Group No.	Course Code	Course Title	Unique Code
1	20BBT12	Concept in Biotechnology	201BT001
1	20BBT21	Genomics, Proteomics and Bioinformatics	201BT002
1	20BBI243	Immunoinformatics	201BT003
1	20BBC333	Biomaterials and Artificial Organs	201BT004
1	20BBC334	Vaccine Development	201BT005
1	20FDB13	Food Chemistry	201BT006
2	20BBC13	Principles of Biochemical Engineering	202BT001
2	20BBT14	R-DNA Technology	202BT002
2	20BBI15	Python Programming	202BT003
2	20BBT243	Bioprospecting and Molecular pharming	202BT004
2	20BBT254	Bioprocess Equipment Design	202BT005
2	20FDB12	Food Microbiology	202BT006
3	20BBI13	Essential Bioinformatics	203BT001
3	20BBT15	Bioanalytical Techniques	203BT002
3	20BBC21	Fermentation Technology	203BT003
3	20BBT22	Industrial Biotechnology	203BT004
3	20BBC241	Agricultural Biotechnology	203BT005
3	20FDB15	Fundamentals of Food Engineering	203BT006
4	20BBI22	Computational Systems Biology	204BT001
4	20BBT23	Healthcare Biotechnology	204BT002
4	20BBC242	Animal Biotechnology	204BT003
4	20BBT251	Food Biotechnology	204BT004
4	20BBC254	Metabolic Engineering	204BT005
4	20FDB242	Genetics and Cell culture Techniques	204BT006
5	20BBT31	Biosafety, Bioethics and Regulatory affair	205BT001
5	20BBT241	Systems Biology	205BT002
5	20BBC252	Pharmaceutical Biotechnology	205BT003
5	20BBC321	Environmental Biotechnology	205BT004
5	20BBC332	Bioenergy Management	205BT005
5	20FDB251	Dairy Technology	205BT006
6	20BBT252	Stem Cells and Tissue Engineering	206BT001
6	20BBT253	Clinical and Pharmaceutical Biotechnology	206BT002
6	20BBC322	Biosensor Technologies	206BT003
6	20BBC324	Nanobiotechnology	206BT004
6	20BBI334	Bio-business and Entrepreneurship	206BT005
6	20FDB321	Food Softy and Toxicology	206BT006

(Group-1): Course Code 20BBT12 **Course Title: Concept in Biotechnology**	
Exam Hours: 3 hours	**Exam Marks(Maximum):100**

Module-1

INTRODUCTION TO BIOLOGY:
Macromolecules; Carbon chemistry; Proteins: Structure, folding, catalysis; Nucleic acids: DNA & RNA; storage and transfer of genetic information; Lipids: membranes, structure & function; Carbohydrate chemistry, energy storage, building blocks.

Module-2

CELL STRUCTURES AND ITS FUNCTIONS:
Eukaryotic and Prokaryotic cells, plant and animal cells, structure of nucleus, mitochondria, ribosomes, Golgi bodies, lysosomes, endoplasmic reticulum, chloroplast, vacuoles; Cell cycle and cell division: Different phases of cell cycle, cell division: Mitosis and meiosis. Mendelian law of inheritance: Monohybrid and dihybrid inheritance, law of segregation and independent assortment; Gene Interaction; Multiple alleles, supplementary and complementary genes, epistasis. Identification of genetic material: classical experiments; chromosome structure and organization, chemical composition of chromatin, structural organization of nucleosomes, heterochromatin, polytene and lamp-brush chromosomes, human chromosomes, chromosomal disorders.

Module-3

SCOPE OF MICROBIOLOGYAND IMMUNOLOGY:
Introduction to the structure and functions of microorganism: Bacteria, Viruses, Fungi and Protozoan's. Microscopy and microbial techniques: Study of microscopes; sterilization techniques: Heat, steam, Radiation, Filtration and chemical methods; Pure culture techniques: Serial Dilution, Streak, Spread, Pour Plate. Immune System, Innate and adaptive immunity, antigens and antibodies; types of immune response, hypersensitivity. Humoral immunity: B-lymphocytes, Immunoglobulin classes, Major Histocompatibility Complex (MHC). Cell mediated immunity. Thymus derived lymphocytes (T-cells), Antigen presenting cells (APC); Immunity to infection, Cytokines.

Module-4

SCOPE OF AGRICULTURAL BIOTECHNOLOGY:
Role of Microbes in agriculture, Bio-pesticides, Bio fertilizers (Nitrogen fixing microbes), GM crops. Plant metabolic engineering and industrial products: Molecular farming for the production of industrial enzymes, biodegradable plastics, antibodies, edible vaccines. Metabolic engineering of plants for the production of fatty acids, industrial oils, flavonoids etc. Basic aspects of Food & Nutrition. Discussion of case studies for addressing health and malnutrition, via Agriculture BT.

Module-5

INDUSTRIALLY IMPORTANT MICROORGANISMS AND PRESERVATION TECHNIQUES:
Different media for fermentation, basic structure of fermenter and different types. Types of fermentation processes (surface, submerged, and solid state) and their products (ethanol, citric acid, lactic acid, enzymes, antibiotics) Biological treatment of waste water, primary, secondary and tertiary treatments. Bio indicators, bioremediation of xenobiotic compounds, Bioleaching of minerals from ores, Biosorption of toxic metals. Solid waste management. Biofuel production from agricultural wastes. Case studies and solutions for current issues of waste management.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbook/Reference Books				
	Title of the book	Author Name	Publisher's Name	Publication year
1	Bioprocess engineering and principles	Paulin and M Doran	Wiley	2nd Edition 2006
2	Elementary Principles of Chemical Processes,	R.M. Felder and R.W. Rousseau	J. Wiley	3rd Edition, 2000.
1	Principles of Genetics,	Gardner,	Wiley Edition-	8th edition, 2005
2	Cell Biology, Genetics, Evolution and	P S Verma, V R	New Publisher	2007
3	Plant biotechnology in Agriculture,	K. Lindsey and M.G.K. Jones,	Prentice hall, New Jersey.	1989.

(Group-1): Course Code 20BBT21 **Course Title: Genomics Proteomics and Bioinformatics**	
Exam Hours: 3 hours	**Exam Marks(Maximum):100**
Module-1	
GENOME ORGANIZATION AND GENE EXPRESSION: Introduction, genetic elements that control gene expression, constitutive and inducible gene expression, correlation between mRNA and protein abundance, functional genomic analysis using forward genetics and reverse genetics. COMPARATIVE GENOMICS: Orthologs and paralogs, Comparative genomics of bacteria and horizontal gene transfer, Comparative genomics of mitochondrial genomes and eukaryotes, applications of comparative genomics.	
Module-2	
TRANSCRIPTOME ANALYSIS: mRNA as a subject of gene expression studies, traditional approaches for analysis of gene expression –transcriptional run off assays, RT-PCR, DNase protection assay,differential display PCR, Genome wide measurement of gene expression – SAGE, Massively Parallel Signature Sequencing, Microarrays, interpretation of RNA analyses, relationship of DNA and mRNA levels.	
Module-3	
PROTEOME ANALYSIS: Introduction, protein databases,2D gel electrophoresis, MALDI-TOF analysis, MASCOT analysis, Mass spectroscopy, peptide mass fingerprinting, peptide sequence analysis by tandem mass spectrometry, SELDI protein chip technology, proteomic analysis of post translational modifications experimental approaches for protein-protein interaction mapping, differential and quantitative proteomics	
Module-4	
Introduction, applications of genomics:In understanding basis of polygenic disorders, pharmacogenomics, Medical proteomics-biomarker discovery and its importance, Pharmaceutical proteomics-role of proteomics in drug development, applications of proteomics for the analysis of genetically modified plants	
Module-5	

Bioinformatics & Biological Databases: Introduction to Bioinformatics, Goals, Scope, Applications in biological science and medicine. Biological databases –Sequence, structure, Genome, Microarray, Metabolic pathway, motif, and domain databases. Mapping databases –genome wide maps. Chromosome specific human maps.SequenceAlignment: Introduction, Types of sequence alignments-Pairwise and Multiple sequence alignment, Alignment algorithms (Needleman &Wunch, Smith &Waterman and Progressive global alignment). Database Similarity Searching-Scoring matrices–BLOSSUM and PAM, Basic Local Alignment Search Tool (BLAST), and FASTA. Next Generation Sequencing –Alignment and Assembly. Molecular Phylogenetics: Introduction, Terminology, Forms of Tree Representation. Phylogenetic Tree Construction Methods -Distance-Based & Character-Based Methods and Phylogenetic Tree evaluation.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbook/Reference Books

	Title of the book	Author Name	Publisher's Name	Publication year
1	Bioinformatics and Functional Genomics	Jonathan Pevsner	Wiley Blackwell	2nd Edition
2	Introduction to Proteomics	Daniel C. Liebler	Humana Press	2002.
3	Principles of Gene Manipulation and	Primrose .S.B,	Blackwell	7th edition,
4	Principles of Proteomics(Advanced	Twayman.R.M,	Taylor and	1st edition, 2004
5				

(Group-1): Course Code :20BBI243 Course Title: Immunoinformatics

Exam Hours: 3 hours	**Exam Marks(Maximum):100**

Module-1

Immunoglobulins: Structure and function-- Monoclonal antibodies. B Cell generation and differentiation: BCR--Antibody diversity: Genetic basis—T- dependent activation of B cells-B-lymphocyte signal transduction. Cytokines. Complement system. Antigen- antibody interaction: antibody affinity and activity- Isolation of lymphoid cells from blood and lymphoid organs--precipitation reaction, agglutination reaction --Radioimmunoassay, ELISA, Western Blot, Immuno-precipitation, Immun-fluoresence, flow cytometry. Cell cultures and Experimental animal models. Analysis of gene expressions.

Module-2

SEQUENCE ANALYSIS: Alignments- DNA alignments- Molecular evolution and phylogeny- viral evolution and escape- prediction of functions. Methods applied in Immunological Bioinformatics-starting from sequence weighing methods to cluster analysis- Gibbs Sampling- HMM- Neural network-microarray and its applications.

Module-3

MHC- I PREDICTION: Prediction of Cytotoxic T Cell (MHC Class I) Epitopes- Antigen Processing in the MHC Class I Pathway. MHC-II PREDICTION: Prediction of Helper T Cell (MHC Class II) Epitopes- Processing of MHC Class II Epitopes

Module-4

B CELL EPITOPE PREDICTION AND WEB SOURCES: Recognition of Antigen by B Cells-vaccine design - Web-Based Tools for Vaccine Design. The IMGT® Immunoinformatics page. Databases associated with Immunoglobulins (or Antibodies) (IG), T cell receptors (TR), Major histocompatibility (MH), Antigens, Allergens, Peptides binding to MH etc.

Module-5

Hybridoma technology for mass production. Chimeric antibodies, antibody engineering via computational tools, large scale manufacture of antibodies. Vaccine development and Immunoinformatics: Recombinant vaccines, combined vaccines, polyvalent vaccines. Immunoinformatics, databases in immunology, DNA, Plant and protein based recombinant antigens as vaccines.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbook/Reference Books

	Title of the book	Author Name	Publisher's Name	Publication year
1	"Immunological Bioinformatics"	Ole Lund Darren Flower,	MIT press, Springer	September 2005, 2006.
2	"Immunoinformatics: Predicting Immunogenicity in Silico"	Darren R Flower	Humana Press	2007
3	"Immunoinformatics- Bioinformatics	Rammensee	Wiley	2003
4	Computational Immunology: Basics	Shyamasree Ghosh	CRC Press	2020
5	Kuby Immunology	Thomas J. Kindt , Richard A. Goldsby, Barbara A borne	W. H. Freeman & Company	2006

(Group-1): Course Code 20BBC333 Course Title: Biomaterials and Artificial Organs

Exam Hours: 3 hours	**Exam Marks(Maximum):100**

Module-1

STRUCTURE OF BIO-MATERIALS AND BIO-COMPATIBILITY

Definition and classification of bio-materials, mechanical properties, composite materials, Nanomaterials and nanocomposites, Tissue-biomaterial interactions, biomaterial characterization, medical devices, Testing of biomaterials: In-vitro, in-vivo pre-clinical tests, safety and biocompatibility evaluation

Module-2

METALS AND CERAMICS
Metallic implant materials, stainless steels, Co-based alloys, Ti-based alloys, ceramic implant materials, aluminum oxides, hydro-apatite, glass ceramics, carbons.

Module-3

SYNTHETIC AND BIOPOLYMERS
Polymerization, poly amides, Acrylic polymers, rubbers, high strength thermoplastics, Bio polymers: Collagen, Hyaluronic acid, chitosan and Elastin.

