Rayat Shikshan Sanstha's

YASHAVANTRAO CHAVAN INSTITUTE OF SCIENCE, SATARA

(AUTONOMOUS)

Lead college

of

Karmaveer Bhaurao Patil University, Satara

Syllabus For

Master of Science

Part - II

BIOTECHNOLOGY

Syllabus to be implemented w.e.f. June 2024

as Per NEP-2020

Preamble:

As per the NEP 2020 guidelines this updated syllabus is prepared for first year undergraduate students of Biotechnology. At this level, to develop their interest towards Biotechnology as applied science and also to prepare them for academic and industrial exposure simultaneously. Introduction of life science subjects will help to form a basic foundation of concepts for students. The interdisciplinary approach with vigor and depth is compatible with the syllabi of other universities, and at the same time is not rigid for the students in the first year of their graduation. The units in the syllabus are well defined with scope and the number of lectures. The references are mentioned with relevance.

Credit Framework for M.Sc. II

Structure of Course: M.Sc. – II Semester – III

Level	Semester	Course Code	Course Title	No. of Lectures Per Week	Credits
6.5	III	**Discipline Specific Courses** (Mandatory)			
		MBTT 531	Bioprocesses & fermentation Technology	4	4
		MBTT 532	Bioinformatics	4	4
		MBTT 533	Genetic Engineering	4	4
		Discipline Specific Elective (Choose Any one among two)			
		MBTT 534 E-I **MBTT 534 E-II**	E-I) Nano biotechnology E-II) Artificial Intelligence in Biotechnology	2	2
		MBTP 535	Research project	12	6
		MBTP 536	Biotechnology practical Laboratory III (based on MBTT 531, 532, 533)	4	2
Total					**22**

Structure of Course: M.Sc. – II Semester –IV

Level	Semester	Course Code	Course Title	No. of Lectures Per Week	Credits
6.5	IV	**Discipline Specific Courses** (Mandatory)			
		MBTT 541	Environmental Biotechnology	4	4
		MBTT 542	Bioentrepreneurship & IPR	4	4
		MBTT 543	Biostatistics & Clinical research	4	4
		Discipline Specific Elective (Choose Any one among two)			
		MBTT 544 E-I **MBTT 544 E-II**	E-I) Genomics and Proteomics E-II) Agriculture Biotechnology	4	4
		MBTP 545	On job Training	8	4
		MBTP 546	Biotechnology practical Laboratory IV (based on MBTT 541, 542, 543)	4	2
Total					**22**

MBTT 531: Bioprocesses & fermentation Technology

Course Objectives: The students should be able to…

1. Learn concept of bioreactor
2. Study digital monitoring in fermentation
3. Understand concept upstream and downstream processing
4. Aware the lab fermentation to scale up procedures

Credits 04	**MBTT531 : Bioprocesses and fermentation technology**	**No. of hrs: 60**
Unit I	**Fermentation and its types**	**15**
	1.1 Introduction to fermentation, 1.2 Type of fermentation– Batch, Fed Batch and Continuous processes. 1.3 Basic Design of fermentor – 1.4 design aspect of Stirred tank reactor and 1.5 non- mechanically agitated bioreactors 1.6 (Air lift and Bubble column). 1.7 Design and operation of immobilized cell reactors. 1.8 Mass transfer, Aeration and agitation of fermentation broth.	
UnitII	**Fermentation media and monitoring of process variables**	**15**
	2.1 Media components C, N, P 2.2 optimization of mwdia, 2.3 Sterilization of media, 2.4 Kinetics of destruction of microorganisms, 2.5 indicator organism, Del factor, 2.6 designs of Batch and continuous sterilization, 2.7 Equipment used. Filter sterilization. Monitoring of process variables: 2.8 Types of sensors, Measurement and control of various parameters (pH, Temperature, dissolved oxygen, microbial biomass, inlet and exit gases, fluid flow, Pressure, Foam),	
Unit III	**Production and Downstream processing**	**15**
	3.1 Concept of primary (growth associated) and secondary metabolites (Non-growth associated) metabolites,	

	3.2 kinetics of growth and product formation. 3.3 Yield and efficiency. 3.4 Downstream processing and unit operations 3.5 General strategy of downstream processing 3.6 Production, recovery (with principles of techniques involved) 3.7 fermentation economics.	
Unit IV	**Fermentative products**	**15**
	4.1 Antibiotics-penicillin,. 4.2 Biotransformation product (steroid) 4.3 wine 4.4 beer 4.5 Xanthan gum 4.6 Lactic acid 4.8 Citric acid by SSF 4.9 Vitamins (Vitamin C) 4.10 Amino acids, 4.11 Enzymes (hydrolase)	

Course Outcome: After completion of syllabus students will be able to…

1. Differentiate various types of design of fermenters/ bioreactors
2. Gain knowledge of Fermentation media , sterilization strain improvement
3. implement knowledge in industrial production, Upstream and DownStream processes
4. utilize the knowledge to learn various production processes.

References:

1. *L. E. Casida* Industrial Microbiology, Wiley Easterbs, New Delhi, 1984
2. *A. H. Patel.* , Industrial Microbiology, Macmillan India Ltd. 1985.
3. *P. Doran,* Bioprocess Engineering, Principles - Academic Press. 1995
4. Bioreactor Design & Product Yield, BIOTOL series - Butter worth Heinemann. 1992
5. *W. Crueger and A*. A *Crueger,* TextBook Of Industrial Biotechnology, Panima , New Delhi. 2005
6. *R. Harrison, P. Todd* Bioseparations science and Engineering, Oxford University Press 2006
7. *S. Lydersen,* Bioprocess Engineering : Systems, Equipment & Facilities Ed. B. N.A. Delia & K.M. Nelson, John Wiley & Sons Inc. 1993

8. *S. C. Prescott. and C. G. Dunn,* Industrial Microbiology, Reed G. AVI tech books. 1983
9. *U. Satyanarayan* Biotechnology, Arunabha Sen Books allied Publishers. 2000
10. *P. F. Stanbury and A. Whittaker* Principles of Fermentation technology, Pergamon press. 1984.

