Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar

(Autonomous)

(Affiliated to Savitribai Phule Pune University, Pune)

Choice Based Credit System (CBCS)

Master of Science (M.Sc.)

Syllabus of

M. Sc. II Biotechnology

Implemented from

Academic Year 2022 - 23

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar (Autonomous)

Board of Studies in Biotechnology

Sr. No.	Name	Designation
1.	Dr. Shubhangi S. Moharekar	Chairman
2.	Dr. Sanjay T. Moharekar	Member
3.	Dr. Sarika R. Deshmukh	Member
4.	Mr. Ashish S. Wani	Member
5.	Prof. Dr. Bimalendu B. Nath	Vice-Chancellor Nominee
6.	Prof. Dr. Nitin S. Desai	Academic Council Nominee
7.	Dr. Jyoti P. Jadhav	Academic Council Nominee
8.	Mr. Nitin Shirole	Industry Expert
9.	Mr. Sachin R. Adsare	Alumni
10.	Dr. Aparnna A. Kulkarni	Member (co-opt)
11.	Mr. Girish P. Kukreja	Member (co-opt)

Programme Structure and Course Titles:

Sr. No.	Class	Semester	Course Code	Course Title	Credits
1.	M.Sc.	I	MSC-BT 111T	Advanced Biological Chemistry	04
2.	M.Sc.	I	MSC-BT 112T	Cell and Molecular Biology	04
3.	M.Sc.	I	MSC-BT 113T	Immunology	02
4.	M.Sc.	I	MSC-BT 114P	Practicals in Advanced Biological Chemistry	02
5.	M.Sc.	I	MSC-BT 115P	Practicals in Cell and Molecular Biology	02
6.	M.Sc.	I	MSC-BT 116P	Practicals in Immunology	02
7.	M.Sc.	I	MSC-BT 117A MSC-BT 117B	Environmental Biotechnology Food Biotechnology	02
8.	M.Sc.	I	MSC-BT 117A P MSC-BT 117B P	Practicals in Environmental Biotechnology Practicals in Food Biotechnology	02
9.	M.Sc.	I	MSC-BT 118A	Genetics	02
10.	M.Sc.	II	MSC-BT 211T	Genetic Engineering	04
11.	M.Sc.	II	MSC-BT 212T	Plant Biotechnology	04
12.	M.Sc.	II	MSC-BT 213T	Bacteriology	02
13.	M.Sc.	II	MSC-BT 214P	Practical in Genetic Engineering	02
14.	M.Sc.	II	MSC-BT 215P	Practicals in Plant Biotechnology	02
15.	M.Sc.	II	MSC-BT 216P	Practicals in Bacteriology	02
16.	M.Sc.	II	MSC-BT 217AT MSC-BT 217BT	Clinical Research Biostatistics	02
17.	M.Sc.	II	MSC-BT 218A P MSC-BT 218B P	Practical in Clinical Research Practical in Biostatistics	02

18.	M.Sc.	II	MSC-BT 219A	Virology	02
19.	M. Sc.II	III	MSC-BT 311T	Animal Biotechnology and Stem Cell Technology	04
20.	M. Sc. II	III	MSC-BT 312T	Bioprocess Engineering	04
21.	M. Sc. II	III	MSC-BT 313T	Bioinformatics	02
22.	M. Sc. II	III	MSC-BT 314P	Practicals in Animal Biotechnology	02
23.	M. Sc. II	III	MSC-BT 315P	Practicals in Bioprocess engineering	02
24.	M. Sc. II	III	MSC-BT 316P	Practicals in Bioinformatics	02
25.	M. Sc. II	III	MSC-BT 317A MSC-BT 317B	Agricultural Biotechnology **OR** Nanobiotechnology	02
26.	M. Sc. II	III	MSC-BT 318AP MSC-BT 318BP	Practicals in Agricultural Biotechnology **OR** Practicals in Nanobiotechnology	02
27.	M. Sc. II	III	MSC-BT 319A	Pharmaceutical Biotechnology	02
28.	M. Sc. II	IV	MSC-BT 411T	Genomics and Proteomics	04
29.	M. Sc. II	IV	MSC-BT 412T	Advanced Bioanalytical Techniques	04
30.	M. Sc. II	IV	MSC-BT 413T	Research Methodology and Scientific Communication	02
31.	M. Sc. II	IV	MSC-BT 414P	Practicals in Bioanalytical Techniques	02
32.	M. Sc. II	IV	MSC-BT 415P	Review and research article writing	02
33.	M. Sc. II	IV	MSC-BT 416A MSC-BT 416B	Medical Biotechnology **OR** Entrepreneurship and Business Administration	02
34.	M. Sc. II	IV	MSC-BT 417A MSC-BT 417B	Animal and Plant Physiology **OR** Ecology and Evolution	02
35.	M. Sc. II	IV	MSC-BT 418	Project	04

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's
New Arts, Commerce and Science College, Ahmednagar (Autonomous)
Syllabus of M.Sc. Biotechnology
under
Faculty of Science

Semester – III	**Paper – I**
Course Code: MSC-BT 311T	**Title of the Course:** Animal Biotechnology and Stem Cell Technology
Credits: 04	**Total Lectures:** 60 Hrs.

Course Outcomes (COs):

a. Students will introduce to the concept of animal tissue culture.

b. Students will study the exact mechanism as well as technique to establish cell lines.

c. Students will able to understand the growth pattern of normal and transformed cells.

d. Students will learn the concept of transgenic animals and their applications.

e. Students will introduce to the animal husbandry and reproductive biotechnology along with concerned bioethics.

Detailed Syllabus:

Unit I: Introduction to Tissue Culture: History, basics of animal tissue culture. Importance of maintenance of sterility and use of antibiotics. Detection of Mycoplasma and viral contaminants. Prevention of cross contamination, eradication of contaminants. Formulation of tissue culture media: natural, synthetic media, sera and substitutes. Introduction to the balanced salt solutions and simple growth medium. Role of carbon dioxide in animal cell culture**.** **(05)**

Unit II: Various Systems of Tissue Cultures: Distinguishing features, advantages and limitations. **Methodology**: i. Primary culture, ii. Explant culture, iii. Suspension culture. Behavior of cells, properties (Contact inhibition, anchorage (in) dependence, cell and tissue response to various factors), utility with different examples.