Module-4

ARTIFICIAL ORGANS
Artificial Heart, Prosthetic Cardiac Valves, Limb prosthesis, Externally powered limb prosthesis, Dental Implants, Artificial cornea, Artificial liver and pancreas, artificial skin.

Module-5

APPLICATIONS
Medical applications of biomaterials, Drug delivery, Bioinspired Materials and Bio mimetics, Tissue engineering, Regenerative medicine, Stem cell biology, modern scaffold structures, advanced fabrication technologies including computer-aided tissue engineering and organ printing, global regulatory requirements, technology transfer and ethical issues

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbook/Reference Books

	Title of the book	Author Name	Publisher's Name	Publication year
1	Fundamentals of Biomaterials	Vasif Hasirci, Nesrin Hasirci	Springer	**2018**
2	Biomaterials, Medical Devices, and Combination Products -	Shayne Cox Gad, Samantha Gad-	CRC Press	2015
3	Joon B. Park, Roderic S. Lakes	Biomaterials – An	Springer	2010
4	Hench L. Larry and Jones J.	Biomaterials,	Woodhead	2005
5	Marek J. Los, AndrzejHudecki, Emilia Wiechec	Marek J. Los, AndrzejHudecki,	Associated Press	2018

(Group-1): Course Code 20BBC334	**Course Title: Vaccine Development**
Exam Hours: 3 hours	**Exam Marks(Maximum):100**

Module-1

Immunopathology: Tolerance and Autoimmunity, Hypersensitive reactions, Primary and Secondary Immunodeficiency, Active and passive immunization, General immunization practices, , AIDS, Immune response to Infectious disease, Basic principles of vaccine development. Vaccination of immune-compromised hosts, Vaccination of human immunodeficiency virus- infected persons. Vaccines and its historical perspective.

Module-2

Traditional and modern methods of vaccine production, Egg and cell based vaccine development, Current and future scenario of Vaccines, Edible Vaccines, Reverse vaccinology, Immunoinformatics approach to identify T and B cell epitopes, Bacterial and Viral vaccine. Passive immunization; antibody, transfusion of immune competent cells, cell based vaccines. Immunomodulators (cytokines) Innovative methods of delivery of immunogens through liposomes, microspheres, ISCOMS.

Module-3

Vaccine Technology: Criteria for effective vaccine, Vaccines, Live, killed, attenuated, sub unit vaccines; Role and properties of adjuvants, recombinant DNA and protein based vaccines, Multivalent subunit vaccines, mini cell vaccines, conjugate vaccines plant-based vaccines, recombinant antigens as vaccines. Interferons, designing and screening for antivirals, mechanisms of action, antiviral libraries, antiretrovirals—mechanism of action and drug resistance. Comparative Genomics as a tool for vaccine design

Module-4

Licensed vaccines, Viral Vaccine (Poliovirus vaccine-inactivated & Live, Rabies vaccines Hepatitis A & B vaccines), Bacterial Vaccine (Anthrax vaccines, Cholera vaccines, Diphtheria toxoid), Parasitic vaccine (Malaria Vaccine). Vaccines against Hepatitis A, Malaria, Typhoid (in clinical trials). Conventional vaccines, antiidiotype vaccine, naked DNA vaccine. Recombinant Vaccines - Definition, recombinant vector vaccines, DNA vaccines. Vaccine potency testing.

Module-5

The vaccine industry, Vaccine manufacturing, Vaccine additives and manufacturing residuals, Regulation and testing of vaccines, Vaccine safety and Legal issues. Regulatory issues- Environmental concerns with the use of recombinant vaccines- Disease security and biosecurity principles and OIE guidelines Method of manufacture- in process control, batch control, test on final products. large scale manufacturing—QA/QC issues

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbook/Reference Books

	Title of the book	Author Name	Publisher's Name	Publication year
1	Vaccines	Stanley A. Plotkin& Walter	Elsevier Publication	**2013**
2	Clinical Immunology	Brostoff J, Seaddin JK, Male D, Roitt	Gower Medical	**2002**
3	Essential Immunology	Roitt, I	Blackwell	**2001**
4	New Vaccine Technologies	Ronald W. Ellis	Landes	**2001**
5	Cheryl Barton	Advances in Vaccine	Espicom Business	**2009**

(Group-1): Course Code : 20FDB13 Course Title: Food Chemistry	
Exam Hours: 3 hours	**Exam Marks(Maximum):100**

Module-1

Proteins: Nomenclature, classification, structure, chemistry and properties of amino acids, peptides, proteins; Essential and non-essential amino acids, Qualitative and quantitative analysis of amino acids and proteins, Changes during food processing. Browning reactions: Enzymatic and non enzymatic browning, advantages and disadvantages, factors affecting their reaction and control.

Module-2

Carbohydrates: Nomenclature and classification, structure, physical and chemical properties of polysaccharides and their functions; Qualitative and quantitative analysis of carbohydrates; changes in carbohydrates during food processing.

Module-3

Lipids: Structure, classification, physical and chemical properties, utilization of fats and oils, margarine, shortenings, salad and cooking oils, importance of fats and oils in diet, introduction to hydrogenation and its importance.

Module-4

Introduction to human nutrition and Dietary requirements of nutrients: Introduction to human nutrition, energy value of foods and its determination by calorimetry and from proximate principles, daily caloric needs for basal metabolism, physical activity and diet induced thermogenesis.

Module-5

Food ingredients and additives: classification and functions, need for food ingredients and additives, Permitted dosages of food additives , food preservatives, antimicrobial agents, thickeners-polysaccharides, bulking agents;
Antifoaming agents, synergists, antagonists. Antioxidants (synthetic and natural, mechanism of oxidation inhibition), chelating agents- types, uses and mode of action; Coloring agents-color retention agents, applications and levels of use, natural colorants, sources of natural color (plant,

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbook/Reference Books

	Title of the book	Author Name	Publisher's Name	Publication year
1	Principles of Biochemistry	D Voet, J G Voet and C W Pratt	John willy & Sons	4th Edition 2012
2	Textbook of Biochemistry.	E. S. West		4th Edition 2017
3	Nutrition and Dietetics.	Shubhangini A. Joshi	Tata Mac Graw Hill Eduation Pvt.	4th Edition 2017
4	General Biochemistry.	J.H. Weil		
5	Biochemistry of Foods.	N.A.M Eskin		

Visvesvaraya Technological University, Belagavi.
Ph.D Coursework Courses – 2020 in BIOTECHNOLOGY

Ph.D Coursework Courses under Group - 2			
SlNo	**Course Code**	**Course Name**	**Page**
1	20BBC13	Principles of Biochemical Engineering	2-3
2	20BBT14	R-DNA Technology	3-4
3	20BBI15	Python Programming	4-5
4	20BBT243	Bioprospecting and Molecular pharming	5-6
5	20BBT254	Bioprocess Equipment Design	6-7
6	20FDB12	Food Microbiology	08

(Group-2):Course Code 20BBC13**Course Title: Principles of Biochemical Engineering**	
Exam Hours: 3 hours	**Exam Marks(Maximum):100**

Module-1

HISTORICAL DEVELOPMENT OF BIOPROCESS TECHNOLOGY:

An overview of traditional and modern applications of biotechnological processes, Roles and responsibilities of a Chemical engineer in bioprocess industry, Steps in bioprocess development. Biology of the cell, classification, construction and cell nutrients. Industrial enzymes -, Nomenclature and Classification of enzymes, structure and functions of enzymes with relevant case studies.

Module-2

EQIPMENTS: Mixing-Power requirement (Calculation of power no), Ungassed and gassed fluids, factors affecting the broth viscosity, Mixing equipments (Banbury mixers, Muller Mixers), Size Reduction(laws of size reduction, Mechanical efficiency and crushing efficiency Concept of Sphericity, Volume surface Mean Diameter, Arithmetic Mean Diameter, Mass mean diameter, Volume Mean Diameter and Proof for sphericity is unity for regular object) Crushing equipments (Jaw crusher, Garyatory crusher, Shredders, Ball mill) Filtration (constant pressure and constant rate filtration explanations with only the equations.

Module-3

INDUSTRIALLY IMPORTANT FILTRATION EQUIPMENTS AND ACCESSORIES: (Rotary filters, Plate and frame filters and Leaf filters) Settling and its type (free and hindered settling: equation for Newton's, Intermediate Stokes regimes and Criteria for selection of the equation) Problems, Size Enlargement operations. Flow pattern in agitated vessel, Role of shear in fermentation broth, bubble shear, rheological behavior of fermentation broth, 3-D Continuity equation, Pressure drop in flow through packed bed and Fluidized bed (Kozeny, Carman, Blake Plummer Equations), Flow of compressible fluids, Time to empty the liquid from a tank (Rectangle Tank and Hemispherical Tank), problems, Problems on calculation of resultant velocity and resultant acceleration of fluid on space ordinates (x, y, z). Numerical

Module – 4

BASICS OF THERMODYNAMICS:

Procedure for Energy balance and Energy balance for cell culture, Concept of Internal energy, Enthalpy-calculations procedure (Enthalpy and internal energy changes calculations using first law of Thermodynamics), calculations of Entropy changes (Entropy changes for constant Temperature, Constant volume, constant pressure and work lost due to entropy) Differential equations of Entropy, Problems on entropy and Its calculations, Gibbs Free energy and other

Module-5

INTRODUCTION TO HEAT TRANSFER:

Overview of Industrial Heat Exchangers (Construction and working principle of DPHE, STHE, Helical coil heat exchangers along with the heat transfer equations) and Concept of LMTD, Boiling Condensation, Nucleate and film boiling (Regimes of pool boiling) Regenerators and Recupretors. Transient growth kinetics, measurement of microbial population by turbidometry and studying the effect of temperature, pH, carbon and nitrogen Batch, fed batch and continuous cultures. Discussion of design strategies and case studies.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.

- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbook/Reference Books

	Title of the book	Author Name	Publisher's Name	Publication year
1	Bioprocess Engineering and principles2nd Edition	Paulin and M Doran	Wiley	2006
2	R.M. Felder and R.W. Rousseau	Elementary Principles of	J. Wiley	2000
1	SC Arrora and Domkundar	Process Heat	Wiley	2006
2	K.V. Narayan	Engineering		2010
3	R.K. Bansal	Fluid Mechanics 3rd edition		2010

(Group-2): Course Code20BBT14**Course Title: R-DNA Technology**

Exam Hours: 3 hours	**Exam Marks(Maximum):100**

Module-1

Introduction to Recombinant DNA technology: Genetic elements that control gene expression, scope and applications of genetic engineering, Isolation and purification of genomic, plasmid DNA and mRNA. Method of creating recombinant DNA molecules.

Module-2

Tools used in Recombinant DNA technology: Vectors: Types, biology and salient features of vectors in recombinant DNA technology: Plasmids, Phages,Cosmids, Phagemids, and Artificial chromosomes. Enzymes: Types and classification: Nucleases, ligases, polymerases, topoisomerases, modifying enzymes, DNase, linkers and adaptors.

Module-3

Gene transfer techniques: Biological, chemical and physical methods. Transformation – Methods, Preparation of competent cells, Introduction of DNA into host cells techniques used for selection, screening and characterization of transformants: Introduction, selectable marker genes, reporter genes, screening of clones, nucleic acid blotting and hybridization.

Module-4

Construction and screening of DNA libraries, Polymerase chain reaction: Construction of genomic and cDNA libraries. Screening of DNA libraries for clone identification. Characterization of clones. Polymerase chain reaction (PCR) -techniques and requirements, types of PCR, applications. Blotting techniques (Southern, Northern), Radioactive and non-radioactive labelling of nucleic acids.

Module-5

Applications and advance in genome editing: Transgenic science in plant and animal improvement, Plant and Animal Biopharming- Animals as bioreactor for recombinant protein, Antisense technology .Genome editing-(Zinc finger nucleases (ZFNs), transcription activator-like effector nucleases (TALENs), CRISPR technology (with case studies).

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbook/Reference Books

	Title of the book	Author Name	Publisher's Name	Publication year
1	Principles of gene manipulation,	S.B. Primrose, R. M Twyman and R.	Wiley	Old (6th edition).,
2	Gene Cloning and DNA Analysis –An Introduction	T.A.Brown;	Wiley-Blackwell	6th Edition 2010
3	Molecular Biotechnology –Principles	B.R. Glick,	ASM Press	
4	Molecular Biology of the cell;	B.Alberts,	Garland	5th Edition 2008;
5	Recombinant DNA	James D. Watson, Watson, Che, Michael Gilman, Jan A. Witkowski, Mark Zoller, Jan Witkowski	Cold Spring Laboratory	1983

(Group-2): Course Code :20BBI15Course Title: Python Programming

Exam Hours: 3 hours	**Exam Marks(Maximum):100**

Module-1

Algorithmic Problem Solving

Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

Module-2

Data, Expressions, Statements

Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments; Illustrative programs: exchange the values of two variables, circulate the values of

Module-3

Control Flow, Functions

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

Module-4

Lists, Tuples, Dictionaries
Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing – list comprehension; Illustrative programs: selection sort, insertion sort, merge sort, histogram.

