Rayat Shikshan Sanstha's
Yashavantrao Chavan Institute of Science, Satara
Syllabus for Master of Science Part II

1. Title: **M.Sc. Biotechnology (Entire)**

2. Year of Implementation: 2022-23

3. Preamble:

The M. Sc. Biotechnology course under autonomy has been prepared keeping in view the unique requirements of M. Sc. Biotechnology students. The emphasis of the contents is to provide students the latest information along with due weightage to the concepts of classical biotechnology so that they are able to understand and appreciate the current interdisciplinary approaches in the study of plant and animal biotechnology, genetic engineering, bioinformatics, genomics, proteomics and applied subjects like Bio-entrepreneurship, IPR etc. The course content also lists new practical exercises so the students gets a hands on experience of the latest techniques that are currently in use. Project curriculum spanning over the two years of the course is designed in a way to give the students first hand research experience as it consists of writing of synopsis, literature review along with actual table work. Along with it students are also provided with an opportunity to peruse internship in industry or research centers. The course will also inspire students to pursue higher studies and research in

biotechnology, for becoming an entrepreneur and enable students to get employed in food, pharmaceuticals and agriculture industries.

4. General Objectives:

- Construction and designing of the courses to suite industrial needs.
- More emphasis on applied aspects of biotechnology
- To develop aptitude of students in the field of research.
- Enrichment of basic knowledge in areas of Biotechnology

5. Duration: One Year

6. Pattern: Semester wise

7. Medium of Instruction: English

8. Structure of Course:
    a. Semester III :
        Theory: 04 Papers
        Practical's: 02 Papers
    b. Semester IV :
        Theory: 04 Papers
        Practical's: 02 Paper

9. Structure of Course:

YASHAVANTRAO CHAVAN INSTITUTE OF SCIENCE, SATARA									
COURSE STRUCTURE UNDER CHOICE BASED CREDIT SYSTEM (CBCS)									
M. Sc. BIOTECHNOLOGY (ENTIRE)									
M. Sc. II SEMESTER– III (Duration – 6 Months)									
Sr. No.	**SUBJECT CODE**	**PAPER NO AND TITEL**	**TEACHING SCHEME**						
			Theory			**Practical**			
			No. of lectures	**Hours**	**Credits**	**Subject**	**No. of lectures**	**Hours**	**Credits**
1	MBTT--301	Bioprocess and Fermentation Technology	4	5	4	MBTP--305 : Bioprocess and Fermentation Technology & Enzymology	5	5	4
2	MBTT--302	Enzymology	4	5	4				
3	MBTT--303	Genetic Engineering	4	5	4	MBTP--306 : Genetic Engineering and Biostatistics / Bioinformatics	5	5	4
4	MBTT-304 A	Bioinformatics	4	5	4				
5	MBTT 304 B	Biostatistics							
	Total of SEM III		**16**	**20**	**16**		**10**	**10**	**08**

YASHAVANTRAO CHAVAN INSTITUTE OF SCIENCE ,SATARA									
COURSE STRUCTURE UNDER CHOICE BASED CREDIT SYSTEM (CBCS)									
M. Sc. BIOTECHNOLOGY (ENTIRE)									
M. Sc. II SEMESTER– IV (Duration – 6 Months)									
Sr. No.	**SUBJECT CODE**	**PAPER NO AND TITEL**	**TEACHING SCHEME**						
			Theory			**Practical**			
			No. of lectures	**Hours**	**Credits**	**Subject**	**No. of lectures**	**Hours**	**Credits**
1	MBTT--401	Genomics and Proteomics	4	4	4	MBTP--405 : Project	5	5	4
2	MBTT--402	Research Methodology	4	4	4				
3	MBTT—403	Bio-entrepreneurship and IPR	4	4	4	MBTP--406 : Internship	5	5	4
4	MBTT--404 A	Animal Biotechnology	4	4	4				
5	MBTT--404 B	Food Biotechnology	4	4	4				
	Total of SEM IV		**13**	**13**	**11**		**10**	**10**	**8**

Other Feature:

A) Library:

Reference and Textbooks, Journals and Periodicals

B) Specific Equipment's:

Computer, LCD Projector, Visualizer, Smart Board

C) Laboratory Equipment's:

Sr No.	Name of Instrument
1	Atomic Absorption Spectrometer
2	Autoclave Vertical
3	Bacteriological Incubator
4	Binocular Research Microscope CX 21i
5	BOD Incubator
6	Centrifuge Remi R-4C
9	COD refluxing unit
10	Colorimeter
11	Combined pH and Conductivity Meter
12	Compound Microscope
13	Conductivity Meter
14	Deep freezer
16	Dissection microscope
17	Distillation assembly
18	Flame Photometer
19	Hemocytometer
24	Horizontal Electrophoresis unit
25	Horizontal Laminar Airflow
26	Hot Plate
27	Lux Meter
29	Microcentrifuge
30	Microscope camera device
31	Microwave Oven
32	MiniCentrifuge Remi
33	Mixer
34	pH Meter
35	Refractometer
38	Refrigerator
39	Rotary Shaker
40	Sonicator Waterbath
42	Spectrophotometer UV-Vis
43	Stabilizer
44	Thermal Cycler
45	Ultra microtome

46	UV transilluminator
47	Vacuum pump
48	Variable type power pack
49	Vertical Electerophoresis Unit
51	Visible Spectrophotometer
52	Water bath
53	Weighing balance

SEMESTER III

SUBJECT CODE	PAPER NO AND TITEL
MBTT-301	Bioprocess and Fermentation Technology
MBTT-302	Enzymology
MBTT-303	Genetic Engineering
MBTT-304 A	Bioinformatics
MBTT-304 B	Biostatistics
MBTP-305	Bioprocess and Fermentation Technology & Enzymology
MBTP-306	Genetic Engineering and Biostatistics / Bioinformatics

SEMESTER III

MBTT 301: Bioprocess & Fermentation Technology

Course Objectives: Student will able to:-

1. Students will learn skills of operation & design aspects of different bioreactors.
2. Students will gain knowledge about roles of different media sources, various techniques of optimization of media as well as digital monitoring of fermentation processes.
3. Students will learn concepts of primary & secondary metabolic product processes & also various analytical & preparative techniques of recovery of products obtained in these processes.
4. Students will apply their skills, techniques & knowledge in understanding the production processes of various industrial scale fermentation.

