method of nth order. Fast Fourier transformation.

Suggested Readings

Babu CA & Seshan CR. 2006. *New Engineering Mathematics*. Narosa Publishing House.

Datta KB. 2002. *Matrix and Linear Algebra*. Prentice Hall.

Narayan S. 1980. *Matrix Algebra*. S Chand & Co.

Rao S. 2006. *Numerical Methods for Scientists and Engineers*. Prentice Hall.

BIF 510 GENETICS & IMMUNOLOGY 3+0

Objective

To learn the basic concepts of genetics and immunology.

Theory

UNIT I

Genetics- Science of genetics - objectives, terminologies, methods; Mendelian principles of inheritance, sex linked inheritance; Concept of linkage, linkage maps and recombination; Mutations - molecular, gene/point and chromosomal.

UNIT II

Phenotype and genotype relationships, role of environment, from gene to phenotype, gene interactions. Study of quantitative traits. Genetics of populations, genetics and evolution. Genetics and diseases.

UNIT III

Immunology - Overview of immune system, innate and acquired immune system; Structure and function of antibody molecule and TCR; Genetics of antibody diversity; MHC I and II, Polymorphism; Characteristics of B Cell and T Cell antigens; MHC Peptide interaction; Affinity maturation.

UNIT IV

Autoimmunity and molecular mimicry; Ligand - receptor interaction in the light of protein structure in immune system; Use of bioinformatics in immunology and vaccine development.

Suggested Readings

Johnson RL. 2006. *Genetics*. Twenty-First Century Books.
Male D. 2003. *Immunology*. Open University Worldwide.
Stansfield WD. 2002. *Genetics*. McGraw-Hill.

BIF 511 INTRODUCTION TO DATABASE SYSTEMS 2+1

Objective

To familiarize the concept of RDBMS and to apply the database techniques to biological databanks.

Theory

UNIT I

Data Abstraction; Data Models; Instances and Schemes; E-R Model - Entity and entity sets; Relations and relationship sets; E-R diagrams; Reducing E-R Diagrams to tables; Network Data Model: Basic concepts; Hierarchical Data Model: Basic Concepts.

UNIT II

Multimedia Databases - Basic Concepts and Applications; Indexing and Hashing; Basic concepts (ISAM, B+ Tree indexed files, B Tree indexed files, Static Hash functions, Dynamic Hash functions); Text Databases; Introduction to Distributed Database Processing, Data Security.

UNIT III

MySQL/MS-Access - Select Statements; Data Definition Statements; Data Manipulation Statements; Data Control Statements; Other Database Objects (Views, Sequences, Synonyms); Introduction to Application Development using Visual Basic; Working with Code and Forms; Variables.

UNIT IV

Procedures and Controlling Program Executor; Standard Controls; Data Access Using Data Control; Connecting to Oracle Database using Visual Basic.

Practical

i. Practical exercise using MySQL
ii. Design of database in MS-Access and MySQL.
iii. Database linking.

Suggested Readings

Date CJ. 1986. *Introduction to Database Systems*. Addison-Wesley.
Korth H & Silberschatz A. 2002. *Database System Concepts*. McGraw-Hill.
Martin D. 1986. *Advanced Database Techniques*. MIT Press.

BIF 512 COMPUTATIONAL & SYSTEM BIOLOGY 2+2

Objective

To understand the computational aspects of structural biology; to familiarize the usage of software for 3D structures of nucleic acids and proteins and to translate the sequence to protein structure.

Theory

UNIT I

Methods of single crystal X-ray Diffraction of macromolecules, NMR of macromolecules Anatomy of Proteins - Ramachandran plot, Secondary structures, Motifs, Domains, Tertiary and quaternary structures.

UNIT II

Anatomy of DNA: A, B, Z DNA, DNA bending etc.; RNA structure; Structure of Ribosome; Principles of Protein Folding; Structural data banks - Protein Data Bank, Cambridge small molecular crystal structure data bank.

UNIT III

Methods for Prediction of Secondary and Tertiary structures of Proteins, DNA, RNA, Fold recognition, *Ab initio* methods for structure prediction; Homology modeling, Methods for comparison of 3D structures of proteins.

