PROGRAM SPECIFICATIONS OF THE
POST GRADUATE PROGRAMS OFFERED BY THE DEPARTMENT

1. Name of the program: Master of Science in Biotechnology

2. Specializations available:

- Elective papers for M.Sc. III semester students (Bioprocess Technology, Genomics and Proteomics, Molecular Diagnostics, Food Technology). Any one of these electives is to be opted by each candidate.
- In M.Sc. IV semester, the Department offered Skill Development course for students which includes following elective papers: Plant metabolic Engineering, Gene Therapy & Nanomedicine, Industrial & Fermentation Technology, Immuno-techniques, Entrepreneurship Management in Biotechnology, Environmental Biotechnology. Any two of these electives is to be opted by each candidate.

3. Program Specifications

School of Studies:	School of Interdisciplinary Education and Research
Department:	Biotechnology
Program:	M.Sc. (Biotechnology)
Head of the Department:	Dr. Renu Bhatt
Date of Approval in Board of Studies:	13.04.2017
Date of Last revision:	2017
Next revision due:	2020

4. Mode of Study: Full time (Semester system)
Class room teaching; experiential learning; tutorials; experimental laboratory training; one semester major project (dissertation) in final semester, and industrial training.

Back ground and purpose of the course:

Creativity is the rule of nature based on innovative thoughts. Biotechnology has the potential to combine the knowledge of basic biology of the natural diversity and innovative technologies to create or evolve novel processes or novel products beneficial for human welfare. Biotechnology has emerged as the most important vehicle for solving the problem of health, food and agricultural issues. The need for qualified human resource for various biotechnology based industries is the driving force to design and implement M.Sc. program in Biotechnology. A sound knowledge of biotechnology is thought to play an important role in the upcoming years to encourage the modern biology driven developmental efforts. There is a need for qualified and competent post graduate students with sound knowledge of Biotechnology in general and specialized technology such as recombinant DNA technology, fermentation technology, bioinformatics, cell and tissue culture, etc in particular. The Department of Biotechnology offers the M.Sc. (Biotechnology) course with an outcome based curriculum emphasizing the Critical, Analytical and Problem Solving skills to equip the students to pursue their scientific and research career with better preparedness and matured professional outlook. The presence of other allied Faculties of the University

provides additional exposure to students the multi-disciplinary approach which is emerging as a key differentiator in the success of modern biology and biotechnology based endeavours. The overall purpose of the course is to impart quality education in the field of Biotechnology and to create trained Biotechnologist.

Learning outcome

M.Sc. Biotechnology is a four-semester course spread over the period of two years. It is designed to offer in depth knowledge of the subject starting from its basic concepts of biotechnology to the state of art technologies used in molecular biology, recombinant DNA technology, microbial technology, animal and plant tissue culture and bioinformatics. Students are also provided extensive laboratory training on the course content and the current requirements of industries as well as research and development sectors. In the final semester every student has to undertake a dissertation project, which is essential for strengthening the hands on skill and analytical thinking in designing and solving a problem relevant to modern biology. In addition the course caters to the requirements of providing complete exposure to NET/SET syllabus for Life Sciences. Advantages of the course include: -

- The course revised in the year 2019 and implemented from the academic session of July 2019 provides exposure to the students to the technologies in-vogue and trains them to take up projects relevant to the industrial needs as well as research and development activities and self-employment opportunities.
- The student after passing the M.Sc. in Biotechnology course has many opportunities of employment, self-employment and higher studies.

Knowledge gained

After completing the program, a student is expected to attain -

- Substantial knowledge in biotechnology, basic knowledge in molecular biology, recombinant DNA technology, microbial technology and knowledge in supported fields like bioinformatics, biostatistics, animal and plant tissue culture etc.
- Some research experience within a specific field of biotechnology, through a faculty supervised Master Dissertation (project).
- Advanced knowledge in some areas of biotechnology (Field of specialization).
- Gets significant exposure of various domains and contemporary research within various fields of biotechnology.

Skills

The students are inculcated -

- The background and experience required to design, analyze, and solve advanced problems in biotechnology.
- Is able to apply advanced theoretical and/or experimental methods, including the use in applied fields of modern biology.
- Can combine and use knowledge from several disciplines (multidisciplinary approach).
- Can critically and independently assess and evaluate research methods and results.
- Has the ability to develop and renew scientific competence independently,

- Is able to enter new problem areas that require an analytic and innovative approach.
- Can disseminate subject matter and results to both specialists and a broader audience.

General competence

The candidate -

- Understands the role of biotechnology in society and has the background to consider ethical problems.
- Knows the historical development of biotechnology, its possibilities and limitations, and understands the value of lifelong learning.
- Is able to gather, assess, and make use of new information.
- Has the ability to successfully carry out advanced tasks and projects, both independently and in collaboration with others, and also across disciplines.
- Has an adequate background for pursuing pedagogic education.
- Has an international perspective on her/his discipline.

M.Sc. (Biotechnology)

PROGRAMME SPECIFIC OBJECTIVES:

- To develop strong student competencies in biotechnology and its applications in a technology-rich, interactive environment.
- To develop strong student skills in research, analysis and interpretation of problems and information relevant to modern biology.
- To prepare the students to successfully compete for employment in biotechnology based research and development sectors, industrial sectors and teaching, and to offer a wide range of experience in research methods, data analysis to meet the industrial needs.

Programme outcomes: on completion of program, the graduates will

- Apply knowledge and skill in the design and development of solutions for problems relevant to modern biology to cater the needs of biotechnology industries.
- Become professionally trained in the area of molecular biology, recombinant DNA technology, microbial technology, animal and plant tissue culture, bioinformatics etc.
- Excel in the research related to biotechnology and quality control of biologicals.
- Demonstrate highest standards of critical, interpersonal and communication skills as well as a commitment to life-long learning.

Course Specific Objectives & Learning Outcomes		
Course Code	**Course name**	**Objectives and Learning outcomes**
LBTC 701	**Cell Biology**	**Course Specific Objective** • The objective of this course is to provide a guide in the basic, fundamental and detailed concepts of Cell Biology. This M.Sc. course is designed for introducing students the ideas and techniques of cell biology that are applicable in all the areas of life sciences. As cell is the basic unit of life, it is essential to understand its biology for students of biotechnology as well as other life science subjects. The aim of this subject is to strengthen the knowledge of the candidate desired to work on the basic as well as applied aspects of biology. **Course Specific Outcome:** After successful completion of the course student will be able to understand • Structural organization of bio-membrane, overview of membrane transport, active and passive transport, facilitated transport. • Targeting, modifications and folding of proteins • Cell signalling molecules and signal transduction pathways • Eukaryotic cell cycle, model organism to study cell cycle, Regulation of cell cycle, Cell death and its regulation.

		• Biology of cancer and carcinogenesis
LBTC 702	**Microbiology**	**Course Specific Objective** • To introduce the concepts of microbiology in a stimulating, elegant, exhaustive and explanatory manner. • To aware students about history and scope of microbiology • To learn the method of cultivation and enumeration of microbes from environment • To understand the ecology of micro-organisms • To understand the nutritional requirements of micro-organisms • To understand microbial growth and population kinetics • To understand mechanism of gene transfer and genetic recombination in bacteria **Course Specific Outcome:** After successful completion of the course student will be able to understand • Major characteristics used in microbial taxonomy • Current methods of microbial identification • Ultrastructure of bacteria, algae, protozoa and viruses • Phototrophic, mixotrophic, saparophytic, symbiotic and parasitic microorganisms • Methodology for measuring growth and growth regulation in microbes • Physical and chemical control of microbes • Transformation, transduction and conjugation in bacteria
LBTC 703	**Biochemistry (Regulation & Metabolism)**	**Course Specific Objective** • The objective of this course is to provide a guide in the basic, fundamental and detailed concepts of biochemistry. • To understand the metabolism and its regulation in living world **Course Specific Outcome:** After successful completion of the course student will be able to understand • Basic concepts of catabolic and anabolic reactions in organisms • Glycolytic pathways, Citric acid cycle, Electron transport chain, Oxidative phosphorylation, Synthesis of ATP and other energy rich compounds • Nitrogen acquisition and assimilation • Biosynthesis of carbohydrate, lipid, nucleotide, amino acid and proteins
LBTC 704	**Recombinant DNA Technology**	**Course Specific Objective** • To introduce the concepts of recombinant DNA technology in a stimulating, elegant, exhaustive and explanatory manner. • To understand the technique of gene manipulation and