Module-5

Files, Modules, Packages
Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbook/Reference Books

	Title of the book	Author Name	Publisher's Name	Publication year
1	Python for Bioinformatics	Sebastian Bassi,	Chapman & Hall/ CRC,	2009.
2	"Programming Python",	Mark Lutz,	O'Reilly Media,	4th Edition 2011,
3	Python Programming using problem	ReemaThareja	Oxford	2017
4	Fundamentals of Python: First Programs	Kenneth A. Lambert	CENGAGE Learning	2011
5	Introduction to Programming in Python: An Inter-disciplinary Approach	Robert Sedgewick, Kevin Wayne, Robert Dondero	Pearson India Education Services Pvt. Ltd	2016

(Group-2): Course Code 20BBC243 Course Title: Bioprospecting and Molecular Pharming

Exam Hours: 3 hours	Exam Marks(Maximum):100

Module-1

Introduction of Bioprospecting- Classical examples of Bioprospecting. Potential value of Bioprospecting-status of bioprospecting in India. Approaches to Bioprospecting-1.Random search 2.Algorithm based search a) Using indigenous knowledge b) Ecological based knowledge c) Evolutionary based knowledge d) Phylogenetic approach. Bioprospecting for known and unknown metabolites-Case studies. Databases and drug discovery-NAPRALERT,NCI and CDRI databases

Module-2

Molecular markers in bioprospecting for known metabolites-microsatellites, AFLP; SNP's etc. Molecular Pharming: Biosynthesis of secondary metabolites and metabolic engineering-secondary metabolite pathways, rate limiting steps, over-expression systems etc. Using GIS based technology to predict species distribution for bioprospecting. Evolutionary significance of plant chemical diversity and chemotaxanomy; IPR issue and trade related issue in Bioprospecting.

Module-3

Valuation of biodiversity hotspots for bioprospecting-Weatern Ghats, Eastern Himalayas. Valuation techniques. Potential for bioprospecting in India -Medicinal plant diversity, indigenous knowledge, human resource. Traditional Knowledge and practice and its role in

Module-4

Bio prospecting and Secondary metabolites; Industrial significance; Fungi in food processing, production of enzymes, alcohols, antibiotics; use of fungi for green chemistry and nano-biotechnological applications. Secondary metabolites; Industrial significance; Fungi in food processing, production of enzymes, alcohols, antibiotics; use of fungi for green chemistry and nano-biotechnological applications. Marine/ fungal and Bacterial Bioprospecting and its industrial applications.

Module-5

The *in-vivo* and *in-vitro* protocols for multiplication and production of economically important metabolites-hairy roots, suspension cultures, micropropogation etc. Role of industry, academic institution collaboration in accelerating research in bioprospecting. Bioprospecting&Biopiracy, Protectability.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbook/Reference Books

	Title of the book	Author Name	Publisher's Name	Publication year
1	Bioprospecting in Life Sciences,	Rajendra Kumar Behara,	Narosa .	2019
2	Molecular Farming in Plants: Recent Advances and Future prospects.	Aiming Wang, Shengwu Ma	Springer Dordrecht	2012
3	Bioprospecting Success, Potential and	Paterson, Russell,	Springer	1st Edition 2017
4	Medicinal Plants -Chemistry and	Daniel,M.	Oxford &IBM	2006
5				

(Group-2): Course Code 20BBT254	**Course Title: Bioprocess Equipment Design**
Exam Hours: 3 hours	**Exam Marks(Maximum):100**

Module-1

Basic Principles of design: Design Factors, Design procedure, Codes and Standards, Optimization, Design Loads, Combined Loading in Equipments, Concept of Stress and Strain, Theories of Failure.

Module-2

Pressure Vessels and bioreactors: Design of unfired pressure vessels: Types of pressure vessels, material of construction, selection of corrosion allowance and weld joint efficiency, purging of vessels, Selection and design of various types of heads. Design principles of bioreactors, Geometric configuration, flanges, nozzles, gaskets, supports

Module-3

Bioreactors and Reaction vessels: Accessories for bioreactors, Study of various types of agitators, aerators, air filters, stabilizers, power requirement.

Reaction vessels - Introduction, classification, heating systems, various types of jackets like plain, half coil, channel, and limpet oil. Study and design of internal coil of reaction vessels, Heat transfer coefficients in coils

Module-4

Heat Exchange Equipments: Introduction, types of heat exchangers, codes and standards for heat exchangers, Materials of construction, baffles and tie rods, tube joining methods, Design of shell and tube heat exchangers.

Module-5

Design of distillation column: Design variables in distillation, design methods for binary systems, plate efficiency, approximate column sizing, plate contactors and plate hydraulic design - Plate design, weir dimensions, weep point, hole size, and Plate pressure drop.

Bioreactors: Material for construction of bioreactors and selection criteria Scale up of bioreactors, safety measures in bioreactors. Economic consideration for scale up

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbook/Reference Books

	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	Process Equipment Design	. D. Dawande, Dennet and	CBS Publications	**7th Edition 2015**
2	Process Equipment Design	M. V. Joshi	McMillan India.	**5thEditon 2016**
3	Process equipment design	L.E. Brownell and	John Wiley,	1963.
4				
5				

(Group-2): Course Code: 20FDB12	**Course Title: Food Microbiology**
Exam Hours: 3 hours	**Exam Marks(Maximum):100**

Module-1

Microbial growth:
Types of microorganisms, their importance in foods, classification of food borne bacteria, fungi & yeast, their morphology and distinguishing features with examples; Growth of microorganisms in foods; Intrinsic (pH, moisture content, redox potential, nutrient content, antimicrobial constituents and biological structures) and extrinsic factors (temp, +RH, presence and concentration of gases) governing growth of microorganisms in food.

Module-2

Food spoilage:
Chemical changes caused by microorganisms in foods (breakdown of proteins, carbohydrates, fats and other constituents during spoilage), specific microorganisms causing spoilage of milk and milk products, meat, fish, egg, cereals, fruits, vegetables and their processed products, quality defects in canned foods, sugar and confectionary products.

Module-3

Food fermentations:
Different types of fermentations (solid -state, submerged, static, agitated, batch, continuous). Starter cultures, Probiotic cultures, Fermented foods - types, methods of manufacture for vinegar, ethyl alcohol, cheese, yoghurt, baker's yeast and traditional Indian foods.

Module-4

Microbial food borne diseases and detection of microbes
Types of microbial food borne diseases (food borne intoxications and Food borne infections), symptoms and prevention of some commonly occurring food borne diseases, detecting food borne pathogens and their toxins- conventional versus rapid and automated methods; genetic and immunologic techniques for detecting food borne pathogens and toxins.

Module-5

Food preservation by controlling microbes Principles of preservation, methods of food preservation – high temperature, low temperature, drying, radiation, , antimicrobial agents (types- chemical preservatives, bio-preservatives, mode of action and their application), hurdle technology, active packaging, novel processing technologies.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbook/Reference Books

	Title of the book	Author Name	Publisher's Name	Publication year
1	Food Microbiology.	W C Frazier & D C West off	Mc-Graw Hill	5th Edition 2014
2	Modern Food Microbiology	**Jay**, James M., **Loessner**, Martin	Springer	2005

3	Essentials of Food Microbiology.	Garbutt John	Hodder Arnold Publication	1997
4	The Microbiology of Safe Food	Stephen J. Forsythe	Wiley	3rd Edition 2020

Visvesvaraya Technological University, Belagavi.
Ph.D Coursework Courses – 2020 in BIOTECHNOLOGY

(Group-3):Course Code 20BBI13**Course Title: Essential Bioinformatics**	
Exam Hours: 3 hours	**Exam Marks(Maximum):100**

Module-1

Biological Databases: Introduction to Bioinformatics, Goals, Scope, Applications in biological science and medicine and Limitations, a) Sequence Databases b) Structure Databases c) Special Databases and applications: Genome, Microarray, Metabolic pathway, motif, multiple sequence alignment and domain databases. Mapping databases – genome wide maps. Chromosome specific human maps. Applications of these databases. Database Similarity Searching: Unique Requirements of Database Searching. Heuristic Database searching, Basic Local Alignment Search Tool (BLAST), FASTA, Comparison of FASTA and BLAST, Database Searching with the Smith–Waterman Method.

Module-2

Sequence Alignment: Evolutionary basis, Homology vs Similarity, Similarity vs Identity. Types of Sequence alignment - Pairwise and Multiple sequence alignment, Alignment algorithms, Scoring matrices, Statistical significance of sequence alignment. Multiple Sequence Alignment: Scoring function, Exhaustive algorithms, Heuristic algorithms, Practical issues. Profiles and Hidden Markov Models: Position-Specific scoring matrices, Profiles, Markov Model and Hidden Markov Model.

Module-3

Motifs and Domains: Motif and Domain databases, Identification of Motifs and Domains in Multiple Sequence Alignment using Regular expressions, Motif and Domain Databases statistical models, Protein Family databases, Motif Discovery in unaligned sequences. Sequence logos. Gene and Promoter Prediction: Promoter and Regulatory elements in Prokaryotes and Eukaryotes. Promoter and Regulatory element prediction – algorithms. Gene prediction. Gene prediction in Prokaryotes and Eukaryotes. Categories of Gene Prediction Programs. Prediction algorithms. Discussions with case studies.

Module-4

Predictive Methods: Predictive methods using Nucleic acid sequence – DNA framework, Masking of repetitive DNA, predicting RNA secondary structure, Finding RNA genes, Detection of functional sites and Codon bias in the DNA. Predictive methods using protein sequence – Protein identity and Physical properties. Structure prediction - Prediction of secondary structure of protein, Antigenic sites, Active sites, Folding classes, specialized structures and Tertiary structures. Discussions with case studies. Concepts involved in Insilco

Module-5

Molecular Phylogenetics: Phylogenetics Basics. Molecular Evolution and Molecular Phylogenetics - Terminology, Gene Phylogeny v/s Species Phylogeny, Forms of Tree Representation. Phylogenetic Tree Construction Methods and Programs - Distance-Based Methods, Character-Based Methods. Phylogenetic Tree evaluation methods. Phylogenetic analysis software and algorithms. Bootstrap methods.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbook/Reference Books

	Title of the book	Author Name	Publisher's Name	Publication year
1	Essential Bioinformatics	JinXiong,	Cambridge University	2006.
2	Bioinformatics Basics: Applications in Biological Science and Medicine	Lukas K. Buehler Hooman H. Rashidi	Tylor & Francis (CRC)	2005
3	Current Protocols in Bioinformatics	Andreas D.	Wiley	2003
4	Bioinformatics and Molecular	Paul G. Higgs,	Blackwell	2005.
5	Bioinformatics: Sequence and Genome Analysis	David Mount	Cold Spring Harbor	2004

(Group-3): Course Code20BBT15**Course Title: Bioanalytical Techniques**	
Exam Hours: 3 hours	**Exam Marks(Maximum):100**

Module-1

BRIEF REVIEW OF ELECTROMAGNETIC SPECTRUM AND ABSORPTION OF RADIATIONS:
Theory of spectroscopy, absorption by organic molecules, choice of solvent and solvent effects, modern instrumentation – design and working principle. Applications of UV-Visible spectroscopy (qualitative and quantitative analysis). Principles of vibrational spectroscopy, frequency and factors influencing vibrational frequency, instrumentation and sampling techniques, interpretation of spectra, applications in biology. FT-IR-theory and applications, Attenuated Total Reflectance (ATR). Raman Spectroscopy, theory, instrumentation, and applications to biology. Discussions with Case studies.

Module-2

FUNDAMENTAL PRINCIPLES OF NMR:
Instrumentation, solvents, chemical shift, and factors affecting chemical shift, spin-spin coupling, coupling constant, and factors influencing the value of coupling constant, spin-spin decoupling, proton exchange reactions, FT-NMR, 2D -NMR, NMDR, NOE, NOESY, COSY and applications in Pharmacy, interpretation of spectra, C13 NMR Introduction, Natural abundance, C13 NMR Spectra and its structural applications. Discussions with Case studies.