MBTT 532: Bioinformatics

Course Objectives: The students should be able to…

1. learn various bioinformatics tools and techniques.
2. understand Concepts of various databases and various methods.
3. study bioinformatics tools for the analysis of the biological experimental data.
4. implement sequencing techniques and gene annotation.

credit 4	**MBTT 532: Bioinformatics**	**No. of hrs : 60**
Unit I	**Basics of bioinformatics**	**15**
	1.1 Bioinformatics: Introduction and definition, Scope and Applications. 1.2 Introduction to Biological Databases: Types of Databases, Biological Databases, Information Retrieval from Biological Databases. 1.3 Protein sequence databases: 1.3.1 Primary protein sequence databases: SWISS-PROT, PIR, TrEMBL. 1.3.2 Secondary protein sequence databases: PROSITE, PROFILE, PRINT. 1.3.3 Literature database: PubMed, PubMed Central. 1.3.4 Structural databases: PDB, MMDB, CATH, SCOP, PdbSum	
Unit II	**Structural bioinformatics**	**15**
	2.1 Protein Structure Basics: Amino acids, Peptide bond formation, Secondary Structures, Tertiary Structures 2.2 Determination of Protein Three-Dimensional Structure. 2.3 Protein Structure Visualization, Comparison and Classification, CATH & SCOP 2.4 Protein Secondary Structure Prediction 2.5 Protein Tertiary Structure Prediction: Homology Modeling	
Unit III	**Gene and promoter prediction**	**15**

	3.1 Gene Prediction: Gene Prediction in Prokaryotes, Gene Prediction in Eukaryotes 3.2 Promoter and Regulatory Element Prediction 3.3 Promoter and Regulatory Elements in Prokaryotes 3.4 Promoter and Regulatory Elements in Eukaryotes	
Unit IV	**Sequence alignment and molecular phylogenetics**	**15**
	4.1 Sequence alignment: Significance of Sequence alignment, Global Alignment and local sequence alignment. 4.2 Pairwise Sequence Alignment: Dot matrix, the dynamic programming (or DP) algorithm, Word or k-tuple methods, Database Similarity Searching: FASTA and BLAST. 4.3 Multiple Sequence Alignment. 4.4 Primer designing software, Software study: Mega4, Clustar Omega, AutoDock, ResMol. 4.5 Phylogenetic analysis, Relationship of phylogenetic analysis to sequence alignment, Genome complexity and phylogenetic analysis, Concept of evolutionary trees.	

Course Outcome: After completion of syllabus students will be able to…

1. apply various bioinformatics tools and techniques for the analysis of the biological experimental data.
2. implement *in-Silico* approach for the protein modeling and drug discovery process.
3. understand the concepts of DNA mutation, Gene expression, protein synthesis.
4. perform various sequencing techniques and gene annotation.

References:

1. *D. W. Mount*, Bioinformatics-Sequence and Genome Analysis Cold Spring Harbor Laboratory Press; 2nd edition, 2004
2. *Thomas Langauer (editor)* Bioinformatics - From Genomes to Drugs Wiley-VCH; 1st edition, 2001
3. *D. W. Mount*, Bioinformatics-Sequence and Genome Analysis Cold Spring Harbor Laboratory Press; 2nd edition, 2004
4. *D.R. M. Graham.* Broad-based Proteomics strategies: a practical guide to proteomics and functional screening et al J.Physiol 2005,
5. *W. Miller* Comparative Genomics et al Annu.Rev. Genomics Hum.Genet 2004
6. *A. Malcoln Campbell, laurie J.* Discovering genomics, Proteomics and Bioinformatics 2006
7. *Y. V. Peter* Trends in Bioinformatics Research, Published by Nova Science Publishers, Incorporated, Mishawaka, IN, U.S.A., 2006.

8. *P Baldi, G W Hatfield* DNA microarrays and gene expression Cambridge University Press, 2002.
9. *J. Xiong.* Essential Bioinformatics Cambridge University Press; 1st edition, 2006.
10. *A. M. Campbell , L. J. Heyer* Discovering genomics, proteomics, and bioinformatics, 2nd edition, CSHL Press : Pearson/Benjamin Cummings, San Francisco, 2007.

MBTT 533: Genetic Engineering

Course Objectives: The students should be able to…

1. Learn basic tools of genetic engineering
2. Study various vectors in genetic engineering
3. Know methodologies of gene cloning
4. Understand the applications of genetic engineering.

Credits 04	**MBTT 533: Genetic Engineering**	**No. of hrs 60**
Unit I	**DNA & Basics of Recombinant DNA Technology**	**15**
	1.1Introduction to DNA structures, Enzymes used in rDNA technology Modification systems, type II restriction endonucleases and properties, isoschizomers and neoschizomers, mcr/mrr genotypes, 1.2 Cohesive and blunt end ligation, linkers, adaptors, homopolymeric tailing. 1.3 Labeling of DNA: Nick translation, random priming, radioactive and non-radioactive probes, use of Klenow enzyme, T4 DNA polymerase, bacterial alkaline phosphatase, polynucleotide kinase, ligase, nuclease. Reverse transcriptase. 1.4 Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence in situ hybridization, 1.5 Restriction maps and mapping techniques, 1.5 DNA fingerprinting, 1.6 chromosome walking & chromosome jumping	
Unit II	**Cloning Vectors**	**15**
	2.1 Gene Cloning Vectors: Plasmids, bacteriophages, Cloning in M13 mp vectors, phagemids, Lambda vectors; insertion and replacement vectors, Cosmid vectors. 2.2 Artificial chromosome vectors (YACs, BACs), Animal Virus derived vectors- SV-40, vaccinia/bacculo & retroviral vectors. **2.3 Expression vectors:** pMal, GST, pET-based vectors. Viral vectors	
Unit III	**Cloning Methodologies**	**15**
	3.1 Insertion of Foreign DNA into Host Cells: Transformation, Transfection: Chemical and physical methods, liposomes, microinjection, macroinjection, electroporation, biolistics, somatic cell	

	fusion. 3.2 Cloning and expression in yeasts (Saccharomyces), animal and plants cells, methods of selection and screening, cDNA and genomic cloning, expression cloning, jumping and hopping libraries. 3.3 Construction of cDNA and genomic DNA libraries. Screening of libraries.	
Unit IV	**PCR and Its Applications**	**15**
	4.1 Primer design, Fidelity of thermostable enzymes, DNA polymerases, multiplex, nested, reverse transcriptase, 4.2 Real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products, PCR in molecular diagnostics 4.3 PCR based mutagenesis. Applications: Sequencing methods: Enzymatic DNA sequencing, Chemical sequencing of DNA, principle of automated DNA sequencing 4.4 Gene silencing techniques: Introduction to siRNA, micro RNA, construction of siRNA vectors, principle and application of gene silencing, Crisper technology.	