		gene cloning **Course Specific Outcome:** After successful completion of the course student will be able to understand • Isolation and quantification of nucleic acids (DNA and RNA) • Amplification of DNA using polymerase chain reaction • Principles of nucleic acid hybridization and blotting techniques • Methods of DNA sequencing • Procedure of gene manipulation and cloning • Use of Restriction endonucleases in gene cloning
LBTC 705	**Laboratory based on LBTC 701 and LBTC 702**	**Course Specific Objective** • The objective of this course is to provide hands on training of experiments of Cell Biology and Microbiology. **Course Specific Outcome:** After successful completion of the course student will be able to perform • Microscopic observation of eukaryotic and prokaryotic cells and their counting • Discrimination between live and dead cells and calculation of percent cell viability • Preparation of culture media for growth of bacteria and fungi • Isolation and cultivation of microbes from different environments
LBTC 706	**Laboratory based on LBTC 703 and LBTC 704**	**Course Specific Objective** • The objective of this course is to provide hands on training of experiments of Biochemistry and Recombinant DNA Technology. **Course Specific Outcome:** After successful completion of the course student will be able to perform • Separation and estimation of biomolecules (carbohydrate, protein and lipid) • Cloning of gene in plasmid based vectors • Insertion of plasmid vector inside competent bacteria using transformation techniques • Screening and selection of bacteria transformed with recombinant DNA
LBTC 801	**Molecular Biology**	**Course Specific Objective** • To introduce the concepts of molecular biology in a stimulating, elegant, exhaustive and explanatory manner. • To aware students about history and scope of molecular biology **Course Specific Outcome:** After successful completion of the course student will be able to understand

		• Central dogma of biology • Mechanism of replication (synthesis of DNA), transcription (synthesis of RNA) and translation (synthesis of proteins) • Control and regulation of gene expression at transcription and translation level • Causes and consequences of DNA damage • Mechanism and significance of DNA damage repair
LBTC 802	**Immunology**	**Course Specific Objective** • The objective of this course is to provide a guide in the basic and detailed concepts of immunology. Understanding the concept of immunology is essential to strengthen the knowledge of the candidate desired to work on the field of health care research, development and manufacturing. **Course Specific Outcome:** After successful completion of the course student will be able to understand • Introduction, history and scope of Immunology • Cells, organs and molecules of immune system • Nature and biology of antigens. Structure and function of antibodies. Kinetics of antigen and antibody interaction • Immunity to infectious agents, autoimmunity, hypersensitivity, transplantation, tumor immunology, vaccination • Hybridoma technology and production of monoclonal antibody
LBTC 803	**Biotechniques**	**Course Specific Objective** • The objective of this course is to provide detailed knowledge of techniques used in biological research and industries. Understanding biotechniques is essential to strengthen the knowledge of the candidate desired to work in the field of biotechnological research, development and manufacturing. Learning biotechniques is important for students of all fields of life sciences. **Course Specific Outcome:** After successful completion of the course student will be able to understand • Principles and applications of microscopy • Principles and applications of centrifugation • Applications of different spectroscopic techniques in biology • Applications of chromatographic techniques in biology • Principle and application of electrophoresis and blotting • Nature and types of radiations and their application in structural and functional analysis of biological samples
LBTC 804	**Enzymology and Enzyme**	**Course Specific Objective** • The objective of this course is to provide a guide in the

	Technology	basic and detailed concepts of enzymology and enzyme technology. Enzymes catalyze biological reactions. If one wants to work on production and synthesis of industrially important biological substance it is very essential for him/her to understand the nature of enzymes and type of reactions they catalyze. **Course Specific Outcome:** After successful completion of the course student will be able to understand • Introduction, nomenclature and classification of enzymes • Enzyme kinetics and mechanism of action of enzymes • Enzyme technology: immobilization of enzymes, commercial production of enzymes, enzyme engineering, design and construction of novel enzymes. • Application of enzymes in medicine (therapeutic enzymes, enzymes as analytical reagents), drug synthesis and biosensors.
LBTC 805	**Laboratory based on LBTC 801 and LBTC 802**	**Course Specific Objective** The objective of this course is to provide hands on training of experiments of Molecular Biology and Immunology. **Course Specific Outcome:** After successful completion of the course student will be able to perform • Isolation of DNA, RNA and proteins • Electrophoretic separation of nucleic acid and proteins • DNA amplification by polymerase chain reaction • Blood group typing • Immunodiffusion techniques
LBTC 806	**Laboratory based on LBTC 803 and LBTC 804**	**Course Specific Objective** • The objective of this course is to provide hands on training of experiments of Biotechniques and Enzymology and Enzyme Technology. **Course Specific Outcome:** After successful completion of the course student will be able to perform • Microscopic observation of biological samples • Centrifugation of biological samples to separate them in various fractions • Chromatographic separation of Biomolecules • Electrophoresis of nucleic acids and proteins • Qualitative and quantitative analysis of solutions using spectrophotometer • Isolation, purification, estimation and characterization of enzymes
LBTC 901	**Plant Biotechnology**	**Course Specific Objective** • The objective of this course is to provide detailed knowledge of plant biotechnology for crop improvement. India is an agrarian country. Plant

		biotechnologist aims for production of high yielding plants, biotic and abiotic stress tolerant plant to suffice the need of increasing population. This course is designed to nurture future plant biotechnologist. **Course Specific Outcome:** After successful completion of the course student will be able to understand • Concept of cellular totipotency • Introduction to the techniques of plant tissue culture • Plant genetic engineering • Agrobacterium mediated gene transfer in plants • Molecular mechanism of photosynthesis and nitrogen fixation • Green house technology
LBTC 902	**Microbial Biotechnology**	**Course Specific Objective** • The objective of this course is to provide detailed knowledge of microbial biotechnology. The course is designed considering the fact that microbes are the simplest and cheapest biological factory for production of industrially important products. **Course Specific Outcome:** After successful completion of the course student will be able to understand • Scope and techniques of microbial technology • Production of proteins, enzymes, polysaccharides and other biopolymers in bacteria, yeast and fungus • Production of products of recombinant DNA in microbes • Application of microbes as biocontrol agents • Utilization of plant biomass by microorganisms
LBTC 903	**Animal Biotechnology**	**Course Specific Objective** • The objective of this course is to provide detailed knowledge of animal biotechnology. This course is designed to provide detailed knowledge of technique of animal cell and tissue culture and how cultured cells can be used as a factory for production of useful products specifically for health care. **Course Specific Outcome:** After successful completion of the course student will be able to understand • Scope of animal biotechnology • Introduction to the balanced salt solutions and growth medium for animal cell and tissue culture • Basic techniques of mammalian cell cultures *in vitro* • Biology and characterization of the cultured cells • Measuring parameters of growth • Applications of animal cell culture
LBTC 904	**Elective (a): Bioprocess Technology**	**Course Specific Objective** • The objective of this course is to provide detailed knowledge of bioprocess technology. This elective