Credits=4	**SEMESTER-III** **MBTT 301: Bioprocess & Fermentation Technology**	**No. of hours per unit/ credits**
Credit –I UNIT I	**Introduction to fermentation and Basic aspects of bioengineering**	**(15)**
	A) Introduction to fermentation, B) Type of fermentation– Batch, Fed Batch and Continuous processes. C) Basic Design of fermentor D) Design aspect of Stirred tank reactor E) Design aspect of non- mechanically agitated bioreactors (Air lift and Bubble column). F) Design and operation of immobilized cell reactors. (Packed Bed Reactor) G) Mass transfer, Aeration and agitation of fermentation broth.	
Credit –1 UNIT II	**Fermentation Media, Sterilization and monitoring of process variables**	**(15)**
	A) Media components C, N, P and their optimization, B) Sterilization of media: Kinetics of destruction of microorganisms C) Indicator organism Del factor, D) Designs of Batch and continuous sterilization E) Equipment used in filter sterilization.	

	F) Monitoring of process variables: i. Types of sensors, ii. Measurement and control of various parameters (pH, Temperature, dissolved oxygen, microbial biomass, inlet and exit gases, fluid flow, Pressure, Foam), iii. Scale Up and Scale Down	
Credit –1 UNIT III	**Production and downstream processing**	**(15)**
	A) Concept of primary (growth associated) and secondary metabolites (Growth non -associated) metabolites, B) Kinetics of growth and product formation. Yield coefficient and efficiency. C) Downstream processing and unit operations, General strategy of downstream processing, Production, recovery (with principles of techniques involved). D) Effluent Disposal strategies used for Textile, dye, dairy, paper and pulp industries, E) Fermentation economics.	
Credit –1 UNIT IV	**Fermentation Products**	**(15)**
	A) Large scale Production processes B) Wine, beer, Cheese, Xanthan gum, Lactic acid, Bread, Citric acid, Antibiotics (Penicillin) C) Fermentative product of Vitamins (Vitamin C), Amino acids (glutamic acid, lysine), D) Enzymes (glucose oxidase, amylase), E) Organic acids (citric acid), F) Biotransformation product (steroid).	

Course Outcomes: Student should be able to:-

1. Design of fermentor/ bioreactors
2. Design & optimize fermentation media
3. Scale up of fermentation process for large scale
4. Different fermentation processes for diverse industrial products

References:-

1. Patel. A. H. *Industrial Microbiology*, India: Macmillan India Ltd. 2nd edition (2011) UNIT 1
2. Doran, Pauline. *Bioprocess Engineering Principles*, New York: Academic Press 2nd edition (2012) UNIT I, II
3. Casida, L. E., *Industrial Microbiology*, New Edge International Publisher, 2nd edition (2019) UNIT I, II
4. Crueger, W. and Crueger, A. *Biotechnology: A Text Book Of Industrial microbiology*, New Delhi, India : CBS Publishers & Distributors, (2016). UNIT I, III
5. Harrison,R, Todd, P. Rudge, S. and Petrides, D. *Bioseparations science and Engineering*, Oxford University Press.(2015). UNIT III, IV
6. Lydersen, Bjorn, D'Elia Nancy & Kim Nelson, *Bioprocess Engineering: Systems, Equipment & Facilities.*, New York: John Wiley & Sons Inc. (1994). UNIT III, IV,
7. Stanbury, P. F. and Whittaker, A., Hall, S. *Principles of Fermentation technology*, Oxford: Butteworth Heinemann, 2nd edition, (2003). UNIT II, III
8. Peppler, H. L., Perlaman, D. *Microbial Technology*, New York: Academic Press.,2nd edition (2014). UNIT IV
9. Satyanarayan U, *Biotechnology*, Kolkata: Arunabha Sen Books allied Publishers. 1st edition, (2005) UNIT I, II
10. Prescott. S.C and Dunn, C.G, *Industrial Microbiology*, by Reed G. London: Globe book services, 4th edition, (2004). UNIT III
11. BIOTOL (Project); Open Universiteit (Heerlen, Netherlands); Thames Polytechnic. *Bioreactors: design, operation and novel applications*, Weinheim, Germany: Wiley-VCH Verlag GmbH & Company KGaA, (2016) UNIT III.

SEMESTER III
MBTT 302: ENZYMOLOGY

Objectives:

1. Students will learn enzymes and their kinetics.
2. Students will understand the structure-function relationship of enzyme.
3. Students will understand the concept of enzyme immobilization.
4. Students will understand the role of enzymes in industry and diagnostics.

Credits=4	**SEMESTER-III** **MBTT 302: ENZYMOLOGY**	**No. of hours per unit/ credits**
Credit –I UNIT I	**Enzymes**	**(15)**
	A) Classification - IUB system, rationale, overview and specific examples. B) Characteristics of enzymes, enzyme substrate complex. Concept of active centre, binding sites, stereospecificity and ES complex formation. Effect of temperature, pH and substrate concentration on reaction rate. C) Activation energy. Transition state theory. Enzyme activity, international units, specific activity, turnover number, end point kinetic assay, Factors affecting catalytic efficiency - proximity and orientation effects, distortion or strain, acid - base and nucleophilic catalysis. D) Methods for studying fast reactions. Chemical modification of enzymes. Isoenzymes and multiple forms of enzymes	
Credit –I UNIT II	**Enzyme Kinetics**	**(15)**
	A) Michaelis - Menten Equation - form and derivation, steady state enzyme kinetics. Significance of Vmax and Km. B) Bisubstrate reactions. C) Graphical procedures in enzymology - advantages and disadvantages of alternate plotting. D) Enzyme inhibition - types of inhibitors - competitive, noncompetitive and uncompetitive, their mode of action and experimental determination.	
Credit –1 UNIT III	**Structure-function relations**	**(15)**