Course Outcome: After completion of syllabus students will be able to…

1. Describe basic tools of genetic engineering
2. Discuss various vectors in genetic engineering
3. Implement methodologies of gene cloning
4. Utilize the applications of genetic engineering

References:

1. *D.M. Glover and D.B. Hames* DNA Cloning : A practical approach, RL Press, Oxford, 1995
2. *D. A. Mickloss and G. A Freyer,* DNA Science: A First Course in Recombinant Technology, Cold Spring Harbor Laboratory Press, New York, 1990.l
3. *S. M. Kingsman* Genetic Engineering: An Introduction to Gene Analysis and Exploitation in Eukaryotes, Blackwell Scientific Publications, Oxford, 1998.
4. *V. Goedel,* Methods in Enzymology Gene Expression Technology, Vol. 185D. Academic Press Inc, San Diego, 1990.
5. *S. L. Berger and A. R. Kimmel*, Methods in Enzymology Guide to Molecular Cloning Techniques, Vol. 152 Academic Press Inc, San Diego, 1996.
6. *J. A. Davis and W. S. Reznikof* Milestones in Biotechnology, Classic Papers on Genetic Engineering, Butterworth-Heinemann Ltd, 1993.
7. *J. Sambrook E. F. Fritsch and Maniatis*, Molecular cloning, vol. I, II, III, II nd edition, Cold spring harbor laboratory press, New York. 1989.
8. *Kim Donghern, Peter B. Kaufman, Leland J. Cseke, William Wu*, Molecular and cellular methods in Biology and Medicine, CRC Press; 1st edition, 1995.

9. *R.W. Old and S. B. Primrose,* Principles of Gene Manipulation, Blackwell Science Ltd, 1980.
10. *M. R. Walker, and R. Rapley*, Route Maps in Gene Technology, Blakwell Science, 1997.

MBTT 534 E I: Nano-biotechnology

Learning Objectives: The students should be able to…

1. Study the basic knowledge of nanoscience and technology.
2. Understand biological nanostructure and various methods of nanomaterials synthesis

Credits 02	**MBTT 534 E I : Nano-biotechnology**	**No. of hrs 30**
Unit I	**Nanoparticle Biosynthesis**	**15**
	1.1 Introduction to Nanoscale, Nanomaterials, Nanoscience And Nanotechnology. 1.2 Its significance, Biosynthesis of nanoparticles from plants, fungi & microorganisms and their application. 1.3 Biological Sensors and Detectors and their applications. 1.4 Future aspects and importance of Nanotechnology in environmental conservation.	
Unit II	**Nanomedicine**	**15**
	2.1 Applications of nano in biology. 2.2 Concept of disease, Cause and molecular/cellular progression of key diseases including infectious, inherited diseases, immunological diseases and cancer. 2.3 Approach to developing nanomedicines. 2.4 Various kinds of nanosystems in use.	

Learning Outcomes: After completion of syllabus The students will be able to…

1. Apply knowledge regarding nanomedicines for various diseases
2. Describe and Identify nanoscopic structure present in natural materials.

References:

1. *RS Greco, FB. Prinz, RL Smith (Editors),* Nanoscale Technology In Biological Systems. CRCPress, 2004.
2. *NH. Malsch,* Biomedical Nanotechnology. Taylor and Francis. CRC press, 2005.
3. *RA Freitas Jr*., Nanomedicine, Vol. I:Basic Capabilities, 1st edition, 2003
4. *P Boisseau, M Lahmani.* Nanoscience: Nanobiotechnology and Nanobiology, Springer Publishers. 2009.

5. *G. Hornyak, H. Tibbals, J. data, J. Moore.* Introduction to Nanoscience and Nanotechnology, CRC Press, 2008.
6. *S.K. Kulkarni* Nanotechnology: Principles and Practices , Capital publish, 3 rd, edition, 2014
7. *V. Pokropivny, R. Lohmus, I. Hussainova, A. Pokropivny and S. Vlassov,* Introduction to Nanomaterials and Nanotechnology by Tartu University Press, 2007.
8. *B. S. Murty, P. Shankar, B Raj, B. B. Rath, James Murday*, Textbook of Nanoscience and Nanotechnology, Springer Berlin, Heidelberg, 2013.
9. *E Gazit.* Plenty of Room for Biology at the Bottom: An Introduction to Bionanotechnology, Imperial college Press, 2007.
10. *S. Challa, S. R. Kumar, J. H. Carola* Nanofabrication towards biomedical application: Techniques, tools, application and impact, John Wiley and sons. 2006.

