CENTRAL UNIVERSITY OF RAJASTHAN

Department of Biotechnology

Syllabus
for
M. Sc. Biotechnology
Effective from academic session 2011-2013

Central University of Rajasthan
City Road, Madanganj-Kishangarh-305802
Ajmer District
Syllabus- M.Sc. Biotechnology

Preamble

The science of Biotechnology has tremendous potential for application in agriculture and medicine. The linkage between basic and applied research and new discoveries and innovations can find direct applications in agriculture and human health. The breakthroughs in modern biotechnology mainly include our ability to produce useful organisms through genetic engineering and cell fusion techniques and improve bioprocess technology to purify novel molecules generated by such processes. It also involves targeting drugs, development of delivery systems and vaccines. Considering this background, the syllabus document is essentially to be formulated which focused on diverse areas from Cell Biology, Biochemistry, Immunology and Genetics with significant laboratory practices which will enable the students to have hands on experience in doing experiments themselves. Therefore the syllabus document can be grouped under following categories.

Basic Sciences

The powerful genetic engineering technology comprising the tools to identify, isolate, and manipulate the individual genes that control the specific characters in plants, animals, humans and microorganisms is the basis for the new developments. The creativity of the scientists and the basic curiosity-driven research will be the keys to the future success. Research related to biosystematics using molecular approaches, mathematical modeling, and genetics including genome sequencing for human beings, animals, and plants, will be a top most priority as we move into the next decade. Knowledge of genome sequencing is clearly evident in many fields. New genes are discovered, which are short, unique and has expressed sequenced tags segments which are used as signatures for gene identification. The influence of high throughput sequencing, collectively with rapidly accumulating sequenced data, is opening new avenues in biosciences. The projected syllabus document should focus on identification of new genes, development of new drug delivery systems, diagnostics, recombinant vaccines, computational biology, and many other related areas.

Plant Biotechnology

The utilization hybrids vigor including apomixis, genes for abiotic and biotic resistance and developing planting material with desirable traits and genetic enhancement of all major crops will govern the research agenda in the next decade. Combination of nutrient management and development of new biofertilizers and biopesticides would be significant from the view- point of sustainable agriculture, soil fertility, and a clean environment. Stress biology, marker-assisted breeding programs, and studying the important genes will be focused areas. Research to develop new genetically improved (transgenic) plants for several legumes, cereals, vegetables and fruit crops is well
advanced. Micropropagation technology has already been exploited considerably by private sector and has now become an emerging paying business. The bioresource and biodiversity constitute the mainstay of the financial system required for plant biotechnology research. Separation of genes for plentiful proteins, combining molecular genetics and chromosome maps, and a much improved understanding of the evolutionary association of the members of the plant kingdom, have led to the potential of plant species being the key source of food, feed, fiber, medicine, and industrial unprocessed material. Molecular fingerprinting and areas of genomics and proteomics will penetrate the barriers of fertilization to allow transfer of important characters from one organism to another.

By identifying appropriate determinants of male sterility, we can extend the benefit of hybrid seeds to more crops. There are innumerable possibilities of producing more proteins, vitamins, pharmaceuticals, coloring material, bioreactors, production of edible vaccines, therapeutic anti-bodies and drugs. Promising leads are obtainable in these areas, and a number of genetically improved crops are ready for field trials. The judicious use of these various plant biotechnologies is necessary to plan a syllabus document.

**Food Sciences**

Availability of sufficient food is another area in which biotechnology offers major inputs for healthier and more nutritious food for over increasing population. There are also serious deficiencies of iodine, iron, and other nutrients. The advent of gene transfer technology and its use in crops, microbes and animals mainly to achieve higher productivity and better quality, including improved nutrition and storage properties is a subject of much consideration. This is necessary to ensure adaptation of living organisms to specific environmental conditions, to increase tolerance to stress conditions, to increase pest and disease resistance, and to achieve higher prices in the marketplace. Genetically improved foods will have to be developed under adequate regulatory processes, with full public understanding following safety and proper labeling of the genetically improved foods. Industrial processes of several bioproducts with well equipped manufacturing units have to be designed. Development of animal vaccines is another area requires inclusion in the syllabus document.

**Environmental Biotechnology**

Ever increasing industrial growth, encroachment on forests and other manmade contribution have polluted the environment extensively. Several engineering and chemical processes have been effectively employed to reduce the toxicity of pollutants in the environment. Additionally, plants and microbes are becoming important factors in pollution control. New developments such as bioindicators, phytoremediation methods, and bioleaching, development of biosensors, and identification and isolation of microbial consortia are priority research areas. Significant work has been done in India, but developing a more biologically oriented approach towards pollution control would be enormously imperative. Cleaning up the large river systems and ensuring the destruction of pesticide residue are priorities in which a biotechnological approach would be
environmentally safe. Phytoremediation to remove the high levels of explosives found in the soil has become a reality.

**Medical Biotechnology**

Advances in molecular biology, immunology, reproductive medicine, genetics, and genetic engineering have revolutionized our understanding of health and diseases and may guide to an era of predictive medicine. Genetic engineering promises to treat a number of mono genetic disorders, and unravel the mystery of polygenetic disorders, with the help of research on genetically improved animals. Globally, there are about 35–40 biotechnology-derived therapeutics and vaccines in use and more than 500 drugs and vaccines in different stages of clinical trials. Every year about 12 million people die of infectious diseases. The main killers according to WHO are acute respiratory infection, diarrhoea diseases, tuberculosis, malaria, hepatitis, and HIV-AIDS. There are vaccines being developed for many diseases, and diagnostic kits for HIV, pregnancy detection, and hepatitis are being developed. The technologies have been transferred to industry. Instrumentation of medical products in conjunction with biotechnology knowledge is progressing rapidly under the title biomedical engineering. The syllabus document preparation has to consider this subject for future research.

**Biodiversity**

Maintenance of biodiversity status adequately and stopping further loss of valuable species is absolutely necessary. There are many gene banks, botanical gardens, and herbaria for conservation purposes. There are also molecular approaches including DNA fingerprinting for plant conservation. The totality of gene species and ecosystems has become exceedingly important, not only to understand the global environment but also from the viewpoint of the enormous commercial significance of the biodiversity. Biotechnology is becoming a major instrument in conservation biology. Twelve percent of the vascular plants are threatened with extinction. Over 5,000 animal species are threatened worldwide, including 563 Indian species. India also has about 2000 species of vascular plants that are threatened. Biodiversity is under threat, and understanding the scale of this destruction and extinction is essential. Additional research is wanted on forests, marine resources, bioremediation methods, restoration ecology, and large-scale tree plantations. Marine resources provide many commodities and benefits including bioactive materials, drugs, and food items and must be characterized and conserved

**Industrial Biotechnology**

Progress in biotechnology has ability to convert basic concepts into products, processes, and technologies by creating an interdisciplinary team. Among the various disciplines of Biotechnology, the pharmaceutical sector has a major impact having numerous diagnostics kits in clinical practice. The polymerase chain reaction (PCR)-based diagnostics are the most common. Industrial enzymes have emerged as a major vehicle for improving product quality. Antibiotic and vaccines production has tremendously
increased using biotechnology tools. The coming decade will witness a boost in biotechnology activities in the industrial sector world wide.