	A) Amylase, Protease (trypsin), Lysozyme, ribonuclease, carboxypeptidase, Multi enzyme complexes - pyruvate dehydrogenase. B) Protein ligand binding, including measurements, analysis of binding isotherms, co-operativity C) Hill and Scatchard plots and kinetics of allosteric enzymes. D) Product inhibition, feedback control, enzyme induction and repression.	
Credit –1 UNIT IV	**Immobilized enzymes**	**(15)**
	A) Relative practical and economic advantage for industrial use, effect of partition on kinetics and performance with particular emphasis on charge and hydrophobicity (pH, temperature and Km). B) Various methods of immobilization - ionic bonding, adsorption, covalent bonding (based on R groups of amino acids), microencapsulation and gel entrapment. C) Immobilized multienzyme systems. D) Biosensors - glucose oxidase, cholesterol oxidase, urease and antibodies as biosensors	

Course Outcomes: Student should be able to

1. Learn the importance and implementation of enzyme kinetics
2. Understand structure-function relations of enzymes
3. Learn the applications of Immobilized Enzyme in the industry
4. Apply the gained knowledge in enzyme based clinical diagnosis

References:-

1. Nicholas C. P. *Fundamentals of Enzymology: Cell and Molecular Biology of Catalytic Proteins*, Oxford University Press. (2009)– UNIT I, II, III.
2. Nicholas C. P. and Stevens L. *Fundamentals of Enzymology, The Cell and Molecular Biology of Catalytic Proteins*, New York : Oxford University Press (2000) -UNIT I, II, III.
3. Moss, Donald William. *Isoenzymes*. Springer Science & Business Media, (2012). – UNIT I.
4. Price, Nicolas C., and Perry A. Frey. *Fundamentals of enzymology. Biochemistry and Molecular Biology Education* 29: (2001) – UNITI and II.
5. Tokushige M., *Allosteric Regulation, Selected Papers in Biochemistry*, Tokyo: University of Tokyo Press, Volume 8 (1971). – UNIT III
6. Guisan, J. *Immobilization of enzyme & cells*, Humana, 3rd edition (2013) – Unit IV

SEMESTER III

MBTT 303: GENETIC ENGINEERING

Objectives:

Student will able to:-

- Learn microscopic analysis of DNA structure.
- Learn concept of designing and construction of vector
- Understand PCR, its type and designing of primer
- Apply the PCR technique in different areas.

Credits=4	**SEMESTER-III** **MBTT 303: GENTETIC ENGINEERING**	**No. of hours per unit/ credits**
Credit –I UNIT I	**DNA & Basics of Recombinant DNA Technology**	**(15)**
	A) Introduction to DNA structures, Enzymes used in rDNA technology, Modification systems, Type II restriction endonucleases and properties, isoschizomers and neoschizomers, Cohesive and blunt end ligation, linkers, adaptors, homopolymeric tailing. B) 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. C) **Hybridization techniques:** Northern, Southern and Colony hybridization, Fluorescence in situ hybridization, Restriction maps and mapping techniques, DNA fingerprinting, chromosome walking & chromosome jumping	
Credit –I UNIT II	**Cloning Vectors**	**(15)**
	A) Gene Cloning Vectors: Plasmids, bacteriophages, Cloning in M13 mp vectors, phagemids, Lambda vectors; insertion and replacement vectors, Cosmid vectors, TA and pGMT vector B) Artificial chromosome vectors (YACs, BACs), Animal Virus derived vectors- SV-40, vaccinia/bacculo & retroviral vectors. C) Expression vectors; pMal, GST, pET-based vectors. Viral vectors	
Credit –1 UNIT III	**Cloning Methodologies**	**(15)**
	A) Insertion of Foreign DNA into Host Cells: Transformation, Transfection: Chemical and physical methods, liposomes,	

	microinjection, macroinjection, electroporation, biolistics, somatic cell fusion, gene transfer by pronuclear microinjection. B) 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, southwestern and far western cloning, yeast two hybrid system, phage display, Construction of cDNA libraries in plasmids and screening methodologies, C) Construction of cDNA and genomic DNA libraries in lambda vector. Principles in maximizing gene expression, Site-directed mutagenesis.	
Credit –1 UNIT IV	**PCR and Its Applications**	**(15)**
	A) Primer design, Fidelity of thermostable enzymes, DNA polymerases, real time PCR, cloning of PCR products, T-vectors, proof reading enzymes, PCR in gene recombination, deletion, addition, overlap extension, and SOEing, site specific mutagenesis, PCR in molecular diagnostics, viral and bacterial detection, B) PCR based mutagenesis. Applications, Sequencing methods, principle of automated DNA sequencing, RNA sequencing. C) Gene silencing techniques: Introduction to siRNA and siRNA technology, micro RNA, construction of siRNA vectors, principle and application of gene silencing. D) Gene Therapy: germ-line therapy in vivo and ex-vivo, suicide gene therapy, gene replacement, gene targeting	

Learning outcome:

Student should understand -

1. Various natural and laboratory-based modification of DNA
2. The mechanism of DNA damage.
3. Tool creating DNA constructs
4. Various protein expression strategies

References:

1. Sambrook J., Fritsch E.F. and Maniatis T. *Molecular Cloning: a Laboratory Manual*, New York: Cold Spring Harbor Laboratory Press (2000).
2. Glover D. M. and Hames B.D. *DNA Cloning: a practical Approach*, IRL Press Oxford, (1955).
3. Kaufman P. B., Kim W. Wu., D. and Cseke L. J. *Molecular and Cellular Methods in*