MBTT 534 E II : Artificial Intelligence in Biotechnology

Learning Objectives: The students should be able to…

1. Understand the principles involved in the Artificial Intelligence
2. Know the applications of AI in Biotechnology.

Credit 2	**MBTT 534 E II : Artificial Intelligence in Biotechnology**	**No. of hrs 30**
Unit I	**Introduction to Artificial Intelligence**	**15**
	1.1 Definition and scope of AI 1.2 Historical overview and key milestones Differentiating AI from human intelligence 1.3 Future of Artificial Intelligence 1.4 Characteristic of Intelligent Agents – Typical Intelligent Agents 1.5 Problem Solving Approach to Typical AI problems. Machine learning basics, 1.6 Deep Learning AI applications: Natural Language Processing - Language Models – Machine Translation; Speech Recognition; Computer Vision - Image classification.	
Unit II	**Applications of AI in Biotechnology**	**15**
	2.1 Artificial Intelligence (AI) Technologies and Advanced Robotics in the Food Industry. 2.2 Technology available for AI relevant to Agro-Industry and Food Supply - AI in decision making for agricultural professionals and farmers. 2.3 Impact and Benefits of AI for a sustainable future Agri-Business and Food Industry 2.4 AI technologies in Systems Biology towards Pharmacogenomics AI in diagnosis of Genetic Diseases, Cancer Diabetes 2.5 Diagnosis of Syndrom, diagnosis of Psychiatric Disorders, AI in Systems Biology for medicine and Cancer Cure.Role of artificial intelligence in Human life, ethical considerations of AI, current initiatives in AI and ethics.	

Learning Outcomes: After completion of syllabus The students will be able to…

1) Explain history and scope of AI.
2) Analyze role of AI applications in Biotechnology.

References:

1. *P. Kaliraj, T. & Devi,* (Eds.) Artificial Intelligence Theory, Models, and Applications (1st ed.). CRC Press, Taylor & Francis Group, Boca Raton, ebook 2021.
2. *S Russell and P Norvig* "Artificial Intelligence: A Modern Approach", Prentice Hall, 3rd Edition. 2010.
3. P. Z. Wang, Fuzzy sets and its applications. Shanghai Science and Technology Press, Shanghai, 55-58. 1983.
4. S. L.Chen, J. G. Li, & X. G. Wang Fuzzy set theory and its application. Beijing, Science publish company. 2005.
5. *A A. Rank, A. Asuncion* UCI machine learning repository 2010,
6. *S. Russell and P. Norvig,* "Artificial Intelligence: A Modern Approach, Prentice Hall,. 2008.
7. *M. Tim Jones,* "Artificial Intelligence: A Systems Approach (Computer Science)", Jones and Bartlett Publishers, Inc.; 1st Edition, 2008.
8. *N. J. Nilsson,* "The Quest for Artificial Intelligence", Cambridge University Press, 2009.
9. *M. T. Jones,* "Artificial Intelligence: A Systems Approach (Computer Science)", Jones and Bartlett Publishers, Inc.; 1st Edition, 2008.

MBTP 536: Biotechnology Practicals (Lab III)

(Based on MBTT 531, 532, 533)

Course Objectives: The students should be able to…

1) Understand screening, maintaining and Inoculum buildup of the isolated organism
2) Know the skill for handling of genetic material
3) Impart skill of measuring the microscopic objects
4) Implement the practical skills of protein extraction, purification and characterization

Credits 02	**Biotechnology Practicals (Lab III) (Based on MBTT 531, 532, 533)**	**No. of Practicals 20**
1	Screening and identification (Genus Level) of a production strain (enzyme/antibiotic) from soil samples	4
2	Maintenance of the isolated production organism (Agar slants/ glycerol stocks /soil culture/ lyophilization) at least two methods.	4
3	Inoculum buildup of the isolated organism for use in bench top fermentation	4
4	Study of different parts and assembly of the bench top fermenter.	4
5	Study of Working of lab bench fermenter (with production of enzyme or antibiotic using screened organism),	4
6	Solid state fermentation: Lab scale production of a product.	4
7	Demonstration of working of industrial fermenters by visiting fermentation industry	4
8	Retrieval of amino acid sequence and nucleotide sequence from NCBI database and perform BLAST.	4
9	Visualize and analyze the 3-D protein structure using RasMol	4
10	Perform homology modeling	4
11	Perform multiple sequence alignment	4
12	Perform primer designing	4

13	Perform phylogenetic studies	4
14	Perform Isolation of plasmid DNA	4
15	Perform In vitro DNA ligation	4
16	Perform Transformation of E.coli	4
17	Perform Restriction mapping	4
18	Perform Bacterial conjugation	4
19	Perform Southern blotting and hybridization	4
20	Perform Dot Blotting	4

Learning Outcomes: After completion of syllabus The students will be able to

1. Apply skill & techniques in isolation, identification & screening of microbial strains from different soil samples
2. Perform multiple and local sequence alignment for their experiment.
3. do practically ligation, transformation of DNA, Blotting techniques
4. skillfully handle genetic material for their applications

References:

1. *P. F. Stanbury, and Whittaker, A.* Principles of Fermentation technology, Pergamon press. 1984.
2. *Sadashivam and Manikam,* practical book of biochemistry springer. 2000.
3. *A. H. Patel.* Industrial Microbiology, Macmillan India Ltd. C. 1985.
4. *David W Mount,* Bioinformatics-Sequence and Genome Analysis Cold Spring Harbor Laboratory Press; 2nd edition, 2004.
5. J. Xiong, Essential Bioinformatics, Cambridge University Press; 1st edition, 2006.
6. *A. Malcoln Campbell, laurie J.* Discovering genomics, Proteomics and Bioinformatics 2006.
7. *S. L. Berger and A. R. Kimmel,* Methods in Enzymology Guide to Molecular Cloning Techniques, Vol. 152 Academic Press Inc, San Diego, 1996.
8. *J Sambrook, E. F. Fritsch and Maniatis*. Molecular cloning, vol. I, II, III, II nd edition, Cold spring harbor laboratory press, New York. 1989.
9. *R.W. Old and S. B. Primrose,* Principles of Gene Manipulation, Blackwell Science Ltd. 1980.
10. *DW Mount*, Bioinformatics-Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press; 2nd edition, 2004

Project

MBTP 535: Research Project (6 credit)

Students will undertake research in specific areas of his Major/Core with an advisory supported by a teacher/Faculty member. Students are required to take 6 credit Research Projects for semester III under the guidance of faculty members.

SEMESTER IV

MBTT 541: Environmental Biotechnology

Learning Objectives: The students should be able to …

1. Gain knowledge of Global and regional threats to the environment.
2. know the Role of Biotechnology in Air Pollution & management
3. Aware the role of Biotechnology in water Pollution & management
4. Understand the environmental laws.