**Bioinformatics**

The integration of biotechnology and informatics is paying rich dividends. Genome projects, drug design, and molecular taxonomy are all becoming increasingly dependent on information technology. Information on nucleotides and protein sequences is accumulating swiftly. The number of genes characterized from a variety of organisms and the number of evolved protein structures are doubling every two years. Development of databases has developed in an unprecedented manner. Bioinformatics will be a major component in the syllabus 2020 prospects.

**Human Resource Development**

There are several M.Sc, and post doctoral and training programs in biotechnology in different institutions and universities covering most Indian states. Short-term training programs, technician training courses, fellowships for students to go abroad, training courses in Indian institutions, popular lecture series, awards, and incentives form an integral part of the human resource development activities in India. Many students after completion of their training course join industries or work in biotechnology-based programs in institutions and laboratories. National Bioscience Career Development Awards have been instituted. Special awards for women scientists and scholarships to the best students in biology help promote biotechnology in India and give recognition and reward to the scientists. To achieve the goal of self-reliance in this field, India will require a strong educational and scientific base; clear public understanding of the new biotechnologies, and involvement of society in many of these biological ventures. India has a large research and educational infrastructure comprising agriculture universities, central and state universities, and national laboratories and research institutions. It should therefore be possible to develop capabilities and programs so that these centers act as regional hubs for entrepreneurs, farmers and industrialists.

**Objectives:** This postgraduate course covers several of the areas with the following objectives in mind.

- Survey of core concepts in biochemical, genetic, molecular and cellular basis of biological phenomena and their applications in biotechnology.
- To employ mathematical, physical, chemical and computational (bioinformatics) approaches in biotechnology.
- To provide strong hands – on – laboratory training.
- To develop human resource for biotechnology research, industry and governance.
Duration: 4 Semesters (2 years)

Eligibility:

A candidate possessing Bachelor’s degree in Botany/Zoology/ Biochemistry/ Microbiology/Genetics/Medicine/Pharmacy/Agriculture/Life Sciences/Biotechnology/Chemistry/Physics/Mathematics and any other area of Biological sciences as main subject with minimum 60% marks.

Admission:

Through Entrance Examination to be conducted by the University on all-India basis. Syllabus for entrance examination will be as decided for the national level examination.

Programme Structure and Courses offered in M.Sc. Biotechnology

SEMESTER I

<table>
<thead>
<tr>
<th>Code</th>
<th>Title of Course</th>
<th>Type of course (core/elective/supportive)</th>
<th>Level</th>
<th>L</th>
<th>P</th>
<th>Credits</th>
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<tbody>
<tr>
<td>MSBT 101</td>
<td>Biochemistry</td>
<td>Core</td>
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<td>MSBT 102</td>
<td>Genetics</td>
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<td>MSBT 103</td>
<td>Microbiology</td>
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<td>MSBT 104</td>
<td>Analytical Techniques in Biology</td>
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<tr>
<td>MSBT 105</td>
<td>Communication Skills</td>
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<tr>
<td>MSBT 106</td>
<td>Mathematics for Biologists *</td>
<td>Supportive</td>
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<td>MSBT 107</td>
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<tr>
<td>MSBT 109</td>
<td>Biology 2**</td>
<td>Supportive</td>
<td>B</td>
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<tr>
<td>MSBT 110</td>
<td>Biochemistry Laboratory</td>
<td>Core</td>
<td>A</td>
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<tr>
<td>MSBT 111</td>
<td>Microbiology &amp; Genetics Laboratory</td>
<td>Core</td>
<td>A</td>
<td>6</td>
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*These courses will be taken by students with biology background.
**These courses will be taken by students who have not studied biology till class 12th.

Total credit: 24

SEMESTER II

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<thead>
<tr>
<th>Code</th>
<th>Title of Course</th>
<th>Type</th>
<th>Level</th>
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<th>Credits</th>
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<tr>
<td>MSBT 201</td>
<td>Cell Biology</td>
<td>Core</td>
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<td>MSBT 202</td>
<td>Molecular Biology</td>
<td>Core</td>
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### SEMESTER- III

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<th>Code</th>
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<tr>
<td>MSBT 301</td>
<td>Computational Biology and Biostatistics</td>
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<td>MSBT 302</td>
<td>Genetic Engineering</td>
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<td>MSBT 303</td>
<td>Plant Biotechnology</td>
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<td>MSBT 304</td>
<td>Animal Biotechnology</td>
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<td>MSBT 305</td>
<td>Developmental and Stem Cell Biology</td>
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<td>MSBT 306</td>
<td>Project</td>
<td>Core</td>
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<td>MSBT 307</td>
<td>Journal Club Presentation</td>
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<td>MSBT 308</td>
<td>Genetic Engineering Laboratory</td>
<td>Core</td>
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<tr>
<td>MSBT 309</td>
<td>Plant and Animal Biotechnology Laboratory</td>
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<td>A</td>
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**Total credit: 24**

### SEMESTER- IV

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<tr>
<th>Code</th>
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<td>MSBT 401</td>
<td>Fermentation Technology and Downstream Processing</td>
<td>Core</td>
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<tr>
<td>MSBT 402</td>
<td>Elective I*</td>
<td>Core</td>
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<td>MSBT 403</td>
<td>Elective II*</td>
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<tr>
<td>MSBT 404</td>
<td>Elective III*</td>
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<td>MSBT 405</td>
<td>Seminar</td>
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<td>MSBT 406</td>
<td>Project</td>
<td>Core</td>
<td>A</td>
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<td>MSBT 407</td>
<td>Project presentation</td>
<td>Core</td>
<td>A</td>
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</tbody>
</table>

**Total credit: 24**

*Three Elective courses from the list given below have to be taken which includes, one course offered by Social Science Department of the University.*
List of Elective Courses for MSBT 402 and MSBT 403:
1. Human Molecular Genetics
2. Human Physiology
3. Genomics and Proteomics
4. Advanced Immunology

The elective course, MSBT 404, offered by Social Science Department of the University:
- Principles and practices of Management, MBA 101
- Entrepreneurship theories and practices, MBA 207
- Marketing management, MBA 201

**Final Total Credit: 96**

Note: The assessment of the student will be as laid down in the relevant Ordinances on Examination and Evaluation:
(a) For passing a semester, the assessment of a student shall be based on:
   (i) Continuous Internal Evaluation (CIE) of 50% marks in each course, and
   (ii) End Semester Examination (ESE) of 50% of marks in each course.
The CIE will consist of – (i) Sessional Tests (ST) (ii) Internal Assessment (IA) (20%).
The IA shall comprise of Home Assignments (HA)/attendance in the Class/attendance/Viva-voce/Group Discussions/Tutorials/Case Studies etc.