		course is designed to guide students who wish to work in industries where biologically important chemicals/food and dairy products/pharmaceuticals are produced in bioreactors/fermenters using live cells as factory. **Course Specific Outcome:** After successful completion of the course student will be able to understand • Introduction to bioprocess engineering • Designing of a fermenter/Bioreactor • Media formulation for industrial fermentation • Types of fermentation process • Downstream processing in bioprocess technology • Industrial production of biochemicals • Food Biotechnology: Food spoilage and preservation process
LBTC 905	**Elective (b): Genomics and Proteomics**	**Course Specific Objective** • The objective of this course is to provide detailed knowledge of genomics and proteomics. This elective course is designed for those who wish to understand the interspecies and intraspecies similarity and diversity at the molecular level. Understanding the entire repertoire of DNA, RNA and protein is essential for understanding all the phenotypes or traits (such as susceptibility to disease, response to a drug) of an organism. **Course Specific Outcome:** After successful completion of the course student will be able to understand • Genomics, transcriptomics, proteomics and metabolomics • Genome sequencing, microarray and protein analysis • Human genome project • Application of genomics and transcriptomics in system biology, disease diagnosis and treatment
LBTC 906	**Elective (c): Molecular Diagnostics**	**Course Specific Objective** • The objective of this course is to provide detailed knowledge of diagnosis and treatment of disease at molecular level. This elective course is designed for those who wish to work in biomedical research and development. Understanding the entire repertoire of DNA, RNA and protein is essential for understanding all the phenotypes or traits (such as susceptibility to disease, response to a drug) of an organism. **Course Specific Outcome:** After successful completion of the course student will be able to understand • Techniques of DNA based diagnosis and treatment • Techniques of immunological diagnosis and treatment • In situ nucleic acid hybridization and amplification • Kits used in modern disease diagnosis laboratory

		• Significance of human genome project in diagnosis at molecular level
LBTC 907	**Elective (d): Food Technology**	**Course Specific Objective** • The objective of this course is to provide detailed knowledge of food processing and food biotechnology. This elective course is designed for those students who wish to build their career in food production and processing industries. Moreover this course will also make students aware about social and regulatory aspects of food biotechnology **Course Specific Outcome:** After successful completion of the course student will be able to understand • Scope of food processing and food biotechnology • Role of microbes in food production, food spoilage and food preservation • Bio-conversion of raw food material and food wastes into value added products • Alternative food products - mushrooms, single cell protein, aquaculture, microbes as food products • Application of Molecular methods in food Production • Regulations for food industries
LBTC 908	**Laboratory based on LBTC 901 and LBTC 902**	**Course Specific Objective** • The objective of this course is to provide hands on training of experiments of Plant Biotechnology and Microbial Biotechnology. **Course Specific Outcome:** After successful completion of the course student will be able to perform • Preparation of culture media for plant tissue culture • Aseptic inoculation and incubation of explant in culture media under controlled environment • Isolation and preservation of industrially important microorganisms • Microbial biomass production
LBTC 909	**Laboratory based on LBTC 903 and LBTC 904 / LBTC 905 / LBTC 906 / LBTC 907**	**Course Specific Objective** • The objective of this course is to provide hands on training of experiments of Animal Biotechnology and elective courses (Bioprocess Technology, Genomics and Proteomics, Molecular Diagnostics, and Food Technology). **Course Specific Outcome:** After successful completion of the course student will be able to perform • Preparation of balanced salt solution and media for animal cell culture • Developing primary cell culture • Maintenance of cell culture, cell passaging • Observation of morphology of cultured cells

		• Measurement of cell viability and cytotoxicity • Experiments based on elective courses (Bioprocess Technology, Genomics and Proteomics, Molecular Diagnostics, and Food Technology)
LBTC 1001	**Bioinformatics & Statistics**	**Course Specific Objective** • The objective of this course is to provide detailed knowledge of bioinformatics and biostatistics. Understanding the concept of statistics is necessary for researchers to test their hypothesis and to analyse their experimental data to make firm conclusions. Learning bioinformatics is also necessary as modern biological research is greatly accelerated by use of computers. **Course Specific Outcome:** After successful completion of the course student will be able to understand • Introduction, scope and application of bioinformatics • Searching database and locating genes • Alignment of gene and protein sequences • Analysis of DNA sequence • Designing primers of specific gene • Generating phylogenetic trees based on DNA sequence and evolutionary relationship • Prediction of protein structure • Computer assisted drug design • Diagrammatic, graphical and tabular representations of data • Measures of central tendency, dispersion, skewness and kurtosis. • Regression and correlation • Basic concepts of hypothesis testing
LBTC 1002	**Elective (a): Plant Metabolic Engineering**	**Course Specific Objective** • The objective of this course is to provide detailed knowledge of **Plant Metabolic Engineering**. Understanding the concept of plant secondary metabolites and its biosynthetic pathways is necessary for researchers so that they can engineer plants for enhanced production of biochemicals or for production of novel biochemicals. Learning this course is also necessary for students who wish to join industries that use plants for synthesis of biochemicals with medicinal and other values. **Course Specific Outcome:** After successful completion of the course student will be able to understand • Introduction, scope and application of plant metabolic engineering • The concept of secondary metabolites • Flavonoid, terpenoid and polyketoid pathways

		• Importance of secondary metabolites in horticulture, agriculture and medicine • Production of secondary metabolites from plant cell cultures • Plant therapeutic proteins, edible vaccines, and bio-plastics.
LBTC 1003	**Elective (b): Gene Therapy &Nanomedicine**	**Course Specific Objective** • The objective of this course is to provide detailed knowledge of gene therapy and nanomedicine. Gene therapy is promising to cure diseases that are caused by defective or faulty genes. Nanomedicines are gaining much attention for their effectiveness as drug and drug-carriers. **Course Specific Outcome:** After successful completion of the course student will be able to understand • Introduction and scope of gene therapy and nanomedicine • Clinical management of metabolic disorders • Strategies of gene therapy • Vectors used in gene therapy • Stem cell and tissue engineering • Types of nanoparticles and their development • Health and Environmental impact of Nanotechnology
LBTC 1004	**Elective (c): Industrial & Fermentation Technology**	**Course Specific Objective** • The objective of this course is to provide detailed knowledge of industrial biotechnology and fermentation technology. This course is useful for those students who wish to build their career in biotechnology industries specifically those industries where products are synthesized in fermenters and bioreactors. **Course Specific Outcome:** After successful completion of the course student will be able to understand • History and scope of microbial biotechnology • Fermenter / bioreactor design and media formulation for industrial fermentation processes • Production of microbial enzymes and their applications • Microbes in mining, bioleaching and oil recovery • Application of microbes in pharmaceutical industry • Role of microorganisms in the production and transformation of food and beverages • Fermented vegetables, pickles, fermented dairy products, - fermented milk, cheese, butter and other milk products. • Spoilage and preservation of milk. • Microbes as bio-fertilizers
LBTC 1005	**Elective (d): Immunotechniques**	**Course Specific Objective** • The objective of this course is to provide detailed

		knowledge of immunological techniques used in research, clinical and pathological labboratories. **Course Specific Outcome:** After successful completion of the course student will be able to understand • Introduction to antigen and antibody interaction • Immunological assays based on molecular binding on solid support • Immune response to bacterial, parasitic and viral infections • Vaccination, immunoinformatics and vaccine design • Microscopic methods based on antigen antibody interactions • Manipulation of the immune response: Regulation of unwanted immune responses and immunomodulation against autoimmunity, transplantation rejections, cancer therapy, congenital and acquired immunodeficiency • Adoptive cell transfer therapy • in vitro and in vivo cell imaging techniques • Molecular diagnosis of immunological disorders
LBTC1006	**Elective (e): Entrepreneurship Management in Biotechnology**	**Course Specific Objective** • The objective of this course is to provide detailed knowledge of entrepreneurship and management for opening and running a biotechnology based company / industry. **Course Specific Outcome:** After successful completion of the course student will be able to understand • Concept of entrepreneur • Nature and characteristics of management • Business opportunity identification process, project cycle and its management, project identification, project appraisal, project closure report • Structure of a biotechnology company, start-up of biotechnology company, new product development, market research, sales & marketing principles • Institutional support system for small scale sectors • Intellectual property rights and protection • Ethical and Other Legal Issues in Biotechnology
LBTC1007	**Elective (f): Environmental Biotechnology**	**Course Specific Objective** • The objective of this course is to provide detailed knowledge of environmental biotechnology. Environmental pollution is increasing day by day which demands for implementation of strategies that can detoxify the hazardous pollutants and restore the environment. This course will teach about the biotechnological measures for restoring environment. **Course Specific Outcome:** After successful completion of the

		course student will be able to understand • Components of environment • Interaction of human and environment • Global environmental problems - green house effect, acid rain, ozone depletion, salination, biodiversity loss, chemical and radiation hazards • Environmental pollution and degradation • Environmental Management • Bioremediation
LBTC 1008	**Dissertation**	**Course Specific Objective** • The hands on training through one full semester project with the Master Thesis gives special expertise within one of the research areas represented at The Department of Biotechnology, GGV **Course Specific Outcome:** • This dissertation programme provides the candidate with knowledge, general competence, and analytical skills on an advanced level, needed in industry, consultancy, education and research