Credits 4	**MBTT 541: Environmental Biotechnology**	**No. of hrs 60**
Unit I	**Global warming & greenhouse gasses**	**15**
	1.1 Global and regional threats to the environment:, 1.2 Greenhouse effect & Global warming, 1.3 Sources of greenhouse gases, 1.4 Effect Measurement & control of greenhouse effect, 1.5 problem of ozone, ozone hole, effect of ozone depletion, measurement & control, 1.6 Development of acid rain, effects, measurement & control. 1.7 Environmental sustainability & Biotechnology.	
Unit II	**Environmental pollution**	**15**
	2.1 Environmental pollution, general, source and nature, 2.2 Air pollution, water and soil Pollution, 2.3 Types, sources and impacts, 2.4 Solid waste: Sources and types, 2.5 Impact on land of solid waste disposal, Recycle Reuse and Recovery. 2.6 Biotechnology and environmental pollution control (waste water and air), 2.7 Biotechnology in control of Industrial pollution and safe disposal of industrial effluents (with 2-3 examples of Industrial effluent types and treatment), 2.8 Activated sludge process, 2.9 Hospital waste management.	

Unit III	**Biotechnological methods for management of pollution**	**15**
	3.1 Management of pollution, 3.2 Atmospheric CO2 reduction, 3.3 management of metal pollution, 3.4 immobilized cells in management of pollution, 3.5 Biodegradation: Biodegradation of xenobiotic compounds: 3.6 Microbial basis of biodegradation Biopesticides, 3.7 Bioremediation: Meaning, Types, Process with examples, 3.8 bioremediation of wastewater (MSW, BSW, ISW) , 3.9 Phytoremediation Metal remediation 3.10 Biofiltration Bioaugmentation, Biostimulation. 3.11 Agricultural bioremediation: 3.12 Microbial composting, biogas	
Unit IV	**Environmental management**	**15**
	4.1 Problems and need of Environmental management Plan: scope, 4.2 EMP preparation, 4.3 Need of EMP Environmental Impact Assessment: 4.4 Objectives of EIA, EIA and International organizations, Stages of EIA process. 4.5 EIA in India: Process Stages of Environmental clearance process, 4.6 ISO 14000 Environmental audits and ethics 4.7 Environmental Laws and Policies.	

Learning Outcomes: After completion of syllabus The students will be able to

1. Apply knowledge of global and regional threats to the environment; Air, water and soil pollution.
2. gain knowledge of role of Biotechnology in effluent treatment,
3. Implement knowledge in biodegradation, bioremediation, bioaugmentation with examples.
4. Understand the concepts of EIA and environmental laws.

References:

1) *Indu Shekhar Thakur* Environmental Biotechnology: Basic Concepts and Applications, I. K. International Pvt Ltd, 2006.

2) *Gareth M. Evans and Judith C.* Furlong. Environmental Biotechnology Theory and Application, John Wiley & Sons Inc. 2003.
3) *Alan H. Scragg.* Environmental Biotechnology, Oxford University Press. 1st edition 2006.
4) *S.K. Agarwal.* Environmental Biotechnology, APH Publishing Co-operation, New Delhi, 2007.
5) *A.G. Murugesan and C. Rajakumari* Environmental Science and Biotechnology Theory and techniques. MJP Publishers, Chennai, 2006.
6) *Holmes, G; Singh, B R; Theodore, L.* Handbook of Environmental management and technology, USA: Wiley Intersciences Publishers, 2000.
7) *Suchandra Choudhury.* An Introduction To Geographic Information Technology. IK International Pvt Ltd., New Delhi, 2009.
8) *M.V. Levin and Gealt, M.A.* Biotreatment of Industrial & Hazardous Waste. McGraw Hill. Inc, New York, 1993
9) *C.P.L. Albert and K.W. Yeung.* Concepts and Techniques of Geographic Information Systems. Prentice Hall, Inc., New Jersey. 2nd edition, 2009.
10) *Asthana & Asthana.* Environment Problems & Solutions. S. Chand Limited, New Delhi, 2001.

MBTT 542: Bioentrepreneurship & IPR

Learning Objectives: The students should be able to…

1. Understand the dynamic role of entrepreneurship and small businesses.
2. Learn to organize and Manage a Small Business.
3. Learn IPR and patent laws.
4. Understand IPR regulations with special reference GMO

Credits 04	**MBTT 542: Bioentrepreneurship & IPR**	**No. of hrs 60**
Unit I	**Introduction to Entrepreneurship**	**15**
	1.1 An Overview of Entrepreneurs and Entrepreneurship: definition, 1.2 Basic principles and practices of management- Definition, concepts and application; 1.3 Organization types, coordination, control and decision making in management 1.4 Characteristics for being an entrepreneur in biotechnology, 1.5 Case studies of successful and unsuccessful bio-entrepreneurs 1.6 Core concept of Market: Identification and evaluation of market potential of various bio-entrepreneur sectors. 1.7 Marketing, Marketing research- concept and techniques	
Unit II	**Enterprises Classification and various promotion schemes**	**15**
	2.1 Types of Enterprises and Ownership Structure: 2.2 small scale, medium scale and large scale enterprises, 2.3 role of small enterprises in economic development; 2.4 proprietorship, partnership, Ltd. companies and co-operatives: their formation, 2.5 capital structure and source of finance. 2.6 Projects: identification and selection of projects; project report: contents and formulation, 2.7 concept of project evaluation, methods of project evaluation: internal rate of return method and net present value method. 2.8 Role of government and schemes, financial institutions in fostering bioentrepreneurship 2.9 Factors affecting biotech business: (finance, infrastructure, equipment, manpower, resources, project location, end product,	