(b) L: Lectures, I.L. : Integrated Learning involving Tutorials, Group Discussions, Assignments, Field work;  P : Practicals, Lab work, Project.
(c) Core (C), Elective (E), Supportive and Socially Oriented (S)
(d) Syllabus of each course may be presented in the following format

**SEMESTER -I**

**MSBT 101 BIOCHEMISTRY**

**UNIT -I**

**Chemical basis of life:** Composition of living matter; Properties of Water; Properties of biomolecules in aqueous environment; Bimolecular hierarchy; Macromolecules; Molecular assemblies; Structure-function relationships.

**Carbohydrates:** Sugars - mono, di, and polysaccharides; Suitability in the context of their different functions- cellular structure, energy storage, signaling; Glycolytic pathway; Kreb’s cycle; Oxidative phosphorylation; Elucidation of metabolic pathways; Logic and integration of central metabolism; entry/ exit of various biomolecules from central pathways; Bioenergetics-basic principles; Equilibria and concept of free energy; Coupled processes; Principles of metabolic regulation; Regulatory steps; Signals and second messengers. Glycosylation of other biomolecules - glycoproteins and glycolipids; Glycogen - Synthesis and Degradation. Regulation of Glycogen Metabolism.
Gluconeogenesis and its Regulation. Metabolism of Fructose and Galactose. Regulation of Carbohydrate Metabolism.

**Contact Hours: 15 hrs**

**UNIT -II**

**Amino acids and Proteins:** structure and functional group properties; Peptides and covalent structure of proteins; Elucidation of primary and higher order structures; Evolution of protein structure; General reactions of Amino Acid Metabolism, Connection of essential and non-essential Amino Acids with Intermediary Metabolism. Decarboxylation of Amino Acids. Processes related to Ammonia Metabolism, Inter-organ relationships in Amino Acid Metabolism, Non-standard Amino Acids. **Cofactors:** Vitamins and coenzymes

**Contact Hours: 15 hrs**

**UNIT -III**

**Lipids:** structure and properties of important members of storage and membrane lipids; lipoproteins; Synthesis of various Lipids, Bile Acids and Cholesterol. Elongation of Fatty Acids, Desaturation of Fatty Acids in Microsomes. Regulation of Fatty Acid Synthesis, Cholesterol Metabolism. Composition and Synthesis of basic groups of Lipoproteins and their changes during Transport in the body.

**Biomembranes:** Biomembrane organization - sidedness and function; Membrane bound proteins - structure, properties and function; Transport phenomena


**Contact Hours: 15 hrs**

**Books recommended**

Genes and Chromosomes - Introduction and scope of genetics; DNA as genetic material; Structure of nucleic acids; Basic principles of Mendelian genetics - Segregation and Independent assortment, alleles and multiple alleles; human pedigrees and inheritance; Cell division - Mitosis and meiosis, cell cycle; Chromosomal basis of inheritance; Gene interactions; Chromosome and its structure; sex determination and sex-linked inheritance; Dosage compensation.

Contact hours: 15 hrs

UNIT -II

Linkage analysis and gene mapping in eukaryotes - Molecular markers; Fine structure of the gene and gene concept

Extra chromosomal inheritance - mitochondrial and chloroplast inheritance

Bacterial genetics - Conjugation, transduction and transformation; Plasmids; Transposable elements - transposons and retrotransposons; Genome organization.

Contact hours: 15 hrs

UNIT -III

Mutations - Spontaneous and induced; Mechanisms of mutagenesis; Assay of mutagenic agents (Ames test); Chromosomal mutations - numerical (trisomy, polyploidy and aneuploidy) and structural changes and detection methods. Mechanism of chromosome mutations; genetic and cytological features of deletions, duplications, inversions, translocations; somatic and germ line mutations.

Population genetics - Hardy-Weinberg equilibrium; Calculation of allele frequency; Molecular Evolution - evolutionary changes of nucleotide sequences and DNA polymorphism; Genes in early development; Maternal effect genes; Pattern formation genes; Homeotic genes.

Contact hours: 15 hrs

Books recommended

MSBT103 MICROBIOLOGY

UNIT -I
Microbial Diversity & Systematics - Classical and modern methods and concepts; Domain and Kingdom; Criteria for classification; Classification of Bacteria according to Bergey's manual; General and Salient features of Bacteria, Archaea, Fungi, Algae, Protozoa and Viruses.


Contact hours: 15 hrs

UNIT -II

Microbial physiology- Physiological adoption and life style of Prokaryotes; Unicellular Eukaryotes and the Extremophiles (with classical example from each group). Nutritional Diversity- Transport of Nutrition, Major and Minor bioelements, nutritional diversity, oxygenic and anoxygenic, photosynthesis, respiration, fermentations, chemolithotrophy.

Contact hours: 15 hrs

UNIT -III
Microbial Interactions and Infection - Host–Pathogen interactions; Microbes infecting humans, veterinary animals and plants; Pathogenicity islands and their role in bacterial virulence.

Microbes and Environment- Role of microorganisms in natural system and artificial system; Influence of Microbes on the Earth’s Environment and Inhabitants; Ecological impacts of microbes; Symbiosis; Microbes and Nutrient cycles; Microbial communication system; Quorum sensing.

Applied Microbiology- Overview of applications of microorganisms in Agriculture, Environment, Food, Industry and Medical Sciences.

Contact hours: 15 hrs

Books recommended


MSBT 104 ANALYTICAL TECHNIQUES IN BIOLOGY

UNIT -I


Contact hours: 15 hrs

UNIT -II


Spectroscopic Techniques- Basic principles of UV, Visible and fluorescence spectroscopy and their applications.

Contact hours: 15 hrs

UNIT -III

Mass spectrometry techniques- MALDI –TOF, LC-MS applications, Microcalorimetry: Differential scanning calorimetry (DSC) and Isothermal titration calorimetry (ITC) and its applications in biomolecular stability and interactions.

Radioactive Tracer Techniques - Radioactive Decay, Half Life, α,β and γ Emitters, Decay of Radioactivity, Types of Radioactivity Used in Biochemistry, Units of Radioactivity Measurements, Gas Ionization and Liquid Scintillation Counters, Gamma Counters, Autoradiography, Biological Hazards of Radiation and Safety Measures in Handling Radioisotopes, Biological Applications.

Contact hours: 15 hrs

Books recommended

MSBT 105 COMMUNICATION SKILLS

UNIT -I
Process of Communication - Concept of effective communication- Setting clear goals for communication; Determining outcomes and results; Initiating communication; Avoiding breakdowns while communicating; Creating value in conversation; Barriers to effective communication; Non verbal communication- Interpreting non verbal cues; Importance of body language, Power of effective listening; recognizing cultural differences.

Presentation skills- Formal presentation skills; Preparing and presenting using Over Head Projector, Power Point; Defending Interrogation; Scientific poster preparation & presentation; Participating in group discussions.

Contact hours: 15 hrs

UNIT -II
Technical Writing skills: Types of reports; Layout of a formal report; Scientific writing skills: Importance of communicating Science; Problems while writing a scientific document; Plagiarism; Scientific Publication Writing: Elements of a Scientific paper including Abstract, Introduction, Materials & Methods, Results, Discussion, References; Drafting titles and framing abstracts.

Computing Skills for Scientific Research: Web browsing for information search; search engines and their mechanism of searching; Hidden Web and its importance in Scientific research; Internet as a medium of interaction between scientists; Effective email strategy using the right tone and conciseness.