Course Structure of M.Sc. Biotechnology Department of Biotechnology, Guru Ghasidas Vishwavidyalaya, Bilaspur 495009 (C.G.)			
Semester	**Course code**	**Subject**	**Marks**
I	LBTC 701	Cell Biology	100
	LBTC 702	Microbiology	100
	LBTC 703	Biochemistry (Regulation & Metabolism)	100
	LBTC 704	Recombinant DNA Technology	100
	LBTC 705	Laboratory based on LBTC 701 and LBTC 702	100
	LBTC 706	Laboratory based on LBTC 703 and LBTC 704	100
II	LBTC 801	Molecular Biology	100
	LBTC 802	Immunology	100
	LBTC 803	Biotechniques	100
	LBTC 804	Enzymology and Enzyme Technology	100
	LBTC 805	Laboratory based on LBTC 801 and LBTC 802	100
	LBTC 806	Laboratory based on LBTC 803 and LBTC 804	100
III	LBTC 901	Plant Biotechnology	100
	LBTC 902	Microbial Biotechnology	100
	LBTC 903	Animal Biotechnology	100
	LBTC 904	Elective (a): Bioprocess Technology	100
	LBTC 905	Elective (b): Genomics and Proteomics	100
	LBTC 906	Elective (c): Molecular Diagnostics	100
	LBTC 907	Elective (d): Food Technology	100
	LBTC 908	Laboratory based on LBTC 901 and LBTC 902	100
	LBTC 909	Laboratory based on LBTC 903 and LBTC 904 / LBTC 905 / LBTC 906 / LBTC 907	100
IV	LBTC 1001	Bioinformatics & Statistics	100
	LBTC 1002	Elective (a): Plant Metabolic Engineering	100
	LBTC 1003	Elective (b): Gene Therapy &Nanomedicine	100
	LBTC 1004	Elective (c): Industrial & Fermentation Technology	100
	LBTC 1005	Elective (d): Immunotechniques	100
	LBTC1006	Elective (e): Entrepreneurship Management in Biotechnology	100
	LBTC1007	Elective (f): Environmental Biotechnology	100
	LBTC 1008	Dissertation	200

COURSE CONTENT M.Sc. (BIOTECHNOLOGY)

FIRST SEMESTER

CORE-1: CELL BIOLOGY (LBTC 701)

Unit-1
Structural organization of Biomembrane, Overview of Membrane Transport, Active and passive transport. Facilitated transport of glucose and water, ATP powered pumps, Ion channels, Resting membrane potential, Symporters and antiporters.

Unit-2
Intracellular protein transport, Protein targeting to and across the ER Membrane, Insertion of membrane proteins into the ER, Protein Modifications and folding in the ER. Protein targeting to cell organells, Molecular Mechanisms of Vesicle mediated protein.

Unit-3
Signalling molecules and cell surface receptor, second messenger, intracellular signal transduction pathway (DAG, Ca^{+2}, c-AMP, G-Proteins), MAKK, Notch, TGF-beta, Jak-STAT signaling pathway.

Unit-4
Eukaryotic cell cycle, model organism to study cell cycle, Regulation of cell cycle, Cell death and its regulation.

Unit-5
Tumor Cells and the Onset of Cancer, Oncogenic Mutations in Growth-Promoting Proteins, Mutations Causing Loss of Growth-Inhibiting and Cell-Cycle Controls, Role of Carcinogens and DNA Repair in Cancer.

Suggested Readings
1. Cell (A Molecular approach): Cooper GM
2. Cell and Molecular Biology: Karp G, 3. Cell Biology: Sadava DE
4. Cell and Molecular Biology: Kish VM and Kleinsmith LJ
5. Cell and Molecular Biology: deRobertis and deRobertis
6. Molecular cell Biology: Lodish H, Berk A, Zipursky SL, Paul M and Darnell J

CORE- 2: MICROBIOLOGY (LBTC 702)

Unit-1

History and Scope of Microbiology, Major characteristics used in microbial taxonomy (numerical and molecular), Current methods of microbial identification (16s rRNA,Gene sequencing, House keeping genes).

Unit-2

Cultivation and enumeration of microbes from environment, Ultrastructure of bacteria, algae, protozoa and viruses,Ecology of micro-organisms

Unit-3

Nutritional requirements of micro-organisms, mode of nutrition, phototrophy, mixotrophy, saparophytic, symbiotic and parasitic organisms

Unit-4

Microbial growth and population kinetics, methodology for measuring growth and growth regulation, Physical and chemical control of microbes

Unit-5

Mechanism of gene transfer and genetic recombination in bacteria: transformation, transduction, conjugation

CORE-3: BIOCHEMISTRY (REGULATION & METABOLISM) (LBTC 703)

Unit-1

Metabolism: basic concepts and design. Coupled reactions, Interconnecting reactions, Electron transport, Oxidative phosphorylation, energetics of chemolithotrops and autotrophs, Synthesis of ATP and other energy rich compounds

Unit-2

Glycolytic pathways, Citric acid cycle, energy production, Carbohydrate Biosynthesis, Glyoxylate cycle, Gluconeogenesis, Glycogenolysis

Unit-3

Nitrogen acquisition and assimilation,Biosynthesis of Aromatic and Aliphatic amino acids in brief Assimilation of amino acids, Mechanism of transamination reaction, Amino acid oxidation and production of urea, Urea cycle Pathways of amino acid degradation

Unit-4

Lipid biosynthesis, *de Novo*biosynthesis, biosynthesis of unsaturated fattyacids, Biosynthesis of membrane lipids and steroids, Essential fatty acids and biosynthesis of eicosanoids, Degradation of fatty acids, β oxidation, ω oxidation

Unit-5

de Novo and salvage pathway of synthesis of purine and pyrimidine bases, Feedback regulation of nucleotide biosynthesis. Catabolism of purine and pyrimidine

Suggested Readings

1. Lehninger Principle of Biochemistry: Nelson & Cox
2. Biochemistry: LubertStryer
3. Text Book of Biochemistry: Devlin, Thomas M
4. Biochemistry: Geoffery, Zubay
5. Basic Biological Chemistry: Mahler and Cordes
6. Harper's Review of Physiological Chemistry: Murray RK, Mayes PA, Gramner DK
8. Biochemistry: KeshavTrehan Wiley Eastern Publications
9. Fundamentals of Bochemistry: JL Jain S Chand and Company
10. Fundamental of Biochemistry: Dr. AC Deb

CORE-4: RECOMBINANT DNA TECHNOLOGY (LBTC 704)

Unit-1

Isolation of DNA and RNA, Quantification of nucleic acids, Polymerase chain reaction, Principle of hybridization, Northern blotting, Southern blotting, Western blotting, South-Western blotting, RFLP, RAPD, AFLP, Radiolabelling of nucleic acids: End labelling, nick translation, labelling by primer extension, DNA sequencing: Maxam-Gilbert (Chemical) and Sanger- Nicolson (dideoxy/ enzymatic) sequencing method, Pyrosequencing

Unit-2

Restriction endonucleases: Types of restriction endonucleases, classification and uses. Analysis of restriction fragments, Restriction mapping, DNA modifying enzymes, Nucleases, Polymerases, Phosphatases and Polynucleotide kinase

Unit-3

Introduction to cloning: Generalized cloning schemes, host genotypes specificities and applications, strategies for selection and screening (Introduction to marker and reporter genes, positive and negative selection, insertion inactivation, α complementation).

