J.J COLLEGE OF ARTS AND SCIENCE (AUTONOMOUS), PUDUKKOTTAI
DEPARTMENT OF BIOTECHNOLOGY
M.Sc., BIOTECHNOLOGY

Course Structure Under Choice Based Credit System
(Applicable for the Candidates Admitted from Academic Year 2019-2020 Onwards)

Sem	Course Code	Course Title	Hrs/ Week	Credit	Exam Hrs	Marks		Total
						Int.	Ext.	
I	P1R1BTCC1	Microbiology	6	5	3	25	75	100
	P1R1BTCC2	Biochemistry	6	5	3	25	75	100
	P1R1BTCC3	Genetics and Molecular Biology	6	5	3	25	75	100
	P1R1BTCC4P	Practical–I (Covering CC1,CC2 & CC3)	6	5	3	40	60	100
	P1R1BTEC1	Stem cells and Nanobiotechnology	6	3	3	25	75	100
Total			**30**	**23**	**-**	**-**	**-**	**500**
II	P2R1BTCC5	Food and Industrial Biotechnology	5	5	3	25	75	100
	P2R1BTCC6	Bioinstrumentation	5	5	3	25	75	100
	P2R1BTCC7	Genetic Engineering	5	5	3	25	75	100
	P2R1BTCC8	Immunology and Immunotechnology	5	5	3	25	75	100
	P2R1BTCC9P	Practical –II (Covering CC5,CC6,CC7 & CC8)	5	5	3	40	60	100
	P2R1BTEC2	Biostatistics	5	3	3	25	75	100
Total			**30**	**28**	**-**	**-**	**-**	**600**
III	P3R1BTCC10	Research Methodology	5	5	3	25	75	100
	P3R1BTCC11	Plant Biotechnology	5	5	3	25	75	100
	P3R1BTCC12	Animal Biotechnology	5	5	3	25	75	100
	P3R1BTCC13	Environmental Biotechnology	5	5	3	25	75	100
	P3R1BTCC14P	Practical -III (Covering CC11, CC12 & CC13)	5	5	3	40	60	100
	P3R1BTEC3	Medical and Pharmaceutical Biotechnology	5	3	3	25	75	100
Total			**30**	**28**	**-**	**-**	**-**	**600**
IV	P4R1BTEC4	Genomics and Proteomics	6	3	3	25	75	100
	P4R1BTCC15PW	Project Work	24	8	-			100
Total			**30**	**11**	**-**	**-**	**-**	**200**
Grand Total			**-**	**90**	**-**	**-**	**-**	**1900**

LIST OF ELECTIVE COURSES

1. Stem Cell Technology and Nano Biotechnology
2. Biostatistics
3. Medical and Pharmaceutical Biotechnology
4. Genomics and Proteomics
5. Mushroom Technology
6. Bioenterpreneurship

PROGRAMME SPECIFIC OBJECTIVES – P.G.

- The graduates of Biotechnology will acquire the skills in approaching and solving challenges related to healthcare, agriculture and environmental sectors through Biotechnological approaches.
- To provide strong fundamentals of biotechnology and its industrial application.
- To discover in depth knowledge of animal and plant biotechnology and also broad area of biochemistry, Immunology and molecular biology.
- It will provide the students to develop independent learning skills in all biochemical and biotechnology studies.
- This course will provide the students to apply their knowledge and skills in their future professional areas.
- This course will help in contributing to the education of academics which impart its effect for university to play an active role in other advanced studies.

PROGRAMME SPECIFIC OUTCOME – P.G.

- Apply their knowledge in other advanced subject area like Nanobiotechnology, Immunotechnology, and Animal and Plant biotechnology for the betterment and advancement of their professional career.
- Gain the theoretical and practical exposure to the basic and the advanced fields of biotechnology.
- Graduate will develop confidence for self education and ability for life-long learning.
- Graduates will be able to undertake any responsibility as an individual and as a team in a multidisciplinary environment.

SEMESTER – I - CORE COURSE I - MICROBIOLOGY

Course code: P1R1BTCC1 **Max Marks: 100**
Hours/ Week: 6 **Internal Marks: 25**
Credits: 5 **External Marks: 75**

COURSE OBJECTIVES

- To introduce the students to the field of microbiology with special emphasis on microbial diversity, morphology, physiology and nutrition; methods for control of microbes and host-microbe interactions.
- To know about the Microorganisms, its structure and classification.
- To learn about the isolation and general characteristics of Microorganisms.
- To study about the pathogens, its diagnostic methods, prevention and treatment for the diseases.
- Motivate the students to become a successful Entrepreneur.

Total Instructional Hours: 72

UNIT I: Basic Microbiology **Hours: 15**

Introduction to Microbiology: Scope of microbiology and emerging avenues, Development of microbiology, Microbial taxonomy and detailed classification of the microbial world as per Bergey's manual of classification (Bacteria, Archaea, Eukarya),

UNIT II: Ultra structure of Prokaryotic and Eukaryotic **Hours: 15**

Ultra structure of Prokaryotic and Eukaryotic cell- The Prokaryotic Cell: Size, shape and arrangement of bacterial cells; structure of cell wall, and structures external (glycocalyx, flagella, pili, etc.,) and internal (plasma membrane, cytoplasm, inclusion bodies, etc.,) to the cell wall. The Eukaryotic Cell: Cilia, flagella, cytoskeleton, cytomembrane systems, mitochondria and chloroplast Comparison of Prokaryotic and Eukaryotic cell.

UNIT III: Microbial Nutrition, Growth and reproduction of microorganisms **Hours: 13**

Cultivation of microorganisms; culture media and types of culture media. Nutritional requirements of microorganisms - nutritional classification of bacteria. Growth curve, Mathematical expression of growth; Measurment of growth and growth yields, Counting of bacteria, Synchronous growth, and continuous culture, growth as affected by environmental factors. Reproduction - sexual and asexual.

UNIT IV: Sterilization and Preservation of Microorganisms: **Hours: 13**

Sterilization - Physical methods, chemical methods and Radiation methods, Antimicrobial agents, Antibiotics and their mode of action, Biosafety and levels of biosafety, Types of microbiological safety cabinets, GLP and GMP, Preservation of Microorganisms- lyophilization and Cryopreservation.

UNIT V: Medical Microbiology: **Hours: 12**

Diseases caused bacteria, virus, fungi, and protozoan's; Fungal diseases, Host parasite interaction-recognition and entry process of different pathogens in plants and animals, Toxins produced, Vaccines, Anti-microbial agents, Antibiotics and disinfectants, National Immunization Programme

UNIT VI: Latest Learning's (For CIA Purpose only) **Hours: 04**

Latest development related to the course during the semester concerned

TEXT BOOKS

1. A text book of Microbiology – R.C.Dubey,Dr.K.Maheswari , 2012, M.Chand Publishers 1st Edition.
2. Text book of Microbiology – D.R.Arora and B.Arora, 2008, CBS Publications; 3rd Edition
3. Marine Microbial Diversity, Karl,D & Buckley,M, 2005, American academy of microbiology, Washington.

REFERENCES

1. Microbiology-M.J. Pelczar, Jr., E.C.S. Chang and N.R. Krieg, 1986, McGraw Hill Company, New York.
2. Microbiology L.M. Prescott, J.P., Hareley, D.A., Klein, W.M.C.,1993, Brown publishers, Dutique Jawa Melbourne.
3. Microbiology-Concepts and applications, M.J. Pelczar, Jr., E.C.S. Chang and N.R. Krieg, 1993, McGraw Hill Company, New York.
4. General Microbiology Vol. II – Dr.CB Powar and Dr.H.F.Daginawala, 2010, Himalaya Publishing House.
5. Biological Oceanography, Miller,C.,Wheeler,P.A, 2012, Wiley-Blackwell Scientific Publications.

NET REFERENCES

- www.microbeworld.org, www.microbiology.org, www.asm.org

COURSE OUTCOME

- Basic knowledge on different structure and characteristics of microbes
- Understand the applied aspects of microbiology
- Understand the role of beneficial microorganisms in the environment and the application to benefit mankind.
- List and describe the mechanisms of action of major chemotherapeutic agents that control microorganisms.
- Explain about factors responsible for the virulence of different pathogenic microorganisms.

SEMESTER – I - CORE COURSE – II
BIOCHEMISTRY

Course Code: P1R1BTCC2 **Max Marks: 100**
Hours/Week: 6 **Internal Marks: 25**
Credits: 5 **Max Marks: 75**

COURSE OBJECTIVES:

- To gain a basic knowledge about the chemical bonding in biological system.
- To have a detailed knowledge about the function and properties of biomolecules
- To learn about the basic metabolic reactions of living organisms
- To have a basic knowledge about the enzymes and biological energy transducers
- Describe the various metabolic pathways involved in cells for its normal functioning.

Total Instructional Hours: 72

UNIT I - Chemical bonding in biological system **Hours: 15**
Percentage solution, molarity, normality, molality, properties of water- hydrogen bonding, hydrophobic interactions, acids bases and their concepts, buffer and electrolytes and their functions – acidity, alkalainity and pH determination - Energy and it's forms-free energy, laws of thermodynamics - Enthalpy and Entropy.

UNIT II - Introduction to biomolecules **Hours: 13**
Carbohydrates, Lipids, Amino acids, Proteins and Nucleic acids, Biomolecules – Introduction - classification, function and properties.

UNIT III - Metabolism of Carbohydrates and Biological energy transducers **Hours: 14**
Glycolysis, gluconeogensis and its significance , TCA cycle , Redox reaction ,Role of high energy phosphates,structure and functions of ATP ,electron transport chain and oxidative phosphorylation , photosynthesis - light and dark reaction.

UNIT IV – Metabolism of Lipids, Aminoacids and Nucleic acids **Hours: 14**
β-oxidation of fatty acids, transamination and oxidation domination reactions of amino acids. Amino acids catabolisms (phenylketonuria, albinism), biosynthesis of nucleotides (de novo synthesis and savage pathway), disorders of lipids, carbohydrates, nucleic acids, amino acids, metabolisms.

UNIT V – Enzymes **Hours: 12**
Classification and nomenclature of enzymes - physico chemical nature of enzymes – enzyme kinetics – mechanism of enzyme action – factors affecting enzyme activity, industrially important enzymes.