Contact hours: 15 hrs

Books recommended


MSBT 106 MATHEMATICS FOR BIOLOGISTS

UNIT -I
Real Number System
Elements of Coordinate Geometry and Algebra; Function shifting graphs, trigonometric functions.
Permutation, combinations and binomial theorem.
Relations, Functions, including Periodic Functions, Inverse Functions
Limits and Continuity: Rates of change and limits, rules for finding limits, target values
and formal definition of limits, extension of the limit concept, continuity.

Contact hours: 15 hrs

UNIT -II
Rates and Topics from Differential Calculus such as max/min of functions of
one variable differentials and approximations.
Partial derivatives, max/min of function of more than one variable and method
of least squares.
Antiderivatives, Indefinite and definite integrals.
Logarithms and Exponential Functions,
Differential Equations and their applications in biology

Contact hours: 15 hrs

Books recommended

  and Sons, 2006.
- Peter C. Foster, Easy Mathematics for Biologists, Hardwood Academic publisher,
  1998.

MSBT 107 PHYSICS FOR BIOLOGISTS

UNIT -I
Quantum Physics: Wave versus particle, Heisenberg’s Uncertainty principle, Matter
waves, Photoelectric effect, Atom and Nuclei, Elements Fermions, Quanta, Particles,
Schrodingger’s wave equations.
Properties of Matter: Elasticity, Hydrostatic, Surface tension, Microscopic consideration for study of properties of matter, Atomic and Molecular structures, Broad classification of solids, Structure of crystalline and amorphous solids, Structure of single crystals.

Contact hours: 15 hrs

UNIT -II

Thermal Physics: Laws of Thermodynamics and their applications in biological systems, Temperature and related topics, Internal energy, Heat and First law of Thermodynamics, Ideal monoatomic gas, Applications of first law to Ideal Gases, Entropy and the Second law.

Fundamental Electromagnetism: Charge and Current, Coulomb’s law, Electric field, Electrostatic potential, Gauss’s law for Electronics, Magnetic effects on steady currents, Forces on currents in a magnetic field, Forces on charges in Electric and Magnetic field, Electromagnetic induction.

Contact hours: 15 hrs

Books recommended


MSBT 108 BIOLOGY 1

UNIT -I

Chemical basis of life, water, Carbon and molecular diversity, structure and function of macromolecules.
Prokaryotic and Eukaryotic cells; cell organelles; cell division and cell cycle; cell metabolism

**Contact hours: 15 hrs**

**UNIT -II**
Ecology and Biosphere, Ecosystems; Evolution and natural selection; Biodiversity and tree of life.

**Contact hours: 15 hrs**

**Books recommended**

**MSBT 109 BIOLOGY 2**

**UNIT –I**
Plant structure, growth development and reproduction; Photosynthesis; transport; Response of plants to internal and external signals

**Contact hours: 15 hrs**

**UNIT –II**
Animal Form and Function; Circulation and gas exchange; Digestive system; Excretion; Endocrine system; Reproduction and development; Nervous system

**Contact hours: 15 hrs**

**Books recommended**

**MSBT 110 BIOCHEMISTRY LABORATORY (Lab-1)**

1. To prepare an Acetic-Na Acetate Buffer system and validate the Henderson-Hasselbach equation.


4. To determine concentration of an unknown protein by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer-Lambert’s Law.

5. Titration of Amino Acids and separation of aliphatic, aromatic and polar amino acids by TLC.

6. Protein purification and separation by gel filtration, ion-exchange chromatography and SDS-PAGE.

**MSBT 111 MICROBIOLOGY AND GENETICS LABORATORY (Lab-2)**

1. Sterilization, disinfection, safety in microbiological laboratory.

2. Preparation of media for growth of various microorganisms.

3. Identification and culturing of various microorganisms.

4. Staining and enumeration of microorganisms.

5. Growth curve, measure of bacterial population by turbidometry and studying the effect of temperature, pH, carbon and nitrogen.


7. UV mutagenesis and Isolation of drug resistant mutants, transposon mutagenesis; Bacterial Conjugation.

**SEMESTER II**

**MSBT 201 CELL BIOLOGY**

**UNIT -I**

**Biomembranes:** Eukaryotic membrane structure, molecular composition, organization and synthesis, membrane transport and transporters, Fick’s law, artificial membrane and transport studies.

**Cytoskeleton:** Microfilaments, intermediate filaments and microtubules – structure and dynamics. Microtubules and mitosis; cell movements. Intracellular transport and the role of kinesin and dynein.

**Contact hours: 15 hrs**

**UNIT –II**
**Intracellular Protein Traffic**: Protein synthesis on free and bound polysomes, uptake into ER, membrane proteins, Golgi sorting, post-translational modifications.

**Cell Signaling**: Cell surface receptors; second messenger system; MAP kinase pathways. Signaling from plasma membrane to nucleus.

**Contact hours: 15 hrs**

**UNIT -III**

**Cell – Cell Adhesion and Communication**: Ca\(^{++}\) dependent cell-cell adhesion; Ca\(^{++}\) independent cell-cell adhesion. Cell junctions and adhesion molecules, movement of leukocytes into tissues.

**Cell Division and Cell Cycle**: Mitosis, meiosis, cell cycle, role of cyclins and cyclin dependent kinases, regulation of Cdk – Cycline activity, induction of cancer with respect to cell cycle.

**Contact hours: 15 hrs**

**Books recommended**


**MSBT 202 MOLECULAR BIOLOGY**

**UNIT -I**

**DNA Replication** - Prokaryotic DNA Polymerase I, II and III, Eukaryotic DNA Polymerases, Fidelity and Catalytic Efficiency of DNA Polymerases, Okazaki Fragments, Replication Origin, Primosomes, Concurrent Replication Mechanism Involving Leading and Lagging Strands of DNA; Problems associated with linear replicons.

Molecular basis of Recombination, Mutations and Repair.

**Contact hours: 15 hrs**

**UNIT -II**

**Transcription** - Prokaryotic RNA polymerase and sigma factors, Prokaryotic and eukaryotic promoters, Eukaryotic RNA Polymerases, Class I, II and III gene promoters, Enhancers and control regions of genes; Mechanism of transcription - Prokaryotic and eukaryotic, Transcription of protein coding genes.

Chromatin structure and remodeling, Histone code and histone modifications.


**Contact hours: 15 hrs**

**UNIT -III**

**Translation** - Genetic Code, Ribosome Structure, tRNAs, Aminoacyl tRNA synthetase, Initiation, Elongation, Termination; Translational Control.


**Contact hours: 15 hrs**

**Books recommended**


**MSBT 203 IMMUNOLOGY**

**UNIT –I**

**Innate Immunity** - The front line of defense against pathogens, Recognition of Pathogen associated molecular patterns by Toll like receptors, Discovery of Toll like receptors from drosophila to human, Innate Immune system of worms, flies, plants and vertebrates The nature of Toll like receptors, Signalling through Toll like receptors, Cells and molecules involved in mounting innate Immunity, The Complement system as a part of the Innate Immunity.