Unit-4

Cloning vectors; Plasmid, Bacteriophage, and other vectors, Cosmid expression vectors, DNA ligases; Joining of DNA Fragments *in vitro*, cohesive and blunt end ligation, linkers, adaptors, Homo polymer tailing, Preparation of the Gene construct, Construction of genomic and c-DNA libraries,

Unit-5

Strategies of gene delivery, expression in bacteria and yeast, expression in insects cells, expression in mammalian cells, expression in plants, *in vitro* translation, Chromosome engineering, Site directed mutagenesis, Targeted gene replacement, gene editing, gene regulation and gene silencing

LABORATORY-1 (BASED ON CORE-1 & CORE-2) (LBTC 705)

Experiments based on Cell Biology and Microbiology are to be performed as assigned by the department.

LABORATORY-2 (BASED ON CORE-3 & CORE-4) (LBTC 706)

Experiments based on Biochemistry and Recombinant DNA Technology are to be performed as assigned by the department.

SECOND SEMESTER

CORE-1: MOLECULAR BIOLOGY (LBTC 801)

Unit-1
DNA replication, Unit of replication, Enzymes involved in DNA replication, replication origin and replication fork, fidelity of replication, Mechanism of DNA replication. Inhibitors of DNA replication.

Unit-2
Transcription, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation.

Unit-3
Ribosome, Translation, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, Mechanism of translation, translational inhibitors, Post- translational modification of proteins.

Unit-4
Control of gene expression at transcription and translation level (regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, Epigenetic regulation, Genomic Imprinting.

Unit-5
DNA damage, DNA repair, DNA damage and repair mechanisms, homologous and site-specific recombination,

Suggested Readings
1. Cell (A Molecular approach): Cooper GM
2. Cell and Molecular Biology: Karp G
3. Cell Biology: Sadava DE
4. Cell and Molecular Biology: Kish VM and Kleinsmith LJ
5. Cell and Molecular Biology: deRobertis and deRobertis
6. Molecular cell Biology: Lodish H, Berk A, Zipursky SL, Paul M and Darnell J

CORE-2: IMMUNOLOGY (LBTC 802)

Unit-1

Introduction and History of Immunology; Organization and structure of lymphoid organs; Cells and molecules of Immune system; Hematopoiesis; innate and acquired immunity, Clonal nature of immune response, Phylogeny of Immune system

Unit-2

Nature and Biology of antigens and super antigens, Antigenicity and immunogenicity; Kinetics and antigen and antibody interaction; Antibody structure and function, Immmunoglobulin gene and Generation of antibody diversity, antigen and antibody interactions-based assays, Hybridoma Technology and monoclonal antibody, Antibody engineering and SCFVs.

Unit-3

Complement System-Activation and regulation; Structure and function of various cytokines and their receptor; Antigen presenting cells; Structure and functions of MHC and HL-A system; Antigen processing and presentation.

Unit-4

T – cell receptor-CD3 complex; Development and differentiation of T cells; Positive and negative regulation; Development and differentiation of B cells; B Cell receptors; Cell mediated cytotoxicity: T cytotoxic cells, Natural Killer (NK) Cells, Antibody dependent cell Cytotoxicity (ADCC), Macrophage-mediated cytotoxicity. Immunological tolerance, Immunosenescence. Immunodeficiency.

Unit-5

Autoimmunity, Hypersensitivity; Transplantation, Immunity to infectious agents, Tumor Immunology, Vaccination

Suggested Readings

1. Essensials of Immunology: Roitt IM
2. Immunology: Kuby
3. Advanced Immunology: Male D, Champion B. Cooke A. and Owen M.
4. Principle and practice of Immunoassay: Christopher P. Price and David J
5. Culture of Animal cell- Ian: Freshney
6. Elements of Biotechnology: Gupta PK
7. Immunolgy : Rao CV

CORE- 3: BIOTECHNIQUES (LBTC 803)

Unit-1

Microscopy: Principles and applications, simple, compound, phase-contrast and fluorescent microscopes. Electron microscopy: SEM and TEM. X-Ray Crystallography, X-ray diffraction, Bragg equation. Application in structural analysis of biomolecules, Centrifugation Techniques: Principles, types of centrifuges, density gradient centrifugation in isolation of cells, cell organelles and biomolecules.

Unit-2

Electromagnetic spectrum, Beer Lambert's Law. Photometry, UV/VIS Spectrophotometry, Infrared spectroscopy, Atomic absorption spectroscopy, ESR and NMR spectroscopy. Mass spectroscopy (LC-MS, GC-MS, MALDI - TOF). Fluorescent spectroscopy. Applications of different Spectroscopic techniques in Biology

Unit-3

Introduction and types of chromatography, paper, thin layer, gas, Gel permeation, ion-exchange, HPLC, FPLC and affinity chromatography and instrumental details of each. Applications of Chromatographic techniques in Biology

Unit-4

Paper and gel electrophoresis, Polyacrylamide gel electrophoresis (native and SDS). Agarose gel electrophoresis. Immunoelectrophoresis. Principle and application of blotting (Southern, Western and Northern and South Western blotting). ELISA

Unit-5

Nature and types of radiations, preparation of labeled biological samples. Detection and measurement of radioactivity, GM counter, Scintillation counter, Autoradiography, Safety measures in handling radioisotopes. RIA, Non radiolabelling. Role of ionizing and non ionizing radiation in Structural and functional analysis of biological sample

Suggested Readings:

1. Nuclear Magnetic Resonance:(2007) Williams
2. Biochemical Techniques theory and practice: (2009) White R
3. Analytical Chemistry: (2000) Christion G. D.
4. A Biologist Guide to Principle and Techniques: (2009) Willson K. and Gounding K.H.
5. An Introduction to Practical Biochemistry:(2008) Plummer D. T.

CORE- 4: ENZYMOLOGY AND ENZYME TECHNOLOGY (LBTC 804)

Unit-1

Introduction to enzymes, enzyme nomenclature, classification of enzymes and enzyme commission numbers. Concept of active centre, binding sites, stereospecificity and ES complex formation. Isolation and purification of enzymes, preparation of purification chart, Enzyme activity, Specific activity and turn over number, Marker enzymes.

Unit-2

Enzyme Kinetics: Steady state, pre-steady state, equilibrium kinetics, Michaelis and Menten,lineweaver-burk, Eadie–Hofstee equationand its derivation, Different methods to calculate the K_m and V_{max} and their significance.

Unit-3

Factor affecting enzyme activity and catalysis: pH, subsrate and enzyme concentration, temperature, coenzyme and cofactorsetc, Mechanism of action of enzymes involving two/more substrates. Role of metal ions in enzyme catalysis. Enzyme inhibition, different types of inhibitors and activators.

Unit-4

Structure and function of enzymes: Lysozyme, chymotrypsin, proteases. Enzyme regulation and control of their activity. Introduction to allosteric enzymes and isozymes.

Unit-5

Enzyme Technology: Immobilization of enzymes, whole cell immobilization and their application, commercial production of enzymes, RNA-catalysis, abzymes, Protein and Enzyme enginering: Design and construction of novel enzymes. Enzymes used in drug synthesis, biosensors. Application of enzymes in medicine (therapeutic enzymes, enzymes as analytical reagents)

Suggested reading:

1. Enzyme Kinetics (2009) Palmer
2. IUPAC Enzyme nomenclature series.
3. Enzyme kinetics: Dixon W. B.
4. General Enzymology :Kulkarni & Deshpande
5. Enzyme Assays:J. Raymond
6. Biochemistry: Voet and Voet
8. Lehninger Principles of Biochemistry by Nelson, Cox
9. Fundamentals of Enzymology Third edition, Nicholas C. Price and Lewis Stevens

LABORATORY-1 (BASED ON CORE-1 & CORE-2) (LBTC 805)

Experiments based on Molecular Biology and Immunology are to be performed as assigned by the department.