UNIT VI: Latest Learnings (For CIA Purpose only) **Hours: 04**

Latest development related to the course during the semester concerned

TEXT BOOKS

1. Biochemistry, Sathyanarayanan.U and Chakrapani.C, (2013), Books and allied (P) Ltd
2. Fundamentals of Biochemistry, Deb,A.C., (7^{th} Edition). New central agency.
3. Fundamentals of Biochemistry, Jain, J.L., (2005), (6^{th} Edition), S.Chand Publications
4. Enzymes, Ashokan.P, 2006, Chinna Publications
5. Molecular Biology, Freifelder. D, 1996, II Edition, Narosa Publishing House, New Delhi.

REFERENCE BOOKS

1. Biochemistry, Zubay,G.L., 1998, Wm.C. Brown Publishers.
2. DNA structure and function, Sinden,S.R., 1994, First Edition**,** Academic Press.
3. Introduction to Protein Structure, Carl Branden and John Tooze, 1999, Second Edition, Garland Publishing.
4. Biochemistry, Garrett.R and Grisham.C, 2010, 4^{th} Edition, Saunders College Publishing.
5. Biochemistry, Hubert, styer, 1995, Freeman and Company, New York.
6. Principles of Biochemistry, Lehninger, Nelson, David.L and M.M.Cox, 2013**.** 6^{th} Edition, W.H.Freeman & Co.
7. Biochemistry, Berg, J.M *et al*., 2012, 7^{th} Edition, W. H. Freeman & Co.
8. Fundamentals of Biochemistry: Life at the Molecular level, Voet, D. *et al.*, 2012, 4^{th} Edition, John Wiley and Sons.
9. Essentials of medical physiology, Sembulingam.K and Prema Sembulingam, 2003, 2^{nd} Edition, Jaypee Brothers Medical Publishers (P) Ltd.

COURSE OUTCOME

- Students will be imparted complete knowledge about structure and function of different biomolecules (proteins, lipids, nucleic acids, and carbohydrates) found in living cells.
- Also the course will provide the knowledge how biomolecules are synthesized and metabolized inside living cells.
- Acquire knowledge on the building blocks of the macromolecules, their chemical properties and their modification and their importance in normal functioning of living organisms.
- Understand the metabolic pathways and identify how the genetic abnormalities disturb the normal homeostasis and link with pathological conditions
- Understand the applications of biochemistry in medicine, agriculture, and pharmaceuticals

SEMESTER – I - CORE COURSE – III
GENETICS AND MOLECULAR BIOLOGY

Course Code: P1R1BTCC3 **Max Marks: 100**
Hours/Week: 6 **Internal Marks: 25**
Credits: 5 **External Marks: 75**

COURSE OBJECTIVES

- Familiarize students with the cell and molecular biology of both Prokaryotes and Eukaryotes.
- Students will acquire basic fundamental knowledge and explore skills in molecular biology and become aware of the complexity and harmony of the cells.
- This course will emphasize the molecular mechanism of DNA replication, repair, transcription, protein synthesis and gene regulation in various organisms.
- Understand the essentials of molecular biology: replication, transcription and translation; enzymes involved in the central dogma of life, proofreading, inhibitors and post modifications.
- Knowledgeable in mutant and it types, genetic recombination, linkage, multifactor crosses; mutation: causative agents, types and the mechanism of repair; complementation and intragenic complementation

Total Instructional Hours: 72

UNIT I: Classical Genetics **Hours: 10**

Dominance, Segregation, Independent Assortment, Co-dominance, Linkage, Crossing Over, Sex linkage and Sex influenced Character. Concept of Gene - Allele, Multiple Alleles, Pseudo Allele.

UNIT II: DNA Replication and Repair **Hours: 15**

Overview of Central dogma. Organization of prokaryotic and eukaryotic chromosomes. DNA replication: Meselson & Stahl experiment, bi–directional DNA replication, Okazaki fragments, Proteomics of DNA replication, Fidelity of DNA replication, Inhibitors of DNA replication, Overview of differences in prokaryotic and eukaryotic DNA replication, Telomere replication in eukaryotes. D-loop and rolling circle mode of replication. Mutagens, DNA mutations and their mechanism, various types of repair mechanisms.

UNIT III: Transcription **Hours: 15**

Structure and function of mRNA, rRNA and tRNA. Characteristics of promoter and enhancer sequences. RNA synthesis: Initiation, elongation and termination of RNA synthesis, Proteins of RNA synthesis, Fidelity of RNA synthesis, Inhibitors of transcription, Differences in prokaryotic and eukaryotic transcription. Basic concepts in RNA world: Ribozymes, RNA processing: 5'-Capping, Splicing-Alternative splicing, Poly 'A' tail addition and base modification.

UNIT IV: Translation **Hours: 15**

Introduction to Genetic code: Elucidation of genetic code, Codon degeneracy, Wobble hypothesis and its importance, Prokaryotic and eukaryotic ribosomes. Steps in translation: Initiation, Elongation and termination of protein synthesis. Inhibitors of protein synthesis. Post-translational modifications and its importance.

UNIT V: Regulation of Gene Expression **Hours: 13**

Organization of genes in prokaryotic and eukaryotic chromosomes, Hierarchical levels of gene regulation, Prokaryotic gene regulation –lac and trp operon, Regulation of gene expression with reference to λ phage life cycle.

UNIT VI: Latest learnings (For CIA Purpose only) **Hours: 04**

Latest development related to the course during the semester concerned

TEXT BOOKS

1. Friefelder, David. "Molecular Biology." Narosa Publications, 1999.
2. Weaver, Robert F. "Molecular Biology" 2nd Edition, Tata McGraw-Hill, 2003.
3. Karp, Gerald "Cell and Molecular Biology: Concepts and Experiments" 4th Edition, John Wiley, 2005.
4. Friefelder, David and George M. Malacinski "Essentials of Molecular Biology" 2nd Edition, Panima Publishing, 1993.
5. Lewin's GENES XI, Published by Jones & Bartlett Learning; 11 edition (January 15, 2013).

REFERENCES

1. Molecular Biology: Genes to Proteins" Tropp, Burton E. 3rd Edition. Jones and Bartlett, 2008.
2. Molecular Biotechnology: Principles and Applications of Recombinant DNA" Glick , B.R. and J.J. Pasternak. 4th Edition. ASM, 2010

COURSE OUTCOME

By the end of this course, students should be able to:

- Describe the basic structure and biochemistry of nucleic acids and proteins and discriminate between them;
- Identify the principles of DNA replication, transcription and translation and explain how they relate to each other.
- Discuss clearly about gene organization and mechanisms of control the gene expression in various organisms.
- Articulate applications of molecular biology in the modern world.
- Comprehend the genetic transfer methods and gene mapping, gene structure analysis, transposons types, nomenclature and their mechanism.

SEMESTER I: PRACTICAL- I (Covering CC1, 2 &3)
MICROBIOLOGY, BIOCHEMISTRY, GENETICS AND MOLECULAR BIOLOGY

Course Code: P1R1BTCC4P **Max Marks: 100**
Hours/Week: 6 **Internal Marks: 40**
Credits: 5 **External Marks: 60**

MICROBIOLOGY

1. Do's and Don'ts.
2. Preparation of solutions in different concentration.
3. Preparation of solid and liquid culture media,
4. Pure culture techniques – Pour plate, Spread plate and Streak plate method.
5. Identification of microorganisms: Macroscopic, Microscopic: staining techniques – simple, gram staining, capsule staining and spores staining. Motility- Hanging Drop Technique and stabbing. Biochemical tests –IMViC tests, Carbohydrate fermentation, Amylase production, Catalase, Oxidase, Urease and TSI .
6. Microscopic identification of fungi – Lactophenol cotton blue wet mount
7. Measurement of microorganisms – Micrometry
8. Determination of microbial growth: Turbidity method and counting chamber method.
9. Isolation and cultivation of algae from different water sources.

BIOCHEMISTRY

1. Preparation of standard solutions.
2. Method for measurement of pH.
3. Preparation of buffers solutions.
4. Reactions of Carbohydrates(Ribose, Glucose, Fructose, Sucrose, Starch)
5. Qualitative tests for Lipids.
6. Qualitative tests for Aminoacids
7. Qualitative tests for Proteins.
8. Qualitative tests for Nucleic acids
9. Analysis of Normal urine.
10. Analysis of abnormal urine.

GENETICS AND MOLECULAR BIOLOGY

1. Isolation of Genomic DNA
2. Estimation of DNA
3. Isolation of Plasmid DNA
4. Isolation of Auxotrophic mutants
5. Mutagenesis in Bacteria
    - Physical method-UV rays
    - Chemical method N-methyl-W-nitro-N-nitrosogunidine

REFERENCES:

1. Sundaraj T, Mrs. Aswathy Sundararaj. (2002) Microbiology Laboratory Manual, First edition, Chennai.
2. Laboratory Manual in General Microbiology (2002) by N. Kannan. Panima Publishers.
3. Dubey, R.C. and Maheshwari, O.K. (2005) Practical Microbiology. S, Chand and Co.Ltd., First edition. New Delhi.
4. Cappuccino, J and Sherman, N. (2002) Microbiology. A Laboratory Manual . 6th Edition. Pearson Education Publication, New Delhi.

NET REFERENCES:

www.cat.cc.md.us/course/bio141/lab manual/index.html

SEMESTER – I - ELECTIVE COURSE- I
STEM CELLS AND NANOBIOTECHNOLOGY

Course Code: P1R1BTEC1 **Max Marks: 100**
Hours/Week: 6 **Internal Marks: 25**
Credit: 3 **External Marks: 75**

COURSE OBJECTIVES

- To learn the unique properties of all stem cells.
- To know the potential uses of human stem cells**.**
- To learn the application of nanotechnology in biological system
- To help the students to understand about nanomaterials and nanomedicine.
- Provide basic knowledge in the interface between chemistry, physics and biology on the Nano structural level with a focus on biotechnological usage.

Total Instructional Hours: 72

UNIT I **Hours: 14**

Introduction to stem cell, definition, classification and source. Development stage, property of stem cell pluripotency, totipotency. Types of stem cell-embryonic and adult stem cell.