Biology and Medicine, Florida: CRC Press. (1995).
4. Desmond S.T. Nicholl, *An Introduction to Genetic Engineering*. USA: Cambridge University Press, (2002).
5. Carson S. and Dominique R. *Manipulation and Expression of Recombinant DNA*., New York: Academic Press, Second edition, (2005).
6. Primrose S. and Twyman R. *Principles of Gene Manipulation and Genomics*. Willy-Blackwell, 7th edition, (2006).
7. Appasani K. *RNA interference Technology- From basic science to drug development*. Forewords by Andrew Fire and Marshall Nirenberg, New York: Cambridge Press, (2005).
8. Berger S. L. and Kimmel A. R. *Methods in Enzymology, Guide to Molecular Cloning Techniques,* San Diogo:Academic press. Inc.,Vol.152, (1998).
9. Gooddol D. V. *Methods in Enzymology*, *Gene Expression Technology*, San Diego:Academic Press, Inc.Vol.185, (1990).
10. Mickloss D.A. and Greyer G.A. *DNA Science. A First Course in Recombinant Technology*, New York: Cold Spring Harbor Laboratory Press, (1990).
11. Primorse S.B. *Molecular Biotechnology*, Oxford: Blackwell Scientific Publishers, 2nd Edition, (1994).
12. Davies J.A. and Roznikolf W. S. *Milestones in Biotechnology. Classic papers on genetic Engineering,* Boston: Butterworth-Helnemann, (1992).
13. Walker M. R. and Repley R. *Route Maps in Gene Technology*, Oxford: Blackwell Science Ltd. (1997).
14. Kingsman S. M. and Kingsman A.J. *Genetic Engineering. An Introduction to gene analysis and exploitation in eukaryotes.* Oxford: Blackwell Scientific Publications (1998).

SEMESTER III

MBTT 304 A: BIOINFORMATICS

Objective:

Student will be able to

- Make students aware about various bioinformatics tools and techniques
- Understand Concepts of various databases and various methods
- Understand how to use bioinformatics tools for the analysis of the biological experimental data.
- Learn Sequencing techniques and gene annotation

Credits=4	**SEMESTER-III** **MBTT 304 A: BIOINFORMATICS**	**No. of hours per unit/ credits**
Credit –I UNIT I	**Introduction to Bioinformatics**	**(15)**
	A) Bioinformatics: Introduction and definition, History, Scope and Applications. Introduction to Unix and Linux systems and basic commands B) Database concepts: Protein and nucleic acid databases, NCBI; publicly available tools; resources at EBI; resources on web; database mining tools, submitting DNA protein sequence to databases: where and how to submit, SEQUIN C) Protein sequence databases: • Primary protein sequence databases: SWISS-PROT, PIR, MIPS, NRL-3D, TrEMBL. • Secondary protein sequence databases: PROSITE, PROFILE, PRINT, pfam, BLOCK, IDENTIFY. D) Structural databases: PDB, MMDB, CATH, SCOP, PdbSum. E) Literature database: PubMed, PubMed Central.	
Credit –I UNIT II	**Structural Bioinformatics**	**(15)**
	A) Protein Structure Basics: Amino acids, Peptide bond formation, Ramchandran Plot, Secondary Structures, Tertiary Structures, and Determination of Protein Three-Dimensional Structure. B) Protein Structure Visualization, Comparison and Classification, CATH & SCOP C) Protein Secondary Structure Prediction, Protein Tertiary Structure Prediction: Homology Modeling D) GENE AND PROMOTER PREDICTION • Gene Prediction: Gene Prediction in Prokaryotes, Gene Prediction in Eukaryotes • Promoter and Regulatory Element Prediction: Promoter and Regulatory Elements in Prokaryotes, Promoter and Regulatory Elements in Eukaryotes	

Credit –1 UNIT III	**Sequence Alignment and Molecular Phylogenetics**	**(15)**
	A) **Sequence alignment**: Significance of Sequence alignment, Global Alignment and local sequence alignment • Pairwise Sequence Alignment: Dot matrix, the dynamic programming (or DP) algorithm, Word or *k*-tuple methods, Database Similarity Searching: FASTA and BLAST • Multiple Sequence Alignment: Exhaustive Algorithms, Heuristic Algorithms, iterative algorithms. B) PAM matrices, BLOSSUM matrices C) Primer designing	
Credit –1 UNIT IV	**Phylogenetic analysis**	**(15)**
	A) Introduction: Evolution, definition of phylogenetic tree, nodes, internodes, root, tree, styles; cladogram, phenogram, curvogram, B) Steps involved in construction of phylogenetic tree C) Concept of evolutionary trees, Maximum parsimony method, Distance methods, The maximum likelihood approach, Sequence alignment based on an evolutionary model, Reliability of phylogenetic predictions, Complications from phylogenetic analysis D) Relationship of phylogenetic analysis to sequence alignment, Genome complexity and phylogenetic analysis	

Student should be able to:

1. Learn Concepts of various databases and various methods for the data retrieval, data storage, and data mining and use that data for the further analysis.
2. Understand gene annotation as well as submission of the sequences to the various databases.
3. Use Various bioinformatics tools and techniques and how to use that for the analysis of the biological experimental data.
4. Create phylogenetic analysis using given biological data

Reference Books:

1. Thomas, Lengauer. "Bioinformatics: from genomes to drugs." (2001).
2. Mount, David W. “Bioinformatics-Sequence and Genome Analysis” *Cold Spring Harbor Laboratory Press*; *2nd edition* (2004).
3. Miller, Webb, Kateryna D. Makova, Anton Nekrutenko, and Ross C. Hardison. "Comparative genomics." *Annu. Rev. Genomics Hum. Genet.* 5 (2004): 15-56.

4. Campbell,MA. Heyer, LJ "Genomics Proteomics & Bioinformatics" *Benjamin Cummings*. (2008)
5. Xiong, Jin. Essential bioinformatics. *Cambridge University Press*; (2006).
6. Griffiths, Anthony JF. Wessler, SR. Lewontin, RC, Carroll, SB (2007) "Introduction to genetic analysis" *W. H. Freeman* (2008).
7. Attwood, TK., David, J. Parry-Smith. Addison Wesley Longman Limited. (1999) ISBN 0-582-32788-1.
8. Twyman, Richard. Principles of proteomics. Taylor & Francis, (2004).