UNIT IV

Molecular interactions of Protein – Protein with special reference to signal transduction and antigen-antibody interaction, Protein - DNA, Protein - carbohydrate, DNA - small molecules. System modeling and metabolomics – concepts and principles.

Practical

i. Usage of softwares for above topics
ii. Molecular Visualization tools: RasMol, QMol, Swiss PDB, Pymol
iii. Biomolecular Interaction Databases: BIND, DIP;
iv. Structure Similarity Search Tools: CN3D, Vast Search

Suggested Readings

Fall CP. 2002. *Computational Cell Biology*. Springer.

Tsai CS. 2003. *Computational Biochemistry*. John Wiley & Sons.

Waterman MS. 1995. *Introduction to Computational Biology: Maps, Sequences and Genomes*. CRC Press.

BIF 513 BIOMOLECULAR SEQUENCE ANALYSIS 1+1

Objective

To understand the local and multiple alignment concepts and to carry out multiple sequence alignment.

Theory

UNIT I

Analysis of protein and nucleic acid sequences, multiple alignment programs,

UNIT II

Development of programs for analysis of nucleic acid sequences, Use of EMBOSS package.

UNIT III

Phylogenetic analysis – Elements of phylogenetic models, tree interpretation, tree data analysis, alignment – building data model.

UNIT IV

Extraction of phylogenetics data sets, Distance and character based methods.

Practical

i. EMBOSS
ii. File Format Converter Tools: BABEL, ReadSeq
iii. Phylogenetic Analysis Tools: Phylip, NTSYS, PAUP
iv. CLUSTALW/CLUSTALX.

Suggested Readings

Baxevanis AD & Ouellettee BFF. 2001. *Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins*. Wiley Interscience.

Mount DW. 2001. *Bioinformatics: Sequence and Genome Analysis*. Spring Harbor, CSHL Press.

Nei M & Kumar S. 2000. *Molecular Evolution and Phylogenetics*. Oxford University Press.

Salemi M & Vandamme AM. 2003. *The Phylogenetic Handbook – A Practical Approach to DNA and Protein Phylogeny*. Oxford University Press.

BIF 514 DYNAMIC WEB-DESIGN 1+2

Objective

This course teaches the basic principles and application of various technologies used in creation of dynamic web content.

Theory

UNIT I

PERL: Strings, Numbers, and Variables. Variable Interpolation, Basic Input and Output, File handles, Making Decisions, Conditional Blocks, Loops, Combining Loops with Input, Standard Input and Output, Finding the Length of a Sequence File

UNIT II

Pattern Matching, Extracting Patterns, Arrays, Arrays and Lists, Split and Join, Hashes, A Real-World Example, BioPERL; Applications.

UNIT III

Creation, hosting and maintenance of web-site using HTML, XML, ASP, JSP.

UNIT IV

Creation, hosting and maintenance of web-site PHP, PERL and CGI.

Practical

i. Creation of Web-based applications, interactive and dynamic web-pages
ii. Connecting databases using CGI scripting
iii. Creation and maintenance of web-sites using HTML, XML, ASP, PHP, PERL and CGI
iv. Retrieval of specific information from web-sites using CGI scripts.

Suggested Readings

Moorhouse M & Barry P. 2004. *Bioinformatics, Biocomputing and Perl: An Introduction to Bioinformatics*. John Wiley & Sons.

Tisdall JD. 2001. *Beginning Perl for Bioinformatics*. O'Reilly.

BIF 515 BIOLOGICAL DATABANKS & DATA MINING 1+2

Objective

To understand the biological databases – types and formats and to learn the retrieval, deposition and analysis of sequences and structures from biological databanks.

Theory

UNIT I

Data warehousing, data capture, data analysis; Introduction to Nucleic Acid and Protein Data Banks; Nucleic acid sequence data banks: Genbank, EMBL nucleotide sequence data bank.

UNIT II

AIDS Virus sequence data bank, rRNA data bank, Protein sequence data banks: NBRF-PIR, SWISSPROT, Signal peptide data bank; Database Similarity Searches.