UNIT II **Hours: 14**

Germ line stem cells Prostate and Mammary SCs, Induced pluripotent Stem cells, Muscle and Cardiac stem cells, Neuro stem cells, Telomeres in stem cell biology. Stem cell plasticity.

UNIT III **Hours: 14**

Stem cell Techniques- Isolation of Blastomere**,** nuclear transfer, Therapeutic cloning, Reprogramming of stem cells, Transplantation, Stem cell therapy, Stem cell politics and ethics. Stem cell bank.

UNIT IV **Hours: 13**

Nano biology – concepts, definitions, prospects; nanoparticles – size, shape, properties. Bio nanoparticles – nanostarch, nano composites – dendrimers. Hot – Dot nanoparticles. Types of biomaterials. Biodegradable polymers.

UNIT V **Hours: 13**

Nanotubes, Nanorods, Nanofibers and Fullerenes for nanoscale drug. Bio nanoelectronics. Applications of nanobiotechnology in medicine, drug designing and cancer treatment. Medical, social and ethical considerations of nanobiotechnology.

UNIT VI: Latest learnings (For CIA Purpose only) **Hours: 04**

Latest development related to the course during the semester concerned

TEXT BOOKS

1. Stem cell technologies, basics and applications, Kaushik D.Deb, 2010 1st edition, Mc Graw Hill education.
2. Stem cells, Eapen cherian, 2011, 1st edition, Jay Pee brothers medical publishers**.**
3. Human Embryonic stem cells, Kiessling AA, 2nd Edition, 2006, Jones and Barlett Publishers.
4. Essentials of Stem cell Biology, Lanza .R, 2005, Academic Press.
5. Adult Stem cell,Turksen,K,2004, Humana Press,INc

REFERENCES

1. Nanobiotechnology, Concepts, Applications and perspectives, C.M. Niemeyer and C.A. Mirkin, WILEY-VCH, Verlag Gmb H & Co, 2004.
2. Bionanotechnology, Lessons from Nature, S. David Goodsell, Wiley-Liss, Inc., 2004.
3. Nanotechnology in Drug Delivery, Melgardt M.deVilliers, Pornanong Aramwit, Glen S. Kwon, Springer-American Association of Pharmaceutical Scientists Press2009.

COURSE OUTCOME

- Gain knowledge on stem cells and their applications.
- Gives understanding about the fundamentals of nanotechnology in biomedical and biological research.
- Learn about the background on Nanoscience
- Understand the synthesis of nanomaterials and their application and the impact of nanomaterials on environment
- Apply their learned knowledge to develop Nanomaterial’s.

SEMESTER - II - CORECOURSE- V
FOOD AND INDUSTRIAL BIOTECHNOLOGY

Course Code: P2R1BTCC5 **Max Marks: 100**
Hours/Week: 5 **Internal Marks: 25**
Credits: 5 **External Marks: 75**

COURSE OBJECTIVES

- To provide knowledge on various processing technologies of food and food products, preservation, long term storage and food safety aspects.
- To know about the structure, principles and applications of Bioreactors.
- Motivate the students to form a Bioprocess based Industries and R&D Labs.
- To study the principles and methodologies of Bioprocess technology.
- To get an idea about the applications of Biotechnology in Industries.

Total Instructional Hours: 60

UNIT I: Introduction to Food Technology **Hours:10**

Food chemistry – Carbohydrates, amino acids, proteins, lipids, vitamins - water soluble and fat soluble, macro- and micro-nutrients.Nutraceuticals, probiotics, antioxidants, vitamins, organic acids, single cell proteins. Food microbiology - Food spoilage – Source of contamination – microorganisms – bacteria, yeast, mould. Enzymes used in food industry – microbial production of enzymes (proteases, amylases, invertases, pectinase, xylanase), immobilization, applications.

UNIT II: Food Preservation **Hours: 11**

Food preservation – Functional and fermented foods - Bakery and cereal products, preservation of fruits and vegetables – dehydration, pickling.Low temperature processing and storage – chilling, cold storage.High temperature processing – drying, heat sterilization. Irradiation – types and source of irradiation, impact of radiation on foods, irradiation of packing material, health consequences of irradiated food. Chemical preservation – organic, inorganic preservatives, Sulphur dioxide, Benzoic acid. High concentration – sugar and salt concentrates. Brief description of packaging of frozen products, dried products, types of packaging.

UNIT III: Introduction to Industrial Biotechnology **Hours: 11**

Introduction - Scope and applications of industrial biotechnology. Isolation and screening of industrially important microorganisms. B**ioreactors:** Introduction to bioreactors - Design and construction of Bioreactors: Monitoring and control of bioreactor: Online and off line control, Controlling systems: Temperature, flow rate, pressure, pH, DO, gas analysis, Types of Bioreactors -Specialized bioreactors (fluidized bioreactors, photo bioreactors, immobilized cell reactors, airlift bioreactor, packed bed bioreactor). Types of fermentation –Aerobic, anaerobic Batch, continuous and fed-batch (variants).Solid state and submerged fermentation.

UNIT IV: Up-Stream and Downstream Processing **Hours:13**

Up-stream processing - media formulation for industrial fermentation. Sterilization: Batch and continuous sterilization systems - filter sterilization. Biomass removal: separation of microbial cells and solid matter; Centrifugation; Sedimentation; Flocculation; Microfiltration; Disintegration of microorganism: Sonication; Bead mills; Homogenizers; Chemical lysis; Enzymatic lysis; Membrane based purification: Ultrafiltration ; Reverse osmosis; Dialysis ; Diafiltration ; Adsorption and chromatography: size, charge, shape, hydrophobic interactions, Biological affinity; Process configurations, Precipitation (Ammonium Sulfate, solvent); Electrophoresis(capillary); Extraction(solvent, aqueous two phase, super critical), Drying – spray driers, drum driers and freeze driers.

UNIT V: Microbial Products **Hours:12**

Production, harvest, recovery and uses – Enzymes, Antibiotics (penicillins, tetracycline, streptomycin), vitamins (B_2, B_{12}), Aminoacids (lysine, glutamic acid,), Organic solvents (acetone, ethanol); Organic acids (acetic acid, citric acid, lactic acid).Use of microbes in minerals and oil recovery.Production, harvest, recovery and uses – Baker‟s yeast, milk products, edible mushrooms.Single Cell Protein (algae/fungi), beverages (Beer, Wine and Brandy).

UNIT VI: Latest learnings (For CIA Purpose only) **Hours: 03**

Latest development related to the course during the semester concerned

TEXT BOOKS:

1. Bioprocess Technology, PT.Kalaiselvan and I.ArulPandi ., 2007. MJP Publishers,
2. Biotechnology: A text book of Industrial microbiology., Wulfcrueger and Anne liesecrueger., 2000, Panima publishing corporation, New Delhi/Bangalore

REFERENCES:

1. Principles of fermentation technology - P.F. Stanbury, A. Whitaker and S.J., 2005. Hall Elsevier publication, second edition,
2. Industrial microbiology – L.E. Casida, 2005. New Age International (P) Ltd, New Delhi.
3. Instrumentation and measurement and analysis, Nakra BC and chaudry KK 2004. II edition tata McGraw hill publishing co. ltd, New Delhi

NET REFERENCES:

1. www.indiastudychannel.com/resource/41331-osmania-university-m-sc-microbiology-
2. www.forsight.org/eoc/index.html.

COURSE OUTCOME:

- Acquire an understanding of relevance of food components,
- Acquire an understanding application and detection techniques in food.
- Acquire an understanding in industrial operations in food, role of microbes
- Course will have a specific focus on bioremediation and treatment of polluted effluent.
- The course will also provide conceptual knowledge and significance of genetically modified microbes.

SEMESTER - II - CORECOURSE- VI
BIOINSTRUMENTATION

Course Code: P2R1BTCC6 **Max Marks: 100**
Hours/Week: 5 **Internal Marks: 25**
Credits: 5 **External Marks: 75**

COURSE OBJECTIVES

- Thorough understanding of the analytical techniques and equipment used in Biological science**.**
- To have a fundamental knowledge regarding the Microscopy, Spectroscopy, Centrifugation.
- To acquire knowledge on the Chromatographic method for the separation of biological products
- To acquaint the students with various techniques used in biological sciences and the emerging areas of biotechnology along with underlying principles.
- To make students learn about modern instruments for various analytical works

Total Instructional Hours: 60

UNIT I: Basic Instruments **Hours: 10**

pH meter, isoelectric focusing. Principles and application of light microscopy, phase Contrast, Bright and Dark field Microscopy fluorescence Microscopy, Electron Microscopy- TEM, SEM, Confocal microscopy and Atomic absorption microscopy.

UNIT II: Separation Techniques **Hours: 12**

Basic principle of centrifugation**,** and its types - Ultra Centrifugation (Preparative and analytical), Density gradient Centrifugation, Rate zonal centrifugation, Differential centrifugation. Standard Sedimentation coefficient. **Chromatography:** Chromatography - Principle, instrumentation and application of Paper Chromatography, Adsorption chromatography, Ion exchange Chromatography, Thin layer Chromatography, Affinity chromatography, HPLC and GC.

UNIT III: Diffraction Methods **Hours: 12**

Principles, Components and applications of X-ray crystallography. Braggs equation, Reciprocal lattice concept, Miller index and Unit cell, Determination of crystal structure, colorimeter, Spectroscopy – Raman effect, UV-Visible, Mass spectroscopy, Atomic Absorption spectroscopy, NMR –Experimental techniques and instrumentation, ESR. LASER and MASER - Principle and applications**.**

UNIT IV: Tracer Techniques **Hours: 12**

Radioactive and stable isotopes: Pattern and rate of radioactive decay isotope-Half life, GM Counter, solid and Liquid scintillation counter, Radiation dosimetry, Radio tracer technique, Autoradiography. Application of isotopes in Biology.

UNIT V: Electrophoretic Techniques **Hours: 11**

Electrophoresis- Agarose Gel Electrophoresis, SDS-PAGE, Native Gel, 2D gel and gradient Gel Electrophoresis, Pulsed field Gel Electrophoresis (PFGE).