SEMESTER III
MBTT 304 B: BIOSTATISTICS
Objectives:

- To make students aware about the importance of Biostatistics in Life science research.
- To teach students how to analyses and present the data.
- To make students aware about statistical inferences based on statistical tools and techniques.
- To teach students the applications of MSEXCEL.

Credits=4	**SEMESTER-III** **MBTT 304 B: BIOSTATISTICS**	**No. of hours per unit/ credits**
Credit –I UNIT I	**Introduction to Biostatistics**	**(15)**
	A) Scope of Biostatistics, Samples & population, Types of variable, Theory of errors, measure of precision, Probable errors of function, rejection of observation Mean (Arithmetic, Harmonic, & Geometric), Median & Mode. Introduction to probability B) **Introduction:** Biological variables, parameters of statistical data display. C) **Types of scales:** linear, power, log, circular (with biological examples) D) **Curves and Equations (**Graphical & diagrammatic representation)	
Credit –I UNIT II	**Probability Distribution & Sampling**	**(15)**
	A) Probability Distribution & Sampling B) Frequency distributions: central tendency, dispersion, skewness, kurtosis C) Probability Distributions: binomial and Poisson D) Normal Distributions and applications E) Properties of Gaussian distributions, Central Limit theorem, Std. error and confidence limits	

	F) standard deviation & standard errors G) Sampling Techniques: Simple Random Sampling, Systematic Sampling, Stratified Sampling, Cluster Sampling	
Credit –1 UNIT III	**Hypothesis Testing**	**(15)**
	A) Hypothesis Testing (with biological examples) B) Principles of hypothesis testing, significance level, null hypothesis, Type I and Type II errors C) Examples of hypothesis testing: z-test, t-test, Chi-square test D) ANOVA E) Regression and Correlation:- Linear and Multiple regression analysis F) Mathematical models **G)** Concept of models: growth and decay, population interactions, optimization, Equilibrium solutions, Analytical solutions, numerical solutions and simulation.	
Credit –1 UNIT IV	**Application Software**	**(15)**
	A) Introduction to MSEXCEL-Use of worksheet to enter data, edit data, copy data, move data. B) Use of in-built statistical functions for computations of Mean, S.D., Correlation, regression coefficients etc. C) Use of bar diagram, histogram, scatter plots, etc. graphical tools in EXCEL for presentation of data. D) Introduction to MSWORD word processor editing, copying, moving, formatting, Table insertion, drawing flow charts etc.	

Learning outcomes:

Student should be able to:

- How data is analyzed and presented
- Statistical inferences based on statistical tools and techniques.
- How to design an experiment
- Use of MSEXEL for data processing and graphical arrangements.

References:

1. Daniel Wayne W. "Biostatistics: A foundation for Analysis in the Health Sciences"*11th Ed. Wiley Series in Probability and Statistics* (2018).
2. Glaser Antony N. "High Yield Biostatistics" *Lippincott Williams and Wilkins*, USA(2001)
3. Chap T. "Introductory Biostatistics"*1st Edition John Wiley, USA*(2003)
4. Mann. Prem S. Introductory Statistics. *Fifth Edition, John Wiley and Sons*(ASIA) Pte Ltd. (2004)
5. Bartle. RG, Sherbert. DR "Introduction to real analysis"*2nd edition John Wiley, USA*(1992)

SEMESTER III

MBTP 305

PRACTICAL COURSE – Bioprocess and Fermentation Technology & Enzymology

Course Objectives: Student will be able to:-

1. Students will learn concept of Bioreactor.
2. Students will understand the digital monitoring in fermentation.
3. Students will learn concept upstream and downstream processing
4. Students will understand the lab fermentation to scale up

Credits=2	**SEMESTER-III** **MBTP: PRACTICAL COURSE – MBTP 305: Bioprocess and Fermentation Technology & Enzymology**	**No. of hours per unit/ credits**
Credit –I **UNIT I**	**Bioprocess and Fermentation Technology**	
	1. Screening and identification (Genus Level) of a production strain (enzyme/antibiotic) from soil samples 02 2. Maintenance of the isolated production organism (Agar slants/ glycerol stocks /soil culture/ lyophilization) at least two methods. 02 3. Optimization of different parameters of the isolated organism (conventional and Statistical design). 02 4. Inoculum buildup of the isolated organism for use in bench top fermentation 01 5. Study of Working of lab bench fermenter (with production of enzyme or antibiotic using screened organism) 01 6. Study of different parts and assembly of the bench top fermenter. 01 7. Assay of product formed (Bioassay or Enzyme assay). 01 8. Solid state fermentation: Lab scale production of a product. 02 9. Demonstration of working of industrial fermenters by visiting fermentation industry 01	

Credit –1 UNIT II	**Enzymology**	
	1. Detection of some common enzymes 01 2. Extraction and Isolation of enzyme (amylase/protease/peroxidase/catalase) 01 3. Study of enzyme activity 01 4. Study of specific activity 01 5. To Asses effect of pH on enzyme activity. 01 6. 5. To Asses temperature stability of the enzyme. 01 7. To Asses effect of substrate conc. (Vmax and Km) on enzyme activity 01 8. To Asses effect of activator on enzyme activity. 01 9. To Asses effect of inhibitor on enzyme activity. 01 10. Study of enzyme immobilization. 01	

Course Outcome: Student should be able to:-

1. Learn operations of Bioreactor.
2. Understand the digital monitoring in fermentation.
3. Learn concept upstream and downstream processing.
4. Understand the lab fermentation to scale up
5. Isolation & purification strategies of enzyme
6. Assay of enzyme and its specific activity
7. Effects of different environmental factors on enzyme activity
8. Concept of immobilization

References:

1. Stanbury, P. F. and Whittaker, A. *Principles of Fermentation technology*,Butterworth-Heinemann, 3rd edition, (2008)
2. Sadashivam and Manikam, *Handbook of Biochemistry, Practical book of Biochemistry,* springer:Pergamon press,(2000).
3. Tokushige M., *Allosteric Regulation, Selected Papers in Biochemistry*,Tokyo:University of Tokyo Press, Volume 8 (1971).
4. A. H. Patel., *Industrial Microbiology,* Madras: Macmillan India Ltd.2nd edition, (1985).