**Antigens** - Antigen recognition by B and T cell receptors, Nature of the antigen molecule Antigenicity, Immunogenicity, haptens, B cell and T cell epitopes, Adjuvants and routes of Immunization, Clonal expansion of B and T cells in response to antigen, T independent and dependent antigen.

**Contact hours: 15 hrs**

**UNIT -II**

**Antibody molecule** - The antibody molecule on B cell surface and its structure and function, Generation of diversity in Immunoglobulin, Isotypes, Allotypes and Idiotypes Isotype switch and affinity maturation, Monoclonal antibodies, their generation and use in diagnosis and therapy, Engineering antibody molecules for better applications.

**MHC molecules** - MHC molecules, their structure and role in antigen presentation to T cells, Antigen processing and presentation, Non-classical MHC molecules, MHC molecules and disease susceptibility, Superantigens.

**Development and Survival of B and T cells** - Generation of B and T cells in the bone marrow and thymus, Rearrangement of antigen specific receptor gene segments and control of lymphocyte development, Signaling through antigen specific receptors, Other signaling pathways, Maturation of T and B cells, their migration to lymphoid organs, their spatial distribution and survival in the lymphoid organ.

**Contact hours: 15 hrs**

**UNIT -III**

**T cell Immunity** - Antigen recognition by T cells, The antigen receptors on T cell surface, T cell receptor gene rearrangement, Antigen presentation and the role of macrophages, dendritic cells and cell surface as well as soluble mediators in activation of T cells, Activation of non classical T cells.
Soluble Mediators - Chemokines, Cytokines, Lipid mediators.

Allergy and Hypersensitivity Reactions - Allergens, sensitization and production of IgE Effector mechanisms in allergic reactions, Types of Hypersensitivity reactions and diseases arising out of them.

Contact hours: 15 hrs

Books recommended

MSBT 204 STRUCTURAL BIOLOGY

UNIT -I

Introduction and importance of Bimolecular Structures and Interactions: Basic chemical building blocks; Conformation and Configuration; Elementary concepts of thermodynamics relevant for biological systems.

Forces that determine Bimolecular Structures and Interactions: van der Waal’s and Electrostatic Interactions; Hydrogen bonding; Hydrophobic Interactions and Role of Water in Bimolecular structure; Disulphide bonds.

Techniques for structure determination: Circular dichroism, X ray diffraction and Nuclear magnetic resonance.

Contact hours: 15 hrs

UNIT -II

Amino acids and Proteins: Structures and biochemical properties of amino acids, Conformational properties of polypeptides and proteins, Definition and examples of Primary, Secondary, Tertiary and Quaternary Structures, Concept of Φ and Ψ angles and the Ramachandran Plot, Structural aspects of α- helix, β-sheet and turns in proteins, Concepts of super-secondary structures and domains in proteins, Membrane Protein structures and their properties, Folding-unfolding equilibrium and denaturation of proteins, Protein folding problem, misfolding, aggregation and amyloid structures. Structural role of molecular chaperones.
Contact hours: 15 hrs

UNIT -III


Contact hours: 15 hrs

**Books recommended**


**MSBT 205 ENZYMEOLOGY**

UNIT -I

**Scope of enzymology, classification and nomenclature** - Kinetics: chemical kinetics; Variations of velocity with [E], [S], pH and temperature; Enzyme inhibition; Bi-substrate reaction kinetics; Uses of kinetic studies in determining enzyme mechanism; Scope for increasing enzyme efficiency; enzyme specificity.

**Allostery** - Allostery cooperativity in hemoglobin; various equations and models of allostery; Regulation of individual enzyme activity and a single metabolic step.

Contact hours: 15 hrs
UNIT -II

Enzyme mechanism - Acid, base, electrostatic, metal ion, free radical, transition state binding and covalent; Proximity and orientation effects, contributions of strain; Cofactors function. Experimental approaches to determine mechanism, along with illustration with eg. chymotrypsin, lysozyme. Rationale for modification of enzyme function(s) for application.

Logic / strategies of pathway regulation; multienzyme complexes and polyfunctional proteins, their importance for cell physiology; enzyme function in vivo & in vivo kinetics. Enzyme applications.

Contact hours: 15 hrs

Books recommended


MSBT 206 VIROLOGY

UNIT -I

Viruses- Structure of animal viruses and plant viruses; Classification of animal and plant viruses; Satellite viruses; Viroids; prions; Diseases causes by animal viruses and plant viruses; Economic loss due to important viruses.

Genome organization of animal viruses; Replication of RNA viruses; Replication of DNA viruses, Genome organization of DNA and RNA plant viruses; Replication of DNA and RNA plant viruses.

Contact hours: 15 hrs

UNIT -II

Infections - Methods to diagnose animal virus infections: Electron microscopy, Tissue culture growth of viruses , Virus quantitation assays, Viral serology: ELISA, neutralization assays; Molecular methods: hybridization, PCR, real time PCR, sequencing, microarray, gene silencing and antiviral assays.

Methods to study plant viruses; Infectivity assays – Sap transmission, insect vector transmission, agroinfection (using Agrobacterium); Ultracentrifugation, Electron
microscopy, Serological methods, Immunelectrophoresis in gels, Direct double-antibody sandwich method, Dot ELISA, Immunosorbent electron microscopy (ISEM), Decoration technique, Polymerase chain reaction; DNA and oligonucleotide microarray; Gene silencing, PTGS & TGS; Viral suppressors of gene silencing.

Contact hours: 15 hrs

Books recommended


MSBT 207 BIOSAFETY AND IPR ISSUES

UNIT -I

Introduction to Intellectual Property: Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of New GMOs; International framework for the protection of IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies; Introduction to History of GATT, WTO, WIPO and TRIPS.

Concept of prior art: Invention in context of “prior art”; Patent databases; Searching International Databases; Country-wise patent searches (USPTO, EPO, India etc.); Analysis and report formation.

Basics of Patents: Types of patents; Indian Patent Act 1970; Recent Amendments; Filing of a patent application; Precautions before patenting-disclosure/non-disclosure; WIPO Treaties; Budapest Treaty; PCT and Implications; Role of a Country Patent Office; Procedure for filing a PCT application.

Contact hours: 15 hrs
UNIT -II

**Patent filing and infringement**: Patent application- forms and guidelines, fee structure, time frames; Types of patent applications: provisional and complete specifications; PCT and convention patent applications; International patenting-requirement, procedures and costs; financial assistance for patenting-introduction to existing schemes; Publication of patents-gazette of India, status in Europe and US.

Patenting by research students, lecturers and scientists-University/organizational rules in India and abroad, credit sharing by workers, financial incentives.

Patent infringement- meaning, scope, litigation, case studies and examples.