UNIT VI: Latest learnings (For CIA Purpose only) **Hours: 03**

Latest development related to the course during the semester concerned

TEXT BOOKS

1. Biophysical chemistry – principles and techniques, Upadhyay , Upadhyay and Nath, 3 rd edition , 2002, Himalaya publishing home.
2. Laboratory manual in biochemistry, J.Jayaram 1981, Wiley publisher.
3. Bioinstrumentation, L. Veerakumari, 1st edition 2011, MJP publishers**.**

REFERENCE BOOKS

1. Analytical biochemistry and separation techniques-A laboratory manual, P.Palanivelu 2nd edition 2001 tulsi books centre**.**
2. Principles and techniques of practical biochemistry, Keith Wilson and John walker, 5th edition 2000, Cambridge University press.
3. Analytical biochemistry, D. Holme and H.Peck, 3rd edition 1998, longman.
4. Physical biochemistry- application to biochemistry and molecular biology, Freifelder, 2nd edition, 1982, W. H.Freeman and company, San Fransisco.

NET REFERENCES:

1. www.explainthe stuff.com
2. www.chemguide.co.uk.

COURSE OUTCOME

- Understand general laboratory procedures and maintenance of research equipments, microscopy, pH meter and preparation of different buffers
- Describe the pH measurement in soil and water samples
- Understand how to isolate cellular constituents
- Realize the need of centrifuges and their uses in research
- Understand how to separate amino acids and sugars using paper & thin layer chromatography
- Apply the concepts of bioanalytical techniques in biotechnology research.

SEMESTER – II - CORE COURSE – VII
GENETIC ENGINEERING

Course Code: P2R1BTCC7 **Max Marks: 100**
Hours/Week: 5 **Internal Marks: 25**
Credits: 5 **External Marks: 75**

COURSE OBJECTIVES:

- To illustrate creative use of modern tools and techniques for manipulation and analysis of genomic sequences.
- To expose students to application of recombinant DNA technology in biotechnological research.
- To train students in strategizing research methodologies employing genetic engineering techniques.
- Understand the concepts, introduction of genetic engineering, introduction about restriction enzymes, ligases, polymerases, vectors, their types, sources and their roles in genetic engineering.
- Knowledgeable in basic techniques of molecular biology and their applications in various aspects.

Total Instructional Hours: 60

UNIT I: Genetic engineering as tool in biotechnology **Hours: 12**

Milestones in the development of genetic engineering. Application of genetic engineering in biotechnology. Molecular tools in genetic engineering - vectors, enzymes - restriction endonuclease. DNA ligase, Acid phosphatase and other DNA modifying enzymes. Restriction enzymes - restriction analysis of genomes- restriction sites- cloning of blunt end DNA, adapters.

UNIT II: **DNA libraries** **Hours: 12**

cDNA library. Genomic Library- Preparation of cDNA libraries and Genomic DNA libraries application of DNA libraries. Gene cloning, gene expression. DNA analysis: labeling of DNA and RNA probes. Southern and fluorescence in situ hybridization, DNA fingerprinting, chromosome walking.

UNIT III: **Techniques for gene expression** **Hours: 11**

Northern and Western blotting, Gel retardation technique, DNA foot printing, Primer extension, S1 mapping, Reporter assays. DNA sequencing and sequence assembly. Maxam-Gilbert's and Sanger's methods, techniques of in vitro mutagenesis, Site-directed mutagenesis, gene replacement and gene targeting, Shot gun sequencing, chemical synthesis of oligonucleotides; sequencing strategies for large genomes. PCR- Principle and applications, various types of PCR.

UNIT IV: **DNA mapping and DNA fingerprinting** **Hours: 11**

Physical and molecular mapping, Hybridization and PCR based methods of fingerprinting. Vectors- and its uses in Genome sequencing. Cloning for gene expression- industrial production of animal and plant proteins in microbes - industrial application of genetic engineering- industrial production of recombinant proteins.

UNIT V: **Genetic engineering of eukaryotes** **Hours: 11**

Genetic engineering of plants and animals vectors used for transformations - shuttle vectors. Protein engineering Metabolic Engineering, site directed mutagenesis. Application of genetic engineering in gene expression studies. Transgenic and gene knockout technologies to study molecular biology, chromosome engineering. Molecular markers. DNA based and PCR - based markers , RFLP, RAPD,RLGS, AFLP STS, EST, SSCP, VNTR, Multi locus probes, Microsatellites and minisatellites, STMS, DAF, AP-PCR, Gene therapy.

UNIT VI: Latest learnings (For CIA Purpose only) **Hours: 03**

Latest development related to the course during the semester concerned.

REFERENCES

1. Biotechnology -Fundamentals and Applications S.S. Purohit & S.K Mathur Agrobotanica , India.
2. Agricultural Biotechnology S.S. Purohit Agrobotanica , India.
3. Biotechnology -Fundamentals and Applications S.S. Purohit & S.K Mathur S.S. Purohit & S.K Mathur.
4. Molecular Biotechnology S.B. Primrose Panima Publishing Corporation, New Delhi.
5. Text Book of Biotechnology C.R. Chhatwal Anmol Publications pvt Ltd, New Delhi
6. Applied Molecular Genetics R .L. Miesfeld , Wiley Liss ,New York Online resources

NET REFERENCE

1. Authentic Web based resources like NCBI, Pub Med, Science direct etc.

COURSE OUTCOME:

- At the end of the course, the student will achieve a sound knowledge on methodological repertoire which allows them to innovatively apply these techniques in basic and applied fields of life science researches.
- Understand and think about the basics of recombinant DNA technology
- To understand the role, use and types of different DNA modifying enzymes viz. Polymerases, Nucleases, restriction endonuclease, ligases etc.
- Acquire basic knowledge of DNA sequencing methods from conventional (Sanger sequencing) to High throughput Next generation sequencing technology, their principle, chemistry, theory and types.
- Students will able to understand the strategies and steps involved in construction of genomic and cDNA library, essential tools and role of each and every constituents

SEMESTER - II - CORE COURSE- IX
IMMUNOLOGY AND IMMUNOTECHNOLOGY

Course Code: P2R1BTCC8 **Max Marks: 100**
Hours/Week: 5 **Internal Marks: 25**
Credits: 5 **External Marks: 75**

COURSE OBJECTIVES

- This course is designed to impart the students to understand the importance of immunology and its theoretical aspects and on the principles of immunology and immunotechnology.
- It also explains the various antigen-antibody reactions involved in diseases, Concept of Monoclonal antibodies and vaccine development.
- To learn the various human hematological techniques.
- Understand human and animal cell culture methods.
- Study about the recent advancement in immunology and know about the diagnostic methods for human infectious diseases.

Total instructional Hours: 60

UNIT I: Immune system and Immune Response **Hours: 12**

Innate and acquired immunity, structure and functions of immune cells- T cells, B cells, Macrophages, NK cells and dendritic cells, Eosinophils, Neutrophils, Mast cells. Organs of immune system- Primary and secondary lymphoid organs. Primary and secondary immune response, Clonal selection theory.

Unit II: Antigens and Antibodies **Hours: 12**

Structure and properties of antigens –Iso and alloantigens-antigen specificity, Haptens and adjuvants- structure and properties. Immunoglobulins-Structure and properties, types and subtypes. Generation of immunological diversity. Complement system- component, properties and functions. Complement pathways and biological significance.

UNIT III: Major Histocompatibility Complex, Allergy and Autoimmunity **Hours: 12**

Structure and functions of MHC and HLA systems. Genetic control of immune response. Tissue transplantation- Tissue typing methods for tissue and organ transplantations. Graft versus host reaction and rejection, xenotransplantation, immunosuppressive therapy. **Hypersensitivity Reactions:** Allergy, Hypersensitivity reactions- types (I, II, III, and IV), **Autoimmunity** Autoimmunity- Autoimmune diseases- Hashimoto's disease, Systemic lupus erythematosus, AIDS.

Unit IV: Immunological Techniques **Hours: 10**

Agglutination-Blood grouping,Widal test, precipitation-Immunodiffussion-Single, Double,Radial and Rocket Immunoelectrophoresis, immune- fluorescence, immunoblotting, ELISA, RIA, Flow cytometry. Production and purification of Monoclonal antibodies, Coomb's test

UNIT V: Immunization **Hours: 11**

Vaccines- conventional, adjuvants, viral vaccines, vaccines to other infectious agents, tumor vaccines ,Peptide vaccines, subunit, DNA vaccines. Toxoids, antisera, edible vaccines, plantibodies, ISCOMs, recombinant antibodies, Immune stimulatory complexes. Common immunization programmes and role of WHO in immunization programs - BCG, small pox, DPT, polia, measles, Hepatitis-B.

UNIT VI: Latest learnings (For CIA Purpose only) **Hours: 03**

Latest development related to the course during the semester concerned.

TEXT BOOKS

1. Immunology by I.M. Roitt, J.Brostoff and D.K Male(1993) Gower medical publishing, London
2. Immunology – short course by E.Benjamini, G.sunshine and Leskpwitz willy-liss 1996
3. Richard M.hyde 1995 Immunology III edition ELBS London
4. J.Kuby, 2003, Immunology 5th edition, W.H. Freeman and Company, Newyork.. 2. C.V.Rao. 2002,

REFERENCES

1. An Introduction to Immunology, Narosa Publishing House, Chennai. 3. K.M.Pavri. 1996, Challenge of AIDS, National Book Trust, India.
2. I.R.Tizard, 1995, Immunology: An Introduction, 4th edition, Saunders College Publishers, New York. 5.
3. I.Roitt, 1994, Essential Immunology, Blackwell Science, Singapore.
4. A. Bul and K.Abbas, 1994, Cellular and Molecular immunology.