SEMESTER III
MBTP 306
PRACTICAL COURSE – MBTP 306: EXERCISES IN GENETIC ENGINEERING AND BIOINFORMATICS

Learning Objectives:

- Students will learn isolation protocol of plasmid
- Students will learn the ligation process of DNA fragments.
- Student will understand the concept of gene transformation in prokaryotes.
- Students will understand the process of hybridization techniques.
- .Students will get to know the electrophoresis
- Students will understand the PCR.
- To learn the biological different databases
- To perform the analysis of sequence
- To predict the structures of proteins and nucleic acids using suitable tools

Credits=2	**SEMESTER-III** **MBTP: PRACTICAL COURSE – MBTP 306: Exercises In Genetic Engineering And Bioinformatics**	**No. of hours per unit/ credits**
Credit –I UNIT I	**Genetic Engineering**	
	1. Isolation of Plasmid DNA 02 2. In vitro DNA ligation 01 3. Restriction mapping 01 4. Transformation of *E. coli* 02 5. Southern blotting and hybridization 02 6. Northern and dot blotting technique 02 7. Isolation of cytoplasmic RNA 01 8. Electrophoresis of RNA on denaturing gels 01 9. RFLP 01 10. Polymerase Chain Reaction and analysis by agarose gel electrophoresis 01	
Credit –1 UNIT II	**Bioinformatics**	
	1. Using the NCBI and Uniprot web resources. 01	

	2. Sequence information resource: Using NCBI, EMBL, Genbank, Entrez, Swissprot/ TrEMBL, UniProt. 02 3. Similarity searches using tools like BLAST and interpretation of results. 01 4. Multiple sequence alignment using ClustalW. 01 5. Phylogenetic analysis of protein and nucleotide sequences. 01 6. Use of gene prediction methods (GRAIL, Genscan, Glimmer). 01 7. Using RNA structure prediction tools. 01 8. Use of various primer designing and restriction site prediction tools. 01 9. Use of different protein structure prediction databases (PDB, SCOP, CATH). 01 10. Construction and study of protein structures using Deepview/PyMol/RasMol. 01 11. Homology modelling of proteins. 01	
	OR **Biostatistics**	
	1. Measures of Central Tendency and Dispersion 02 2. Statistical Analysis using EXCEL. (Descriptive statistics and graphical presentation) 02 3. Sketching of pmf/pdf of Binomial, Poisson and Normal distributions. 02 4. Correlation and Regression Analysis 01 5. Simple random sampling and stratified sampling. 01 6. Hypotheses testing and confidence intervals. 02 7. Analysis of Variance 01 8. Word processing. 01	

Learning Outcomes:

- Students will learn kit based and manual protocol for plasmid isolation.
- Students will learn concept of restriction mapping and ligation.

- Students will understand probe, hybridization, and electrophoresis.
- Students will understand the RNA isolation and denaturing gel electrophoresis.
- Lean the biological different databases
- Carry out the analysis of sequence
- Make the structures of proteins and nucleic acids using suitable tools

References:-

1. Green, M. R., &Sambrook, J. *Molecular Cloning: a Laboratory Manual.* Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press. 2012.
2. Sambrook J, Fritsch E. F. and Maniatis, *Molecular cloning,*NewYork: Cold spring harbor laboratory press,.vol. I, IInd edition(1989)
3. Mount, David W. "Bioinformatics-Sequence and Genome Analysis" *Cold Spring Harbor Laboratory Press*; *2nd edition* (2004).
4. Miller, Webb, Kateryna D. Makova, Anton Nekrutenko, and Ross C. Hardison. "Comparative genomics." *Annu. Rev. Genomics Hum. Genet.* 5 (2004): 15-56.
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6. Xiong, Jin. Essential bioinformatics. *Cambridge University Press*; (2006).
7. Griffiths, Anthony JF. Wessler, SR. Lewontin, RC, Carroll, SB (2007) "Introduction to genetic analysis" *W. H. Freeman* (2008).

SEMESTER IV
MBTT 401: GENOMICS AND PROTEOMICS

Objectives:

- Students will be able to describe the fundamental of genome organization, genomics and the techniques used for the analysis of genomic data.
- Students will be able to compare DNA and RNA microarray techniques with the applications in basic research.
- Students will be able to demonstrate the protein and protein purification strategies.
- Students will be able to illustrate the protein identification techniques like 1D and 2D gel electrophoresis; Protein analysis techniques like MALDI-TOF and microarray.

Credits=4	**SEMESTER-III** **MBTT 401: GENOMICS AND PROTEOMICS**	**No. of hours per unit/ Credits**
Credit –I UNIT I	**Genomics**	**(15)**
	A) Genomics and Proteomics overview, omes and omics, Concepts and applications B) Genome overview at the level of Chromosome (with model organisms example); Strategies for large scale DNA sequencing- Whole genome analysis techniques, Next generation sequencing methods; Organization, structure and mapping of genomes (with model organisms example) C) Comparative genomics - Goals, bioinformatics of genome annotation, methods and limitations D) Structural genomics –Goals, methods, applications **E)** Functional genomics –Goals, methods, applications	
Credit –I UNIT II	**Transciptomics and Microarray and Applications**	**(15)**
	A) Introduction to transcriptomics and expression profiling B) DNA and RNA Microarray– Preparation, working and analysis.	