	quality issues, etc)	
Unit III	**Intellectual Property Rights**	**15**
	3.1 Characteristics and Types of Intellectual Properties 3.2 Tools of IPR- Introduction and types, Treaties, Conventions, Laws, Acts, agreements pertaining to Biotechnology, 3.3 Tools of IPRs- 1. Patents- prerequisites for patenting, 3.4 Biological Patents –a. Plant b. Animal c. Microbial patents 3.5. Process patents and Product patents with one case study each. 3.6 Indian and International scenario, 3.7 Protection of Plant varieties and Plant breeders rights, 3.8 Industrial Designs-Designs of gadgets used in Biotechnology	
Unit IV	**Biosafety, rules and regulations regarding GMO**	**15**
	4.1 Biosafety and Societal Concern, Public debate and concern on genetically modified microorganisms, plants and animals, 4.2 scientific analyses of the concern, Biosafety regulation 4.3 guidelines on developing and using the genetically modified organisms. 4.4 Patenting of Biological Materials: International conventions. International cooperation, obligations with patent applications, 4.5 Can live form be patented- with special reference to Factor VIII, Erythropoietin, tissue plasminogen, hybridoma technology etc. 4.6 Patenting of higher plants, animals, genes, DNA sequences, transgenic organisms.	

Learning Outcomes: After completion of syllabus The students will be able to

1. Develop the business plan.
2. Apply knowledge of fundamentals of Management and Administration.
3. Identify Legal forms of the business for registration of the small scale industries, agencies for the registration of the companies.
4. gain knowledge of IPR and patent rules and copyright act.

References:

1. Entrepreneurship And Business of Biotechnology, Prof S N Jogdand, Himalaya Publisher. 2009.
2. *S. Anil Kumar,* Entrepreneurship Development, New Age International (P) Ltd. Publishers. 2003.

3. *Robert Mellor,* Entrepreneurship for Everyone: A Student Textbook, Sage Publication Ltd. 2009.
4. *Richard Blundel & Nigel Lockett ,* Exploring Entrepreneurship: Practices and Perspective, Oxford University Press. 2011.
5. Entrepreneurial Development: Text and Cases, Entrepreneurship Sultan Chand & Sons. 1992.
6. *Shreefal S. Mehta,* Commercializing Successful Biomedical Technologies, Cambridge University Press. 2008.
7. Handbook Of Bioentrepreneurship, Patzelt, Holger; Brenner, Thomas, Springer. 2008.
8. *Dr. B.L.Wadehra,* Law Relating To Intellectual Property, Fifth Edition, Universal Law Publishing Co.Pvt. Ltd. 2011
9. *H K Das* Textbook of Biotechnology,4th edition, Wiley India Pvt. Ltd, New Delhi. 2010.
10. *P. Ganguli,* Intellectual Property Rights, Tata McGraw-Hill Publishing Company Ltd.7. World Intellectual Property Rights (WIPO). 2001.

Semester IV

MBTT 543 : Biostatistics & Clinical research

Learning Objectives: The students should be able to…

1. Know the mathematical applications in the biology
2. Understand basic techniques, correlation and regression in statistics
3. study the principles involved in the ethical, legal, and regulatory issues
4. Familiar with the basic methods involved in conducting clinical research.

Credits 4	**MBTT 543 : Biostatistics & Clinical research**	**No. of hrs 60**
Unit I	**Introduction to Statistics and Correlation and regression**	**15**
	1.1 Introduction to Statistics: Measures of central tendency–mean, mode, median and their properties 1.2 Measures of dispersion–variance, standard deviation, coefficient of variance symmetry and skewness, measures of skewness 1.3 Correlation and regression: 1.4 Bivariate correlation, positive correlation, negative correlation, 1.5 Measures of correlation, Regression analysis	
Unit II	**Experimental statistics**	**15**
	2.1 Design of experiments, Principles of design – 2.2 randomization, replication, local control, treatment group and control group. 2.3 Level of significance, p-value, normal distribution, 2.4 T-test: t-test for mean, equality of two means, paired t-test, unpaired t test, chi-square test: chi square test for goodness of fit, 2.5 Analysis of variance table (ANOVA)	
Unit III	**Introduction to Clinical Research**	**15**
	3.1 Brief History of Clinical Research: Sulfanilamide Tragedy, 3 Thalidomide Disaster, Nazi Experiments, Tuskegee Study, Belmont report, Nuremberg code, Declaration of Helsinki. 3.2 Clinical Research: An Overview, guidelines in Clinical Research. 3.3 Different types of Clinical Research. 3.4 Clinical Pharmacology: Pharmacokinetics, Pharmacodynamics, Bioavailability, Bioequivalence, Terminologies and definition in	

	Clinical Research. 3.5 Drug Development Process: Preclinical trial, Human pharmacology (Phase-I), Therapeutic exploratory trial (Phase-II), Therapeutic confirmatory Trial (Phase-III) and Post marketing surveillance (Phase-IV). Pharmacovigilance. 3.6 Guidelines in Clinical Research: International conference on harmonization (ICH), 3.7 Guidelines for good clinical practices, 3.8 ICMR guidelines for biomedical research on human subjects.	
Unit IV	**Regulation and Ethics in Clinical Research**	**15**
	4.1 Regulation in Clinical Research: Drug and cosmetic act, FDA, 4.2 Schedule Y, Ethics committee and their responsibilities. 4.3 Ethics committee submission, adverse event and safety reporting. 4.4 Role of sponsors. Study preparation, Study feasibility, Vendors/Service provider selection, Investigator selection, 4.5 Budgeting in Clinical trial, Agreement (CTA), 4.6 Regulatory submission and approval, 4.7 Sponsors obligation in Good Clinical Practice. 4.8 Clinical Research Operation: Monitoring and Clinical Evaluation: Protocol in Clinical Research, Informed Consent, Case Report Form, Investigator's Brochure (IB), 4.9 Inclusion and exclusion criteria, Randomization, Blinding, Ethics and Regulatory submission. 4.10 Clinical Research Regulatory Submission & approval Process: IND, NDA and ANDA submission Procedure. 4.11 DCGI submission procedure. Other Regulatory authorities-EMEA, MHRA, PhRMA.	