Module-3

BASIC PRINCIPLES AND INSTRUMENTATION OF ION FORMATION AND TYPES: Fragmentation processes and fragmentation pattern, Chemical ionization mass spectroscopy (CIMS), Field Ionization Mass Spectrometry (FIMS), Fast Atom Bombardment MS (FAB MS), Matrix Assisted laser desorption / ionization MS (MALDI-MS), GC-MS. LC-MS. MS-MS. Discussions with Case studies

Module-4

INTRODUCTION TO X-RAY: Generation of X-rays, X-ray diffraction, Bragg's law, X-ray powder diffraction, interpretation of diffraction patterns and applications. Single crystal diffractions of biomolecules. Fibre diffraction. Neutron diffraction. XAFS. ORD Principle, Plain curves, curves with cotton effect, octant rule and its applications with example, circular dichroism and its relation to ORD. Discussions with Case studies

Module-5

CHROMATOGRAFIC TECHNIQUES:
Classification of chromatographic methods based on mechanism of separation: paper chromatography, thin layer chromatography, ion exchange chromatography, column chromatography and affinity chromatography – technical questions and applications. Gas Chromatography: Theory and principle, column operation, instrumentation, derivatisationmethods and applications. HPLC, LC-MS and applications in HPTLC. Discussions with Case studies.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbook/Reference Books

	Title of the book	Author Name	Publisher's Name	Publication year
1	Fundamentals of Bioanalytical Techniques and Instrumentation,	SabariGoshal and A KSrivastava,	PHI,	2009
2	Principles of Instrumental Analysis	Donglas A. Skoog, James, J. Leary,	Cengage Learning	7th Edition. 2017.
3	Practical Pharmaceutical Chemistry,	A. H. Beckett & J.	A&C Black	4thEdition, 1988.
4	Instrumental Methods of Chemical	B. K. Sharma,	Goel	9th Edition, 2000
5	Biochemical Methods of Analysis,	SarojDua and NeeraGarg,	Alpha Science,	2010

(Group-3): Course Code :20BBT21Course Title: Fermentation Technology

Exam Hours: 3 hours	**Exam Marks(Maximum):100**

Module-1

HISTORY OF DEVELOPMENT OF FERMENTATION INDUSTRY: The range of fermentation process, Microbial biomass, enzymes, metabolites, recombinant products, Transformation process, the component parts of Fermenter. Types of industrial bioprocesses; submerged, surface, solid state fermentations: aerobic, anaerobic and light based processes. The differences between laboratory, pilot, and manufacturing scale bioreactor experiments, Green biologics of fermentation technology, types of Reactor and reactor design, process economics. Discussions with case studies

Module-2

SCREENING OF IMPORTANT METABOLITES FROM MICROBIAL SOURCES: Primary and secondary screening of industrially important microbes, Screening methods, General Techniques in improvement of industrial strains, Isolation of auxotrophic mutants, resistant mutants, revertant mutants, Selection by induced mutants producing improved yields of secondary metabolites. Preservation and storage at reduced temperature; Agar slopes, liquid

Module-3

INTRODUCTION TO CULTURE MEDIUM AND FORMULATION: Energy sources, Carbon & Nitrogen sources, Minerals, Growth factors, Buffers, Precursors and regulators, Oxygen and antifoam ingredients, Medium optimization. Substrates for solid state fermentation, Evaluation methods for complex Substrates differences based on product use.

Module-4

STERILIZATION PROCESS AND INOCULUM DEVELOPMENT

Medium sterilization, Design for Batch sterilization process, Calculation of del factors and holding time. Design of continuous sterilization process, Sterilization of Fermenters, Feeds & liquid wastes, Filter sterilization of media. Discussions with case studies Development of Inoculum, criteria for transfer, development of inoculum in yeast, bacterial and mycelial processes, aseptic inoculation of plant fermenters. Inoculum development methods.

Module-5

LABORATORY TO LARGE SCALE FERMENTATION PROCESSES: Batch, Continuous culture, Synchronous, nonsynchronous growth kinetics, Feedback systems, comparison of Batch and Continuous culture in industrial processes and investigative tools. Fed batch culture, Applications of Fed back cultures Techniques and trends in Fermentation technology for the production of recombinant vaccines, therapeutic proteins, antibiotics and diagnostics. Discussions with case studies. Treatment and disposal procedure for industrial effluents.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbook/Reference Books

	Title of the book	Author Name	Publisher's Name	Publication year
1	Principles of Fermentation Technology	Stanbury& Whitaker	, Second Edition, BH	1995
2	Biotechnology Text book of Industrial Microbiology	W. Crueger and A. Crueger	Sinauer Publishers	1990
3	Industrial Microbiology	Casida	Wiley	1986
4	Biotechnology : A Text Book of Industrial Microbiology	T.D. Brock	Smaeur Associates	1990
5	Comprehensive Biotechnology	Moo-Young, M., Bull, A. T., Dalton, H.	Pergamon Press	1987

(Group-3): Course Code 20BBT22 Course Title: Industrial Biotechnology

Exam Hours: 3 hours	Exam Marks(Maximum):100

Module-1

INTRODUCTION: The era of the discovery of Microbes, Pasteur and fermentation, The discovery of Antibiotics, Production strains, screening techniques, Growth of Industrial Fermentations, Screening techniques, Strain Development, Preservation of Microorganisms and Preparation of Inoculum

Module-2

MICROBIAL TRANSFORMATION AND PRODUCTION MEDIA: Characteristics of an IdealProduction Media, Raw materials for production,Screening for production Media, Principles ofSterilization, Sterilization equipment, Sterilization ofproduction Media, Sterilization of Air.

Module-3

PRINCIPAL TYPES OF FERMENTOR IN INDUSTRIES: Introduction to Fermentors, Factors involved in fermentor Design, Fermentor configurations, Principal operating characteristics of fermentors,Computer control of Fermentation process, Computer application

Module-4

MICROBIOLOGICAL ASSAY: Introduction and History of Assay, Microbiological assay of: Vitamins and Amino Acids, Antibiotics, Trace elements. Advantages and Disadvantages of Microbiological Assay, Automation of Microbiological Assay

Module-5

INDUSTRIAL APPLICATIONS OF MICROBES: Pharmaceutical sector, Food and Enzymes Industries.Fermented foods. Sewage and Sewage disposal,Objectives of Sewage treatment, Collection of Sewage,Sewage treatment Methods

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbook/Reference Books

	Title of the book	Author Name	Publisher's Name	Publication year
1	Microbiology	Michael J PelczarJr Chan ECS, Noel R	Tata McGraw HillPublishing	5th edition
2	Microbiology	Prescott, Harley, Klein	McGraw Hill.	10th edition
3	The Air Spora: A manual for catching	Maureen E. Lacey	Springer	2007
4	Soil Microbiology	NS Subba Ra	Oxford and	4th edition,
5	Text Book of Microbiology	Anantahnarayan and	Universities Press.	7th edition

(Group-3): Course Code 20BBC241	**Course Title: Agriculture Biotechnology**
Exam Hours: 3 hours	**Exam Marks(Maximum):100**

Module-1

INTRODUCTION TO AGRICULTURAL BIOTECHNOLOGY: Introduction, history and scope ofagriculture in India. Staple food, fiber, fuel and fruitcrops of India and abroad, Agro-climatic zones andcropping pattern of India. Conventional cropimprovement programs-Introduction, Selection andHybridization, Mutation, Haploidy and PolyploidyBreeding. Modern agriculture biotechnology for foodsecurity and national economy. Green-revolution.

Module-2

APPLICATIONS OF PLANT TRANSFORMATION TECHNOLOGY:
Productivity and performance disease resistance, genes and gene constructs used for viralresistance by coat protein mediated production, bacterialresistance by lysozyme gene and fungal resistance bychitinase and beta glucanase genes. Agrobacteriummediated transformation. Crop improvement to resistadverse soil conditions. Salinity tolerance,

Module-3

INTRODUCTION TO PLANT CELL CULTURE:
Explant selection, sterilization and inoculation; Various media preparations; MS, B5, SH PC L-2; Callus and cell suspension culture; plant regeneration: organogenesis. Somatic embryogenesis; soma clonal variation, its genetic basis and application in crop improvement. Role of tissue culture in rapid clonal propagation, production of pathogen - free plants and "synthetic seeds"; haploid production: advantages and methods. Protoplast technology

Module-4

ANTISENSE RNA TECHNOLOGY(ACC synthase gene and polygalacturonase): Delay of softening and ripening of fleshy fruits by antisense RNA for ACC synthase gene in tomato, banana. Use of antisense RNA technology for extending shelf life of fruits and flowers Protection of cereals, millets and pulses following harvest using biotechnology. Biotechnology for fortification of agricultural products- Golden rice, transgenic sweet potatoes. Importance of biofertlilizers in agriculture. (Rhizobium azatobacter, Mycorrhiza, Frankia and Blue green algae) current practices and production of biofertilizers

Module-5

AN OVERVIEW OF LEGAL AND SOCIOECONOMICIMPACT OF BIOTECHNOLOGY:
Biotechnology & hunger. Ethical issues associated with labelling and consumption of GM foods. Public perception of GM technology. Biosafety management. Cartagena protocol on biosafety. Ethical implication of BT products, public education, Biosafety regulations, experimental protocol approvals, guidelines for research, environmental aspects of BT applications

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbook/Reference Books

	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	Biotechnology- Expanding Horizons	Singh BD	Kalyani Publishers	**2003**
2	Plant Tissue Culture: Theory and Practice, a revised edition	Bhojwani SS and Razdan MK	Panima Publishing	**1996**
3	Plant biotechnology in Agriculture	Lindsey, K and	Prentice Hall	**1990**
4	Crop Biotechnology	Rajashekaran K,	American	**1990**
5				

(Group-3): Course Code : 20FDB15 Course Title: Fundamentals of Food Engineering	
Exam Hours: 3 hours	**Exam Marks(Maximum):100**

Module-1

Introduction to food engineering: Material and energy balances- Basic principles, total mass and component mass balance. Material balance calculations involved in dilution, concentration and dehydration. Heat balance calculations. Fluid flow theory and application - Fluid statics and fluid dynamics, mass and energy balances in fluid flow. Newtonian and non-Newtonian fluids, streamline and turbulent flow. Fluid flow applications- measurement of pressure and velocity. Liquid transport system. Pipelines and pumps for food processing plants-positive displacement pumps, air-lift pumps, propeller pumps, centrifugal pumps and jet pumps.

Module-2

Heat transfer in food processing: Thermal properties of foods, modes of heat transfer, conductive heat transfer in a rectangular slab, tubular pipe, and multilayered systems. Natural and forced convection. Estimation of convective heat transfer coefficient in forced and natural convection. Estimation of overall heat transfer coefficient.

Module-3

Heat exchangers: Plate, tubular, scraped surface, and steam infusion. Thermal process calculation- Commercial sterility concept, Microbial inactivation rates at constant temperature. Effect of temperature on thermal inactivation of microorganisms. Calculation of processing time in continuous flow systems.

Module-4

Psychrometrics: Properties of dry air, composition of air, specific volume of air, specific heat of dry air, enthalpy of dry air, dry bulb temperature. Properties of water-vapor- Specific volume, specific heat and enthalpy. Properties of air-vapor mixtures- Gibbs-Dalton law, Dew-point temp, humidity ratio, relative humidity, wet bulb temperature. The psychrometric chart- Use of psychrometric chart to evaluate complex air conditioningprocesses.

Module-5

Material handling: Theory and classification of various material handling equipments. Conveyors (gravity and powered conveyors), elevators (bucket and screw-type elevators), trucks (high lift and pallet trucks), cranes and hoists. Sorting and grading– advantages and methods

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbook/Reference Books

	Title of the book	Author Name	Publisher's Name	Publication year
1	. Introduction to Food Engineering	Singh, R. P., & Heldman, D. R	Academic Press, New Delhi	(5th ed.): 2014

2	Fundamentals of Food Process Engineering	Toledo, R.T. (2007).	Springer	1991
3	Food Process Engineering Operations:	Boca raton. Toledo, R.T.	CRC Press,	2007
4	Fundamentals of Food Process Engineering	Gustavo, V. B-C., &Ibarz, A	Springer, New York..	(3rd ed.): (2002).

(Group-4): Course Code 20BBI22 **Course Title: Computational Systems Biology**	
Exam Hours: 3 hours	**Exam Marks(Maximum):100**

Module-1

Introduction to Systems Biology: Scope, Applications. Concepts, implementation and application. Databases for Systems Biology, Mass Spectrometry and systems Biology. Bioinformatics databases supporting systems biology approaches.