COURSE OUTCOME:

- Get a deep foundation in the immunological processes.
- Students will gain knowledge on how the immune system works and also on the immune system network and interactions during a disease or pathogen invasion.
- Explain role of immune cells and their mechanism in preventing the body from foreign attack and infectious disease, cancer and other disease development.
- Apply the knowledge of immune associated mechanisms in medical biotechnology research.
- Design experiment to see effect of drug molecule on immune response

SEMESTER –II - PRACTICAL II (COVERING CC5, 6, 7 & 8)
FOOD AND INDUSTRIAL BIOTECHNOLOGY, BIOINSTRUMENTATION, GENETIC ENGINEERING, IMMUNOLOGY AND IMMUNOTECHNOLOGY

Course Code: P2R1BTCC9P **Max Marks: 100**
Hours/Week: 5 **Internal Marks: 40**
Credits: 5 **External Marks: 60**

COURSE OBJECTIVES

- To understand the various analysis of immunological techniques.
- Students will able to perform varieties of Gel Electrophoresis.
- To give practical experience in understanding different steps in blotting techniques

FOOD AND INDUSTRIAL BIOTECHNOLOGY

1. Isolation of industrially important microorganisms.
2. Screening of industrial microorganisms
3. Factors influencing and affecting the growth of microorganisms .
4. Microbial products : Ethanol, Citric acid, Lactic acid and Amylase.
5. Determination of quality of milk : Methylene blue reduction test.
6. Production of organic acids - Citric acid production & estimation
7. Production of alcohol (wine)- Alcohol production & estimation
8. Screening Production and assay for lipase producing organisms
9. Penicillin production and estimation

BIOINSTRUMENTATION

1. Separation of pigments by Paper Chromatography and Column Chromatography.
2. Separation of amino acid by Thin layer Chromatography.
3. Demonstration of Agarose gel Electrophoresis.
4. Poly Acrylamide Gel Electrophoresis.
5. Biochemical Estimation of DNA/ RNA using Spectrophotometer.
6. Isolation and separation of plasmids and nucleic acids using agarose gel electrophoresis.
7. Demonstration of PCR

IMMUNOLOGY AND IMMUNOTECHNOLOGY

1. Agglutination test-ABO blood grouping, Rh Typing
2. Agglutination test -WIDAL test, CRP and ASO
3. Double immuno diffusion
4. Radial immuno diffusion
5. Immuno electrophoresis
6. Rocket immuno electrophoresis
7. Total count of RBC
8. Total count of WBC
9. Differential staining of WBC

10. Demonstration of ELISA
11. Demonstration of Lymphoid organs in rat
12. Demonstration of Western blotting.

GENETIC ENGINEERING

1. Isolation of genomic DNA and plasmid DNA
2. Restriction and Ligation
3. Agarose gel electrophoresis
4. Demonstration of PAGE, Gel Doc and Electroporator.
5. Blotting Techniques.
6. GFP Cloning.

REFERENCE BOOKS:

1. Analytical biochemistry and separation techniques-A laboratory manual, P.Palanivelu, 2nd edition 2001, Tulsi books centre.
2. Laboratory manual in biochemistry, J.Jayaram 1981, Wiley publisher.
3. Principles and techniques of practical biochemistry, Keith Wilson and John walker, 5th edition 2000, Cambridge University Press.
4. Practical Immunology, F. C. Hay, M. R. Olwyn. P. N. Westwood. N. L. Hudson, 2002, 4 Ed, UK: Blackwell Company Ltd.
5. Hand Book of Practical and Clinical Immunology. G. P. Talwar. 2009, 2 Ed, Vol. II, New Delhi: CBS Publishers and Distributors.
6. Molecular Cloning: A Laboratory Manual J. Sambrook and M. Green. 2012. 4 Ed. (3 Volume set). New York: spring Harbor Laboratory Press.
7. Laboratory Manual for Genetic Engineering. J. Vennison, 2009, New Delhi: PHI learning Private ltd,

SEMESTER- II - ELECTIVE COURSE- II
BIOSTATISTICS

Course Code: P2R1BTEC2 **Max Marks: 100**
Hours/Week: 5 **Internal Marks: 25**
Credits: 3 **External Marks: 75**

COURSE OBJECTIVES

- To recognize the importance of Bio-Statistics
- To use technology to perform regression analysis
- To derive Mathematical Expectation, Binomial, Poisson and Normal Distribution
- To interpret concepts of sampling results correctly, effectively and in context
- To demonstrate a solid understanding of interval estimation and hypothesis testing

Total instructional Hours: 60

Unit I: **Introduction of Bio-Statistics and correlation** **Hours:12**

Introduction to Bio-Statistics – Definition of Bio-statistics – Development of Bio-statistics – Application of Bio-statistics – Role of Bio-statistics Correlation Analysis: Correlation – Correlation co-efficient – Scatter Diagram – Spearman's rank correlation co-efficient (Related problems)

Unit II: **Regression** **Hours:12**

Regression Analysis: Regression – Regression co-efficient – properties – Linear Regression line (Related problems)

Unit III: **Probability Distribution** **Hours:11**

Theoretical Distribution – Binomial, Poisson and Normal Distributions (Basic theory and related problems)

Unit IV: **Sampling** **Hours:11**

Basic Concepts of Sampling – Simple random sample stratified sample and systematic sampling, sample statistic, sampling distribution and standard error

Unit V: **Testing of Hypothesis** **Hours:11**

Test of significance – Test for mean and difference of means – Student t - test, Chi - Square test, F-test, ANOVA: one way and two way classification

UNIT VI: Latest learnings (For CIA Purpose only) **Hours: 03**

Latest development related to the course during the semester concerned.

TEXT BOOKS:

1. Biostatistics. P.N.Arora and P.K. Malhan, Himalaya Publication House, 2006.
2. Statistical and Numerical methods. PR. Vittal, V. Malini.

REFERENCE BOOKS:

1. Fundamentals of Biostatistics. Veer BalaRastogi, Ane Books Pvt. Ltd, 2009.
2. Biostatistics. P. Ramakrishnan - Saras Publications, 1995.

COURSE OUTCOMES:

The students will be able to

- Interpret results of descriptive statistics methods effectively.
- Demonstrate an understanding of the central concepts of Regression Analysis
- Discuss the relation between Binomial and Poisson Distribution
- Interpret results of the principal methods of statistical inference and design.
- Communicate the results of statistical analysis accurately and effectively.

SEMESTER - III - CORECOURSE- X
RESEARCH METHODOLOGY

Course Code: P3R1BTCC10 **Max Marks: 100**
Hours/Week: 5 **Internal Marks: 25**
Credits: 5 **External Marks: 75**

COURSE OBJECTIVES

- To impart scientific, statistical and analytical knowledge for carrying out research work effectively.
- To understand science frameworks for scientific inquiry
- To understand the various methods for conducting empirical research
- To examine trends and patterns in the use of various research methods
- To get knowledge to prepare research documents for publication
- To screen and select the correct journals to publish their research findings
- To articulate informed opinion about the value of empirical research

Total Instructional Hours: 60

Unit I: Biosafety **Hours: 12**

Biosafety regulations - Good laboratory practices - Good manufacturing practices in industry. Storage and disposal of hazardous wastes: radioactive materials – pathogenic strains. GMO's and their release in environment. Experimental protocol approvals -Levels of containment - Environmental aspects of biotech applications.

Unit II: Research in Biological Sciences **Hours: 12**

Research: research in Biological sciences- Objective – thrust areas and research priorities in Biotechnology to meet global competency- Origin of the research problem - Collection of literature: Internet –library – index card preparation - Experimental approach. Setting up of a Laboratory: laboratory administration – collaborations - inventories and inspections – personnel – Recruitment hiring – mentoring - promoting and terminating.

Unit III: Manuscript Preparation **Hours: 11**

Scientific communication: Introduction – manuscript preparation: Original – review – short communication. Thesis writing - Proof correction – symbols used for correction- preparation for Oral and poster presentation – preparation of Power Point presentations - communication skills for effective presentation.

Unit IV: Research Publications **Hours: 11**

Standards of journals: national and international – online and printed – paid and unpaid – peer reviewed journal – SCI journals – impact factor- h-index.

Research engines: Elsiever, Springer, Pubmed, Google scholar, Academic journals, online digital library- Social network for research community: Research gate, Research Pages, Frontiers Research Network, Elsevier Lab.

Unit V: Research Proposal **Hours: 11**

Writing research proposal for getting financial support – Sponsoring agencies – (DST, DBT, UGC, CSIR, ICMR, MoEF, MoEs, DRDO, DRDE, TNSCTE, TNSCST and NABARD). Research ethics – Intellectual property Rights – Overcome the difficulties in biological research.

UNIT VI: Latest learnings (For CIA Purpose only) **Hours: 03**

Latest development related to the course during the semester concerned.

TEXT BOOKS

1. Research methodology for biological science, Gurumani N, 2009, MIP publisher (Unit-I-III).
2. Essentials of Research Design & Methodology, Geofferey R, Marczyk, David De Mattea, David Festinga, 2005, John Wiley & Sons Publisher.
3. Free Study material for Unit- III: http://www.unom.ac.in/asc/Pdf/Session%201-%20Financial%20resources%20for%20research%20&%20development%20sponsored%20agencies.pdf

REFERENCES

1. Guide to publish a scienctifc paper, Ann M. Korner, 1996, Bioscript Press.
2. How to write and Publish a scientific paper, Rober A. Day, 1996, Cambridge Univeristy Press.
3. Bio-Statistics, Arora, PN and Malhan, PK, Himalaya Publishing House.
4. Fundamentals of Bio-Statistics Veer Bala Rastogi, Ane Book India.

COURSE OUTCOME

- Get knowledge on research proposal preparation and apply to the sponsoring agencies.
- Benefits through socio-research networks.
- Understanding of the history and methodologies of scientific research, applying these to recent published papers
- Understanding and practicing scientific reading, writing, presentations
- Appreciating scientific ethics through case studies.

SEMESTER – III - CORE COURSE- XI
PLANT BIOTECHNOLOGY

Course Code: P3R1BTCC11 **Max Marks: 100**
Hours/Week: 5 **Internal Marks: 25**
Credit: 5 **External Marks: 75**

COURSE OBJECTIVES

- It gives introduction to the various transformation techniques employed in plant systems.
- It also describes the application of genetically modified plants in the various fields of science.
- Obtain practical skills (in basic plant tissue culture and advanced molecular biology techniques) and to enhance students' understanding of the knowledge learned from the theory lectures in the second semester.
- Have hands-on experience and training in genetic engineering techniques
- Learn preparation of nutrient media, sterilization techniques, and development of axenic cultures through in vitro culture, cryopreservation.

Total Instructional Hours: 60

UNIT I: Plant tissue culture **Hours: 12**

Scope and Importance of plant tissue culture- Media composition and types (MS, LS, BS and NG) hormones and growth regulators, explants for organogenesis, somoclonal variation, production of haploid plants. Micropropagation, somatic embryogenesis, synthetic seed preparation, embryo rescue, protoplast culture and somatic hybridization. Cryopreservation, germplasm collection and conservation.