LABORATORY-2 (BASED ON CORE-3 & CORE-4) (LBTC 806)

Experiments based on Biotechniques and Enzymology and Enzyme Technology are to be performed as assigned by the department.

THIRD SEMESTER

CORE-1: PLANT BIOTECHNOLOGY (LBTC 901)

Unit-1

Introduction to the techniques of plant tissue culture, Concept of cellular totipotency, Nutritional requirements, single cell culture, micro-propagation, somaclonal variation, somatic embryogenesis and production of embryoids

Unit-2

Haploid and double haploid production, Protoplast isolation and culture, Somatic hybridization and cybrid production and their applications in crop improvement, Productions of virus free plants using meristem culture

Unit-3

Basis of tumor formation, hairy roots, features of Ti and Ri plasmids, mechanisms of transformation, binary vectors, use of 35S and other promoters, genetic markers, use of reporter genes, transformation on monocots, Transgene stability and gene silencing, Herbicide and insect resistance , Plant Genetic Engineering: Transgenic plants, Genetically modified (GM) plants (Bt cotton, Bt Brinjal)

Unit-4

Photoregulation and phytochrome regulation of nuclear and chloroplast genes expression, Molecular biology of light and dark reactions of photosynthesis, Molecular mechanism of nitrogen fixation, Genetics of *nif*genes

Unit-5

Plant secondary metabolites: Control mechanisms and manipulation metabolic pathways of production of alkaloids and industrial enzymes, biodegradable plastics, therapeutic proteins, Edible vaccines, purification strategies, Green house Technology, Biotic and Abiotic stress

Suggested Readings

1. Plant Tissue Culture: MK Razdan and SS Bhojwani
2. Genetic Transformation of Plants: Jackson JF, Linskens H
3. Plant Tissue Culture Concepts and Laboratory Exercises: Robert N Trigiano, Dennis JGray
4. Applied and fundamental Aspects of Plant Cell, Tissue, and Organ Culture: Reinert J and Bajaj
5. Elements of Biotechnology:: PK Gupta

CORE-2: MICROBIAL BIOTECHNOLOGY (LBTC- 902)

Unit-1
Microbial biotechnology, scope and techniques, Bioprospecting of microbial diversity, Isolation and preservation of industrially important microorganisms.

Unit-2
Genomics, Transcriptomics, Proteomics, Metabolomics, metagenomics and Systems Biology. Definition, methodology and application in Microbial technology. Functional enzymes.

Unit-3
Production of proteins and enzymes in bacteria, yeast and fungus, recombinant and synthetic vaccines. Microbial polysaccharides and polymers. Microbial resources for biopolymer production.

Unit-4
Microbes as biocontrolagents microbial insecticides (Baculoviruses,entomopathogenic fungi, *Bacillus thurinigiensis*, *Bacillus sphaericus*, *Bacillus popilae*, Microbe derived inhibitors. Entamopathogenic viruses (Baculovisus, Nuclear Polyhedrosis Virus)

Unit-5
Microbial biomass production, utilization of plant biomass by microorganisms (lignocellulose biodegradation). Application of ligninolyticmicrorganisms and enzymes in biodegradation of recalcitrant xenobiotics

Suggested reading:

1. Microbial Biotechnology (2006) Alexander n. Glazer Hiroshi Nikaido W.H.Freeman and Company
2. Molecular Biotechnogy: Principles a nd Applications of Recombinant DNA –(2011) Bernaral R.
3. Glick and Jack J. Pastemak ASM Press. Washington, D.C (2004).
4. Fungal Ecology and Biotechnogy (2003) RastogiPublicaions, Meerut.

CORE-3: ANIMAL BIOTECHNOLOGY (LBTC 903)

Unit-1

Introduction to the balanced salt solutions and simple growth medium. Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium, Serum & protein free defined media and their applications.

Unit-2

Primary and secondary cell culture, Development of cell lines, Biology and characterization of the cultured cells. Basic techniques of mammalian cell cultures *in vitro*.

Unit-3

Maintenance of cell culture, Cell Passaging, Measuring parameters of growth, Measurement of viability and cytotoxicity.

Unit-4

Cell synchronization, Cell transformation, Apoptosis, Cryopreservation, Common cell culture contaminants.

Unit-5

Applications of animal cell culture: cell culture based products, vaccines, Hybridoma technology and monoclonal antibodies, stem cells and their applications, Animal cloning, IVF technology, Organ, organotypic and histotypic cultures.

Suggested Readings

1. Culture of Animal Cells: Freshney
2. Animal Cell Culture: John RW Masters
3. Animal Cell Culture Techniques: Martin Clynes
4. Transgenic Animals: Generation and Use: Louis-Marie Houdebine

ELECTIVE (A): BIOPROCESS TECHNOLOGY (LBTC-904)

Unit-1

Introduction to bioprocess engineering, bioreactors, isolation, preservation and maintenance of industrial microorganisms, kinetics of microbial growth and death, media formulation for industrial fermentation.Designing of a fermenter/Bioreactor, Air and media sterilization.

Unit-2

Types of fermentation process, analysis of batch fed batch and continuous bioreactions, stability of microbial reactors, specialized bioreactors (pulsed, fluidized, photo bioreactors etc.), Measurement and control of bioprocess parameters

Unit-3

Downstream processing, removal of microbial cells and solid matters, foam separation, precipitation, filtration, centrifugation, cell disruption, liquid-liquid extraction, chromatography, membrane process, drying and crystallization

Unit-4

Industrial production of chemicals: solvents (acetone, butanol). Microbial production of Bioflavourant and Biocolourant antibiotics (penicillin, streptomycin, tetracycline) amino acids (lysine, glutamic acid)

Unit-5

Food Biotechnology: Food spoilage and preservation process. Causative organisms and process. Physical and chemical preservation process. Dairy products, wine, beer and other alcoholic Beverages. Mushroom-types, isolation and culture

Suggested Readings

1. General Microbiology: Sullia SB and Shantharam S
2. Microbial Biotechnology: Glaser AN and Nilaido
3. Industrial Microbiology: Prescott & Dunn
4. A text of Industrial Microbiology: Crueger W and Crueger A
5. Priciples of Fermentation Technology: Stanbury PF, Ehitaker H, Hall SJ
6. The Handbook of Microbial Bioresources by V.K. Gupta, G.D. Sharma

ELECTIVE (B): GENOMICS AND PROTEOMICS (LBTC 905)

Unit-1

Genomics:Omics and importance, Genome sequencing, Shotgun sequencing, Whole Genome sequencing, Human Genome project.

Unit-2

Transcriptomics:DNA Microarray for analysis of gene expression patterns. cDNA based and oligonucleotide based DNA microarray. Application in system biology and disease diagnosis. Single nucleotide polymorphisms, Predictive genomic medicine.

Unit-3

Proteomics:Proteome- General Account, Isoelectric focusing, Protein profiling by one Dimensional and 2 Dimensional gel electrophoresis, Detection and quantitation of proteins in gels,Pros and cons of various staining methods, Image analysis of 2D gels, Application of 2D PAGE.

Unit-4

Basics of mass spectrometry, Tandem MS/MS spectrometry, MALDI TOF and ESI, and theirapplication in proteomics, Peptide sequencing by tandem mass spectrometry. Protein microarrays, Yeast two hybrid system, Clinical and biomedical application of proteomics

Unit-5

Metabolomics: Metabolomics: Definition, History, Tools, Databases and the Applications.