Module-2

Network Models and Applications: Natural Language Processing and Ontology enhanced Biomedical data mining, text mining. Integrated Imaging Informatics - ntegrin, centroid, cell culture. Standard platforms and applications – metabolic control analysis, glycolysis, metabolic network, Michaelis-Menten kinetics, and flux balance analysis. Signal Transduction - phosphorylation, Jak-Stat pathway, MAP kinase.

Module-3

Biological Processes: Mitochondria, cyclin, Cdc2. Modeling of Gene Expression - lactose, lac operon, tRNA. Analysis of Gene Expression Data – support vector machines, cDNA microarray. Evolution and Self-organization - hypercycle, quasispecies model, self-replication. Reconstruction of metabolic network from Genome Information.

Module-4

Integrated Regulatory and Metabolic Models: Phosphorylation, Gene expression, and Metabolites. Estimation Modeling and Simulation – Circadian rhythms, Petri net, mRNA. Deterministic - Circadian rhythms, mRNA, Circadian oscillations. Multi scale representations of Cells and Emerging Phenotypes - Gene Regulatory Networks, attractor, and Boolean functions. Mathematical models and Optimization methods for De Novo Protein design. Global Gene expression assays. Mapping Genotype - Phenotype relationship in cellular networks.

Module-5

Multiscale representations of cells and Emerging phenotypes: Multistability and Multicellurarity. Spatio-Temporal systems biology, Interactomics, Cytomics – from cell state to predictive medicine. Modeling Tools: SBML, MathMLCellML, Petri Nets and Bioinformatics with case studies.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbook/Reference Books

	Title of the book	Author Name	Publisher's Name	Publication year
1	Computational Systems Biology	Andres Kriete, Roland Eils	Academic Press	2006
2	Transactions on Computational Systems Biology	Corrado Priami,	Springer – Publisher.	2012
3	Systems Biology	Michael G. Katze	Springer	2013.
4	Systems Biology	Isidore Rigoutsos,	Oxford	2006.

5	Systems Biology: Principles, Methods, and Concepts.	Konopka A.K.	CRC Press	Tailor & Francis.2007.

(Group-4): Course Code 20BBT23 **Course Title: Healthcare Biotechnology**	
Exam Hours: 3 hours	**Exam Marks(Maximum):100**
Module-1	
Introduction to health Biotechnology: Red, blue, green and white Biotechnologies, Applications, Drug production (case study; Insulin), Pharmacogenomics, Gene therapy; Stem cell gene therapy, Germ line gene therapy, Genetic testing; Forensic/identity testing, Newborn screening, Prenatal diagnostic screening. Mutations Detection	
Module-2	
Medical biotechnology, current status and future prospects. Classification of genetic diseases: Chromosomal disorders – Numerical disorders e.g. trisomies & monosomies, Structural disorders e.g deletions, duplications, translocations & inversions, Chromosomal instability syndromes. Gene controlled diseases – Autosomal and X-linked disorders, Mitochondrial disorders.. Molecular basis of human diseases: - Pathogenic mutations Gain of function mutations: Oncogenes, Huntingtons Disease, Pittsburg variant of alpha 1 antitrypsin. Loss of function - Tumour Suppressor. Genomic. Dynamic Mutations - Fragile- X syndrome, Myotonic dystrophy. Mitochondrial diseases	
Module-3	
Drug Design and Synthesis: Synthesis of compounds in accordance with the molecular structure and biological activity concept: Analgesics, neuromuscular blocking agents, anti-fertility drugs and bactericidal & bacteriostatic agents (sulphonamides, mercury compounds	
Module-4	
Molecular Diagnostics: Immunological Approaches To Detect Protein Biomarkers of Disease, Enzyme-Linked Immunosorbent Assays, Protein arrays, and Immunoassays. DNA-Based Approaches to Disease Diagnosis: Allele-Specific Hybridization, Real-Time PCR To Detect Infectious Disease, Detection of Multiple Disease-Associated Mutations Using Microarrays, epigenetic markers and Detection of SNPs by Mass Spectrometry	
Module-5	
Health care biotechnology Industry: Bioeconomy, Biopharmaceutical Industries, Products versus chemical medicines, intellectual property protection and management, the innovation cycle, patent application, commercialization, and competition.	
Question paper pattern: • The question paper will have ten questions. • Each full question is for 20 marks. • There will be 2 full questions (with a maximum of four sub questions in one full question) from each module. • Each full question with sub questions will cover the contents under a module. • Students will have to answer 5 full questions, selecting one full question from each module. ■	
Textbook/Reference Books	

	Title of the book	Author Name	Publisher's Name	Publication year
1	Medical Biotechnology	Bernard R. Glick, Terry L. Delovitch	Washington, D.C.: ASM	2014

2	Health Care Biotechnology, a practical guide	DiMiritis Dogramatiz,	CRC press,	2011
3	Biotechnology and Your Health:	Bernice Zeldin	Chelsea House	2005
4	Health and Pharmaceutical	D.M. Chetan, K.P.	Firewall	2006
5	Medical Biotechnology	Judit Pongracz, Mary Keen	Elsevier Health Sciences.	2009

(Group-4): Course Code :20BBC242	**Course Title: Animal Biotechnology**
Exam Hours: 3 hours	**Exam Marks(Maximum):100**

Module-1

INTRODUCTION TO ANIMAL CELL CULTURE

History and development of animal tissue culture. Equipment and materials, Principles of sterile techniques. Sources & types of tissues, balanced salt solutions Cell culture media - components of the medium, physical, chemical and metabolic functions of media. Role of serum and supplements, serum-free media, features and specifications of MEM, DMEM, RPMI and Ham's medium. Role of antibiotics in media. Measurement of cell viability and cytotoxicity. Dye exclusion and inclusion tests, colonigenic assay, macromolecular estimation, MTT based assay. Measuring parameters of growth – growth curves, PDT, Plating efficiency and factors influencing growth

Module-2

CELL LINES & ITS CULTURE

Primary culture, Establishment of Primary Culture, Development of cell lines, characterization of cell lines, maintenance and preservation of cell lines. Contamination -causes, detection and control, cell transformation – normal v/s. transformed cells, growth characteristics of transformed cells. Viral and chemical-mediated methods of cell immortalization, Scale-up of

Module-3

INVITRO FERTILIZATION & CLONING

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

Module-4

MOLECULAR BREEDING

Introduction to different breeds of cattle, sheep, goats, pigs, canines and poultry, genetic characterization of livestock breeds, marker assisted breeding of livestock, introduction to animal genomics, different methods for characterization of animal genomes, SNP, STR, QTL, RFLP, RAPD, genetic basis for disease resistance, Immunological and nucleic acid based methods for identification of animal species, detection of meat adulteration using DNA based methods, detection food/feed adulteration with animal protein,

Module-5

OTHER APPLICATIONS

Application of animal cell culture- Concepts of tissue engineering - skin, liver, kidney, Principles and species suitable for aquaculture (Indian major carps and prawns) Pearl culture - pearl producing mollusks, rearing of oysters, nucleation for pearl formation and harvesting of pearls, Probiotics and their significance in aquaculture.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbook/Reference Books

	Title of the book	Author Name	Publisher's Name	Publication year
1	Culture of animal cells, A manual of basic technique	R. Ian Freshney	Wiley-Liss, Inc	1994)
2	Animal Cell Biotechnology	Spier, RE and Griffith	JB Academic Press	**1990**
3	Methods in Cell Biology	JP Mather and D	Academic	**1998**
4	Fish & Fisheries of India	V. G. Jhingram	Central	**1997**
5	Reproductive Techniques in Farm Animals	Gordon I	CABI	**2005**

(Group-4): Course Code 20BBT251 Course Title: Food Biotechnology

Exam Hours: 3 hours	Exam Marks(Maximum):100

Module-1

BASIC CONSTITUTES OF FOOD: Basic constituents of food, colloidal systems in food, molecular stability of colloidal systems, types of food starches, soluble fibers: pectin's, mucilage & gums, protein rich foods, oils in foods. Food Microbiology: Microbial growth pattern, types of microorganisms associated with food: mold, yeast and bacteria. Contaminants of food stuff, milk and meat during handling and processing. Mechanism of food spoilage. Biochemical changes caused by microorganism. Determination of various types of food products. Food borne intoxicants and mycotoxins.

Module-2

FOOD PRESERVATION TECHNOLOGY: Food preservation by high and ultrahigh temperatures- canning, drying. Food dehydration: Equipments for food dehydration: fixed tray dehydration, cabinet drying, tunnel drying. Freeze dehydration, controlled atmosphere, storage, Food preservation by irradiation treatment. Preservation by freezing and refrigeration. Frozen foods. Thermal properties of frozen foods. Food freezing equipments: Air blast freezers, plate freezers and immersion freezers. Preservation by Chemicals and Bacteriocins.

Module-3

INTRODUCTION TO PLANT CELL CULTURE: Explant selection, sterilization and inoculation; Various media. Food Production Technology: Importance of food industry, specific objectives of food processing, impact of foodprocessing on food constituents. Production of single cell protein, Tailoring of milk proteins and milk fats, Production of fermented food products: yoghurt, probiotic cheese. Nutritional value, labeling of constituents: Soya foods, organic foods, dietary foods, nutritional
food supplements, Use of plant cell culture for the production of food additives (Vanillin, Capsaicin),microbial transformations, regulatory and social aspects of BT. Food packaging, edible films, Marketing of food and promotional strategies.

Module-4

BIOTECHNOLOGY FOR IMPROVED PROCESSING: Role of biotechnology in food industry, maintenance of nutritional quality, Enzymes in bakery and cereal products, utilization of hydrolases and lipases enzymes. Applications of immobilized enzymes in food industry, enzymes for enhanced flavor and aroma compounds, enzymes in fat and oil industries. Genetically modified plants for high nutritional food.

Module-5

FOOD QUALITY ASSURANCE AND CONTROL: Importance and functions of quality assurance and control. Methods of quality, concept of rheology, assessment of food materials-fruits, vegetables, cereals, dairy products, meat and processed food products. Microbiological safety of food products, chemical safety of food products, contaminants by heavy metal, fungal toxins and pesticide residue. Food regulations, grades and standards, USFDA/ ISO 9000 Series. Food adulterations and safety, sensors and instrumental analysis in quality control food laws and standards.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbook/Reference Books

	Title of the book	Author Name	Publisher's Name	Publication year
1	Food Biotechnology	James M, Jay	CBS Publishers	2nd edition, 2005
2	Food Biotechnology	Kalidasshetty	CRC Press.	1st ed. 2005
3	Applied dairy microbiology	H. Elmer, L James,	CRC press	2nd edition, 2005
4	Introduction to Food Engineering	R. Paul Singh	Academic	3rd Ed., 2004
5	Food Processing Technology: Principles and practice".	P. Fellows	Woodhead Publishing	2nd Ed., 2005.

(Group-4): Course Code 20BBC254	**Course Title: Metabolic Engineering**
Exam Hours: 3 hours	**Exam Marks(Maximum):100**

Module-1

INTRODUCTION AND METABOLIC REGULATION:

Introduction: Importance of metabolic engineering and its multidisciplinary nature. An overview of Cellular Metabolism, Transport Processes, Passive Transport, Facilitated Diffusion, Active Transport, Fueling Reactions, Fermentative Pathways, Glycolysis, TCA Cycle and Oxidative Phosphorylation, Anaplerotic Pathways, Catabolism of Fats, Organic Acids, and Amino Acids, Biosynthetic Reaction, Biosynthesis of Amino Acids, Biosynthesis of Nucleic Acids, Fatty Acids.

Module-2

METABOLIC FLUX AND APPLICATIONS OF METABOLIC FLUX ANALYSIS:

Metabolic flux analysis and its application, Methods for experimental determination of metabolic flux by isotope dilution method. Production of Glutamic Acid and regulation by Bacteria, Calculation of Theoretical Yields, Metabolic Flux Analysis of Lysine Biosynthetic Network in *C. glutamicum*, Metabolic Flux Analysis of Specific Deletion Mutants of *C. glutamicum*, Metabolic Fluxes in Mammalian Cell Cultures, Determination of Intracellular Fluxes, Application of Flux Analysis to the Design of Cell Culture Media.

Module-3

REGULATION OF METABOLIC PATHWAYS:

Regulation of Enzymatic Activity, Overview of Enzyme Kinetics, Simple Reversible Inhibition Systems, Irreversible Inhibition, Allosteric Enzymes: Cooperativity, Regulation of Enzyme Concentration, Control of Transcription Initiation, Control of Translation, Global Control: Regulation at the Whole Cell Level, Regulation of Metabolic Networks, Branch Point Classification, Coupled Reactions and the Role of Global Currency Metabolites.