UNIT II: Plant transformation techniques **Hours: 12**

Mechanism of DNA transfer–*Agro bacterium* mediated gene transfer, Ti and Ri plasmids as vectors, role of virulence genes; design of expression vectors; 35S promoter, genetic markers, reporter genes; viral vectors. Direct gene transfer methods-particle bombardment, electroporation and microinjection.

UNIT III: Metabolic engineering of plants **Hours: 11**

Plant cell culture for the production of useful chemicals and secondary metabolites (Hairy root culture, Biotransformation, Elicitation) - pigments, flavonoids, alkaloids; mechanism and manipulation of shikimate pathway. Production of Industrial enzymes, PHB, therapeutic proteins, edible vaccines and antibiotics using transgenic technology.

UNIT IV: GM-Technology **Hours: 11**

Crop improvement, productivity, performance and fortification of agricultural products–Bt cotton, Bt brinjal. Herbicide resistance, viral resistance, bacterial resistance, fungal resistance crops. Golden rice and transgenic sweet potato. Strategies for engineering stress tolerance, Antisense Technology- Delayed fruit ripening.

UNIT V: Transgenic plants **Hours: 11**

Current status of transgenic plants in India and other countries, Ethical issues associated with GM crops and GM food; labeling of GM plants and products. Importance of integrated pest management and terminator gene technology. Environmental impact of herbicide resistance crops and super weeds.

UNIT VI: Latest learnings (For CIA Purpose only) **Hours: 03**

Latest development related to the course during the semester concerned.

TEXT BOOKS

1. Plant Biotechnology:the genetic manipulation of plants, Slater, A., Fowler, M.R and Scott, N.W.2008. Oxford University Press
2. Text Book of Biotechnology, Satyanarayanan, U. 2005, Books and allied (p) Ltd.
3. Tissue Culture Theory and Practice, Bhojwani, and Razdan, M.K. 2004.
4. Biotechnology in crop improvement, Chawla, H.S, International Book distributing Company (1998).
5. Elements of Biotechnology, Guptha, P.K, Rastogi and Co. Meerut, 1996.

REFERENCES

1. Genes and Agriculture, Chrispeels M.J.et al. Plants, Jones and Bartlett Publishers, Boston.1994.
2. Plant cell, tissue and organ culture, Gamborg O.L. and Philips G.C. (2nd Ed.) Narosa Publishing House. New Delhi.1998
3. Plant Biotechnology, Hammound J, P McGravey & Yusibov.V, Springer verlag.2000
4. Plant Biochemistry and Molecular Biology, Heldt, Oxford and IBH Publishing Co. Pvt.Ltd. Delhi. 1997
5. Plants from test tubes, Lydiane Kyte and John Kleyn. An introduction to Micropropagation (3rd Ed.). Timber Press, Portland. 1996.
6. Advanced methods in plant breeding and biotechnology, Murray D.R. Panima Publishing Corporation.1996
7. Plant cell electroporation and electrofusion protocols, Nickoloff J.A.Methods in molecular biology, Humana press incorp, USA. 1995.

COURSE OUTCOME

At the end of the course,

- The students will gain an insight into the concepts and techniques of Plant Biotechnology and its application to crop plants.
- Familiar with sterile techniques, media preparation, DNA extraction methods, and isolation of specific gene
- Apply tissue culture techniques for the large scale production of food crops and medicinal plants with economically useful traits.
- Apply knowledge of molecular markers for the identification of traits in various genomes.
- Apply genetic engineering concepts to induce biotic and abiotic stresses in plants

SEMESTER – III - CORE COURSE- XII
ANIMAL BIOTECHNOLOGY

Course Code: P3R1BTCC12 **Max Marks: 100**
Hours/Week: 5 **Internal Marks: 25**
Credit: 5 **External Marks: 75**

COURSE OBJECTIVES

- It gives introduction to the various transformation techniques employed in animal systems.
- It also describes the application of genetically modified animals in the various fields of science.
- The techniques of animal cell culture and its industrial and medical applications are described.
- Understand the basic properties of cancer cells.
- Describe the principle and application of gene manipulation.
- Illustrate how transgenic animals can be produced with a specific gene of interest and their clinical advantages.

Total Instructional Hours: 60

UNIT I: **Animal cell culture** **Hours: 12**

Introduction, cell culture laboratory-design, layout and maintenance.Equipment and Instrumentation. Methods of sterilization, types of culture media, composition, preparation and metabolic functions. Culture and maintenance of primary and established cell lines. Cell adhesion, Cell proliferation and differentiation. Characterization of cultured cells, viability, cytotoxicity, growth parameters, cell death and Apoptosis.

UNIT II: Stem cells and Tissue Engineering **Hours: 11**

Scope of tissue engineering, embryonic and adult stem cells, properties, identification, stem cells culture, techniques and their applications in modern clinical sciences. Tissue engineering, biomaterials used in tissue engineering, three dimensional culture and transplantation of engineered cells. Tissue engineering - skin, bone and neuronal tissues.

UNIT III: Transgenic Animals and Animal cloning **Hours: 12**

Methods involved in the production of transgenic animals, importance and applications of transgenic animals. Gene knock out and mice models for tackling human diseases. Animal cloning: methods of cloning and their importance with reference to domestic animals. IVF-technology for livestock and humans.

UNIT IV: Applications of Animal Biotechnology: **Hours: 11**

Improvement of biomass, disease resistant, recombinant vaccines for poultry, livestock-pharming products. Pharmaceutical products produced by mammalian cells - plasminogen activator, erythropoietin, blood clotting factors, glycoprotein hormones, interleukins, Interferons, and Cell culture based vaccines.

UNIT V: Animal models **Hours: 11**

Use of cell lines as alternative for animal models for research. Testing of drugs on human volunteers, use of animals for research and testing; animal and human cloning- ethical and social issues, organ transplantation and xeno transplantation.

UNIT VI: Latest learnings (For CIA Purpose only) **Hours: 03**

Latest development related to the course during the semester concerned.

TEXT BOOKS

1. Animal Biotechnology, M. M. Ranga, 2nd Edition, 2003, Agrobios India.
2. Animal Cell Culture: A practical approach, Freshney, E.D., 2000, John Wiley Pub., NewYork.

REFERENCES

1. Animal Biotechnology, Ballinic C.A., Philips J.P and Moo Young M. Pergamon press, New York. 1989.
2. Molecular Biology of Gene, Watson J.D.et al. (6^{th} Ed.) Publisher Benjamin Cummings, 2007.
3. Methods in Enzymology guide to molecular cloning techniques, Berger S. L. and A.R. Kimmel. (Vol 152). Academic Press Inc. San Diego.1996
4. Molecular Biotechnology, Glick, B.R. and Pasternak J.J.ASM Press, Washington DC.2003.
5. Methods in Cell Biology, Jenni, P, Mather and David Barnes, (Vol 57) Academic Press, 2001.
6. Molecular Biology of the Gene, Watson J.D et al. (6^{th} Ed), the Benjamin Cummings Pub.Co.Inc.USA.2008

COURSE OUTCOME

At the end of the course,

- The students will gain an insight into the concepts and techniques of animal biotechnology and its wide industrial and medicinal applications.
- Describe the mechanism of gene therapy and its uses.
- Illustrate how different blood products like antibodies, hormones and vaccines are produced industrially.
- Describe the features of stem cell and their application.
- Differentiate between the different methods adopted for generating transgenic animals

SEMESTER - III - CORE PAPER-XIII
ENVIRONMENTAL BIOTECHNOLOGY

Course Code: P3RIBTCC13 **Max Marks: 100**
Hours/Week: 5 **Internal Marks: 25**
Credits: 5 **External Marks: 75**

COURSE OBJECTIVES

1. The course explains the application of biotechnology in environment and to understand the energy sources, and remediation using biotechnology and its control.
2. Students will get an idea about the hazards to our environment, solutions to protect and for sustainable development.
3. This course is important in the era of industrialization leading to environmental hazards.
4. Students to take up a career in tackling industrial pollution and also who is willing to take up the research in areas like development of biological systems.
5. To learn the remediation of contaminated environments and for environment-friendly processes such as green manufacturing technologies and sustainable development.

Total Instructional Hours: 60

UNIT I: Basic concepts of ecology **Hours: 12**

Components of Environment – Hydrosphere, lithosphere, atmosphere and biosphere – definitions with examples; Interaction of man and environment; Concept of habitat and ecological niches; Limiting factor; Energy flow, food chain, food web and tropic levels; Ecological pyramids and recycling. N.P.C and S cycles in nature. Population ecology.

UNIT II: **Environmental pollution** **Hours: 12**

Types, Causes and Effects of pollution - Air, Water, Land and Noise. Global Environmental Problems – Green House Effect, Acid rain, El Nino, Ozone depletion, deforestation, desertification, salination, biodiversity loss; chemical and radiation hazards.

Unit III: Environmental Management **Hours: 11**

Concept of health and sanitation, environmental diseases – infectious (water and air borne) and pollution related, spread and control of these diseases, health hazards due to pesticide and metal pollution, waste treatment, solid waste management, environmental standards and quality monitoring.

UNIT IV: Solid waste management **Hours: 11**

Sewage sludge treatment and utilization, refuse disposal, excreta disposal in unsewered area; composting and vermiculture.; biodegradation of noncellulosic wastes for environmental conservation and fuel; bioconversion of cellulosic wastes into protein and fuel; biodegradation of xenobiotics; bioremediation of contaminated soils and waste lands; radioactive product waste disposal. Environmental problems and treatment of industrial waste waters: Distillery, tannery, paper pulp etc. Toxicity testing in waste water treatment plants. Solid waste management: Anaerobic digestion, Composting**.**

UNIT V: **Hazardous waste management and Biogeotechnology** **Hours: 11**

Biodegradation of Xenobiotics, Pesticides, Oil biodegration – Superbug, Bioleaching, Bioremediation – *In situ* and *ex situ* bioremediation. Biotechnological applications for Hazardous waste management, uses and constraints of Genetically Engineered Microorganisms (GEMs) in the environment. Bioleaching of metals, biobeneficiation, microbially enhanced oil recovery, biodesulfurization of coal. Microbes in the environment- Biofilms and its relevance in microbial survival, its effect in the environment. 16. Microbial Insecticides: Biopesticides. Bacterial, fungal and viral insecticides.