Cell Lines: Definition, establishment and maintenance. Finite and Continuous Cell line. Normal, Transformed and established cell lines: characteristic features **(06)**

Unit III: Maintenance of Cell Lines: Feeding and subculturing - criteria and methodology

for normal and transformed cell lines, passage number. **(03)**

Unit IV: Organ Culture: Methods, behavior of organ explant and applications of organ culture. Histotypic and organotypic cultures: methods and applications. Introduction to organ transplants, tissue engineering, bio-artificial organs **(05)**

Unit V: Growth Studies: Cell proliferation, cell cycle. Measurement of viability and cytotoxicity. Cell cloning and types. Cell synchronization. Cell transformation. Cryopreservation of cultured cells **(06)**

Unit VI: Application of Animal Cell Culture: For *in vitro* testing of drugs, production of viral vaccines and pharmaceutical proteins, monoclonal antibodies. Mass production of biologically important compounds. Propagation of viruses (viral sensitivity of cell lines). Harvesting of products, purification and assays. **(05)**

Unit VII: Stem Cell Technology: Concept, characteristics of adult stem cells, embryonic stem cells, embryonic carcinoma cells, induced pluripotent stem cells. Identification, purifications, assessment of proliferation, Long term maintenance and characterization. Stem cell self-renewal and pluripotency: molecular mechanisms. Concept of stem cell niche with examples Neural stem cells, Hematopoietic stem cells, Mesenchymal stem cells. Therapeutic applications of stem cells. **(12)**

Unit VIII: Transgenic Animals: Overview of different methods of introduction of a transgene viz. microinjection method, embryonic stem cell mediated gene transfer, retrovirus mediated gene transfer, etc. Targeted gene insertion, gene silencing by RNAi, CRISPR/Cas9 for targeted genome editing. Transgenic animals: fish, sheep, pig, etc. Concept of Knockout technology: methods and application. Mouse models for human genetic disorders, neurodegenerative disorders. **(10)**

Unit IX: Animal Husbandry and Reproductive Biotechnology: Overview of livestock breed and their productivity in India. Artificial breeding: Various methods of semen collection, artificial insemination, estrous synchronization, cryopreservation of germ cells. *In vitro* fertilization and embryo transfer technology. Animal cloning: concept and application in conservation. **(05)**

Unit X: Biosafety Issues and Bioethics: associated with animal tissue culture, developing

transgenic animals and human cloning. **(03)**

Suggested Readings:

1. Freshney I. R. 2010, Culture of Animal cells, A John Wiley & Sons, Inc. Publications, USA.

2. Masters R.W. 2000, Animal Cell Culture, Oxford University Press. USA.

3. Lanza R. 2006, Essentials of Stem Cell Biology, Academic Press, USA.

4. Banerjee G.C. 1998, Text book of Animal Husbandry, Oxford and IBH Publishing Co. Pvt. Ltd. India

5. Glick B.R., Pasternak J.J., Patten C. L., 2010, Molecular Biotechnology, ASM press, USA

6. Twyman R. M., 2005, Gene Transfer to Animal Cells, Taylor & Francis USA.

Semester – III	**Paper – II**
Course Code: MSC-BT 312T	**Title of the Course:** Bioprocess Engineering
Credits: 04	**Total Lectures:** 60 Hrs.

Course Outcomes (COs):

a. Students will be aware of fermentation process in biotechnology.
b. Students will critically evaluate and solve issues or problems pertaining to fermentation and also kinetics of product formation and sterilization process.
c. Students should be able to gain in-depth understanding about large scale product formation.
d. Students will able to give an account of important microbial/enzymatic industrial processes.

Detailed Syllabus:

Unit I: Bioprocess Development: An interdisciplinary challenge. Biotechnology & bioprocess engineering, Definition of bioprocess and bioprocess engineering. Overview of bioprocesses with their various components. Aseptic operations and containment. Types of fermentations: Solid state fermentation, dual/multiple, aerobic, anaerobic, batch, fed-batch, continuous.

Design of fermenter/ bioreactors: Overview of types of bioreactors. Novel Designs of Bioreactors (CSTR, Disposable, etc.). Kinetics of operation of bioreactors: batch, fed batch and continuous processes. Growth linked and non growth linked products. Kinetic modeling. Model structures, material balances and energy balances.

Isolation, screening and maintenance of industrially important microbes. Strain improvement: product formation and inhibition pathways and their regulations. Strain improvement by: mutation, protoplast fusion, parasexual cycle and genetic engineering. Inoculum development: Inoculum development for bacterial, yeast and mycelial processes **(14)**

Unit II: Media for Industrial Fermentations: Medium requirements for fermentation processes, carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements. Medium formulation (Statistical design) of optimal growth and product formation.

Sterilization of media and air: Thermal death kinetics of microorganisms, del factor, design organism. Design of sterilization process (batch and continuous), sterilization of bioreactor, feed and liquid waste, sterilization of air, exhaust air, theory of depth filter, designing of depth filters.

Monitoring of process variables: Types of sensors, measurement and control of various parameters (pH, temperature, dissolved oxygen, microbial biomass, inlet and exit gases, pressure, foam). Computer control of variables. Scale up and scale down: Importance, parameters involved **(10)**

Unit III: Mass transfer, Aeration and Agitation of Fermentation Broth:

Mass transfer: Concept of mass transfer, molecular diffusion and role in bioprocess. Two–film theory, convective mass transfer, volumetric mass transfer. Liquid-solid, liquid-liquid and gas- liquid mass transfer equations and significance in bioprocess.

Aeration: Oxygen uptake in cell cultures. Oxygen transfer from gas bubble to cell. Gas hold up, KLa importance. Measurement of KLa. Determination of KLa. Factors affecting KLa. Agitation: Design of impellors and their flow patterns.

Fermentation broth rheology: Newtonian and non newtonian fluids, factors affecting broth rheology. Power requirement for mixing, power number. Reynolds number, flow regimes in fermentation tank (Laminar, turbulent and transition). Correlation between mass transfer coefficient and operating variables. **(10)**

Unit IV: Downstream Processing: Bio separation: filtration, centrifugation, sedimentation, flocculation. Cell disruption. Extraction (Liquid-liquid, Aqueous two phase, supercritical fluid). Distillation, purification by chromatographic techniques- Adsorption chromatography, Affinity chromatography, Gel filtration chromatography, Ion exchange chromatography, HPLC, Reverse osmosis and ultrafiltration, drying, crystallization, whole broth processing. **(12)**

Unit V: Industrial Production and Recovery process of: vitamin c, butanol, enzyme, antibiotic, organic acid, recombinant vaccine, biotransformation product- steroids, exopolysaccharide. **(08)**

Unit VI: Quality Control (QC) and Quality Assurance (QA): Roles and responsibilities of QC and QA departments. Common quality control tests – Pyrogen test, LAL test, Ames test, Endotoxin test. Standard Operating Procedures (SOP). Good Manufacturing Practices (GMP). Regulations on use and distribution of biotechnology products. **(06)**

Suggested Readings:

1. Stanbury, P. F., Whittaker, A. and Hall, S., (2016) Principles of Fermentation technology, Springer, Third edition

2. Peppler, H. J., Perlman D. (1979), Microbial Technology, Vol I and II, Academic Press, Second edition (E book by Elsevier)

3. Casida, L. E., (1984), Industrial Microbiology, Wiley Easterbs, New Delhi

4. Casida, L. E., (2019), Industrial Microbiology, New age International, New Delhi, Second Edition.

5. Patel A.H. (2011), Industrial Microbiology, Macmillan India Ltd., Second Edition.

6. Crueger, W. and Crueger, A. (2005) A Text Book of Industrial Biotechnology, Panima, New Delhi.

7. Schuler M. and Kargi F. Bioprocess Engineering -Basic Concept, Prentice Hall of India, New Delhi.

8. Pauline D., (2012), Bioprocess Engineering Principles - Academic Press, second Edition

9. Lydersen B., Elia N. D. and Nelson K. M. (1993) Bioprocess Engineering: Systems, Equipment and Facilities, John Wiley and Sons Inc.

10. Harrison R., Todd P. (2006), Bioseparations science and Engineering,Oxford University Press

11. Aydin B., (2019) Essentials in Fermentation Technology Springer; Kindle edition

Semester – III	**III**
Course Code: MSC-BT 313T	**Title of the Course:** Bioinformatics
Credits: 02	**Total Lectures:** 30 Hrs.