Module-4

METABOLIC ENGINEERING IN PRACTICE:

Enhancement of Product Yield and Productivity, Ethanol, Amino Acids, Solvents, Extension of Substrate Range, Metabolic Engineering of Pentose Metabolism for Ethanol Production, Cellulose-Hemicellulose Depolymerization, Lactose and Whey Utilization, Sucrose Utilization, Starch Degrading Microorganisms, Extension of Product Spectrum and Novel Products, Antibiotics, Polyketides, Vitamins, Biopolymers, Biological Pigments, Hydrogen, Pentoses: Xylitol, Improvement of Cellular Properties, Prevention of Overflow Metabolism, Alteration of Substrate Uptake, Maintenance of Genetic Stability.

Module-5

BIOSYNTHESIS OF METABOLITES AND BIOCONVERSIONS:

Primary metabolites: Alteration of feedback regulation, limiting of accumulation of end products, resistant mutants. Secondary metabolites: Precursor effects, prophage, idiophase relationship, enzyme induction, feedback repression, catabolic repression, important groups of secondary metabolic enzymes, phosphotransferase, ligases oxidoreductases, oxygenases, carboxylases. Advantages of bioconversions, specificity, yields. Factors important to bioconversions, regulation of enzyme synthesis, permeability co metabolism, conversion of insoluble substrates.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbook/Reference Books

	Title of the book	Author Name	Publisher's Name	Publication year
1	Metabolic Engineering Principles and Methodologies	Gregory N. Stephanopoulos,	Academic Press	**1998**
2	Control of metabolic process	A.C. Bowden and M.L. Cardens	Plenum Publisher	**1991**
3	Bioprocess engineering basic concepts	M.L. Shuler and	Pearson hall	1992
4	Fermentation and enzyme Technology	Wang D I C	A L John	1992
5	Scale-up Methods in Chemical Engineering	Johnson and Thring	Johnson and Thring	2006

(Group-4): Course Code: 20FDB242 Course Title: Genetics and Cell culture Techniques

Exam Hours: 3 hours	**Exam Marks(Maximum):100**

Module-1

Overview of genetics: Chemical structure of nucleic acids, proteins; introduction to Genetics, DNA replication, transcription and translation; DNA repair mechanism; modifying enzymes; Genetic code, Regulation of gene expression in Prokaryotes and Eukaryotes.

Module-2

Genetic engineering: Recombinant DNA technology- Methodology Involved PCR, RT-PCR, electrophoresis, electro blotting and capillary blotting; microbial gene transfer mechanisms, mutation, types of mutations, molecular mechanism of mutations, applications to produce genetically modified foods.

Module-3

Cell culture technology: Introduction to plant and animal tissue cultures and cell cultures in general; Cell culture lab design and equipments, Media and reagents; Animal, mammalian and other cell lines for in vitro testing of drugs, toxicity of environmental pollutants, production of vaccines and therapeutic proteins & production of stem cells; Principles of cryobiology and molecular diagnostics, Technological aspects for commercial utilization of cell cultures: Reactor studies, scale up and biosafety.

Module-4

Cell Lines: Primary culture – Mechanical and enzymatic mode of desegregation, establishment of primary culture. Subculture -passage number, split ratio, seeding efficiency, criteria for subculture. Cell lines -definite and continuous cell lines, characterization, authentication, maintenance and preservation of cell lines. Contamination -bacterial, viral, fungal and mycoplasma contaminations, detection and control, cell transformation – normal vs. transformed cells.

Module-5

Cell Culture: Scale-up of animal cell culture – Factors to be considered. Scale-up of suspension cultures Batch reactor, continuous culture, perfusion systems. Scale-up of monolayer cultures – roller bottles, Nunc cell factory, microcarrier cultures, organotypic culture, matrices, factors affecting culture and perspectives.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbook/Reference Books

	Title of the book	Author Name	Publisher's Name	Publication year
1	Culture of Animal Cells,.	R Ian Fredhney (Edited by)	Wiley-Blackwell	3rd Edn
2	Animal Biotechnology	Murray Moo-Young	Pergamon Press, Oxford	1989
3	Molecular Biotechnology: Principles and Applications of Recombinant DNA	Bernard R. Glick Jack J. Pasternak	Wiley	5th edition 2017
4	Plant Cell Culture: A Practical Approach	R.A. Dixon & Gonzales	IRL Press.	1985
5	Animal Cell Technology, Principles and practices.	Butter, M	Oxford press	1987

Visvesvaraya Technological University, Belagavi.
Ph.D Coursework Courses – 2020 in BIOTECHNOLOGY

(Group-5):Course Code :20BBT31 **Course Title: Biosafety, Bioethics and Regulatory Affairs**	
Exam Hours: 3 hours	**Exam Marks(Maximum):100**
Module-1	
BIOTECHNOLOGY AND SOCIETY Introduction to science, technology and society, issues of access-Case studies/experiences from developing and developed countries. Ownership, monopoly, traditional knowledge, biodiversity, benefit sharing, environmental sustainability, public vs. private funding, biotechnology in international relations, globalization and development divide. Public acceptance issues for biotechnology: Biotechnology and hunger: Challenges for the Indian Biotechnological research and industries	
Module-2	
LEGAL ISSUES & BIOETHICS The legal, institutional and socioeconomic impacts of biotechnology; biotechnology and social responsibility, Public education to increase the awareness of bioethics with regard to generating new forms of life for informed decision making – with case studies. Principles of bioethics: Legality, morality and ethics, autonomy, human rights, beneficence, privacy, justice, equity etc. The expanding scope of ethics from biomedical practice to biotechnology, bioethics vs. business ethics, ethical dimensions of IPR, technology transfer and other global biotech issues	
Module-3	
BIOSAFETY CONCEPTS Ethical conflicts in biotechnology - interference with nature, fear of unknown, unequal distribution of risks and benefits of biotechnology, Rational vs. subjective perceptions of risks and benefits, relationship between risk, hazard, exposure and safeguards, Biotechnology and biosafety concerns at the level of individuals, institutions, society, region, country and the world. The Cartagena protocol on biosafety. Biosafety management. Ethical implications of biotechnological products and techniques Laboratory associated infections and other hazards, assessment of biological hazards and levels of biosafety, prudent biosafety practices in the laboratory/ institution. Experimental protocol approvals, levels of containment.	
Module-4	
REGULATIONS Biosafety assessment procedures in India and abroad. International dimensions in biosafety, bioterrorism and convention on biological weapons. Social and ethical implications of biological weapons. Biosafety regulations and national and international guidelines with regard to recombinant DNA technology. Guidelines for research in transgenic plants. Good manufacturing practice and Good lab practices (GMP and GLP). National and international regulations for food and pharma products.	
Module-5	
OTHER SECTORS: The GM-food debate and biosafety assessment procedures for biotech foods & related products, including transgenic food crops, case studies of relevance. Key to the environmentally responsible use of biotechnology. Environmental aspects of biotech applications. Use of genetically modified organisms and their release in environment. Discussions on recombinant organisms and transgenic crops, with case studies of relevance. Plant breeder's rights. Legal implications, Biodiversity and farmers rights. Biosafety assessment of pharmaceutical products such as drugs/vaccines etc. Biosafety issues in Clinical	

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbook/Reference Books

	Title of the book	Author Name	Publisher's Name	Publication year
1	Biotechnology and Safety Assessment	Thomas, J.A., Fuch, R.L	Academic Press.	3rd Edition
2	Biological safety Principles and practices	Fleming, D.A., Hunt, D.L	ASM Press	**5th Edition 2017**
3	Bioethics &Biosaftey	SateeshMK	IK Publishers	2008
4	Biotechnologies and development	Sassaon A	UNESCO	1988
5	Biosafety Management	P.L. Traynor	Virginia polytechnic Institute	

(Group-5): Course Code:20BBT241Course Title: Systems biology

Exam Hours: 3 hours	**Exam Marks(Maximum):100**

Module-1

INTRODUCTION TO SYSTEMS BIOLOGY: Scope, Applications. Concepts, implementation and application. Databases for Systems Biology, Mass Spectrometry and systems Biology. Bioinformatics databases supporting systems biology approaches.

Module-2

NETWORK MODELS AND APPLICATIONS: Natural Language Processing and Ontology enhanced Biomedical data mining, text mining. Integrated Imaging Informatics-Integrin, centroid, cell culture. Standard platforms and applications - metabolic control analysis, glycolysis, metabolic network, Michaelis-Menten kinetics, and flux balance analysis. Signal Transduction - phosphorylation, Jak-Stat pathway, MAP kinase. Biological Processes - mitochondria, cyclin, Cdc2. Modelling of Gene Expression - lactose, lac operon, tRNA. Analysis of Gene Expression Data - support vector machines, cDNA microarray. Evolution and Self-organization - hypercycle, quasispecies model, self-replication. Reconstruction of

Module-3

INTEGRATED REGULATORY AND METABOLICMODELS: Phosphorylation, Gene expression, andMetabolites. Estimation Modeling and Simulation -Circadian rhythms, Petri net, mRNA. Deterministic -Circadian rhythms, mRNA, Circadian oscillations. Multiscale representations of Cells and Emerging Phenotypes -Gene Regulatory Networks, attractor, and Booleanfunctions. Mathematical models and Optimizationmethods for De Novo Protein design. Global Geneexpression assays. Mapping Genotype - Phenotype relationship in cellular networks

Module-4

MULTISCALE REPRESENTATIONS OF CELLS AND EMERGING PHENOTYPES:Multistability andMulticellularity, Spatio-Temporal systems biology,Interactomics, Cytomics – from cell state to predictive medicine.

Module-5

MODELING TOOLS: SBML, MathMLCellML, Petri Nets and Bioinformatics tools with case studies and discussions.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbook/Reference Books

	Title of the book	Author Name	Publisher's Name	Publication year
1	Computational Systems Biology.	Andres Kriete, Roland Eils	Academic Press	2006.
2	Systems Biology	Andrzej K. Konopka	CRC	2006
3	Transactions on Computational	CorradoPriami	Springer	2009
4	Systems Biology	Fred C. Boogerd,	Elsevier	2007
5	Introduction to Systems Biology,	Sangdun Choi.	Humana Press.	2007

(Group-5): Course Code :20BBC252Course Title: Pharmaceutical Biotechnology

Exam Hours: 3 hours	**Exam Marks(Maximum):100**

Module-1

INTRODUCTION: Introduction to pharmaceutical biotechnology, pharmacokinetic concepts, current research trends, new advances and approved biologicals for pharmaceutical use and manufacturing principles. Quality assurance and control; Concept of GMP, GLP.

Module-2

THERAPEUTICS BASED ON BIOTECHNOLOGY: Hematopoietic growth factor and coagulation factors, interferons and cytokines; Preparation and standardization of hormones-thyroid, insulin and growth hormones; Enzymes-Enzymatic therapy and monographs;antibiotics and their derivatives-penicillin, streptomycin, tetracycline, cephalosporins, macrolides, peptide antibiotics (any two); vaccines BCG, DPT, Poliomyelitis, Typhus, toxoids- diptheria and tetanus; antitoxins diptheria and gas-gangrene(any two); others-whole human blood, dried human plasma, gamma globulins, clinical dextran and absorbable haemostats, uses, and storage

Module-3

BIOTRANSFORMATION: Introduction, methods used in biotransformation, steroid transformation, contraceptives, L-Dopa, chemical reactions and mechanisms (hydroxylation, aromatization, synthetic routes, epoxidation and others), production and application of monoclonal antibodies.

Module-4

NUTRACEUTICALS: Antioxidants, flavanoids, carotenoids, cholesterol lowering chemicals, nutritional importance and their functions, deficiency diseases, nutritional status evaluation. Drug delivery systems: Introduction to drug delivery systems and methods, overview of barriers, calculation of drug metabolism and, pharmacodynamics.