UNIT III

BLAST, FASTA, PSI-BLAST algorithms; Pair wise sequence alignment - NEEDLEMAN and Wunsch, Smith Waterman algorithms; Multiple sequence alignments - CLUSTAL, Patterns, motifs and Profiles in sequences.

UNIT IV

Derivation and searching; Derived Databases of patterns, motifs and profiles: Prosite, Blocks, Prints-S, Pfam, etc.; Primer Design.

Practical

i. Gene Information Resources
ii. Protein Information Resources
iii. Structural Databases
iv. Sequence Analysis and Database Similarity Search Tools: BLAST, PHI-BLAST, PSI-BLAST, FASTA, EMBOSS, CLUSTAL, TCOFFEE
v. Use of similarity, homology and alignment tools.

Suggested Readings

Letovsky S. (Ed).1999. *Bioinformatics: Databases and Systems*. Kluwer.

LeÛn D & Markel S. 2003. *Sequence Analysis in a Nutshell: A Guide to Common Tools and Databases*. O'Reilly.

NCBI(www.ncbi.nlm.nih.gov).

PUBMED (www.pubmedcentral.nih.gov) and database web-sites.

BIF 516 MOLECULAR MODELLING AND DRUG DESIGN 2+2

Objective

To understand the Modelling of small molecules; to understand the computational chemistry principles and to familiarize the role of computers in drug-discovery process.

Theory

UNIT I

Concepts of Molecular Modelling, Molecular structure and internal energy, Application of molecular graphics,

UNIT II

Energy minimization of small molecules, Use of Force Fields and MM methods, Local and global energy minima. Techniques in MD and Monte Carlo. Simulation for conformational analysis, *Ab initio*, DFT and semi-empirical methods.

UNIT III

Design of ligands, Drug-receptor interactions, Classical SAR/QSAR, Docking of Molecules;

UNIT IV

Role of computers in chemical research; Structure representation, SMILES; Chemical Databases, 2D and 3D structures, reaction databases, search techniques, similarity searches; Chemoinformatics tools for drug discovery.

Practical

i. Modelling Tools: MODELLER, Geno3D
ii. Docking Tools: Chimera, Dock, MOE, AutoDock Tools, GRAMM, Hex, ArgusLab;
iii. 3D-Structure Optimization Tools: CHEMSKETCH, CHEM 3D, ISIS Draw, CHEMDRAW

Suggested Readings

Bunin BA. 2006. *Chemoinformatics: Theory, Practice and Products*. Springer.

Gasteiger J & Engel T. 2003. *Chemoinformatics: A Textbook*. Wiley-VCH.

Hinchliffe A. 2003. *Molecular Modelling for Beginners*. John Wiley & Sons.

Leach AR. 1996. *Molecular Modelling: Principles and Applications*. Longman.

BIF 517 COMPARATIVE AND FUNCTIONAL GENOMICS 2+1

Objective

To understand the genomic and proteomic concepts and to learn the usage of various algorithms and programmes in analysis of genomic and proteomic data.

Theory

UNIT I

A brief account of recombinant DNA technology, PCR and molecular marker techniques. *Genomics* - Whole genome analysis, Comparative and functional genomics,

UNIT II

Pathway analysis, Repeat analysis, Human genetic disorders, Candidate gene identification, Linkage analysis, Genotyping analysis.

UNIT III

Concepts of Pharmacogenomics *Proteomics* - Introduction to basic Proteomics technology, Bio-informatics in Proteomics, Gene to Protein Function: a Roundtrip,

UNIT IV

Analysis of Proteomes, Analysis of 2-D gels, Protein to Disease and *vice versa*, Human Genome and science after Genome era. SAGE.

Practical

i. Gene Prediction Tools: GENSCAN, GRAIL, FGENESH
ii. NCBI Genomic Resources
iii. Proteomics Tools: EXPASY, CDART

Suggested Readings

Azuaje F & Dopazo J. 2005. *Data Analysis and Visualization in Genomics and Proteomics*. John Wiley & Sons.

Jollès P & Jörnvall H. 2000. *Proteomics in Functional Genomics: Protein Structure Analysis*. Birkhäuser.