Learning Outcomes: After completion of syllabus The students will be able to

1) Apply principles involved in the ethical, legal, and regulatory issues in clinical human subject's research, including the role of IRB.
2) Analyze the infrastructure required in performing clinical research
3) Determine steps involved in developing and funding research studies.
4) Explain data management system

References:

1. *Pieter Kubben, Michel Dumontier, Andre Dekker,* Fundamentals of Clinical Data Science, Springer International Publishing, 2018.

2. *Mark. Elsley,* A Guide to GCP for Clinical Data Management , Canary Publications, 2017.
3. *Lawrence M. Friedman, Curt D. Furberg David L. DeMets,* Fundamentals of Clinical Trials, Springer; Kindle Edition 5th edition, 2015.
4. *Dr. Stephen B Hulley MD MPH, Steven R Cummings MD.* Designing Clinical Research Paperback, 2013.
5. *Frederick P Ognibene, John I. Gallin* Principles and Practice of Clinical Research 2nd Edition Elsevier Science, 2011.
6. *Richard K. Rondel, Sheila A. Varley, Colin F. Webb,* Clinical Data Management 2nd Edition, Wiley, 2000.
7. *Rosner, B.* Fundamentals of Biostatistics. Boston, MA:DuxburyPress, 2000.
8. *W. W. Daniel* Biostatistics: a Foundation for Analysis in the Health Sciences. New York:Wiley. 1987.
9. *P. S. Sunderrao and J. Richards*. An introduction to Biostatistics, Prentice Hall Pvt. Ltd. India, 2000.
10. *R. C. Campbell,* Statistics for Biologists, Cambridge University Press, Cambridge. 1989.

MBTT 544 E I: Genomics and Proteomics

Learning Objectives: The students should be able to…

1. Aware of omics era.
2. Understand different advanced tools and techniques used in omics research.
3. Understand concept and application s of gene expression studies
4. Learn various techniques of proteomics and genomics

Credits 4	**MBTT 544 E I : Genomics and Proteomics**	**No. of hrs 60**
Unit I	**Genomics**	**15**
	1.1 Genomics and Proteomics overview, omes and omics, Concepts and applications 1.2 Genome overview at the level of Chromosome; Strategies for large scale DNA sequencing- Whole genome analysis techniques, Next generation sequencing methods 1.3 Comparative genomics - Goals, bioinformatics of genome annotation, methods and limitations 1.4 Structural & Functional genomics – Goals, methods, applications	
Unit II	**Transciptomics and Microarray and Applications**	**15**
	2.1 Introduction to transcriptomics and expression profiling 2.2 DNA and RNA Microarray – Preparation, working and analysis. 2.3 Investigative techniques –EST, SAGE, SNP 2.4 Applications in basic research and medical genetics, Metagenomics, 2.5 Toxicogenomics, Pharmacogenomics, Gene disease association.	
Unit III	**Proteomics and its applications**	**15**
	3.1 Proteomics – Introduction, Concept, application, 3.2 Advantages and limitations of Expressional Proteomics, Functional Proteomics, Structural Proteomics - with at least one explanatory example for each. 3.3 Applications in Peptidomics/Drug discovery, 3.4 Applications in Toxicoproteomics, Biomarkers in disease diagnosis, 3.5 Applications in Identification and characterization of novel	

	proteins	
Unit IV	**Techniques in Proteomics**	**15**
	4.1 Protein separation techniques, Strategies in protein identification, 4.2 2D Gel electrophoresis, Isoelectric Focusing (IEF) 4.3 Mass spectrometry in proteomics – Principle, techniques, components and variations (HPLC, ESI, MALDITOF, FT-MS, MS/MS, Quadrupole) and analysis, applications 4.4 Protein- Protein interactions- experimental and computational-two hybrid, Phage display 4.5 Protein Microarray - Preparation, working and analysis.	

Learning Outcomes: After completion of syllabus The students will be able to

1. Apply their gained knowledge in recent advancement in genomics and proteomics
2. Implement tools and techniques used in genomics and proteomics research.
3. understand the concept and applications of gene expression studies
4. aware various techniques of proteomics in their research

References:

1. Thomas Langauer (editor) (2001) Bioinformatics - From Genomes to Drugs Wiley- VCH; 1st edition
2. D W Mount (2004) Bioinformatics-Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press; 2nd edition
3. A. Malcoln Campbell, laurie J. Heyer, Benjamin Cummings; (2006) Discovering genomics, Proteomics and Bioinformatics, 2nd edition
4. J Xiong (2006) Essential Bioinformatics. Cambridge University Press; 1st edition
5. P Baldi and G W Hatfield (2002) DNA microarrays and gene expression Cambridge University Press
6. M J Brownstein, A B Khodursky (2003) Functional Genomics : Methods and Protocols Humana Press
7. Griffiths A., Wessler S., Lewantin R., Carroll S (2008) Introduction to genetic analysis, 9th edition
8. Pennington SR, Dunn MJ., Stephen R BIOS (2001) Proteomics from protein sequence to function
9. V Gomase (2003) Transcriptomics VDM Publishing
10. R Twyman (2004) Principles of proteomics. Taylor & Francis

MBTT 544 E II: Agriculture Biotechnology

Learning Objectives: after completion of syllabus The students should be able to…

1.Understand the basic and advanced knowledge of agriculture biotechnology.

2. apply the crop improvement techniques Basic and advanced.