Suggested Readings

1. Genome 3: TA Brown,
2. Principals and Techniques of Biochemistry and Molecular Biology: Wilson and Walker
3. Proteomics: R Twyman
4. Metabolomics: M Tomita and T Nishioka

ELECTIVE (C): MOLECULAR DIAGNOSTICS (LBTC 906)

Unit-1

Southern, northern, dot/slot blot; electrophoresis, nucleic acid probe preparation, DNA sequencing, interpretation, troubleshooting.

DNA amplification techniques and applications including reverse transcriptase (RT)-PCR, in situ PCR, mutational analysis: PCR, sample preparation, experimental design, primers, controls, product detection

Unit-2

Ligase chain reaction, nucleic acid sequence-based amplification, branched DNA detection. Introduction to common approved kits and their applications. RT-PCR, relative RT-PCR, competitive RT-PCR: experimental design, controls, kits, and specialized applications. RACE, RNA fingerprinting

Unit-3

Immunological Diagnostics: agglutination, RIA, ELISA's, immunofluorescence, Western blots --Bioluminescence

Unit-4

PCR-based mutation detection: single-stranded conformational polymorphism analysis, heteroduplex analysis, denaturing gradient gel electrophoresis, chemical cleavage, ribonuclease cleavage; allele-specific and multiplex PCR; competitive oligonucleotide priming, protein truncation

Unit-5

In situ nucleic acid hybridization and amplification: ISH, FISH, ISA. Applications and limitations; DNA chips, automation, gene therapy; applications in diagnosis of genetic disorders, human genome project, ethical considerations

Suggested Reading:

1. Immunology: Kuby
2. Molecular Diagnostics: For the Clinical Laboratorian Hardcover: William B. Coleman, Gregory J. Tsongalis
3. Fundamentals of Molecular/Diagnostics: David E. Bruns, Edward R. Ashwood 4. Molecular Biotechnology: Pasternak
5. Textbook of Clinical Chemistry and Molecular Diagnostics: Carl A. Burtis, Edward R. Ashwood, David E. Bruns
6. Introduction to Molecular Diagnostics (DX-INSIGHTS)
7. Biophysical chemistry: Upadhya&Nath
8. A Biologist Guide to Principle and Techniques: Willson K and Gounding KE

ELECTIVE (D): FOOD TECHNOLOGY (LBTC 907)

Unit-1
Introduction to Food Biotechnology, Application Biotechnology to food stuffs, Food Processing Biotechnology, Unit Operation in Food Processing Unit Operation, Quality factors of Food, food Deterioration and its control.

Unit-2
Application of Molecular methods in food Production, Methods of molecular cloning in food, Techniques for development of new plant varieties, GMO as food.

Unit-3
Microbial Biotechnology in Food Products, Role of microbes in food products, Microbial Food Spoilage; Use of microbes for production of food (Yeast; Bacteria and other microorganism-based process)

Unit-4
Raw material for food and its modification, Bio conversion of food raw material, Conversion of food waste in value added products, (conversion of Whey, molasses, starch and etc.)

Unit-5
Alternative food products- Mushrooms, Single cell protein, Aqua culture, Microbes as food product, etc. Social and Regulatory aspects of Food Biotechnology, Regulations for food industries

LABORATORY-1 (BASED ON CORE-1 & CORE-2) (LBTC 908)

Experiments based on Plant Biotechnology and Microbial Biotechnology are to be performed as assigned by the department.

LABORATORY-2 (BASED ON CORE-3 & ELECTIVES) (LBTC 909)

Experiments based on Animal Biotechnology and elective subject (Bioprocess Technology / Genomics and Proteomics / Molecular Diagnostics / Food Technology) are to be performed as assigned by the department.

FOURTH SEMESTER

CORE-1: BIOINFORMATICS & STATISTICS (LBTC 1001)

Unit-1

Introduction to Bioinformatics, Searching database and locating genes, Alignment of gene sequences, Local and Global. Analysis of DNA sequence, Finding and calculating core nucleotide sequence, Predicting ORFs, location of transcription start point and end point, getting polypeptide sequence of the extracted core nucleotide sequence, application of bioinformatics.

Unit-2

Designing primers of specific gene, generation of restriction maps, Generating phylogenetic trees based on DNA sequence and evolutionary relationship Analysis of proteins: Protein classification, homology modeling, trading, prediction of protein structure (secondary and 3 dimensional), tools for structure prediction, validation and visualization.

Unit-3

Computer assisted drug design- concept, methods and practical approaches, various computational methods applied to design the drugs: QSAR and 3DQSAR methods, CADD software demonstration

Unit-4

Diagrammatic, graphical and tabular representations of data; measures of central tendency, dispersion, skewness and kurtosis. Linear regression, Pearson correlation coefficient and Rank correlation

Unit-5

Basic concepts of hypothesis testing, two kinds of error, level significance, p value, t- Test for mean and difference between two means, partial t-test., and Chi square test for goodness of fit. Analysis of variance for one way and two way classified data

Suggested Readings

1. Bioinformatics primers : Gribskov, M. and Devereux, J.
2. Bioinformatics: Sequence and Genome Analysis By David W. Mount, University of Arizona, Tucson
3. Discovering Genomics, Proteomics, & Bioinformatics, Second Edition By A. Malcolm Campbell, Davidson College; Laurie J. Heyer, Davidson College; With a Foreword by Francis S. Collins
4. Biostatistics:P.N.Arora ,P.K.Malha
5. Introductory statistics for Biology: Bishop Martin
6. Molecular databases for protein and sequence and structure studies: SillinceA. and Sillince M.

ELECTIVE (A): PLANT METABOLIC ENGINEERING (LBTC 1002)

Unit-1

The concept of secondary metabolites, Historical and current views, Importance of secondary metabolites in medicine and agriculture, Introduction to various pathways

Unit-2

Flavanoid pathway: The basic structure, Stereochemistry, Chemical synthesis of different intermediates, The biochemical pathway, Different regulatory points, Intermediate pools and their significance in horticulture, agriculture and medicine, Regulatory genes, Regulation of gene expression

Unit-3

Terpenoid pathway: The basic structure, Stereochemistry, Chemical synthesis of different intermediates, The biochemical pathway, Different regulatory points, Intermediate pools and their significance in horticulture, agriculture and medicine, Regulatory genes, Regulation of gene expression

Unit-4

Polyketoid pathway: The basic structure, Stereochemistry, Chemical synthesis of different intermediates, The biochemical pathway, Different regulatory points, Intermediate pools and their significance in horticulture, agriculture and medicine, Regulatory genes, Regulation of gene expression

Unit-5

Production of secondary metabolites from plant cell cultures; Processes for enhancing the production of secondary metabolites. Technology of plant cell culture for production of chemicals; Bioreactors systems and models for mass cultivation of plant cells, Plant Therapeutic proteins, Edible vaccine, Bioplastic.

Suggested reading:

1. Tissue Culture: Bhan
2. Plants from test tubes. An introduction to Micropropogation: Lydiane Kyte & John Kleyn
3. A test book book on Biotechnology: Kumar H.D
4. Applied and fundamental Aspects of Plant Cell, Tissue and Organ Culture: Reinert J. and Bajaj Y.P.S

ELECTIVE (B): GENE THERAPY & NANOMEDICINE (LBTC 1003)

Unit-1
Clinical management and Metabolic manipulation – Diabetes, Phenylketouria, Familial Hyper- cholesterolemia, Rickets, ADA, Congenital hypo-thyroidism

Unit-2
Gene therapy – Molecular basis of disease and disease model, Ex-vivo, In-vivo, In-situ gene therapy, Strategies of gene therapy: gene augmentation, 'Vectors used in gene therapy - retrovirus, adenoviruses, Herpes 'Synthetic vectors liposomes, receptor mediated gene transfer, Gene therapy trials, HLA typing, Graft rejection.

Unit-3
Stem cell and tissue engineering: plastic surgery, Embroynic and adult stern cell, Potential use of stem cells - Cell based therapies

Unit-4
Types of nanoparticles and their development, uses in Nanomedicine and therapeutically applications in medical biotechnololgy

Unit-5
Health and Environmental impact of Nanotechnology:Special emphasis to risk assessment and risk management of nanomaierials, ethical and legal aspects of nanotechnology, and nano-industry and nano-entrepreneurship.