BIF 518 PHARMACOGENOMICS & IPR 2+1

Objective

To understand the translation of Bioinformatics into commercial gains; to familiarize the concepts of microarray – data acquisition and analysis and

learn the IPR issues in Biological sciences with special emphasis on bioinformatics.

Theory

UNIT I

Bioinformatics companies, Genomes, transcriptomes and proteomes – their applications in medicine and agriculture, disease monitoring, profile for therapeutic molecular targeting.

UNIT II

Diagnostic drug discovery and genomics. Pharmacogenomics and its application. SNPs and their applications. Microarray and genome wide expression analysis: Introduction to basic microarray technology, Bioinformatics in microarrays, Getting started – target selection.

UNIT III

Customised microarray design, Image processing and quantification, Normalization and filtering, Exploratory statistical analysis, Public Microarray data resources.

UNIT IV

Patenting and data generation from patent literature for commercial benefits. IPR, and bioinformatics. Bioinformatics patents.

Practical

i. Microarray Analysis Tools: MAGICTool
ii. Stanford Microarray Database
iii. Gene Expression Omnibus
iv. Creation of an On-line company.

Suggested Readings

Blalock EM. 2003. *A Beginner's Guide to Microarrays*. Springer.

Catania M. 2006. *An A-Z Guide to Pharmacogenomics*. American Association for Clinical Chemistry.

Chakraborty C & Bhattachary A. 2005. *Pharmacogenomics.* Biotech Books.

Stekel D. 2003. *Microarray Bioinformatics*. Cambridge University Press.

BIOINFORMATICS

List of Journals

- Bioinformatics - Oxford University Press
- BMC Bioinformatics - BioMed Central
- Briefings in Bioinformatics - Oxford University Press
- Briefings in Functional Genomics and Proteomics - Oxford University Press
- Computers in Biology and Medicine – Elsevier
- Journal of Bioinformatics and Computational Biology (JBCB) – World Scientific Publishers
- Journal of Biomedical Informatics – Elsevier
- Journal of Computational Biology - Mary Ann Liebert, Inc. publishers
- Journal of Molecular Modelling – Springer
- Nucleic Acids Research – Oxford Press
- Protein Engineering, Design and Selection *(PEDS)* – Oxford Press

e-Resources

- Bioinformatics.Org: The Open-Access Institute - http://bioinformatics.org/
- European Molecular Biology Network - http://www.embnet.org/
- European Bioinformatics Institute -http://www.ebi.ac.uk/
- The European Molecular Biology Laboratory - http://www.embl.org/
- International Society for Computational Biology - http://www.iscb.org/
- National Center for Biotechnology Information - http://www.ncbi.nlm.nih.gov/
- ExPASy Proteomics Server - http://us.expasy.org/
- Mouse Genome Informatics - http://www.informatics.jax.org/
- Center for Molecular Modeling - http://cmm.info.nih.gov/modeling/
- RCSB PDB - http://www.rcsb.org/pdb
- Bioinformatics resources - http://www.biochem.ucl.ac.uk/bsm/BCSB/bioinfo_resources/bioinform_res.htm
- South African National Bioinformatics Institute - http://www.sanbi.ac.za/
- Swiss Institute of Bioinformatics - http://www.isb-sib.ch/
- Protein Structure Prediction Center - http://predictioncenter.llnl.gov/
- Programs for Genomic Applications -http://www.nhlbi.nih.gov/resources/pga/
- Computational Molecular Biology At NIH - http://molbio.info.nih.gov/molbio/
- Gene Ontology Home - http://www.geneontology.org/
- All About The Human Genome Project (HGP) - http://www.genome.gov/
- UCSC Genome Browser - http://genome.ucsc.edu/

COMPULSORY NON-CREDIT COURSES

(Compulsory for Master's programme in all disciplines; Optional for Ph.D. scholars)

CODE	COURSE TITLE	CREDITS
PGS 501	LIBRARY AND INFORMATION SERVICES	0+1
PGS 502	TECHNICAL WRITING AND COMMUNICATIONS SKILLS	0+1
PGS 503 (e-Course)	INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE	1+0
PGS 504	BASIC CONCEPTS IN LABORATORY TECHNIQUES	0+1
PGS 505 (e-Course)	AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES	1+0
PGS 506 (e-Course)	DISASTER MANAGEMENT	1+0

Course Contents

PGS 501 LIBRARY AND INFORMATION SERVICES 0+1

Objective

To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search.