Course Outcomes (COs):

a. Students will learn about the bioinformatics databases, data format and data retrieval from the online sources

b. Students will get in-depth knowledge about alignment methods and its applications.

c. Students will able to understand the structure prediction methods for protein.

d. Students will learn the concept of chemoinformatic and drug designing.

Detailed Syllabus:

Unit I: Introduction to Bioinformatics: Computers in biology and medicine **(02)**

Unit II: Biological Databases: Database concept. Types of database (Flat file, Relational, Object oriented). Types of biological databases (primary, secondary and specialized). Nucleic acid sequence databases (GenBank, EMBL, DDBJ). Protein sequence databases (Swiss-prot, Uniprot). Protein structure database (PDB). Literature database (PubMed, Scopus, etc.) **(06)**

Unit III: Biological Sequence Analysis: Global and local alignment. Pairwise sequence alignment (Dot Matrix, Dynamic programming, word method). Scoring matrices for protein and nucleotide sequences (PAM series and BLOSUM series). Gap penalty and penalty scheme. Database similarity searching by blast and fasta. Multiple sequence alignment (progressive, iterative and block based method). Phylogenetic analysis **(08)**

Unit IV: Structural Bioinformatics: PDB file format. Visualization of major secondary structure (helices, beta sheets). Protein structure prediction**.** Need and concept of protein structure prediction. Protein secondary structure prediction methods. Tertiary structure prediction. Ramchandran plot **(08)**

Unit V: Molecular Modeling and Chemoinformatic: Structure based drug designing. Compound library formatting and filtering (physicochemical and substructure filters). Pose

prediction strategies in molecular docking: Rigid body docking, flexible ligand docking (conformational search method, fragmentation method, database method), pharmacophore modelling **(06)**

Suggested Readings:

1. Lesk, A. M. 2002. Introduction to Bioinformatics. Oxford: Oxford University Press.

2. Mount, D. W. 2001. Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.

3. Baxevanis, A. D., & Ouellette, B. F. 2001. Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins. New York: Wiley-Interscience.

4. Pevsner, J. 2015. Bioinformatics and Functional Genomics. Hoboken, Wiley-Blackwell, NJ.

5. Bourne, P. E., & Gu, J. 2009. Structural Bioinformatics. Hoboken, NJ: Wiley-Liss.

6. Lesk, A. M. 2004. Introduction to Protein Science: Architecture, Function, and Genomics. Oxford: Oxford University Press.

Semester – III	**Paper – IV**
Course Code: MSC-BT 314P	Title of the Course: Practicals in Animal Biotechnology
Credits: 02	**Total Lectures:** 60 Hrs.

Course Outcomes (COs):

a. Students will prepare the medium for animal cell culture and filter sterilize it.

b. Students will establish the primary cell culture from chick embryo.

c. Students will learn to prepare chromosomes from cell lines.

d. Students will able to perform cytotoxicity of drugs.

Detailed Syllabus:

1. Preparation of BSS and medium and its filter sterilization	**(02)**
2. Sterility test for BSS, medium, PBS	**(02)**
3. Initiation of primary cell culture from chick embryo	**(03)**
4. Subculture and establishment of cell line	**(02)**
5. Growth curve analysis of cell line	**(02)**
6. Chromosome spread preparation from cell line	**(01)**
7. Cytotoxicity testing of any drug	**(03)**

Suggested Readings

1. R. Ian Freshney. 2010, Culture of Animal cells, 5th Edition, A John Wiley & Sons, Inc., Publications, USA

2. R.W.Masters. 2000, Animal Cell Culture - Practical Approach, 3rd Edition, Oxford University Press. USA

3. Banerjee G.C. 1998, Text book of Animal Husbandry, Oxford and IBH Publishing Co. Pvt. Ltd. India

Semester – III	**Paper – V**
Course Code: MSC-BT 315P	**Title of the Course:** Practicals in Bioprocess engineering
Credits: 02	**Total Lectures:** 60 Hrs.

Course Outcomes (COs):

a. Students will practically learn working of laboratory fermenter
b. Students will practically understand how to chemical parameter affect growth of microorganisms.
c. Students will be able to isolate, identified antibiotic or enzyme producing bacteria.
d. Students will visit the fermentation industry.

Detailed Syllabus:

1. Screening and identification (Genus Level) of a production strain (enzyme /antibiotic) from natural samples. **(03)**
2. Maintenance of the isolated production organism (Agar slants/ glycerol stocks /soil culture/ lyophilization) at least two methods. **(02)**
3. Medium optimization for laboratory scale production of enzyme/antibiotics. **(02)**
4. Study of working of lab bench fermenter (with production of enzyme or antibiotic using screened organism) **(03)**
5. Recovery and assay of product formed (Bioassay or Enzyme assay) **(02)**
6. Solid state fermentation: lab scale production of a product. **(02)**
7. Visit to fermentation industry and report writing **(01)**

Suggested Readings:

1. Butterworths H. 1992, BIOTOL series, Bioreactor Design and Product Yield.
2. Chand S., Dubey R.C. and Maheshwari D.K. 2012 Practical microbiology,
3. Kumar B.S. 2013, Panima Publishing Corporation, A laboratory manual of practical microbiology, New Delhi, India.
4. Roy and Prasad M.M., 2010, Laboratory Manual of Microbiology.

Semester – III	**VI**
Course Code: MSC-BT 316P	**Title of the Course:** Practicals in Bioinformatics
Credits: 02	**Total Lectures:** 60 Hrs.

Course Outcomes (COs):

a. Students will learn to access bioinformatics databases and data retrieval from the online sources

b. Students will get in-depth knowledge about alignment methods and database similarity searching.

c. Students will able to predict three dimensional structure of protein.

d. Students will learn the use of tools like Swiss PDB Viewer and its applications.

e. They will learn molecular docking for Protein and ligand.

Detailed Syllabus:

1. Using online resources like NCBI, PubMed, GenBank, UniProtKB, PDB **(02)**

2. Sequence alignment using BLAST/ Database similarity searching using BLAST **(02)**

3. Use of protein secondary database prosite/pfam/prodom **(01)**

4. Multiple sequence alignment and phylogenetics analysis (Clustal/Tcoffee/Mega/phylip) **(02)**

5. Basic structure visualization using DeepView (Performing basic tasks like selecting and displaying structures, colouring, measuring distances and labeling) **(02)**

6. Energy minimization, amino acid mutation and ramchandran Plot analysis using swiss PDB Viewer **(02)**

7. Prediction of protein tertiary structure using any method (MODELLER, SWISS Model, EasyModeler) **(02)**

8. Molecular docking using AutoDock/ArgusLab and molecular visualization of docked complexes **(02)**

Suggested Readings:

1. Baxevanis A. D. 2001 Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Latest Edition. Publisher: New York, John Wiley & Sons, Inc.

2. Teresa A., Parry-Smith D. J. 2004, Introduction to Bioinformatics. Publisher: Pearson Education (Singapore) Pvt.Ltd.

3. Gibas C., Jambeck P. 2001, Developing Bioinformatics Computer Skills. Publisher: Shroff Publishers and distributors O'Reilly Media, Inc.,

4. Bourne P. E., Weissig H. 2003, Structural Bioinformatics (Methods of Biochemical Analysis, V. 44), Publisher: Wiley-Liss.