	Microarray databases and bioinformatics tools C) Investigative techniques –EST, SAGE, SNP D) Applications in basic research and medical genetics, Metagenomics, Toxicogenomics, Pharmacogenomics, Gene disease association.	
Credit –1 UNIT III	**Proteins and Proteomics**	**(15)**
	A) Introduction, Concept, application, advantages and limitations of Expressional Proteomics, Functional Proteomics, Structural Introduction of proteins and proteomics, types of proteins, protein folding and misfolding and diseases, Anfinsen's experiment, B) protein purification strategies: steps in protein purification (Lysis, fractionation, protein solubilization, protein precipitation, protein quantification) **C)** Methods of protein purification (Column based). D) Proteomics-with at least one explanatory example for each. E) Applications of Peptidomics/Drug discovery, Toxicoproteomics, Biomarkers in disease diagnosis, Identification and characterization of novel proteins	
Credit –1 UNIT IV	**Techniques in Proteomics**	**(15)**
	A) Strategies in protein identification, Polyacrylamide gel electrophoresis (PAGE), 2D Gel electrophoresis, Isoelectric Focusing (IEF), staining methods for 1D and 2D PAGE. B) Mass spectrometry in proteomics – C) Principle, techniques, components and variations (HPLC, ESI, MALDITOF, FT-MS, MS/MS, Quadrupole) and analysis, applications D) Protein- Protein interactions- experimental and computational- two hybrid, Phage display; E) Protein Microarray- Preparation, working and analysis.	

	Proteomics and Microarray databases and allied bioinformatics tools	

Learning Outcomes:

- Students should come to know about resent advances in genomics and proteomics.
- Students should acquire knowledge about tools and techniques used in genomics and proteomics research.
- Students should understand concept and applications of gene expression studies
- Students should learn and apply the techniques of proteomics.

REFERENCES:

1. Langauer T. *Bioinformatics - From Genomes to Drugs* (editor) Wiley- VCH; 1st edition (2001)
2. Mount D. W. *Bioinformatics-Sequence and Genome Analysis* Cold Spring Harbor Laboratory Press; 2nd edition ((2004)
3. Graham D. R. M. *Broad-based Proteomics strategies: a practical guide to proteomics and functional screening* J. Physiol 563: 1, 1-9, (2005).
4. Miller W. et al, *Comparative Genomics Annu. Rev. Genomics* Hum. Genet, 5: 15-56 (2004)
5. Campbell A. M., Heyer L. J., Cummings B. *Discovering genomics, Proteomics and Bioinformatics* 2nd edition, (2006).
6. Baldi P. and Hatfield G.W. *DNA microarrays and gene expression*, Cambridge University Press (2002)
7. JinXiong, *Essential Bioinformatics,* Cambridge University Press; 1st edition (2006)
8. Brownstein M. J., Khodursky A. B. *Functional Genomics: Methods and Protocols*, Humana Press (2003)
9. Reeves G. A. et al, *Genome and proteome annotation: organization, interpretation and integration,* J.Roy.Soci.6, 129-147 (2009).
10. Griffiths et al. *Introduction to genetic analysis,* W. H. Freeman (2008)
11. Lesk A. M. *Introduction to genomics* Oxford: Oxford university press (2007)

12. Richard T. *Principles of proteomics* Taylor & Francis (2004)

13. Hames B. D. *Protein Expression: A practical approach (series 1999)* Oxford University Press (1999).

14. Pennington S. R. and Dunn M. J. *Proteomics from protein sequence to function,* Oxford: BIOS (2001)

15. Gavaert K. and Vandekerchhove J. *Review: Protein identification methods in Proteomics Electrophoresis* 21, 1145-1154 (2000)

16. Gomase V. and Tagore S. *Transcriptomics: expression, pattern, analysis* Saarbrücken: VDM Verlag Dr. Müller, (2009).

SEMESTER IV

MBTT 402: RESEARCH METHODOLOGY AND CLINICAL RESEARCH

Learning Objective

- Students will learn skills of basics of research
- Students will gain knowledge about defining research problems
- Students will learn concepts of how research is done.
- Students will apply their skills, techniques & knowledge in understanding drug development processes & different phases in clinical trails
- Students will apply their skills & knowledge in understanding standard operating procedures and good clinical practices.

Credits=4	**SEMESTER-III** **MBTT 402: RESEARCH METHODOLOGY AND CLINICAL RESEARCH**	**No. of hours per unit/ Credits**
Credit –I UNIT I	**Introduction**	**(15)**
	A) Meaning of Research, Objectives of Research, Types of Research, Research Approaches, Significance of Research, Research Methodology, Research and Scientific Method B) Defining the Research Problem: i. What is a Research Problem, ii. Selecting the Problem, iii. Necessity of Defining the Problem, iv. Technique Involved in Defining a Problem	
Credit –I UNIT II	**Research Design**	**(15)**
	A) Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Basic Principles of Experimental Designs B) Sampling Design i. Census and Sample Survey, ii. Implications of a Sample Design,	

	iii. Steps in Sampling Design, iv. Criteria of Selecting a Sampling Procedure, v. Characteristics of a Good Sample Design, vi. Different Types of Sample Designs, vii. How to Select a Random Sample, Random Sample from an Infinite Universe	
Credit –1 UNIT III	**Introduction to clinical research and Drug Development Process**	**(15)**
	A) Overview of Drug Development Process B) Briefing of clinical trials phases C) Protocol and clinical trial Designing: i. Definition of protocol, its importance and purpose ii. Protocol format: Chapters (Headings) and broad contents of protocol, Important scientific and administrative aspect included in protocol, iii. Introduction to Research Methodology, iv. Protocol writing team and role of each member, v. Clinical trial design: Types of study designs, vi. Sampling, vii. sample size, viii. randomization, ix. Inclusion & Exclusion criteria, **x.** Phases of clinical trial & Types of trials.	
Credit –1 UNIT IV	**Good Clinical Practice (GCP) ICH regulations**	**(15)**
	A) Ethical Principles and their origin, Ethics in clinical research: As per ICMR & GCP, i. Ethics committees: Roles & responsibility of IEC and IRB, ii. Ethics in relation to vulnerable groups &special situations, iii. Responsibilities of Sponsors, Investigators & Regulators, B) ICH: Purpose, regulations & guidelines, Informed consent and	

	Informed consent form, Essential Documents C) Drug Regulatory Affairs (Clinical Trial): i. Regulatory Authority in India (DCGI & CDSCO), ii. Schedule Y of Drugs & Cosmetics Act, iii. International Scenario of Regulatory Aspects: FDA, CFR	

Learning Outcome:

After completing these modules the students should learn:

- Skills of basic research
- Acquire knowledge about defining research problems
- Concepts of how research is done.
- Drug development processes and clinical phase trials
- Good Clinical Practices, Good Manufacturing Practices, GCP/ GMP
- Importance of research documentations.
- Responsibilities of Sponsors, Investigators & Regulators
- Drugs and Cosmetics Acts.
- Importance of Pharmacovigilance.