UNIT VI: Latest learnings (For CIA Purpose only) **Hours: 03**

Latest development related to the course during the semester concerned.

TEXT BOOKS

1. Environmental Biotechnology- Dilip Kumar MarKandey and Neelimn Rajvaidya (APH publishing corporation, New Delhi)
2. Applied Biotechnology – LP Rema (MJP publishers, Chennai).

REFERENCES

1. Environmental Biotechnology by Alan Scragg. Pearson Education Limited, England.
2. Environmental Biotechnology by S.N. Jogdand. Himalaya Publishing House.Bombay.
3. Wastewater Engineering – Treatment, Disposal and Reuse. Metcalf and Eddy, Inc., Tata Mc Graw Hill, NewDelhi
4. Environmental chemistry by A.K. De Wiley Eastern Ltd. NewDelhi

COURSE OUTCOME

At the end of the course the students will,

1. Obtain knowledge on basic principles and technologies of decontamination of persistent organic pollutants (dangerous contaminants of the environment) mainly by means of the biological approaches i.e. using bioremediation etc.
2. The students will know about the principles and techniques underpinning the application of biosciences to the environment.
3. Explain the importance of environmental protection, diversity in environmental systems, processes and biotechnology
4. Understand and explain the importance of molecular approaches and control measures to protect environmental insults.
5. Understand existing and emerging technologies that are important in the area of environmental biotechnology in controlling various types of pollution and hazardous materials.

SEMESTER – III - PRACTICAL III (COVERING CC11, CC12 & CC13)
PLANT, ANIMAL & ENVIRONMENTAL BIOTECHNOLOGY

Course Code: P3R1BTCC14P **Max Marks: 100**
Hours/Week: 5 **Internal Marks: 40**
Credits: 5 **External Marks: 60**

COURSE OBJECTIVE

Encourage the students to get self-employability by learning all these techniques.

PLANT BIOTECHNOLOGY:

1. Preparation of plant tissue culture media and Organ culture (Shoot tip, nodal and leaf culture)
2. Callus culture: Initiation and regeneration.
3. Anther culture for the production of haploids.
4. Isolation, culture and fusion of protoplasts.
5. Isolation of plant genomic DNA from plant by CTAB method
6. Synthetic seeds (Entrapment method).
7. Establishment and maintenance of suspension culture.
8. Separation and estimation of secondary metabolites β-carotene from carrot and anthocyanin from beetroot
9. Extraction & Separation of Chlorophyll A & B using Column Chromatography.

ANIMAL BIOTECHNOLOGY

1. Preparation of Media for cell culture.
2. Trypsinization.
3. Cell viability test.
4. Cell counting.
5. Cytotoxicity testing
6. Animal Handling and care

ENVIRONMENTAL BIOTECHNOLOGY

1. Determination of total dissolved solids, BOD and COD of water sample
2. Estimation of Chromium in Industrial effluent by colorimetry
3. Estimation of Calcium & Chloride in water sample by titration method
4. Isolation of bacteriophages from sewage
5. Sludge analysis (a) Organic matter, (b) Nitrogen (c) Phosphorous (d) Potassium
6. Biodegradation of industrial aromatic compounds
7. Determination of Phosphate and nitrate from sewage samples
8. Microbial analysis of water-MPN technique.
9. Assessment of air quality – Enumeration of microbes.

REFERENCES

1. Animal Cell Culture: A practical approach, Freshney, E.D., 2000, John Wiley Pub., New York.
2. Plant Tissue culture theory & practical, Bhojwani and Razdan, M.K, 2004.
3. Tissue culture, methods and application, Hurse P.I. and Patterson.
4. Handbook of cell and Organ culture M.K Marchan, D, J. (2^{nd}Ed). Burgess Pub. Co., Minneapolis, USA. (1964).
5. Plant cell culture – A Practical Approach, Dixon, L.A. and R.A. Gonzales. , Revan Press, New York.
6. Plant Tissue Culture Methods and Applications in Agriculture, Quak, F. Academic Press, New York. (1981)

SEMESTER- III - ELECTIVE COURSE- III
MEDICAL AND PHARMACEUTICAL BIOTECHNOLOGY

Course code: P3R1BTEC3 **Max Marks: 100**
Hours/ Week: 5 **Internal Marks: 25**
Credits: 3 **External Marks: 75**

COURSE OBJECTIVES

- To know the systemic medical biotechnology
- To update newer developments in pharmaceutical Biotechnology/emerging trends/ novel mechanisms of drug action etc.
- To critically analyze the day to day development in new drugs in medical and Pharmaceutical biotechnology.
- Student's comprehensive information and insights in pharmaceutical biotechnology and the development of biopharmaceuticals in pharmaceutical industry.
- Students will gain an understanding in both scientific knowledge of designing and producing navel biologics, and business challenges in biopharmaceutical companies.

Total Instructional Hours: 60

UNIT I: Introduction **Hours:10**

Introduction and Scope of Pharma industry and biopharmaceuticals, Biotechnology and drug design: Development and economics, Preclinical studies and principles of process development, early prof -of- concept of chemical and biological entities, Orphan drugs. Provisions for and use of unlicenced medicines. Drug abuse and dependence, Prescription and non-prescription drugs.

UNIT II: Toxicology **Hours:15**

Introduction, Scope and importance: Basic concepts, Dose response-Fundamental issues in toxicology, LD50, ED50, PD50, Graphs and calculations. Dose response relationships for cumulative effects. Factors influencing dose response. Fate of toxicants and mechanism of action of toxins, biotransformation of toxins and their clearance from the body; Toxicokinetics and Toxicity testing-Invitro methods and invivo methods.

UNIT III: Drug Manufacture and Formulation **Hours:10**

Basic concepts and applications, composition, preparation, physicochemical considerations in manufacture of current biotech products and herbal medicines. Qualitiy controle (QC), storage and stability of biotech products. Concept and testing of preformulations and their parameters. Tablets: compressed, granulation, coatings, pills, capsules. Parental preparations, Herbal extracts.

UNIT IV: Analysis of Pharamceuticals **Hours:10**

Validation techniques for pharmaceutical industries, pilot plant, scale-up techniques. Analytical methods and tests for various drugs-Alkalimetry, Acidimetry, Iodimetry, Aqueous and non-aqueous titration, Diazotization, Complexometry, Gravimetry, Potentiometry methods. Packaging techniques-Glass containers, plastic containers, film wrapper, bottle seals; Quality Assurance (QA) and Quality Controle (QC).

UNIT V: Advanced pharmacology and Pharmacotherapy **Hours:12**

Introduction and scope: Psychotherapeutic agents, Immuno-modulators, heavy metals and heavy metal antagonists, therapeutic gases. Free radical biology, antioxidants and antitoxicants. Pharmacotherapy; Special emphasis on vitamins, growth regulators, Growth factors, cold remedies, laxatives, analgesics, non-steroidal contraceptives, external antiseptics, antacids, biological, herbal products. Pharmacotherapy of migrane, Alzheimers, TB, Diabetes and male sexual dysfunction. Hormone replacement therapy (HRT). Advances and promises of gene therapy in combating diseases wherein cure presently unknown.

UNIT VI: Latest learnings (For CIA Purpose only) **Hours: 03**

Latest development related to the course during the semester concerned.

TEXT BOOKS

1. A Text Book of Modern Toxicology, Ernest Hodgson 2004, 3 rd Edn. John Wiley & Sons, Inc.
2. Industrial Pharmaceutical Biotechnology, Heinrich Klefenz,2002, Wiley-VCH Edn,

REFERENCES

1. Priciples of Medicinal chemistry-Foye,2008, L W Publishers.
2. Biopharmaceuticals, Biochemistry and Biotechnology- Gary Walsh,2003, Wiley Pub, 2nd Edn.
3. Biopharmaceutical Drug Design and Development, S.Wu Pong, Y Rojanasakul, and J Robinson,2008, Humana Press.
4. Pharmaceutical Biotechnology- K Sambamurthy and Ashutosh Kar, 2006, New age International Publishers-New Delhi.
5. Pharmaceutical Biotechnology-S P Vyas and V K Dixit2007, CBS Publishers.
6. Drug Delivery and Targeting for Pharmacists and Pharmaceutical Scientists, Anya M.Hillery *et.,al*. 2005.
7. Hand book of Modren Pharmaceutical Analysis, Satinder Ahuja *et.,al* .2001, Acadimic Press.

COURSE OUTCOME

- Elucidate scientific principles for biotechnology in pharmaceutical product development
- Describe organization & processes in biotechnology and pharmaceutical industry for their operations and research and development, plus FDA oversight roles
- Apply the concepts of biopharmaceuticals in pharmaceutical industry
- Apply the knowledge of pharmaceutical manufacturing in the production of biopharmaceuticals
- Develop the strategies of new drug discovery

SEMESTER - IV- ELECTIVE COURSE - IV
GENOMICS AND PROTEOMICS

Course Code: P4R1BTEC4 **Max Marks: 100**
Hours/Week: 6 **Internal Marks: 25**
Credits: 3 **External Marks: 75**

COURSE OBJECTIVES

- To understand the genome architecture and to extract information of gene function, gene regulation, protein evolution and targets for drug designing.
- To provide students with the skills from acquisition of genomic data to its analysis.
- To provide the knowledge of Next Generation Sequencing (NGS) through various tools.
- To provide a brief introduction about human genome project and other genome projects, a precise note on the transcript analysis techniques such as DNA chip and microarray for gene screening,
- Students to gain the knowledge on advanced techniques for example co-immunoprecipitation, protein microarray and computational tools of protein - protein interactions.

Total Instruction Hours: 72

UNIT I: Genome Organization **Hours: 15**

Anatomy of the Eukaryotic and Prokaryotic Genome, Repetitive DNA Content of Genomes. How genes work, Gene-protein relations, Genetic fine structure, Mutational sites Complementation, **Genome Mapping** – Mapping Genomes, Genetic and Physical Maps, Sequencing Genomes, Methodology for DNA Sequencing, Assembly of a Contiguous DNA Sequence, understanding a Genome Sequence, Locating the Genes in a Genome Sequence, Determining the Functions of Individual Genes.