**Biosafety**: Historical Background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartagena Protocol.

**Contact hours: 15 hrs**

**Books recommended**


**MSBT 208 IMMUNOLOGY AND CELL BIOLOGY LABORATORY (Lab-3)**

- Selection of animals, Preparation of antigens, Immunization and methods of bleeding, Serum separation, Storage.
- Antibody titre by ELISA method.
- Double diffusion, Immuno-electrophoresis and Radial Immuno diffusion.
- Complement fixation test.
- Isolation and purification of IgG from serum or IgY from chicken egg.
- SDS-PAGE, Immunoblotting, Dot blot assays
- Blood smear identification of leucocytes by Giemsa stain
- Separation of leucocytes by dextran method
- Demonstration of Phagocytosis of latex beads
- Separation of mononuclear cells by Ficoll-Hypaque
- Lymph proliferation by mitogen / antigen induced
- Lymph node Immunohistochemistry (direct and indirect peroxidase assay)
- Immunodiagnostics using commercial kits
• Simple and differential staining procedures, Animal cell culture,

MSBT 209 MOLECULAR BIOLOGY AND ENZYMOLOGY laboratory (Lab-4)

• Isolation of plasmid and genomic DNA, quantitation of DNA
• Separation of DNA on Agarose gel electrophoresis
• Restriction Enzyme digestion of DNA
• Ligation and cloning in a plasmid vector
• Transformation of E.coli with standard plasmids, Calculation of transformation efficiency
• Isolation of recombinant plasmid DNA, Confirmation of the insert, Restriction mapping
• Polymerase Chain Reaction
• Isolation of Enzymes such as alkaline phosphatase from plant tissue
• Enzymatic Assays (Amylase): Determination of optimum pH,
• Effect of temperature and substrate concentration,
• Determination of Km & Vmax,
• Effect of inhibitors

SEMESTER-III

MSBT 301 COMPUTATIONAL BIOLOGY AND BIOSTATISTICS

UNIT –I

Elements of programming languages - C and PERL; Data base concept; Database management system; Database browsing and Data retrieval; Sequence database and genome database; Data Structures and Databases; Databases such as GenBank; EMBL; DDBJ; Swissprot; PIR; MIPS; TIGR; Hovergen; TAIR; PlasmoDB; ECDC; Searching for sequence database like FASTA and BLAST algorithm.

Practical exercises - Searching PubMed, Introduction to NCBI, NCBI data bases, BLAST BLASTn, BLASTp, PSI-BLAST.

Cluster analysis - Phylogenetic clustering by simple matching coefficients; Sequence Comparison; Sequence pattern; Regular expression based pattern; Theory of profiles and their use in sequence analysis; Markov models; Concept of HMMS; Baum-Welch algorithm; Use of profile HMM for protein family classification; Pattern recognition methods.

Contact hours: 15 hrs

UNIT –II
Modelling - Methods for modeling; Homology modeling; Threading and protein structure prediction; Structure-structure comparison of macromolecules with reference to proteins; Force fields; Molecular energy minimization; Monte Carlo and molecular dynamics simulation.

Practical exercises - Sequence manipulation Suite, Multiple sequence alignment, Primer designing, Phylogenetic Analysis. Protein Modeling, Protein structure Analysis, Docking, Ligplot interactions.

Contact hours: 15 hrs

UNIT -III

Introduction to Statistics: Selection of Sample or Sampling, Theory: Qualitative, Random and Non-random Sample. Collection of Data, their Classification, Tabulation, Graphic Representation and Diagrammatic Representation. Measures of Central Tendency - Mathematical Averages, Mean, Median and mode.

Statistical Analyses: Fundamental concepts in applied probability; Exploratory data analysis and statistical inference; Probability and analysis of one and two way samples; discrete and continuous probability models; Expectation and variance; Central limit theorem; Inference; Hypothesis; Critical region and error probabilities; Correlation and Regression. Tests for proportion; Equality of proportions; equality of means of normal populations (variance known, variance unknown); t-test, $\chi^2$ test for independence; P-value of the statistic; Confidence limits; Introduction to one way and two-way analysis of variance; Data transformations.

Practical exercises: Introduction to MS EXCEL-Use of worksheet to enter data, edit data, copy data, move data. Use of in-built statistical functions for computations of Mean, S.D., Correlation, regression coefficients etc. Use of bar diagram, histogram, scatter plots, etc. graphical tools in EXCEL for presentation of data. Introduction to SYSTAT package.

Contact hours: 15 hrs

Books recommended


MSBT 303  GENETIC ENGINEERING

UNIT -I

Enzymes used in Recombinant DNA Technology: Restriction Enzymes; DNA ligase, E. coli DNA polymerase I and Klenow enzyme, T4 DNA polymerase, Reverse transcriptase, Polynucleotide kinase, Alkaline phosphatase.

Methods producing labeled probe: Nick translation, Primer extension, Radioactive and non-radioactive probes.

Hybridization techniques: Northern, Southern, Western and South Western; DNA-Protein Interactions- mobility shift assay; DNasel footprinting; Methyl interference assay.

Cloning Vectors: Plasmids and plasmid vectors, new generation of plasmid cloning vectors; Lambda vectors - Insertion and Replacement vectors, Cosmids; High capacity cloning vectors - YACs; BACs and PACs; Shuttle vectors; Expression vectors - pMal, GST, pET-based vectors; Protein purification; Histag; GST-tag; MBP-tag etc.; Vectors used for cloning in animal cells - SV-40; vaccinia/baculovirus and retroviral vectors; Plant based vectors, Ti vectors.

Contact hours: 15 hrs

UNIT -II

Cloning Methodologies: Methods for construction of genomic and cDNA libraries - vectors used, generation of cDNAs, preparation of genomic DNA for library construction, Lambda in vitro packaging, Methods used in the identification and analyses of recombinant DNA clones, Protein-protein interaction and yeast two hybrid system; Phage display; Cloning for expression, Principles in maximizing gene expression.

PCR: Primer design; DNA polymerases; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, colony PCR, cloning of PCR products; Application of PCR technology.

Methods and applications of site-directed mutagenesis.

Contact hours: 15 hrs

UNIT- III
Methods for DNA Sequencing: Concept of Enzymatic and Chemical sequencing of DNA; Automated DNA sequencing; High throughput sequencing; RNA sequencing.

Gene silencing techniques: Introduction to siRNA; siRNA technology; Micro RNA; Construction of siRNA vectors; Principle and application of gene silencing; Gene knockouts.

Basic concepts in Gene Therapy and vectors used. Transgenics - plants and animals; Methods for analysis of gene expression - genomics and proteomics.

Contact hours: 15 hrs

Books recommended


MSBT304 PLANT BIOTECHNOLOGY

Unit I

Plant Tissue Culture: Historical perspective; Totipotency; Organogenesis; Somatic embryogenesis; Regulation and applications; Artificial seed production; Micropropagation; Somaclonal variation; Androgenesis and its applications in genetics and plant breeding; Germplasm conservation and cryopreservation.

Agrobacterium-plant interaction; Virulence; Ti and Ri plasmids; Opines and their significance; T-DNA transfer; Disarming the Ti plasmid.

Genetic Transformation: Agrobacterium-mediated gene delivery; Cointegrate and binary vectors and their utility; Direct gene transfer - PEG-mediated, electroporation, particle bombardment and alternative methods; Screenable and selectable markers; Characterization of transgenics; Chloroplast transformation; Marker-free methodologies; Gene targeting.