5. Leach, A. 2001, Molecular Modelling: Principles and Applications. Publisher: Prentice Hall.

6. Branden, To. J. 1999, Introduction to Protein Structure. Garland Publishing Inc. New York

Semester – III	**Paper – VIIA**
Course Code: MSC-BT 317A	**Title of the Course:** Agricultural Biotechnology
Credits: 02	**Total Lectures:** 30 Hrs.

Course Outcomes (COs)

a. Students will learn importance of agriculture and its role in national economy
b. Students will be able to recall the basic concepts of plant biotechnology
c. Students will learn fundamental cellular events during the process of plant cell culture and its applications
d. Students will learn applications of advance biotechnological techniques in agriculture
e. Students will understand importance of microbes in agriculture

Detailed Syllabus

Unit I: Introduction to Agricultural Biotechnology: Importance of agriculture in national economy. Biotechnology in Agriculture: *In-Vitro* plant propagation (Micropropagation)**.** Virus indexing and production of virus free plants. Constraints in use of bioreactors in plant production and scale up for commercialization. Advantages of biotechnological methods over conventional methods of crop improvement

a) Homozygous plant production through anther & pollen culture
b) Embryo rescue & embryo culture in rearing viable hybrid embryos
c) Endosperm culture & production of triploids
d) Induced polyembryony
e) Somaclonal and gametoclonal variations and their applications in crop improvement
f) Somatic hybridization **(10)**

Unit II: Recombinant DNA technology in Agricultural Biotechnology: Improvement of crop quality (FlavrSavr tomato, Golden rice)**,** chloroplast manipulations for production of vaccines, antibodies and increased production **(05)**

Unit III: Microbes in Agriculture: Beneficial microorganisms in agriculture: Biofertilizer (bacterial, cyanobacterial and fungal), microbial bio insecticides**,** major pest and diseases of horticultural crops and their control by biotechnological methods

Development, formulation (with various carrier materials) of bio-inoculant for better productivity:

i. Growth promoting,
ii. Nitrogen fixing,
iii. Phosphate solubilizing,
iv. Metal chelating (siderophores)
v. Growth hormone producing microorganisms

Agricultural biotechnology and agribusiness**,** opportunities in the agriculture biotechnology **(07)**

Unit IV: Recent advances: Plant genotyping by different methods: PCR, Plant fingerprinting, microsatellite, nanotechnology. Homogenous assays qualitative real time PCR assays, applications.

CRISPR based technology: Introduction, techniques, and its application in plants. Plant DNA barcoding- introduction, barcoding markers (matK, rbcl, ITS, tmHpsbA). Recent advances in plant barcoding, benefits, limitations **(08)**

Suggested Readings

1. Plant molecular breeding, 2009, New bury HJ, John Wiley and Sons, USA.
2. Chawla H.C., 2004, Introduction to plant biotechnology(Science Publication)
3. Kumar A., Shekhawat N. S. 2009, Plant tissue culture and molecular Markers: their role in improving crop productivity (IK International)
4. Das HK, 2010, Biotechnology, 4th edition, Wiley India Pvt. Limited, India
5. Slater A, Scott NW, 2008, Plant Biotechnology: the genetic manipulation of plants Oxford Press.
6. Fowler M R, Green M R & Sambrook J., 2014, Molecular Cloning: A Laboratory Manual. 4th Ed. Vol. I, II& III. Cold Spring Harbor Laboratory Press.
7. Grierson D. 2012, Plant Genetic Engineering, Springer Netherlands.
8. Primose SB & Twyman RM. 2006, Principles of Gene Manipulation and Genomics 7th Ed. Blackwell Publishing.
9. Sambrook J. and Russel D, 2001, Molecular Cloning: A Laboratory Manual 3rd Ed Cold Spring Harbor Laboratory Press.
10. Philips C.L. and Wetter L.R., 1995, Plant cell tissue and organ culture: fundamental methods, National Research council, Canada, PRL, Saskatoon.

Semester – III	**Paper – VIIB**
Course Code: MSC-BT 317B	**Title of the Course:** Nanobiotechnology
Credits: 02	**Total Lectures:** 30 Hrs.

Course Outcomes (COs):

a. This course facilitates better understanding nanobiotechnology field.

b. Students will able to characterize nanoparticles using standardized methods.

c. Students will able to understand applications of nanomaterials in various field.

d. Students will learn techniques of nanoparticle analysis using X-ray diffraction, Electron microscope etc.

Detailed Syllabus:

Unit I: Introduction to Nanobiotechnology: History of nanotechnology**,** Types of nanoparticles and their properties: quantum dots, polymeric nanoparticles, lipid nanoparticles, metal nanoparticles, metal oxide nanoparticles, composite, concept of nanobiotechnology **(03)**

Unit II: Methods for synthesis of Nanomaterials:

Chemical methods - Chemical precipitation and coprecipitation, Sol-Gel synthesis, Micro emulsions synthesis, hydrothermal, solvothermal synthesis methods

Physical methods: Microwave assisted synthesis, core-shell nanostructure, quantum dot (QDs) synthesis

Biological methods: Overview and concept of microbial/plant mediated nano-particle production; methods of microbial/plant mediated nanoparticle production **(07)**

Unit III: Characterization of Nanomaterials: Optical (UV-Vis/Fluorescence), X-ray diffraction, imaging and size determination (Electron microscopy- TEM, SEM) **(05)**

Unit IV: A. Applications of Nanomaterials: Protein targeting - Small molecule/nanomaterial - protein interactions; nanomaterial-cell interactions-manifestations of surface modification (polyvalency). Peptide/DNA coupled nanoparticles; lipid and inorganic nanoparticles for drug delivery; metal/metal oxide nanoparticles (antibacterial/anti-fungal/anti-viral activities); anisotropic and magnetic particles (hyperthermia).

B. Applications of Nanobiotechnology: Nanomedicines, nanoparticles for diagnostics and imaging, food science (food processing, food packaging, detection of pathogens). Nanosensors -nanotechnology for water remediation and purification. Nanotechnology in agriculture. Green nanotechnology. Gene therapy. **(10)**

Unit V: Concerns of Nanomaterials / Nanobiotechnology: Environmental and health impact of nanomaterials. Genotoxicity and cytotoxicity evaluation of nanomaterials. Ecotoxicology **(05)**

Suggested Readings:

1. Sulabha K. Kulkarni, (2009), Nanotechnology; Principals and Practices, New Delhi, Capital Publishing company.
2. Michael A. Stroscio and Mitra Dutta, (2004), Biological Nanostructures and Application of Nanostructures in Biology, Kulwer Academic Publishers.
3. Elisabeth S. Papazoglou, Aravind Parthasarathy, (2007), BioNanotechnology, Morgan & Claypool Publishers' series.

Semester – III	**Paper – VIIIA**
Course Code: MSC-BT 318A-P	**Title of the Course:** Practicals in Agricultural Biotechnology
Credits: 02	**Total Lectures:** 60 Hrs.