UNIT II: Genome Analysis **Hours: 15**

DNA Sequencing databases, Sequence analysis programs, Pairwise sequence alignment, Multiple sequence alignment, The first complete genome sequence and database, DNA sequencing, Genomic sequencing, Sequencing cDNA Libraries of expressed genes, Accuracy and computers storage of sequence, Sequence formats, Conversions of one sequence format to others.

UNIT III: Gene Prediction and Genome Rearrangement **Hours: 14**

Introduction, testing the reliability of an ORF Prediction, gene prediction methods and tools, The Biological Problem, Permutations .Analyzing Genomes with Reversals of Oriented Conserved Segments, Applications to Complex Genomes, **Comparative Genomics –** Completed genomes, Sequence assembly and gene identification, functional classification of genes.

UNIT IV: Protein Classification **Hours: 13**

Structural elements and terminology: Helix, Sheet, Strand, Loop and coil, Active site, Architecture, Blocks, Class and Domains, Fold, Motif, PSSM. Principles of classification: Based on structural features, Phylogenetic relationship. Properties of protein in solution and in membranes. Interaction with other molecules like lipids, carbohydrates, metal Ions.

UNIT V: Protein Structure Prediction **Hours: 12**

Use of sequence pattern, leucine zipper, coiled coil, transmembrane, signal peptide, cleavage site. Secondary structure prediction: Chou – Fasman / GOR method, Neural network, nearest neighbor method, tertiary structure prediction, threading profile, contact potential, modeling.

UNIT VI: Latest learnings (For CIA Purpose only) **Hours: 03**

Latest development related to the course during the semester concerned.

TEXT BOOKS

1. Discovering Genomics, Proteomics and Bioinformatics. Campbell, A.M. & Heyer, L.J., 2002. Discovering Genomics, Proteomics and Bioinformatics. Benjamin.
2. An Introduction to Molecular Human Genetics. Pasternak, 2000. Fitzgerald

REFERENCE BOOKS

1. Genome. Brown, T.A. 2002. John Wiley Press, US.
2. Principles of Genome Analysis & Genomics. Primrose and Twyman, 2003. Blackwell.
3. From Genes to Genomes. Dale and Schartz, 2003. Humana.
4. Principles of Biochemistry. Lehninger, A. L., 1984. CBS publishers and distributors, New Delhi, India
5. Principles of Biochemistry. Horton, Moran, Ochs, Rawn, Scrimgeour., 2005. Prentice Hall Publishers.

COURSE OUTCOME

- Explain genomic technologies and the ways in which genomic data are stored.
- Have hands-on experience on various bioinformatics tools available for analyzing genes and genomes.
- Describe the different secondary structure of protein. Interpret the properties of protein in solution and in membranes.
- The students will also study the depth of expression analysis of a protein.
- The student will be equipped with knowledge of various proteomic techniques required to measure the expression level of proteins which could be used in future

ELECTIVE COURSE- V
MUSHROOM TECHNOLOGY

Course Code: **Max Marks: 100**
Hours/Week: 5 **Internal Marks: 25**
Credits: 3 **External Marks: 75**

COURSE OBJECTIVES

1. To study the general characteristics and structure of Mushrooms.
2. To know about the importance and need of Mushrooms.
3. To acquire knowledge regarding the cultivation and contamination possibilities of Mushrooms.
4. Motivate the students to form a Mushroom cultivation unit.

Total Instruction Hours: 60

UNIT I: Introduction to Mushrooms: **Hours: 10**

Introduction – edible and non-edible mushrooms - History of mushrooms; Classification and distribution of mushrooms; most commonly cultivated mushrooms in the world - life cycle of mushroom – Applications of mushroom in various fields.

UNIT II: **Spawn Preparation and Cultivation** **Hours: 11**

Spawn preparation - Isolation of pure culture; Nutrient media for pure culture – layout of spawn preparation room – raw material of spawn - sterilization – preparation of mother spawn and multiplication. Cultivation of mushroom – layout of mushroom shed - small scale and large scale production unit. Types of raw material – preparation and sterilization; Mushroom bed preparation – maintenance of mushroom shed – harvesting method and preservation of mushrooms.

UNIT III: Nutrient Values of Mushrooms **Hours: 13**

Nutrient values of Mushrooms – protein, carbohydrate, fat, fibre, vitamins and amino acid contents – short and long term storage of Mushrooms – preparation of Indian and Western dishes from Mushrooms. Medicinal value of Mushrooms.

UNIT IV: **Cultivation and Economic Importance** **Hours: 11**

Cultivation of following types of mushroom – milky Mushroom, oyster Mushroom, button Mushroom and any one medically valuable Mushroom - Preparation of compost and cultivation of *Agaricus bisporus* and *Pleurotus flabelltus*. Economics of mushroom cultivation : Fixed assets, recurring expenditure, labour, economics of cultivation throughout the year and seasonal growing. Formulation of project report for getting finance from funding agencies.

UNIT - V: **Mushroom Recipies And Research Centres** **Hours: 13**

Soup, cutlet, omlette, samosa, pickles, curry, chutney and Briyani.Research centers: International level, National level and Regional level.Cost benefit ratio : Marketing in india and abroad – Export value.

UNIT VI: Latest learnings (For CIA Purpose only) **Hours: 03**

Latest development related to the course during the semester concerned.

TEXT BOOKS :

1. Oyster Mushrooms. Marimuthu *et al.,* 1991. Dept. of Plant pathology, TNAU, Coimbatore.
2. Mushroom cultivation. Tewan and Pankaj Kapoor S.C. 1993. . Mittal Publication. Delhi.

REFERENCES :

1. Hand book of Mushrooms. Nita Bahl. 1988. II ed., Vol I & II.ct and environmental impact. 2nd ed., CRC press.
2. Mushroom cultivation: A practical guide to growing mushrooms at home, Paul Stamets, J.S. and Chilton, J.S. 2004. Agarikon Press
3. Mushrooms: Cultivation, nutritional value. Shu Fing Chang, Philip G. Miles and Chang, S.T. 2004. , medicinal effe1.
4. Modern Mushroom Cultivation. Singh, Reeti and Singh, V.C. (2005). Agrobios, India.
5. Food and Nutrition. Swaminathan, M 1990., Bappco. The Bangalore Printing and Publishing Co Ltd., Bangalore

COURSE OUTCOME

- Students understand the importance of mushrooms.
- Students know the characteristics of mushrooms.
- Acquire knowledge on mushroom production technologies.
- Students know the applications of mushroom biotechnology.
- Students know the cultivation methods of different mushrooms.

ELECTIVE COURSE-VI
BIOENTREPRENEURSHIP

Course Code: **Max Marks: 100**
Hours/Week: 5 **Internal Marks: 25**
Credits: 3 **External Marks: 75**

COURSE OBJECTIVES

- To teach students about concepts of entrepreneurship
- To identifying a winning business opportunity,
- To gathering funding and launching a business,
- To growing and nurturing the organization and harvesting the rewards.

Total Instruction Hours: 60

UNIT I: Basics of Bioentrepreneurship **Hours: 14**

Importance of entrepreneurship; advantages of being entrepreneur - freedom to operate; introduction to bioentrepreneurship – biotechnology in a global scale; Scope in bioentrepreneurship; types of bio-industries – biopharma, bioagri, bioservices and bioindustrial; innovation – types, out of box thinking; skills for successful entrepreneur – creativity, leadership, managerial, team building, decision making; opportunities for bioentrepreneurshipentreprenuership development programs of public and private agencies (MSME, DBT, BIRAC, Startup & Make in India); patent landscape, IP protection & commercialization strategies

UNIT II: Accounting and Finance **Hours: 13**

Business plan preparation; business feasibility analysis by SWOT, socio-economic costs benefit analysis; funds/support from Government agencies like MSME/banks and private agencies like venture capitalists:/angel investors for bioentrepreneurship; business plan proposal for „virtual startup company"; statutory and legal requirements for starting a company/venture; basics in accounting practices: concepts of balance sheet, profit and loss statement, double entry book keeping; collaborations & partnerships; information technology for business administration and expansion.

UNIT III: Business Strategy **Hours: 10**

Entry and exit strategy; pricing strategy; negotiations with financiers, bankers, government and law enforcement authorities; dispute resolution skills; external environment/ changes; avoiding/managing crisis; broader vision–global thinking; mergers & acquisitions.

UNIT IV: Marketing **Hours: 10**

Market conditions, segments, prediction of market changes; identifying needs of customers; Market linkages, branding issues; developing distribution channels - franchising; policies, promotion, advertising; branding and market linkages for „virtual startup company".

UNIT V: Knowledge Centre and R&D **Hours: 10**

Knowledge centres e.g., in universities, innovation centres, research institutions (public & private) and business incubators; R&D for technology development and upgradation; assessment of technology development; managing technology transfer; industry visits to successful bio-enterprises, regulations for transfer of foreign technologies; quality control; technology transfer agencies; Understanding of regulatory compliances and procedures (CDSCO, NBA, GLP, GCP, GMP)

UNIT VI: Latest learnings (For CIA Purpose only) **Hours: 03**

Latest development related to the course during the semester concerned.

REFERENCE BOOKS

1. Enterprise for life scientists: Developing innovation and entrepreneurship in the biosciences. Adams, D. J., & Sparrow, J. C. 2008. Bloxham: Scion.
2. Biotechnology entrepreneurship: Starting, managing, and leading biotech companies. Shimasaki, C. D. 2014. Amsterdam: Elsevier. Academic Press is an imprint of Elsevier.
3. Business modeling for life science and biotech companies: Creating value and competitive advantage with the milestone bridge Onetti, A., & Zucchella, A. (n.d.).. Routledge.
4. Innovation, Commercialization, and Start-Ups in Life Sciences. Jordan, J. F. 2014. London: CRC Press.
5. The Dynamics of Entrepreneurial Development and Management. Desai, V. 2009. New Delhi: Himalaya Pub. House.

COURSE OUTCOME

- Students should be able to gain entrepreneurial skills.
- Understand the various operations involved in venture creation.
- Identify scope for entrepreneurship in biosciences.
- Utilize the schemes promoted through knowledge centres and various agencies.