Practical

Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; e-resources access methods.

PGS 502 TECHNICAL WRITING AND COMMUNICATIONS SKILLS 0+1

Objective

To equip the students/scholars with skills to write dissertations, research papers, etc.

To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

Practical

Technical Writing - Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.;

commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.

Communication Skills - Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors); Concord; Collocation; Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers.

Suggested Readings

Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.

Collins' Cobuild English Dictionary. 1995. Harper Collins.

Gordon HM & Walter JA. 1970. *Technical Writing*. 3rd Ed. Holt, Rinehart & Winston.

Hornby AS. 2000. *Comp. Oxford Advanced Learner's Dictionary of Current English*. 6th Ed. Oxford University Press.

James HS. 1994. *Handbook for Technical Writing*. NTC Business Books.

Joseph G. 2000. *MLA Handbook for Writers of Research Papers*. 5th Ed. Affiliated East-West Press.

Mohan K. 2005. *Speaking English Effectively*. MacMillan India.

Richard WS. 1969. *Technical Writing*. Barnes & Noble.

Robert C. (Ed.). 2005. *Spoken English: Flourish Your Language*. Abhishek.

Sethi J & Dhamija PV. 2004. *Course in Phonetics and Spoken English*. 2nd Ed. Prentice Hall of India.

Wren PC & Martin H. 2006. *High School English Grammar and Composition*. S. Chand & Co.

PGS 503 (e-Course) **INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE** **1+0**

Objective

The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Theory

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and bio-diversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Suggested Readings

Erbisch FH & Maredia K.1998. *Intellectual Property Rights in Agricultural Biotechnology*. CABI.

Ganguli P. 2001. *Intellectual Property Rights: Unleashing Knowledge Economy*. McGraw-Hill.

Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC & Aesthetic Technologies.

Ministry of Agriculture, Government of India. 2004. *State of Indian Farmer*. Vol. V. *Technology Generation and IPR Issues*. Academic Foundation.

Rothschild M & Scott N. (Ed.). 2003. *Intellectual Property Rights in Animal Breeding and Genetics*. CABI.

Saha R. (Ed.). 2006. *Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies*. Daya Publ. House.

The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.

PGS 504 BASIC CONCEPTS IN LABORATORY TECHNIQUES 0+1

Objective

To acquaint the students about the basics of commonly used techniques in laboratory.

Practical

Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets; washing, drying and sterilization of glassware; Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath; Electric wiring and earthing. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy

Suggested Readings

Furr AK. 2000. *CRC Hand Book of Laboratory Safety*. CRC Press.

Gabb MH & Latchem WE. 1968. *A Handbook of Laboratory Solutions*. Chemical Publ. Co.

PGS 505 (e-Course) AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES 1+0

Objective

To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

Theory

UNIT I

History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

UNIT II

Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

UNIT III

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Readings

Bhalla GS & Singh G. 2001. *Indian Agriculture - Four Decades of Development*. Sage Publ.

Punia MS. *Manual on International Research and Research Ethics*. CCS, Haryana Agricultural University, Hisar.

Rao BSV. 2007. *Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives*. Mittal Publ.

Singh K.. 1998. *Rural Development - Principles, Policies and Management.* Sage Publ.

PGS 506 DISASTER MANAGEMENT 1+0
(e-Course)

Objectives

To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards, and risks vulnerability; and capacity building.

Theory

UNIT I

Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion

UNIT II

Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water

pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.

UNIT III

Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media. Central, State, District and local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.

Suggested Readings

Gupta HK. 2003. *Disaster Management*. Indian National Science Academy. Orient Blackswan.

Hodgkinson PE & Stewart M. 1991. *Coping with Catastrophe: A Handbook of Disaster Management*. Routledge.

Sharma VK. 2001. *Disaster Management*. National Centre for Disaster Management, India.