Module-5

RECOMBINANT PROTEINS AND PROTEOMICS
IN DRUG DEVELOPMENT: Role of proteomics in drug development Application of recombinant proteins in pharmaceutical industry, health care and future prospects.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbook/Reference Books

	Title of the book	**Author Name**	**Publisher's Name**	**Publication year**
1	Biopharmaceuticals: Biochemistry and Biotechnology	Walsh G	John Wiley & Sons Ltd	**2003**
2	Pharmaceutical :Fundamentals and Applications Biotechnology	Crommelin, Daan J. A., Sindelar, Robert D.,	Springer	**2013**
3	Wolff Burger's Medicinal Chemistry and Drug Discovery	Manfred E	Wiley & Sons, Inc	**2000**
4	Binghewang, Terunasiahaan, Richard soltero	Drug delivery: principles and applications	applications John wiley& sons	**2005**
5	Drug Metabolism: An Introduction	Michael D. Coleman	John Wiley & Sons,	2005

(Group-5): Course Code 20BBC321 Course Title: Environmental Biotechnology	
Exam Hours: 3 hours	**Exam Marks(Maximum):100**

Module-1

INTRODUCTION TO ENVIRONMENT:

Concerns pertaining to Ecological damage, Environmental Pollution Types - Water, Soil, Air, Noise and Thermal pollutions, their sources and ecological effects of pollutants on living and non-living systems.. Acid rain: sources and solutions. Significance of GHGs and carbon footprint; Biodegradation, of xenobiotic compounds, organisms involved in degradation of chlorinated hydrocarbons, substituted simple aromatic compounds, polyaromatic hydrocarbons, pesticides, surfactants and microbial treatment of oil pollution. Microbial desulfurization of coal. Environmental implications of Acid mine drainage and its remediation; Role of Biotechnology in providing solutions to environmental problems.

Module-2

BOD, COD and TOC – Estimation and correlation; Definition of Waste; Physical, Chemical and Biological characteristics of Industrial waste. Nitrification and Denitrification and their kinetics; Wastewater treatment systems. Waste Management in different industries (food processing, leather tanning, pharmaceutical, textile) Solid waste management: landfills, composting, earthworm treatment, recycling and processing of organic residues, Sources and dispersion of atmospheric pollutants and dispersion models. Control methods for air pollutants, noxious pollutants and odor control; Design of air pollution control equipments; Photochemical reactions.

Module-3

WASTE TREATMENT METHODS:

Types (Suspended and Attached growth processes), Aerobic and Anaerobic treatment of wastes; Other biological treatment process, Anaerobic digestion – Stoichiometry & Kinetic relationships, design consideration, Process modeling and control, Biological nutrient removal, Biological treatments with Case studies; Bioremediation types and biorestoration of contaminated lands. Handling of hazardous wastes from bioprocess industries and related case studies.

Module-4

ENVIRONMENTAL SENSING TECHNIQUES:

Characterization of water contaminants and their measurement Spectroscopic techniques, AAS, NAA, GCMS, HPLC, Electro analytical techniques, Environmental sensing techniques. Discussions with Case studies.

Module-5

ENVIRONMENTAL POLICIES AND REGULATIONS:

Waste minimization and its plan; Conservation of water and energy, Fugitive loss, Programs of municipal pollution control, Risk evaluation and decision analysis. Sustainable development, Environmental Management Systems, ISO and ISO 14000 series: Introduction, Areas covered in the series of standards, Necessity of ISO certification, Environmental Auditing; Other tools for environmental management, Environmental Impact assessment(EIA) and its future and scope. Objectives, Elements of EIA, Baseline studies Methodologies of EIA, Types of impacts, Prediction of impacts and its methodology, Uncertainties in EIA, Status of EIAs in India. EIA at various industries

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbook/Reference Books

	Title of the book	Author Name	Publisher's Name	Publication year
1	Textbook of Environmental Biotechnology	Pradipta Kumar Mohapatra	I K International	**2007**
2	Hazardous Waste Management	Buckingham and Evans	McGraw Hill International	2001
3	Biochemical Engineering	Bailey &Ollis	McGraw Hill	**1986**
4	Standard Methods for the Examination	Laura Bridgewater	American	**2007**
5	Environmental Management	N K Uberoi	Excel Books publication	**2007**

(Group-5): Course Code 20BBC332	**Course Title: Bioenergy Management**
Exam Hours: 3 hours	**Exam Marks(Maximum):100**

Module-1

BIOENERGY CONCEPTS- INTRODUCTION

Biopower, bioheat, Biofuels, advanced liquid fuels, drop-in fuels, Biobased products, Sustainability & Resilience, Bioenergy & Environment, Carbon Footprint, Emissions of biomass to power generation applications, Emissions from biofuels,

Module-2

BIOMASS

Properties and types, proximate and ultimate analysis, calorific value, density, moisture content, energy content in biomass, chemical composition of biomass, Biomass logistics, Harvesting or collection, Densification, Transport, Storage.

Module-3

BIOMASS FEEDSTOCKS

Harvested Feedstock:

Feedstocks for first generation biofuels – Sugar crops, grains, oil seeds considered in terms of their potential for production; land use; competition with food and other industrial crops; energy inputs in production; and transport logistics.

Feedstocks for second generation Biofuels - Dedicated plantation, Forestry and agricultural residues, secondary biomass feedstocks (agricultural, industrial, commercial, and municipal organic wastes) considered in terms of their production, composition, purity, conversion potential and environmental impacts.

Feedstocks for third generation feedstocks - Micro and macro algae considered in terms of development of new biomass feedstocks and technical constrains. Biofuels from biomass conversion processes (solid: biochar; liquids: bioethanol and biodiesel; gaseous: biogas and syngas).

Residue Feedstocks: Agricultural waste, Forestry waste, Farm waste, Organic components of residential, commercial, institutional and industrial waste

Module-4

BIOMASS CONVERSION TECHNOLOGIES

Pretreatment of biomass (pelleting; chipping; biodrying etc.), Biorefineries& end products Biochemical Conversion: Hydrolysis, enzyme & acid hydrolysis, Fermentation for bioethanol and Bio-butanol production, Anaerobic digestion for biogas/biomethane production, Trans-esterification for biodiesel production Thermochemical Conversion: Combustion, Gasification, Pyrolysis Types of reactors, chemical equilibrium and reaction kinetics. Management of solids / liquids / gaseous biomass process waste. Heat generation from biomass boilers and stoves (operation, sizing criteria). Power generation from biofuels: engines (ICE), turbines (steam, ORC, gas) and fuel cells.

Module-5

LIFE CYCLE ANALYSIS

Cradle-to-grave, field to wheels concepts; Goal and scope determination, defining LCA boundaries; Life Cycle Inventory, Life Cycle Assessment; Advanced low-carbon fuels from waste; Bio-electrochemical systems (e.g. microbial fuel cell) for bioenergy and chemical production.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbook/Reference Books

	Title of the book	Author Name	Publisher's Name	Publication year
1	Biorenewable Resources: Engineering New Products from Agriculture	Robert C. Brown	Wiley-Blackwell	**2003**
2	Anaerobic Biotechnology for Bioenergy Production: Principles and	Samir K. Khanal	Wiley-Blackwell	**2008**
3	Bioenergy : power, fuels and products	Jennifer A. De-	Policy	2006
4	Introduction to Bioenergy	Vaughn C. Nelson	CRC	2017

5	Bioenergy: Biomass to Biofuels	Anju Dahiya	Academic press	2014

(Group-5): Course Code: 20FDB251 Course Title: Dairy Technology	
Exam Hours: 3 hours	**Exam Marks(Maximum):100**

Module-1

Introduction: Understanding about milk, milk - composition, food and nutritive value, physico-chemical properties; milk reception at dairies, quality and quantity tests at reception. Equipments used in liquid milk processing.

Module-2

Unit Operations in Milk Processing: Principles of milk processing: Filtration, milk storage, bulk cooling, stirring and mixing, standardization, pasteurization, sterilization, centrifugation, homogenization, evaporation and condensation.

Module-3

Production of Milk Products

Drying of milk, principle and equipment: spray dryer, cyclone separator. Manufacturing of milk products and principles of processing of cheese, ice-cream, butter, special milk products, casein, whey, curd, butter milk etc. Equipment for indigenous milk productsmanufacturing. Enzymes and their role in the manufacture of dairy products.

Module-4

Non-thermal processing and packaging: UV, High pressure, Ultrasound, Membrane, High intensity pulsed electric field applications in milk processing.

Packaging: Filling Operations: Principles and working of different types of bottle filters and capping machine, pouch filling machine, pre-pack and aseptic filling. Filling and Packaging machines for milk and milk products, asepticpackaging.

Module-5

Dairy plant maintenance: Bulk milk handling system, care and maintenance, Hygienic design concepts, sanitary pipes and fittings, CIP system. Preventive maintenance program for Dairy Plant, Maintenance organization, development of optimum organization planned overhaul and PERT planning, Utilities and sanitation in processing plant.

By-product utilization from dairy industries.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbook/Reference Books

	Title of the book	Author Name	Publisher's Name	Publication year
1	Outlines of Dairy Technology.	Sukumar De	Oxford University	1980
2	Dairy Plant System and Layout.	Tufail Ahmed	Publisher Kitab Mahal	2003

3	Engineering for Dairy and Food Products.	A W Farrall.	John Wiley and Sons	
4	Indian Dairy Products.	K S Rangappa and K T Achya	Asia Publishing House,	1975
5	Milk and Milk Products.	Clarence Henry Eckles	Mc-Grew Hill	

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Ph.D Coursework Courses – 2020 in BIOTECHNOLOGY

(Group-6):Course Code :20BBT252Course Title:Stem Cells and Tissue Engineering

Exam Hours: 3 hours	**Exam Marks(Maximum):100**

Module-1

Stem Cells: Concepts and Types of Stem cells: Embryonic, Adult and Induced stem cells. Embryonic stem cells: Pluripotent, Totipotent and Multipotent cells. Adult stem cells: Hematopoietic, Neural stem cells, Epidermal and Epithelial stem cell.

Module-2

Growth and applications of stem cells: Cell culture methods, Cell isolation, selection, maintenance of primary and early passage cultures. Clinical potential of stem cells: Organ and tissue regeneration, cardiovascular treatment, Cell deficiency therapy, treatment of any brain related defects.

Module-3

Introduction to Tissue Engineering: History and scope of tissue engineering. The isolation and handling of human and animal tissue. The major methods of preparing a primary culture. Introduction to cell adhesion: cell–cell adhesion, cell–matrix adhesion and signalling, cell proliferation, and differentiation.

Module-4

Basic growth and Differentiation of Tissues: Morphogenesis and tissue engineering-gene expression, cell determination and differentiation. In vitro control of tissue development: In vitro culture parameters, growth factors, mechanobiology, tissue development and organ engineering. In vivo synthesis of Tissue and Organs.

Module-5

Tissue engineering for tissue regeneration: using bone marrow mesenchymal stem cells (MSCs) and adipose derived stem cells (ASCs). Therapeutic strategy for repairing the injured spinal cord using stem cells. Wound and Disc repair using stem cells. Engineering of tissues: cartilage, bone and skin. Biomaterials in tissue engineering.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbook/Reference Books

	Title of the book	Author Name	Publisher's Name	Publication year
1	Stem cell and Tissue Engineering	Song Li, Nicolas L' Heureux and	World scientific	**2014**
2	Principles of Tissue Engineering	R Lanza, Langer R and Vacanti J	Elsevier	2013
3	Tissue Engineering	John P. Fisher, A	CRC Press	2007.
4	Tissue Engineering and Artificial	JD Bronzino	Taylor and	4th edition
5				

(Group-6): Course Code:20BBT253
Course Title: Clinical and Pharmaceutical Biotechnology

Exam Hours: 3 hours	**Exam Marks(Maximum):100**

Module-1

INTRODUCTION: Introduction to pharmaceutical biotechnology, pharmacokinetic concepts, current research trends, new advances and approved biological for pharmaceutical use and manufacturing principles. Quality assurance and control; Concept of GMP, GLP.

Module-2

THERAPEUTICS BASED ON BIOTECHNOLOGY: Hematopoietic growth factor and coagulation factors, interferons and cytokines; Preparation and standardization of hormones-thyroid, insulin and growth hormones; Enzymes-Enzymatic therapy and monographs;
antibiotics and their derivatives-penicillin, streptomycin, tetracycline, cephalosporins, macrolides, peptide antibiotics (any two); vaccines BCG, DPT, Poliomyelitis, Typhus, toxoids-diptheria and tetanus; antitoxinsdiptheria and gas-gangrene(any two); others-whole human blood, dried human plasma, gamma globulins, clinical dextran and absorbable haemostats, uses, and storage.

Module-3

BIOTRANSFORMATION: Introduction, methods used in biotransformation, steroid transformation, contraceptives, L- Dopa, chemical reactions and mechanisms (hydroxylation, aromatization, synthetic routes, epoxidation and others), production and application of monoclonal antibodies.

Module-4

NUTRACEUTICALS: Antioxidants, flavonoids, carotenoids, cholesterol lowering chemicals, nutritional importance and their functions, deficiency diseases, nutritional status evaluation. Drug delivery systems: Introduction to drug delivery systems and methods, overview of barriers, calculation of drug metabolism and, pharmacodynamics.