3. Imbibe the knowledge about Bioreactors and Genetic markers.

4. Aware the information about Biopesticides, post harvesting protection and quality improvement

Credits 4	**MBTT 544 E II : Agriculture Biotechnology**	**No. of hrs 60**
Unit I	**Crop improvement**	
	1.1 Advantages of biotechnological methods over conventional methods of crop improvement. 1.2 Homozygous plant production through anther & pollen culture 1.3 Embryo rescue & embryo culture in rearing viable hybrid embryos 1.4 Endosperm culture & production of triploids 1.5 Apomixis 1.6 Induced Polyembryony 1.7 Somaclonal and gameto clonal variations and their applications in crop improvement 1.8 genome annotation gene pyramid Mass breeding 1.9 Allele mining	15
Unit II	**Bioreactors and Markers**	
	2.1 Use of bioreactors in plant production 2.2 Scale-up Marker assisted selection – 2.3 introduction to markers (RFLP, AFLP, microsatellites, RAPD, QTL), 2.4 generation of maps using markers, 2.5 case studies of MAS, 2.6 virus indexing	15
Unit III	**Transgenics in crop improvement**	
	3.1 Stress tolerance, 3.2 risk assessment with respect to high and low impact crops.	15

	3.3 Plants as biofactories for molecular farming: 3.4 edible vaccines, 3.5 plantibodies, 3.6 nutraceuticals	
Unit IV	**Biopesticides, post harvest protection and quality improvement**	
	4.1 Baculovirus 4.2 pesticides, 4.3 Myco pesticides. 4.4 Post harvest protection- Antisense RNA technology for extending shelf life of fruits and flowers. 4.5 Genetic Engineering for quality improvement – Seed storage proteins, 4.6 Flavours- Capsaicin,Vanillin etc.	15

Learning Outcomes: After completion of syllabus The students will be able to

1. Improve the crop quality and yield.
2. Explain the scientific knowledge of Bioreactors and markers.
3. Describe the transgenic technique for crop improvement.
4. Analyze the Biopesticides, post harvest protection and quality improvement & set up an agro business.

References:

1. *Ahindra Nag* A textbook of Biotechnology, Oxford book Co, IInd Edition. 2004.
2. H. D. Kumar Agricultural biotechnology, Daya Publ House, India, 2005.
3. *Bhojwani S S, Soh WY* ,Agro biotechnology and plant tissue culture, Oxford & IBH Publ, India. 2006.
4. H. Rawat H, Agricultural biotechnology, Oxford Book Co, India.1st edition , 2008.
5. H. J.Newbury , Plant molecular breeding, John Wiley and Sons., USA. 2009.
6. *S.S. Bhojwani and S.P. Bhatnagar* Embryology of Angiosperms,Vikas Publ House, India. 2009.
7. *Ashwani Kumar, Shekhawat NS* Plant tissue culture and molecular markers: the or role in improving crop productivity (IK International) 2009.
8. *Hou CT, Shaw JF* Biocatalysis and agricultural biotechnology, CRC Press, USA, 2009.
9. *H K Das,* Biotechnology ,Wiley India Pvt. Limited, India ,4th edition, 2010.
10. *Thakur S. and Ajay Kumar* Agriculture Biotechnology at a glance, Sharma Publishers and distributors, 2nd edition. 2019.

MBTP 546: Biotechnology Practicals (Lab IV)

(Based on MBTT 541, 542 543)

Learning Objectives: The students should be able to…

1. Gain experimental knowledge of Bioremediation of heavy metals & quantitation of TSS, DO, BOD, COD
2. Acquire practical knowledge of Business plan writing and Project report writing
3. apply experimental knowledge about various statistical analysis
4. implement knowledge of DMP, DQA & case study in clinical settings.

Credits (Credit 02)	MBTP 546: Biotechnology Practicals (Lab IV) (Based on MBTT 541, 542 543)	No. of Practicals hours
1	Isolation and purification of pathogenic microorganisms from polluted soil	4
2	Biochemical tests of isolated pathogenic microorganisms from polluted soil	4
3	Microbial bioremediation of heavy metals	4
4	Estimation of Total Soluble Solid & Total Dissolved solid of waste water	4
5	Quantitative estimation of BOD of waste water	4
6	Quantitative estimation of COD of waste water	4
7	Study of market research and its analysis	4
8	Business plan writing and Project report writing for funding	4
9	Marketing and Sales in Bioentrepreneurship	4
10	Case study biotech industrial projects	4
11	Study of various components during patent writing	4
12	Study of procedure for filling patent	4
13	Analysis of mean mode and median for given data	4

14	Perform t test for given data	4
15	Perform ANOVA and correlation for given data	4
16	Case Report Form in clinical research.	4
17	Clinical Case Study Report	4
18	Data Management Plan (DMP) in clinical trials.	4
19	Clinical Data Quality Assessment (DQA) in clinical trials.	4
20	Study visit to Biotechnology industry	4

Learning Outcomes: After completion of syllabus The students will be able to

1. Apply techniques in microbial strains screening from different soil samples
2. Implement skills in preparation of case study reports
3. acquire skill & knowledge in analysis of mean mode and median for given data
4. gain skill & techniques in performing ANOVA and correlation

References:

1. *H Thatoi, Supriya Dash.* Practical Biochemistry (Principle and protocols) – Dreamtech Press, 2nd edition 2020.
2. *G. Swarajya Lakshmi.* Environmental Science A practical Manual – BS Publications . 2018.
3. *JKPatra , G Das , SK Das, H Thatoi* A Practical Guide to Environmental Biotechnology, Springer, 2020.
4. *Asthana & Asthana.* Environment Problems & Solutions. S. Chand Limited, New Delhi, 2001.
5. *Vikas Dhikav,* Textbook of Clinical Research by 1st Edition Sold By: atithibooks, 2017.
6. *GP Mohanta,* Textbook On Clinical Research A Guide For Aspiring Professionals And Professionals, Pharmamed Press, Sold By: Meripustak, 2000.
7. Entrepreneurial Development: Text and Cases, Entrepreneurship Sultan Chand & Sons. 1992.
8. *Patzelt, Holger; Brenner, Thomas,* Handbook Of Bioentrepreneurship, Springer. 2008.
9. *B. L.Wadehra,* Law Relating To Intellectual Property, Fifth Edition, Universal Law Publishing Co. Pvt. Ltd. 2011.
10. *H. K. Das, T*extbook of Biotechnology,4th edition, Wiley India Pvt. Ltd, New Delhi. 2010

On Job Training

MBTP 545: on Job Training (Internship) 4 Credit

OJT will provide the opportunities for internship with local/regional industries, business organization, health and allied areas, local government, etc. so that students may actively engage with the employability opportunities. Students will undergo 4 credit work based learning/OJT/internship.