Contact hours: 15 hrs
Unit II

**Molecular Mapping & Marker Assisted Selection (MAS):** Quantitative and qualitative traits; MAS for genes of agronomic importance, e.g. insect resistance, grain quality and grain yield; Molecular polymorphism, RFLP, RAPD, STS, AFLP, SNP markers; Construction of genetic and physical map; Gene mapping and cloning; QTL mapping and cloning.

**Strategies for Introducing Biotic and Abiotic Stress Resistance/Tolerance:**
Bacterial resistance; Viral resistance; Fungal resistance; Insects and pathogens resistance; Herbicide resistance; Drought, salinity, thermal stress, flooding and submergence tolerance.

**Contact hours: 15 hrs**

Unit III

**Genetic Engineering for Plant Architecture and Metabolism:** Seed storage proteins; Protein engineering; Vitamins and other value addition compounds; Source-sink relationships for yield increase; Post-harvest bioengineering; Plant architecture; Flowering behaviour.

**Plants as Biofactories:** Concept of biofactories; Fermentation and production of industrial enzymes, vitamins and antibiotics and other biomolecules; Cell cultures for secondary metabolite production; Production of pharmaceutically important compounds; Bioenergy generation.

**Plant Genomics:** Identification of candidate genes using genetic information (positional cloning), Using biochemical and expression analysis (microarray analysis, proteomics, metabolomics); Characterization and functional analysis of candidate genes: transformation, mutant populations, knockout systems; Heterologous expression systems; Protein analysis; Bioinformatics and databases; Genoinformatics.

**Contact hours: 15 hrs**

**Books recommended**

MSBT 305 ANIMAL BIOTECHNOLOGY

Unit I

Animal cell culture: Requirements for animal cell, tissue and organ culture; Primary culture, secondary culture; Continuous cell lines; Suspension cultures; Somatic cell cloning and hybridization; Transfection and transformation of cells.

Contact hours: 15 hrs

Unit II

Animal cloning: Basic concepts; Applications of cloning of farm animal and endangered species; in situ and ex situ preservation of germplasm; in utero testing of foetus for genetic defects; Pregnancy diagnostic kits; Anti-fertility animal vaccines.

Transgenic animal technology and its applications; Gene therapy, Viral vectors used for gene transfer, Generation and use of gene knockouts, RNAi technology.

Contact hours: 15 hrs

Unit III

Hybridoma technology: Applications in diagnostics and therapy; Approaches to development of vaccines. Phage display technology for production of antibodies.

Social, Cultural, Economical, Legal and IPR issues in animal biotechnology.

Contact hours: 15 hrs

Books Recommended

- Ian R. Gordon, Reproductive Technologies in Farm Animals, CAB Intl., 2005.
MSBT 306 DEVELOPMENTAL AND STEM CELL BIOLOGY

UNIT I


Contact hours: 15 hrs

UNIT II

Differentiation: Cellular basis of differentiation, trans-differentiation, metaplasia and regeneration.

Growth and post embryonic development: Apoptosis, aging and senescence, abnormal development. Evolutionary developmental biology, environmental effects on development.

Contact hours: 15 hrs

UNIT III

Stem cell biology: Applications, types of stem cells, hematopoietic stem cells, maintenance of stemness and control of differentiation, characterization and expansion, inducible pleuripotent stem cells. ES cell technologies, Concept of Cell replacement therapy and regenerative medicine.

Contact hours: 15 hrs

Books recommended

MSBT 306 PROJECT

MSBT 307 JOURNAL CLUB PRESENTATION

MSBT 308 GENETIC ENGINEERING  (Lab-5)

1. Isolation of genomic DNA from bacteria/yeast
2. PCR amplification of a gene and its analysis by agarose gel electrophoresis
3. Isolation of plasmid DNA
4. In vitro DNA ligation and transformation of E. coli.
5. Characterization of transformants: DNA gel electrophoresis,
6. Restriction map Analysis.
7. Southern blot analysis.
8. Isolation of cytoplasmic RNA.
10. Electrophoresis of RNA on denaturing gels.
11. RT-PCR technique

MSBT 309 PLANT AND ANIMAL BIOTECHNOLOGY (Lab-6)

Plant tissue culture techniques

- Introduction to plant tissue culture technique: Surface sterilization and media preparation. Role of additives in different explant culture.
- Effect of plant growth regulators on various explants for callus induction, Cell suspension culture, growth analysis, cell plating efficiency.
- Organogenesis and Somatic embryogenesis.
- Shoot tip and nodal sector culture.

Animal tissue culture techniques

- Introduction to cell culture medium and the function of different components of the medium on cell growth.
- Familiarisation with tissue culture laboratory and P1 to P4 facilities.
- Preparation of glass wares and media for cell culture.
- Development and maintenance of cell lines.
- Serum and protein free media and their applications.
• Application of animal cell culture techniques in hybridoma culture and Stem cell research.

SEMESTER IV

MSBT 401  FERMENTATION TECHNOLOGY AND DOWNSTREAM PROCESSING

UNIT I

Growth rate parameters: Specific growth rate, doubling time, validity of exponential growth law, growth yield, metabolic quotient, Effect of substrate concentration, Monod growth Kinetics, Determination of $K_s$, Definition of lag period.
Factors influencing choice of method; Dry and wet mass, volume, yields, metabolic rates light scattering cell count.

Batch & Plug Flow Culture: Open and closed systems, growth phases, Mathematical model of simple batch culture, variations in actual practice plug flow culture with and without feedback.

Chemostat Culture: General principle, Balance equations critical dilution rate, Biomass productivity, comparison with batch cultures, residence time distribution, Test of validity, imperfect mixing, wall growth Transient state analysis.


Contact hours: 15 hrs

UNIT II


Scale up Principles: Methods of scale up and their analysis.

Process Control: Measurement and control of bioprocess parameters like temp., D.O., speed, pH, antifoam etc., Basic principles of feedback control.

Contact hours: 15 hrs
UNIT III

Downstream processing: Bioseparation - filtration, centrifugation, sedimentation, flocculation; Cell disruption; Liquid-liquid extraction; Purification by chromatographic techniques; Reverse osmosis and ultra filtration; Drying; Crystallization; Storage and packaging; Treatment of effluent and its disposal.

Contact hours: 15 hrs

Books recommended


List of Elective Courses [MSBT 402, MSBT 403]
1. Human Molecular Genetics
2. Human Physiology
3. Genomics and Proteomics
4. Advanced Immunology

UNIT I

HUMAN MOLECULAR GENETICS

Genes in pedigrees: Behaviour of monogenic, oligogenic and polygenic; traits/diseases Behavior and characteristics of the patterns of inheritance of the DNA sequence, Allelic, locus and clinical heterogeneity; Complementation study through pedigrees.

Complications to the basic pedigree pattern: Complications to the basic pedigree patterns: pseudodominant, pedigree patterns, nonpenetrance, imprinting, anticipation, germ line and somatic mosaicsims.

Mutations: Difference between polymorphism and mutations; Types of mutations; Mutations and DNA repair associated syndromes, Molecular pathology – evaluation of pathogenic mutations; Database of pathogenic mutations.