Suggested Reading:
1. Molecular Biotechnology: Pasternak
2. Diagnostic and Therapeutic Antibodies: Methods in Molecular Medicine by Andrew JT George, Catherine E Urch.
3. Molecular Diagnosis of Infectious Diseases (Methods in Molecular Medicine):Jochen Decker, U. Reischl Amazon.
4. Human Molecular Genetics: T. Strachan, Andrew Read Amazon Sales Rank
5. Essentials of Epidemiology in Public Health: Ann Aschengrau, George R, III Seage
6. Animal form and Function, Breneman: Sidhwick &Jacson
7. Animal physiology: Goger Eckert
8. Mamal Ecology: Blakie

ELECTIVE (C): INDUSTRIAL & FERMENTATION TECHNOLOGY (LBTC 1004)

Unit-1
History and scope of microbial biotechnology, the bioreactor/fermenter-types and parts, scale-up, media design for fermentation processes, Economic aspects of fermentation

Unit-2
Biotechnological application of microorganisms, Production of chemicals and pharmaceuticals (bioconversion), Production of microbial enzymes and their applications, Microbes in mining-Bioleaching, oil recovery, Application of microbes inpharmaceutical industry

Unit-3
Role of microorganisms in the production and transformation of food and beverages, Food fermentation - Bread leavening by yeast and other micro-organisms, chemicalleavening, brewing: Manufacture of Beer- microbiological aspects. Wine - Kinds of wines, manufacture, microbial spoilage, Distilled liquors. Vinegar -methods of manufacture

Unit-4
Fermented vegetables - Pickles - Fermented dairy products — Fermented milk, cheese, butter and other milk products - spoilage of milk - preservation of milk.

Unit-5
Biofertilizers- manufacture, formulation and utilization, Microbes as Biofertilizers - Chemically fixed Nitrogen versus biologicallyfixed Nitrogen, biopesticides.

Suggested Readings
1. Microbial Biotechnology: Alexandern, Glazer Hiroshi Nikaido
2. Molecular Biotechnology: Principles and Applications of Recombinant DNA:Bernaral R Glick and Jack J. Pasternak
3. Principles of Fermentation Technology:Whittaker & Stan bury
4. Bioprocess Engineering Principles Operational Modes of Bioreactors, BIOTOL series - Butter worth, Heinemann
5. Bioreactor Design and Product Yield, BIOTOL series - Butter worth Heinemann
6. Bioprocess Engineering : Systems, Equipment & Facilities : LydersenNA Delia and KM Nelson,
7. Bioseparationand Bioprocessing: Subramaniam,G

ELECTIVE (D): IMMUNOTECHNIQUES (LBTC 1005)

Unit-1

Introduction to antigen and antibody interaction; Methods for generation of antibody; Monoclonal antibody and Hybridoma technology; Antibody engineering and ScFvs, Abzymes, Immunoprecipitation based methods; Agglutination based techniques; Immunological assays based on molecular binding on solid support (RIA, ELISA, ELISPOT, Western blotting) Methodological options and considerations. Methods for determination of Antigen antibody affinity: Equilibrium dialysis; SPR

Unit-2

Microscopic methods based on antigen antibody inetarctions: Immunocytochemistry, Immunohistochemistry, immunoelectronmicroscopy, Imagining techniques based on immunofluorescence: immunofluorescence microscopy; Confocal microscopy, Intravital imagining methods. Isolation and enrichment of specific immune cells, Flow-cytometer and FACS for quantitative/qualitative analysis and sorting of different immune cell subsets, Magnetic Activated Cell Sorting, Techniques for cell cycle analysis, Assays for apoptosis and cell death, Cell functional assays-lymphoproliferation, Cell-mediated cytotoxicity, mixed lymphocyte reaction, Detection of apoptosis

Unit-3

Immune response and bacterial, parasitic and viral infections, Immunization, strategies: Vaccination; Recombinant DNA and protein based vaccines, Peptide vaccines, conjugate vaccines; Passive Immunization: Antibody, Transfusion of immuno-competent cells, Stem cell therapy; Cell based vaccines, edible vaccines; Immunoinformatics and vaccine design

Unit-4

Manipulation of the immune response: Regulation of unwanted immune responses and immunomodulation against autoimmunity, transplantation rejections, cancer therapy, congenital and acquired immunodeficiency; tolerance and autoimmune diseases, Transplantation and Tumor Immunology, diagnosis and therapeutic approaches. Cytokine related diseases: diagnosis and therapeutic application of cytokines

Unit-5

Adoptive cell transfer therapy; Animal models: Transgenic mice and gene knockout by targeted disruption, in vivo cell tracking techniques, Cell imaging techniques-in vitro and in vivo. Molecular diagnosis of immunological disorders: ex. DiGeorge syndrome, humoral immunodeficiency, cellular immunodeficiency (due to defects in IFNg receptor a and b chain, MHC Class I)

Suggested Readings

1. Immunobiology: Kenneth Murphy
2. Cellular and Molecular Immunology: Abbas AK, Lichtman AH and Pillai S
3. Immunology: Kuby
4. Essential Immunology: Roit I

ELECTIVE (E): ENTREPRENEURSHIP MANAGEMENT IN BIOTECHNOLOGY (LBTC1006)

Unit-1
Concept of entrepreneur, nature of entrepreneur, entrepreneurial characteristics, function of an entrepreneur, role of entrepreneurship in developing economy

Unit-2
Nature and characteristics of Management, Scope and Functional areas of management, Management V/s Administration, Roles of Management, Levels of Management, Basic managerial functions, management as profession.

Unit-3
Business opportunity: Business opportunity identification process, project cycle and its management, project identification, project appraisal, project closure report.

Unit-4
Structure of a Biotechnology Company, Start-up of Biotechnology Company, New Product Development, Market Research, Sales & Marketing Principles, Institutional support system for small scale sector, SIDO, NSIC, SIDBI, SIBRI, BCIL

Unit-5
Intellectual Property Principles in Biotechnology, Health Care Overview and Role of Government in Biotechnology, Ethical and Other Legal Issues in Biotechnology, national and international policies on Biotechnology

Suggested Readings
I. Principles of Management: PC Tripathi, PN Reddy
2. Dynamics of Entrepreneurial Development & Management: Vasant Desai
3. Entrepreneurship Development— Poornima.M.Charantimath
4. Management Fundamentals : Robers Lusier — Thomson
5. Entrepreneurship Development: SS Khanka
6. Management: Stephen Robbins

ELECTIVE (F): ENVIRONMENTAL BIOTECHNOLOGY (LBTC 1007)

Unit-1
Components of Environment - Hydrosphere, lithosphere, atmosphere and biosphere — definitions with examples; Interaction of man and environment; Environmental Studies as a multidisciplinary subject

Unit-2
Global Environmental Problems - Green House Effect, Acid rain, Ozone depletion, salination, biodiversity loss; chemical and radiation hazards.

Unit-3
Environmental pollution and degradation- Pollution of air, water and land with reference to their causes, nature of pollutions, impact and control strategies; noise pollution; Habitat Pollution by Chlorinated Hydrocarbons (DDT, PCBs, Dioxin etc)

Unit-4
Environmental Management - Concept of health and sanitation, environmental diseases — infectious (water and air borne) and pollution related, health hazards due to pesticide and metal pollution, solid waste management

Unit-5
Bioremediation - Oil spills, pesticides, Wastewater treatment, chemical degradation, heavy Metals

Suggested Readings
1. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology: Verma PS and Agrawal VK
2. Environmental Biotechnology: Chhatargy
3. Environmental Pollutions: Peavy and Rowe
4. Environemental Biology: Verma PS and Chand S
5. Environmental Biotechnology: Indu Shekhar

DISSERTATION (LBTC 1008)