Course Outcome (COs)

a. Students will be able to recall the basic techniques of plant biotechnology

b. Students will learn fundamental process of plant cell culture and its applications

c. Students will learn applications of advance biotechnological techniques in agriculture

d. Students will learn techniques of bio-fertilizer production

Detailed Syllabus:

1. Organization of commercial plant tissue culture laboratory (1)
2. To study virus indexing with suitable example ELISA and PCR (Demonstration) (1)
3. To study embryo culture/embryo rescuing (1)
4. Micropropagation of suitable plant and study effect of auxin/cytokinin ratio on *in-vitro* growth of explant (organogenesis/somatic embryogenesis) (3)
5. Haploid plant production by anther/pollen culture (2)
6. To study endosperm culture for regeneration of triploid/seedless plants. (1)
7. Nongel techniques for plant genotyping and CRISPR based technology (Demonstration using web resources) (1)
8. Isolation and characterization of agriculturally important microorganism. (2)
9. Preparation, formulation (using suitable carrier material) of biofertilizer. (1)
10. Application (pot trials) of biofertilizer (Nitrogen fixing, Phosphate/Sulphur/Zinc/Potassium/Calcium solubilizing microorganisms) (2)

Suggested Readings

1. Castle D. 2014, Handbook on Agriculture, Biotechnology and Development

2. Rai M.K. 2006, Handbook of Microbial Biofertilizers ISBN 13: 978-1-56022-269-9

3. Verma, A. S., Das S. and Singh A. 2014, Laboratory Manual for Biotechnology S. Chand Publishing ISBN 9789383746224

Semester – III	**Paper – VIIIB**
Course Code: MSC-BT 318B-P	**Title of the Course:** Practicals in Nanobiotechnology
Credits: 02	**Total Lectures:** 60 Hrs.

Course Outcomes (COs):

a. Students will understand the methods of nanoparticle synthesis.

b. Students will able to characterize nanoparticles using standardized methods.

c. Students will able to investigate genotoxicity and cytotoxicity evaluation of nanomaterials.

Detailed Syllabus:

1. Synthesis of metal/metal oxide Nanoparticles by: (05)

a. Physical

b. Chemical

c. Microbial

d. Plant based method

2. Characterization of nanomaterials by spectroscopic method: (03)

i. Analysis of absorption spectra of thin films of Nanomaterials

ii. Determination of absorption coefficient for different wavelength

iii. Demonstration on X-ray crystallography using web sources or PowerPoint presentation.

3. Applications of nanoparticles: (06)

1. Antibacterial activities of synthesized nanoparticles (MIC/MBC determination)

2. Antifungal activities of synthesized nanoparticles (MIC/MBC determination)

3. Cytotoxicity testing of nanoparticles using MTT/Trypan blue assay

4. Cytotoxicity testing of nanoparticles using onion root tip assay

Suggested Readings:

1. N. R. Rao (Editor), Achim Müller (Editor), Anthony K. Cheetham (Editor), (2004), The Chemistry of Nanomaterials: Synthesis, Properties and Applications, 2 Volume Set C, Wiley Publisher.

2. Christof M. Niemeyer (Editor), Chad A. Mirkin (Editor), April 2004, Nanobiotechnology: Concepts, Applications and Perspectives, Wiley Publishers.

3. Mark Ratner and Daniel Ratner, Nanotechnology: A Gentle Introduction to Next Big Idea, Low Price edition, Third Impression, Pearson Education.

4. G. Schmidt, Wiley Weinheim , (2004), Nanoparticles: From theory to applications

5. (2005), Nanochemistry: A Chemical Approach to Nanomaterials – Royal Society of Chemistry, Cambridge UK .

Semester – III	**Paper – IX**
Course Code: MSC-BT 319 A	**Title of the Course:** Pharmaceutical Biotechnology
Credits: 02	**Total Lectures:** 30 Hrs.

Course Outcomes (COs):

a. Students will learn the action mechanism of drug
b. Students will understand the process of clinical trials
c. Students will gain the knowledge of regulatory authorities

Detailed Syllabus:

Unit I: Introduction to Pharmaceutical Biotechnology and Drug discovery: Drug targets-Structure and functions; Physicochemical properties of drugs; Drugs from natural sources. Pharmacodynamics, pharmacokinetics and drug metabolism, drug tolerance & intolerance, drug allergy, drug induced side effects with examples. **(08)**

Unit II: Drug action and Resistance: Mechanism of action of anti-diabetic (Insulin), anticancer (Daunorubicin), anti-inflammatory (Diclofenac) and antibiotics (Ciprofloxacin), Phases of clinical trials for drug testing **(08)**

Unit III: Biopharmaceuticals: Introduction and scope of biopharmaceutical industry, Biotherapeutics: Various categories of therapeutics like vitamins (B), antibiotics (Protein Synthesis Inhibitor), hormones (Estrogen), enzymes (L-Asparginase), hematopoietic growth factors and coagulation factors, interferons and cytokines for anti-infective and cancer therapy. **(06)**

Unit IV: Role of Regulatory Authorities in Drug Approvals: Investigational new drug application**,** National regulatory authorities, Mutual Indian drug regulations, & pharmacopeia**,** The U.S. Food and Drug Administration (FDA), The Central Drugs Standard Control Organisation (CDSCO)**,** European regulations, European medicines agency and the new EU drug approval system, Centralized procedure, Drug patenting and licencing in Pharma industry. **(08)**

Suggested Readings:

1. Kaiser O and Muller R. 2004, Pharmaceutical Biotechnology: Drug Discovery andClinical Application, Wiley VCH publisher.
2. Vyas and Dixit, 1991, Pharmaceutical Biotechnology, New Delhi, CBS Publisher.
3. GuptaP. K.2004, Elements of Biotechnology, 10th edition, Rastogi Publication.
4. PurohitS.S, 2002, Biotechnology Fundamentals and Applications, Agro bios Publisher.
5. Daan J. A. and Crommelin, 1997, Pharmaceutical Biotechnology: An Introduction for Pharmacists and Pharmaceutical Scientists, 2-nd edition, Taylor & Francis.
6. Gary Walsh, 1992, Pharmaceutical Biotechnology: Concepts and Applications, Wiley.

Semester – IV	**Paper – I**
Course Code: MSC-BT 411T	**Title of the Course:** Genomics and Proteomics
Credits: 04	**Total Lectures:** 60

Course Outcomes (COs):

a. Students will understand the concept of genomics and proteomics

b. Students will learn sequencing techniques and different branches of genomics

c. Students will understand methodologies in genomics and its applications

e. Understand types of proteomics

f. Learn detail techniques used in proteomics

h. Understanding of applications of proteomics subjects in various fields

Detailed Syllabus:

Genomics

Unit I: Genomics and proteomics overview, omes and omics, concepts and applications **(02)**

Unit II: Whole Genome sequencing – methods, assembly and analysis, NGS platforms **(04)**

Unit III: Comparative genomics - Goals, bioinformatics of genome annotation, methods and limitations. Structural genomics – Goals, methods, applications. Functional genomics –Goals, methods, applications. **(06)**

Unit IV: Introduction to transcriptomics and expression profiling. DNA and RNA Microarray –preparation, working and analysis. Investigative techniques –EST, SAGE, SNP, MPRAs **(10)**

Unit V: Applications of genomics – Metagenomics, toxicogenomics, pharmacogenomics, basic research, medical genetics **(08)**

Proteomics

Unit VI: Introduction of Proteomics: Introduction to proteomics. types of proteomics: protein expression proteomics. Structural and functional proteomics**.** Protein structure-function relationship **(03)**

Unit VII: Techniques in Proteomics: Protein isolation and separation techniques, Structural analysis of proteins - X-ray crystallography, NMR spectroscopy, 2 D electrophoresis, peptide

mapping & sequencing. Protein structure prediction- homology modeling. Mass spectrometry: (MALDI_TOF, ESI Tandem, Ion Trap)**,** peptide mass fingerprinting. LC-MS, SILAC. **(15)**

Unit VIII: Applications of Proteomics: Protein expression profiling**,** protein-protein interaction, protein-DNA interaction and detection methods (Yeast 1, 2 and 3 hybrid systems, phage display, Chip Technique**)**, protein microarrays and its databases.