Contact hours: 15 hrs
UNIT II

**Organization of human genome and genes:** General organization of human Genome-Nuclear and Mitochondrial, Mitochondrial Genome organization, Mitochondrial mutations and myopathies.

**Nuclear Genome Organization:** size and banding of human chromosomes; distribution of tandems and interspersed repetitive DNA, Gene distribution and density in human nuclear genome, Organization of genes: rRNA encoding Genes, mRNA encoding Genes, small nuclear RNA genes, Overlapping genes, genes within genes, multigene families, pseudo genes, truncated genes and gene fragments

**Gene mapping:** Mapping: physical and genetic; Strategies in identifying human disease genes: Human Genome project – History and Reality; Techniques and Technology involved in genome mapping- low and high resolution mapping; Strategies and milestones in mapping and sequencing of human genome approaches to physical and genetic mapping; Principles and strategies for identifying unknown disease or susceptibility genes; Beyond genomics – the physical and genetic mapping the post genomic era.

**Contact hours: 15 hrs**

UNIT III

Potential of using animal models for human diseases, Types of animal models, Transgenic animals- generation, detection and use in the study of different diseases, Genes in Pedigrees, Complex diseases.

New approaches to treating disease- Treatment of genetic disease ; gene therapy; methods for inserting and expressing a gene in a target cell or tissue; Methods for repairing or inactivating a pathogenic gene in a cell or tissue; Some examples of attempts at human gene therapy; Cancer genetics- evolution of cancer; Oncogenes; Tumor suppressor genes; stability of the genome; control of the cell cycle.

Evolution of human genome; Molecular phylogenetics and comparative genomics; Evolution and migration of human populations.

**Contact hours: 15 hrs**

**Books recommended**

• Anthony J. F. Griffiths, Susan Wessler; Sean B Carroll; John Doebley. An Introduction to Genetic Analysis, Freeman, 10th edition 2012.
• T. Strachan, Andrew P. Read, Human molecular genetics, Garland Science, 2004

HUMAN PHYSIOLOGY

UNIT I

Digestive System: Food Intake and Regulation, Digestive Processes, Enzymes and Secretions in the Oral Cavity and their Functions, Stomach and Intestine, Digestive Glands and their Regulation, Disorders and Homeostatic Imbalances.

Cardiovascular System: Formed Elements of Blood, Blood Plasma, Blood Groups, Blood Coagulation, Homeostasis, Heart and Cardiac Cycle, Origin, Conduction and Regulation of Heart Beat, Cardiac Disorders, Lymphatic System

Contact hours: 15 hrs

UNIT II

Respiratory System: Exchange of Gases, Transport of Gases, Control and Regulation of Respiration, Disorders.


Contact hours: 15 hrs

UNIT III

Uro-Genital System: Mechanism of Urine Formation and Regulation, Haemodialysis and Homeostatic Imbalances In Excretion, Reproductive Cycles, Fertilization, Implantation, Nidation and Placentation and Regulation of Fertility.

Skeletal System: Components of Skeletal System; Skeletal Organization; Axial and Appendicular System; Bone Structure and Function, Development and Growth.
Contact hours: 15 hrs

Books recommended


GENOMICS AND PROTEOMICS

UNIT I

Genomes: History of genomics, DNA based phylogenetic trees, genomes and human evolution, evolution of nuclear, mitochondrial and chloroplast genomes, the concept of minimal genome and possibility of synthesizing it, genetic maps, physical maps, EST and transcript maps, exomes, comparative genomics and colinearity, synteny in maps.

Whole Genome sequencing and analysis: Genome sequencing methods review, analysis of the genomes of viruses, bacteria, archaea, eukaryotic – fungi, parasites, plant genomes (Arabidopsis and rice), Animal genomes (fruit fly, mouse, human).

Contact hours: 15 hrs

UNIT II

Annotation of whole genome sequence and functional genomics: In Silico methods, insertion mutagenesis, Targeting Induced Local Lesions in Genomes (TILLING), management of data, gene expression and transcript profiling, EST, contigs and unigene sets, use of DNA chips and microarrays.

Pharmacogenomics: Use in biomedicine involving diagnosis and treatment of diseases, genomics in medical practice, personalized medicine, DNA polymorphism and treatment of diseases, Application of SNP-technology-mapping genes underlying
monogenic and multigenic disorder, use of SNP in pharmacogenomics, pharmacogenomics and industry.

**Contact hours: 15 hrs**

**UNIT III**

**Proteomics:** Introduction and overview of tools used in proteomics studies, protein - protein interaction, DNA- Protein interaction, application of quantitative proteomics for the analysis of protein - protein interactions and interactomes, two-hybrid systems, mass spectrometry for the analysis of protein complexes, their significance and limitations.

**Drug Discovery and Development:** Structure prediction and human proteomics, mutant proteins, use of computer simulations and knowledge-based methods in the design process, proteomic methods for the detection and analysis of protein biomarkers for diseases, De-novo design; making use of databases of sequence and structure, protein structure and drug discovery, proteins in diseases, current issues, drug targets, drug efficacy, protein chips and antibody microarray techniques in cancer research.

**Contact hours: 15 hrs**

**Books recommended**

- Dubitzky, Werner; Granzow, Martin; Berrar, Daniel P. *Fundamentals of Data Mining in Genomics and Proteomics*, Springer-Verlag (Eds.) 2007.

**ADVANCED IMMUNOLOGY**

**UNIT I**

**Immune response in infection:** Infectious agents and how they cause diseases, Innate immune response giving cue to adaptive immune response. The humoral response to infection, Generation of neutralizing antibodies and control of infection, Adaptive immune response to infection, the role of CD4+ and CD8+ and other T cells, The mucosal immune response, Generation of Immunological memory, Immune response in
Bacterial, parasitic and viral infections, Study of host pathogen interactions, Mechanisms of pathogen survival in an immune competent host, Indicators of protective immunity, Immune modulation and failure of host defense mechanisms in infection.

Contact hours: 15 hrs

UNIT II

Auto immunity and Transplantation reactions: Nature of Immune response to self
Prevention of such responses, Genetic and Environmental basis of auto immune response
Immunological mechanisms of transplant rejection, Mechanisms of transplant survival,
Immunodeficiency diseases, Genetic basis of Immunodeficiency, Acquired Immune
deficiency.

Tumor Immunology: Failure of the Immune system in Cancer, Immune modulation for control of Cancer, Immuno therapy for Cancer.

Contact hours: 15 hrs

UNIT III

Vaccines: Approaches for vaccine development, New Vaccine development, Live Vaccine, Peptide Vaccine, Naked DNA vaccine, Subunit Vaccine, Delivery of Vaccine through mucosal route, Adjuvants for Vaccine, Failures of vaccines.

Contact hours: 15 hrs

Books recommended


**MSBT 404 Elective III: Social science**

The choice of courses for MSBT 404 are:

- Principles and practices of Management, MBA 101
- Entrepreneurship theories and practices, MBA 207
- Marketing management, MBA 201

**MSBT 405 Seminar**

**MSBT 406 Project**

**MSBT 407 Project presentation**