Module-5

RECOMBINANT PROTEINS AND PROTEOMICS
IN DRUG DEVELOPMENT: Role of proteomics in drug development Application of recombinant proteins in pharmaceutical industry, health care and future prospects.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbook/Reference Books

	Title of the book	Author Name	Publisher's Name	Publication year
1	Biopharmaceuticals: Biochemistry and Biotechnology	Walsh G	John Wiley & Sons Ltd.	2nd Edition
2	Pharmaceutical Biotechnology: Fundamentalsand Applications	Crommelin,Daan J. A., Sindelar,	Springer	5th edition 2019

(Group-6): Course Code :20BBC322Course Title: Biosensor Technologies	
Exam Hours: 3 hours	**Exam Marks(Maximum):100**

Module-1

BIOSENSOR CHARACTERISTICS

Definition and components of biosensor, Basic measurement system, Measurement, Measure and, Errors in Measurements, Signal and Noise, Calibration, Method validation, Surface chemistry, Mass transport, Static characteristics- accuracy, precision, linearity, hysteresis, threshold; dynamic range, Dynamic Characteristics – response time, damping, calibration, standards and AC/DC bridges, Biocompatibility and surface fouling, sensor integration and systems fabrication.

Module-2

TRANSDUCERS

Various types of transducers; principles and applications - Calorimetric, Optical, Potentiometric / Amperometric, Conductometric / Resistometric, Piezoelectric, Semiconductor, Impedimetric, Chemiluminescence - based Biosensors, Quantum dots, Fluorescence, Raman Spectroscopy and Fluorescence Enhancement and DNA microarrays

Module-3

BIOCHEMICAL RECOGNITION

Chemical reactions: history of gravimetric and colorimetric reactions. Problems of specificity. Enzymes: biological catalysts, specificity, activity, storage/shelf life. Enzyme kinetics in solution and on a surface. Chemical equilibrium- forcing an unfavorable reaction. Cells: Signal transduction through chemoreception, membrane potential, cell metabolism, cytotoxicity, and transformed 'bioreporter' organisms. Antibodies: Immunochemistry, binding affinity and kinetics; hapten synthesis. Nucleic Acids (RNA and DNA): Basic biochemistry, hybridization; Amplification/self-replication; Secondary Structure and folding Aptamer (oligonucleotide) based recognition and molecularly imprinted polymers. Common assaying formats i) Labels: Radioisotopes, fluorophores, dyes, enzymes/substrates, liposomes, electroactive compounds. ii) ELISAs and nucleotide capture assays.

Module-4

MODERN INTEGRATED BIOSENSORS

Bioelectronic sensors (Fundamentals of microelectronics and CMOS based sensors) Biophotonic sensors (Fundamentals of photonic sensors, Resonant optical sensors, Plasmonic sensors) Biomechanical sensors (Principles of micro-electromechanical (MEM) resonators and sensors) Microfluidic devices for Lab-on-a-chip (Fabrication, Devices and techniques)

Module-5

APPLICATIONS

Biosensor applications in clinical chemistry, medicine and health care, biosensors for veterinary, agriculture and food, Low cost - biosensor for industrial processes for online monitoring; biosensors for environmental monitoring. Application of enzymes in analysis; design of enzyme electrodes and their application as biosensors in industry, healthcare, food and environment, Mobile/Point of Care biosensors

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
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- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbook/Reference Books

	Title of the book	**Author Name**	**Publisher's Name**	**Publication year**
1	Chemical Sensors and Biosensors: Fun damentals and Applications	F.-G. Bănică	Wiley	**2012**
2	Advances in Biosensors	B.D. Malhotra, A.P.F.Turner	Elsevier JAI	**2003**
3	Electronic Measurements and Instrumentation	P. Sharma	Umesh Publications	**2006**
4	Bioelectronics: From Theory to Applications	I.Willner, E.Katz	Wiley-VCH Verlag GmbH & C0	**2006**
5	Biosensors for environmental monitoring	Bilitewski, U.Turner	A.P.F. Harwood, Amsterdam	**2000**

(Group-6): Course Code 20BBC324 Course Title: Nano Biotechnology	
Exam Hours: 3 hours	**Exam Marks(Maximum):100**

Module-1

INTRODUCTION TO NANOMATERIALS AND NANOBIOMATERIALS:

History of Nanotechnology and Nanobiotechnology, scope and Applications. Structures and properties of Carbon based, metal based and bionanomaterails: Fullerenes, Bucky Ball, Nanotubes, Quantum Dots, Magnetic, Nano Shells,Dendrimers, Nanocarriers, Nanocrystals, Nanowires, Nanomembranes, hybrid biological/inorganic, protein & DNA based nanostructures. Introduction & overview of 1st, 2^{nd} and 3^{rd} generation biomaterials.

Module-2

CHARACTERIZATION OF NANOSTRUCTURES:

UV-Visible spectroscopy, Electron Microscopy-Scanning electron microscopy (SEM), Atomic Force microscopy (AFM), Transmission electron microscopy (TEM), Scanning Probe microscopy (SPM), Scanning tunnel microscopy (STM); Fourier Transform infrared spectroscopy (FTIR); X-ray spectroscopy

Module-3

NANO SYNTHESIS AND FABRICATION:
Introduction & overview of Nanofabrication: Bottom up-self-assembly and Top down approaches using processes like Ball milling, Sol-gel Process, Chemical Vapor deposition (CVD). Plasma or flame spraying synthesis, Ion-Bean sculpting electrodeposition and various lithography techniques. Nanolithography and Soft lithography. Biosensors: types, applications and developments. Biosensor in modern medicine.

Module-4

APPLICATION OF NANOBIOTECHNOLOGY:
Medical Nanobiotechnology: Diagnostics: Imaging: Benefits and Applications. Nanotherapeutics: cancer treatment – Nanotechnology based chemotherapy (Smart Bomb), Pebbles, wound care products, Implantable materials for vascular interventions, Implantables materials for orthopaedics and dentistry. Active implantable devices and biomics. Nanosurgery. Pharmaceutical Nanobiotechnology: Drug delivery – Nanoparticles used as drug delivery systems, types of drug loading, drug release (sustained and targeted release mechanism), Biodegradable polymers. Application in the field of Nano Surgery and Tissue Engineering. Nano Safety Issues**:** Nanotoxicology: Toxicology health effects caused by Nanoparticles, Ethics Challenges and Future.

Module-5

BIOMEMS AND NEMS:
Micro & Nano-Electromechanical systems – Fabrication process – choice of materials – advantages and limits of various approaches, Applications, Thermal Radiations, Magnetic, Chemical and Mechanical Transducers – Sensing and Actuators.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
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- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbook/Reference Books

	Title of the book	Author Name	Publisher's Name	Publication year
1	Nanotechnology in biology and Medicine	Tuan Vo-Dine, Tylor and Francis	CRC	**2009**
2	Introduction to Nano Science and nanotechnology	Poole C P and Owens F J	Wiley	**2004**
3	Nanotechnology	Greggory Timp	Springer	**1999**
4	Nanotechnology	Nanotechnology	IK	**2008**
5	Biological Molecules in Nanotechnology	Stephen lee and Lynn M Savage	International Business	**1998**

(Group-6): Course Code 20BBI334 Course Title: Bio business and Entrepreneurship Development

Exam Hours: 3 hours	**Exam Marks(Maximum):100**

Module-1

BIO ENTERPREUNERSHIP:

Introduction to bio-business, from the Indian context, SWOT analysis of bio-business. Concept of Entrepreneurship - Evolution of Entrepreneurship, Development of Entrepreneurship; Stages in entrepreneurial process; Role of entrepreneurs in Economic Development; Entrepreneurship in India; Entrepreneurship - its barriers. Small scale industries: Definition; Characteristics; Need and rationale; Objectives; Scope; Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study. Global bio business and industry future trends

Module-2

BUSINESS OPPORTUNITY IN AGRI BIOTECHNOLOGY:

Business opportunity, Essential requirement, marketing, strategies, schemes, challenges and scope-with case study on Plant cell and tissue culture technique, polyhouse culture. Herbal bulk drug production, Nutraceuticals, value added herbal products. Bioethanol production using Agri waste, Algal source. Integration of system biology for agricultural applications. Biosensor development in Agri management.

Module-3

BUSINESS OPPORTUNITY IN INDUSTRIAL BIOTECHNOLOGY:

Business opportunity, Essential requirement, marketing strategies, schemes, challenges and scope-with case study- Pollution monitoring and Bioremediation for Industrial pollutants, Pesticides, Herbicides etc. Integrated compost production- microbe enriched compost. Biopesticide/insecticide production. Fermented products-probiotic and prebiotics. Stem cell production, stem cell bank, contract research. Production of monoclonal/polyclonal antibodies, Single cell protein and secondary metabolite production. Contact research in microbial genomics.

Module-4

PROJECT MANAGEMENT, INTELLECTUAL PROPERTY, TECHNOLOGY MANAGEMENT AND STARTUP SCHEMES:

Building Biotech business challenges in Indian context-biotech partners (BICEPS, BIRAC, DBT, Incubation centres. etc.), operational biotech parks in India. Indian Company act for Bio business-schemes and subsidies. Meaning of Project; Project Identification; Project Selection; Project Report; Need and Significance of Report; Contents; Formulation; Guidelines by Planning Commission for Project report; Network Analysis; Errors of Project Report; Project Appraisal. Identification of business opportunities: Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study. Patent expiry and Entrepreneurship opportunity, Principles of Technology leasing, licensing and transfer, Start-up schemes in Indian government, Business incubation support schemes, Successful start-ups-case study.

Module-5

REGULATORY AFFAIRS, BIOETHICS & BIO-SAFETY:

Regulatory affairs in Bio business-regulatory bodies and their regulations (ex.FDA, EU, DSIR, AYUSH, FSSAI etc.,) Public education of the process of biotechnology involved in generating new forms of life for informed decision-making. Ethical concerns of biotechnology research and innovation Interference with nature, fear of unknown, unequal distribution of risks. Rational vs. subjective perceptions of risks and benefits, relationship between risk, hazard, exposure and safeguards. Biosafety concerns at the level of individuals, institutions, society, region, country and the world. The Cartagena protocol on biosafety. Biosafety management

Question paper pattern:

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- Each full question is for 20 marks.
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- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbook/Reference Books

	Title of the book	Author Name	Publisher's Name	Publication year
1	Management Fundamentals – Concepts, Application, Skill	Robers N. Lusier	SAGE publication	2012
2	Entrepreneurship Development	S.S.Khanka –	S.Chand& Co	2007
3	Bioethics & Biosafety	R	APH	2007
4	Principles of Management	P. C.Tripathi,	Tata McGraw	2018
5	Biotechnology Entrepreneurship: Leading, Managing and Commercializing Innovative	Craig Shimasaki	AP	2020

(Group-6): Course Code: 20FDB321	**Course Title: Food Safety and Toxicology**
Exam Hours: 3 hours	**Exam Marks(Maximum):100**

Module-1

Food safety: Types of food hazards: biological, chemical and physical; Risk assessment; Existing and emerging pathogens due to globalization of food trade; Newer systems of safety evaluation such as HACCP.

Module-2

Food testing: Testing of food ingredients & additives; Animal studies including LD50; Ames test for teratogenicity; Natural toxic constituents in plant foods; Shellfish poisoning

Module-3

Derived food toxicants: Chemicals from processing such as fumigants, chlorinated solvents, autoxidation products, carcinogens in smoked foods and pyrolysis, pesticides and herbicides. Toxicants generated during food processing and packaging such as nitrosamines, acrylamide, benzene, dioxins, furans etc. , persistent organic pollutants, food carcinogen and mutagens.

Module-4

Determination of Toxicants in Foods: Biotransformation. Natural Toxins in Animal Foodstuffs. Natural Toxins in Plant Foodstuffs. Fungal Toxins Occurring in Foods. Toxic Food Contaminants from Industrial Wastes. Pesticide Residues in Foods. Food Additives. Toxicants Formed during Food Processing.

Module-5

Food toxicity: Intentional and unintentional additives; Toxicity due to microbial toxins including botulinum and staphylococcal toxins, mycotoxin and due to other food pathogens; Food allergy and intolerance; Detoxication strategy.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbook/Reference Books

	Title of the book	Author Name	Publisher's Name	Publication year
1	1. Handbook of Food Toxicology. CRC Press.	S. S. Deshpande,	CRC press	2002
2	Nutritional and Safety Aspects of Food Processing.	Tannenbaum SR,	Marcel Dekker Inc	1979
3	Microbiological Safety of Food.	Hobbs BC, Christian J.H.B.	Academic Press Inc	1974
4	Chemical Toxicology of Food.	Galli, C.L,	Elsevier-North-Holland Biomedical Press	1978
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