Health care, biomarkers in disease diagnosis, biomarker, drug development and their target identification, identification and characterization of novel proteins **(12)**

Suggested Readings:

1. Primrose, S. B., Twyman, R. M., Primrose, S. B., & Primrose, S. B. 2006, Principles of Gene Manipulation and Genomics. Malden, MA: Blackwell Pub.

2. Liebler, D. C. 2002, Introduction to Proteomics: Tools for the New Biology. Totowa, NJ: Humana Press.

3. Campbell, A. M., & Heyer, L. J. 2003, Discovering Genomics, Proteomics, and Bioinformatics. San Francisco: Benjamin Cummings.

4. Baldi P. and Hatfield G. W. 2002, DNA microarrays and gene expression. Cambridge University Press.

5. Twyman R.M. 2004, Principle of Proteomics. BIOS Scientific Publishers.

Semester – IV	**Paper – II**
Course Code: MSC-BT 412T	**Title of the Course:** Advanced Bio analytical Techniques
Credits: 04	**Total Lectures:** 60

Course Outcomes (COs):

a. The course will help students to study basic instrumentation, principle and procedure of various sophisticated instruments like electron microscopy, confocal microscopy and freeze drying.
b. Students will learn applications of bioanalytical techniques in scientific research.
c. These techniques will prove as promising tools in disease diagnosis and cure.

Detailed Syllabus:

Unit I: Microscopic Techniques: Staining and visualization of cells and subcellular components by light microscopy, cryotomy, scanning and transmission microscopes, different fixation and staining techniques for electron microscope, freeze-etch and freeze-fracture methods for EM, image processing methods in microscopy, confocal microscopy, single cell imaging. **(08)**

Unit II: Histochemical, Immuno, Radiolabeling techniques and electrophysiological methods: Overview of histochemical and immunotechniques

Radiolabeling techniques - Detection and measurement of different types of radioisotopes normally used in biology. Incorporation of radioisotopes in biological tissues and cells. Molecular imaging of radioactive material

Electrophysiological methods – Single neuron recording, patch-clamp recording, ECG, brain activity recording, lesion and stimulation of brain, pharmacological testing, PET, MRI, fMRI and CAT **(18)**

Unit III: Advanced Application of Spectroscopy: UV visible spectrophotometer, fluorescence spectroscopy, circular dichroism, optical rotatory dispersion (ORD), NMR, IR and ESR spectroscopy. Molecular structure determination using X-ray diffraction and X ray crystallography. Molecular analysis using light scattering. Mass spectrometry and LC-MS and surface plasma resonance methods **(18)**

Unit IV: Advanced Chromatography and Electrophoretic technique: Introduction, principle and applications of HPTLC, HPLC, GLC, GC, IF and 2 D electrophoresis, capillary electrophoresis, DGGE (Denaturing gradient gel electrophoresis) **(08)**

Unit V: Advanced Bio-analytical Techniques and Automated Systems: Advances in PCR technology and its applications (modifications), Next Generations Sequencing (NGS): principles and instrumentation, NGS data processing tools, automated microbial identification system. Automated DNA/RNA microarray systems **(08)**

Suggested Readings:

1. Wilson K.M., Walker J.M, 2010, Principles and Techniques of Biochemistry and Molecular Biology, 7th edition, Cambridge University Press, UK
2. Pattabhi V and Gautham N. Kluwer, 2002, Biophysics, 1stedition, USA, Academic Publisher.
3. Rodney B., 2000, Modern experimental biochemistry, 3rd edition,USA,Prentice Hall Publisher.
4. David H., Peck H., 1998, Analytical Biochemistry, 3rd edition, Prentice Hall, UK.
5. Arthur V., Jeffery G.H., 2004, Text Book of Quantitative Chemical Analysis, 6thEdition, New Delhi, Pearson publication.
6. Upadhyay B., Upadhyay S. and Nath N., 2009, Biophysical chemistry, e-book, Mumbai, Himalaya publication house.
7. Steven R., Ordoukhanian, P., Salomon P., 2018, Next Generation Sequencing Methods and Protocols, New York, Humana press publication.
8. Wang X., 2016, Next-Generation Sequencing Data Analysis, 1stEdition, Boca Raton,

Semester – IV	Paper – III
Course Code: MSC-BT 413T	**Title of the Course:** Research Methodology & Scientific Communication
Credits: 02	**Total Lectures:** 30 Hrs.

Course Outcomes (COs):

a. Students will learn the concept of research communication.

b. Students will study different types of scientific methods to analyze and write research articles.

c. Students will able to understand the methods of data collection and analysis.

d. Students will learn the concept of ethics and plagiarism.

Detailed Syllabus:

Unit I: Introduction to Research Methods: Types of research philosophies (positivist, interpretivist, pragmatist and realistic), various steps in scientific research. Scientific temper and attitude. experimental design, defining controls; reductionist and holistic approaches of scientific research. **(05)**

Unit II: Scientific Methodology: Problem identification, critical thinking, hypothesis formulation and hypothesis testing (power analysis), types of reasoning, theory and scientific law **(03)**

Unit III: Data Collection and analysis: Types of data, methods and techniques of data collection, methods of primary data collection (observation/ experimentation/ questionnaire/ interviewing/ case/ pilot study) methods of secondary data collection (internal/ external), schedule method

Research data organization: Creating, analyzing, formatting data & content using spreadsheets, managing lab work books.

Data Analysis using statistical tools**:** Data distributions, statistical tests for comparison of sample means andsample variance-t-test, non-parametric tests, correlation and regression, F, t and Z distribution; goodness of fit, chi-square. Softwares for data analysis. **(08)**

Unit IV: Research in Practice: Literature review, journals, conference proceedings, journal

impact factor, citation index, h, g, h-g index. **(04)**

Unit V: Research Ethics: Social implications of research, bio-safety issues, Animal experimentation ethics and human experimentation ethics. Plagiarism and scientific misconduct. Ethics in scientific communication, patent submissions. Use of URKUND, Turnitin and iThenticate software **(03)**

Unit VI: Scientific Communication: Importance of scientific communication. Types of scientific communications.

Different modes of scientific communication:

Scientific Writing: Characteristic of good scientific writing, structure and content, style, literature references.

Report Writing: Types of research reports, guidelines for writing a report, report format. Details of research proposal writing. Research paper writing (IMRAD format). Thesis writing.

Oral forms of scientific Communication: Popular and scientific talks, poster presentations, organizing presentation material, use of audio visual aids in presentation elements of presentation preparation: objective, subject, audience, length of talk managing and delivering presentations. **(07)**

Suggested Readings:

1. Hofmann H., 2010, Scientific Writing and Communication Papers, Proposals, and Presentations. New York: Oxford University Press.
2. Ferris T. L. J., Sitnikova E., and Duff A. H., 2010, Building graduate capabilities to communicate research and plans successfully, Int. J. Eng. Educ., vol. 26, no. 4, pp. 891–899.
3. Michael Alley, 2018, The Craft of Scientific Writing, fourth edition, Springer.
4. Stephen B. Heard, 2018, The Scientists Guide To Writing, Princeton University Press.
5. Graziano A. M., Raulin M. L. 2012, Research Methods: A Process of Inquiry Pearson Publication, Delhi.
6. Barass R., 2002, Scientists Must Write: A Guide to Better Writing for Scientists, Engineers and Students, Routledge Publication, UK.
7. Resnik D. B., 1998, The Ethics of Science: An Introduction, Routledge Publication, UK.

8. Fisher R A, 1971, The Design of Scientific Experiment, Collier Macmillan Publishers, London.

Semester – IV	**Paper – III**
Course Code: MSC-BT 414P	**Title of the Course:** Practicals in Bioanalytical Techniques
Credits: 02	**Total Lectures:** 60 Hrs.

Course Outcomes (COs):

a. This skill based course will teach the students the various instrumentations that are used in the analytical laboratories.

b. Students will learn techniques like 2D electrophoresis, PCR, Chromatography.

c. Students will be able to study techniques like ELISA.

Detailed Syllabus:

1. Separation of mixture of proteins by gel filtration chromatography. **(02)**
2. Separation of mixture of amino acids by ion exchange chromatography. **(02)**
3. 2D electrophoresis for separation of proteins. **(02)**
4. Amplification of DNA/RNA by PCR and analysis of PCR product. **(02)**
5. Quantitative detection of antigen by Sandwich ELISA **(02)**
6. In situ detection of proteins by immunoflorescence microscopy **(01)**
7. Affinity chromatography - separation of IgG from Serum by protein A sepharose chromatography **(02)**
8. Demonstration of HPLC technique **(01)**
9. Separation of secondary metabolites by Thin Layer Chromatography. **(01)**

Suggested Readings:

1. Jayaram T. 1981. Laboratory manual in Biochemistry, Wiley Estern Ltd. New Delhi.
2. Plummer D. 1988. An Introduction to Practical Biochemistry. 3rd ed. Tata McGraw Hill, New Delhi.
3. Nath RL. 1990. Practical Biochemistry in Clinical Medicine. Academic Pub.
4. Sadasivam S and Manickam A. 1996. Biochemical Methods. 2nd ed. New Age International (P) Ltd. Publisher, New Delhi.

Semester – IV	**Paper – V**
Course Code: MSC-BT 415P	**Title of the Course:** Review and research article writing
Credits: 02	**Total Lectures:** 60 Hrs.

Course Outcome:

a. Students will learn to write a research or review paper.

b. Students will experience to present scientific research paper,

c. Students will learn to use data analysis software like Excel/SPSS.

Detailed Syllabus

1. Research data collection and analysis **(03)**
2. Review paper writing/ report writing **(03)**
3. Presentation of scientific research paper from reputed journal. **(04)**
4. Use of data analysis softwares (Excel, SPSS) **(03)**
5. Group discussion on recent inventions in biotechnology **(02)**

Suggested Reading:

1. Hofmann H., 2010, Scientific Writing and Communication Papers, Proposals, and Presentations. New York: Oxford University Press.
2. Ferris T. L. J., Sitnikova E., and Duff A. H., 2010, Building graduate capabilities to communicate research and plans successfully, Int. J. Eng. Educ., vol. 26, no. 4, pp. 891–899.
3. Michael Alley, 2018, The Craft of Scientific Writing, fourth edition, Springer.
4. Stephen B. Heard, 2018, The Scientists Guide To Writing, Princeton University Press.
5. Graziano A. M., Raulin M. L. 2012, Research Methods: A Process of Inquiry Pearson Publication, Delhi.

Semester – IV	**Paper – VI**
Course Code: MSC-BT 416A	**Title of the Course:** Medical Biotechnology
Credits: 02	**Total Lectures:** 30 Hrs.

Course Outcomes (COs):

a. Students will know numerous examples of discoveries in the field of medical biotechnology.

b. Students will learn the use of organisms to produce diagnostic and therapeutic products that help to treat and prevent human diseases.

c. Student will study Prevention, Diagnosis and Treatment of diseases

d. Student can be able to obtain knowledge in molecular, cell biological, genetic and immunological scientific areas.

Detailed Syllabus:

Unit I: Introduction to molecular basis of Disease: Introduction to medical biotechnology**,** Worldwide market in medical biotechnology**,** Revolution in diagnostics and therapy**,** Recent researches in medical biotechnology**,** Single gene disorders: Thalassemia**,** Infectious disorders- Malaria, Hepatitis B, Dengue**,** Effect of antimicrobial drugs: on bacterial, fungal and viral pathogens **(08)**

Unit II: Diagnosis: Prenatal diagnosis, karyotype analysis**,** diagnosis using protein and enzyme markers: Enzyme probes glucose oxidase, monoamine oxidase, diagnosis using monoclonal antibodies– hormonal disorders & infectious diseases**,** Biosensors in clinical diagnosis, microarray technology for disease diagnosis**,** FISH Technology for disease diagnosis**,** genetic counselling. **(08)**

Unit III: Therapies: Strategies of gene therapy: Gene augmentation, antisense therapy, ribozymes, Gene therapy trials: ADA deficiency, Cystic fibrosis, HIV**,** Enzyme therapy: Gauchers disease**,** Hormone replacement therapy: Diabetes**.** **(09)**

Unit IV: Applications of medical biotechnology: Expression of industrially important products, Production of recombinant proteins from pro and eukaryotic hosts, Recombinant

hormone. Pharmacogenomics (cancer, depression), Edible Vaccines **(05)**

Suggested Readings:

1. Pasternak J. J., 2005, Introduction to Human Molecular genetics, John willey Publications
2. Pratibha N.V., RaoV. 2010, Medical Biotechnology, Oxford Press, USA.
3. Pongracz J., Mary K., 2008, Medical Biotechnology, Humana Press. New Jersey.
4. Bernald G, Terry L D, Cheryl L., 2014, Medical Biotechnology, ASM press, USA.
5. Bernard R. Glick, Jack J. Pasternak, and **Cheryl L**. 1994, Pattern Molecular Biotechnology- Principles and Applications of Recombinant DNA, 4th Edition, ASM press, USA.

Semester – IV	**Paper – VI**
Course Code: MSC-BT 416B	**Title of the Course:** Entrepreneurship and Business Administration
Credits: 02	**Total Lectures:** 30 Hrs.

Course Outcomes (COs):

a. Students will understand the nature of entrepreneurship.

b. Students will understand the function of the entrepreneur in the successful, commercial application of innovations.

c. Students will able to confirm an entrepreneurial business idea.

d. Students will explore entrepreneurial leadership and management style.

e. Students will understand principle and practice of business management.

Detailed Syllabus:

Unit I: Introduction to Entrepreneurship: Meaning and concept of entrepreneurship. Need and importance of entrepreneurship. The history of entrepreneurship development. Skills and characteristic of successful entrepreneurs. Entrepreneurship process. Factors impacting emergence of entrepreneurship. Role of entrepreneurship in economic development. Evolution and growth of entrepreneurship in India **(08)**

Unit II: Starting the venture Generating business idea – Sources of new ideas. Methods of generating ideas. Creative problem solving. Opportunity recognition and assessment Environmental scanning, Competitor and industry analysis; Feasibility study: Market feasibility:-Marketing plan: marketing research for the new venture. Steps in preparing marketing plan - Technical/operational feasibility - Financial feasibility. **(10)**

Unit III: Principles and Practice of Management – Definition, functions, process, scope and significance of management. Nature of management, managerial skills and activities. Difference between management and administration. Planning and organization nature, objectives and significance of planning, element and steps of planning. Span of control. Line and staff relationship. Authority, delegation and decentralization, organizational structures. Formal and informal organizations. Staffing, decision making process. **(12)**

Suggested Readings:

1. Robert D., Michael P. and Dean S., 2007, Entrepreneurship, Tata McGraw Hill, New Delhi.

2. Brace R., and Duane R., 2019, Entrepreneurship. Pearson Prentice Hall, New Jersy (USA).

3. Lall M. and Sahai S. 2008, Entrepreneurship. Excel Book, New Delhi.

4. Prasad L.M., 2020, Principal and Practice of management, S. Chand Publication

5. Koontz D. and Donnel O., (2020). Essential of Management, Tata Mc Graw.

6. Koontz and Weihrich 2008, Essential of Management, Tata Mc Graw.

7. James S., Edward F., Gilbert D. R., 2018 Management. Prentice Hall of India.

Semester – IV	**Paper – VII**
Course Code: MSC-BT 417A	**Title of the Course:** Animal and Plant Physiology
Credits: 02	**Total Lectures:** 30 Hrs.

Course Outcomes (COs):

a. Students will understand the important physiological function of animals

b. Students will study nervous system in detail.

c. Students will develop understanding about sense organs like ear, eye.

d. Students will understand the important plant physiological processes

Detailed Syllabus:

Unit I Circulatory system: Blood corpuscles, anatomy of heart structure, plasma functions, blood volume, blood volume regulation, blood groups, ECG - its principle and significance, cardiac cycle, blood pressure, neural and chemical regulation of all above. **(05)**

Unit II Nervous system and Excretory system: Structure of neurons and brain, central and peripheral nervous system. reflex action**,** comparative physiology of excretion, kidney, regulation of water balance **(05)**

Unit III Sense organ: Vision, hearing and tactile response **(05)**

Unit IV Plant Physiology: The plant cell: structure and attributes**,** inhibitors and enhancers of growth- characterization and effects of plant hormones, mechanisms of auxin, gibberelin and cytokinin action**,** gas as a hormone- ethylene: physiological and biochemical attributes of fruit ripening process.

Development of the chloroplast- biogenesis and assembly of chloroplast proteins- import pathways, processing and organizing thylakoid proteins

Photosynthesis- light phase: transfer of photosynthetic electrons, structure and function of the light-receptor system in thylakoids, electron transfer system and the photophosphorylation,

Photosynthesis- Attributes of CO_2 fixation (C2, C3, C4 and CAM) and calvin cycle.

Development of the plant- phytochromes and cryptochromes: their biochemical and molecular characterization, and response mechanisms

Development of the plant- the role of the circadian clock: characterization and functions

Plant interaction (biotic and abiotic) and plant response to abiotic stress. **(15)**

Suggested Readings:

1. Guyton, A.C., Hall, J.E. 2006, Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.
2. Taiz L., Zeiger E., 1998, Plant Physiology pp._544-557 and 564-571, 2nd edition, Sinauer Associates, Sunderland, Mass.
3. Tortora, G.J., Grabowski S., 2006, Principles of Anatomy & Physiology. XI Edition John Wiley & son
4. Haswell A., A Textbook of Zoology, Vol. II- T. Jeffery Parker and William.
5. Buchanan, B. B., Gruissem, W., Jones, R. L., 2000, Biochemistry & molecular biology of plants. Rockville, Md.: American Society of Plant Physiologists.
6. Dey PM, Harborne JB, eds. 1997, Plant Biochemistry, Academic Press, San Diego.

Semester – IV	**Paper – VII**
Course Code: MSC-BT 417B	**Title of the Course:** Ecology and Evolution
Credits: 02	**Total Lectures:** 30 Hrs.

Course Outcomes (COs):

a. Student will learn the evidence for evolution and differentiate between its causes
b. Student will gain the knowledge of energy and nutrient flow through different scales of ecological organization
c. Student will understand the ecological concepts.

Detailed Syllabus:

Unit I: Introduction to Ecology - Organismal Ecology: Plants & animal adaptations, plant-animal interactions (mutualism, commensalism, competition, predation)
Population Ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations.
Community Ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones**,** Ecological Succession: types; mechanisms; changes involved in succession; concept of climax.
Biodiversity: (Species richness, evenness and diversity indices, endemism, species-area relationships) **(08)**

Unit II: Ecosystem Ecology and Biogeography- Ecosystem structure; ecosystem function; energy flow and mineral cycling (C, N, and P); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine). Major terrestrial biomes; theory of island biogeography; biogeographical zones of India applied ecology. **(06)**

Unit III: Evolution as the Core Theme in Biology - History of evolutionary thought; evidence for evolution**,** species concepts and speciation**,** mechanisms of evolution: natural selection, levels of selection. **(08)**

Unit IV: Life history strategies and Molecular evolution - Adaptive radiation**,** biogeography and evolutionary ecology**,** molecular clocks**,** systems of classification – (cladistics, phenetics)**,** molecular systematic**,** gene expression and evolution. **(08)**

Suggested Readings:

1. Sharma P. D. 2005, Ecology and Environment, New Delhi, Rastogi Publication.
2. Dash, 2009, Fundamentals of Ecology, 3rd edition, New Delhi, Tata McGraw-Hill Education.
3. Santra S. C. 2010, Fundamentals of Ecology and Environmental Biology, New Central Book Agency.
4. HallK. 2007, Strickberger's evolution, Jones & Bartlett Publishers.
5. Odum E. 2005, Fundamentals of Ecology, 5th edition, Cengage Learning India.
6. Smith & Smith, 2015, Elements of Ecology, 9th Edition, Pearson.

Semester – IV	**Paper – VIII**
Course Code: MSC-BT 418	**Title of the Course:** Project
Credits: 04	**Total Lectures:** 60 Hrs.

Course Outcome (CO)

a. Students will able to conduct their research work at their own.

b. Students will learn the reviewing of literature from different sources.

c. Students will able to write their thesis based on their research work.

Detailed Syllabus:

Project work, Thesis Submission and presentation:

1. Project work / Thesis / Dissertation shall be carried out under the supervision of a qualified teacher in the concerned Department./Research Institute/Industry
2. Project work / Thesis / Dissertation shall be pursued for a minimum of 12 weeks during the final semester, following the preliminary plan of work carried out in during the previous semester.
3. The Project Report/Thesis / Dissertation report is to be prepared as per standard scientific research methodology and duly signed by the supervisor(s) and the Head of the Department shall be submitted to the concerned department.
4. The assessment (Internal and external) of the project work will be as per college guidelines.