References:

1. Kothari C. R. "*Research Methodology: Methods & Techniques*" New Age International Publishers, New Delhi. (Second Revised Edition), (2014).
2. Oliver, Paul, *Understanding the Research Process*, SAGE Publications Ltd, London, (2010)
3. Gerring, John., *Case Study Research, Principles & Practice*, Cambridge University Press, 2nd edition, (2019)
4. Katzung, B.G. *Basic and Clinical Pharmacology*, Prentice hall, International, McGraw-Hill, 15th edition (2021)
5. Agrawal, Reshma. *Research Methods Concepts, Process and Practice*., Pragun Publication (2012).
6. D.R Krishna & V. Klotz., *Clinical pharmacokinetics: A Short Introduction,* Springer Verlag, 1st edition, (1990)
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9. David Grahame-Smith, Jeffrey Aronson, *Oxford Textbook of Clinical pharmacology and drug therapy*, OUP Oxford; 3rd edition, (2002)
10. Richard A. Helms & David J. Quan, *Text Book of Therapeutics Drug and Disease Management*, Lippincott Williams and Wilkins; 8th edition (2006)

SEMESTER IV

MBTT 403: BIO-ENTREPRENEURSHIP AND IPR

Objectives:

- Understanding the dynamic role of entrepreneurship and small businesses
- Organizing and Managing a Small Business
- Business Plan Creation
- To learn IPR and patent laws.
- To understand IPR regulations with special reference GMO.
- To learn biosafety regulation and guidelines on developing and using the GMO.

Credits=4	**SEMESTER-III** **MBTT 403: BIO-ENTREPRENEURSHIP AND IPR**	**No. of hours per unit/ Credits**
Credit –I UNIT I	**An Overview of Entrepreneurs and Entrepreneurship:**	**(15)**
	A) An Overview of Entrepreneurs and Entrepreneurship: definition, B) Basic principles and practices of management- Definition, concepts and application; Organization types, coordination, control and decision making in management C) Characteristics for being an entrepreneur in biotechnology, Case studies of successful and unsuccessful bio-entrepreneurs D) Core concept of Market: Identification and evaluation of market potential of various bio-entrepreneur sectors. E) Marketing, Marketing research- concept and techniques	
Credit –I UNIT II		**(15)**
	A) Types of Enterprises and Ownership Structure: small scale, medium scale and large scale enterprises, role of small enterprises in economic development; proprietorship, partnership, Ltd. companies and co-operatives: their formation, capital structure and source of finance. B) Projects: identification and selection of projects; project report: contents and formulation, concept of project evaluation, methods	

	of project evaluation: internal rate of return method and net present value method. C) Role of government and schemes, financial institutions in fostering bioentrepreneurship D) Factors affecting biotech business: (finance, infrastructure, equipment, manpower, resources, project location, end product, quality issues, etc)	
Credit –1 UNIT III	**Characteristics and Types of Intellectual Properties Tools of IPR**	**(15)**
	A) Introduction and types, Treaties, Conventions, Laws, Acts, agreements pertaining to Biotechnology, Tools of IPRs B) Patents- prerequisites for patenting, Biological Patents – i. a. Plant b. Animal c. Microbial patents ii. Process patents and Product patent with one case study each. iii. Indian and International scenario, Protection of Plant varieties and Plant breeders rights, Industrial Designs- Designs of gadgets used in Biotechnology.	
Credit –1 UNIT IV		**(15)**
	A) Biosafety and Societal Concern, Public debate and concern on genetically modified microorganisms, plants and animals, scientific analyses of the concern, B) Biosafety regulation and guidelines on developing and using the genetically modified organisms. C) Patenting of Biological Materials: International conventions. International cooperation, obligations with patent applications, Can live form be patented- with special reference to Factor VIII, Erythropoietin, tissue plasminogen, hybridoma technology etc. Patenting of higher plants, animals, genes, DNA sequences, transgenic organisms	

Learning Outcomes:

- Students can understand fundamentals of Management and Administration.
- Students will understand Legal forms of the business for registration of the small scale industries, agencies for the registration of the companies
- Students can be able to prepare the business plan
- Students will understand IPR and patent rules and copyright act.
- Students will understand IPR regulations regarding GMO.

References:

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2. S Anil Kumar "Entrepreneurship Development" *New Age International (P) Ltd. Publishers*, (2003)
3. Mellor. Robert "Entrepreneurship for Everyone: A Student Textbook", *Sage Publication Ltd.* (2009)
4. Blundel Richard and Lockett Nigel "Exploring Entrepreneurship: Practices and Perspective", *Oxford University Press*, (2011).
5. Mehta. Shreefal S "Commercializing Successful Biomedical Technologies" Cambridge University Press (2008) (Unit I,II)
6. Patzelt Holger, Brenner. Thomas, "Handbook of Bioentrepreneurship" Springer (2008)
7. Wadehra. BL "Law Relating To Intellectual Property" Fifth Edition, *Universal Law Publishing Co.Pvt. Ltd.*(2011)
8. Das. HK "Text book of Biotechnology" *4th edition Wiley India Pvt. Ltd, New Delhi*(2010)
9. Chawala. HS, "Introduction to Plant Biotechnology"*3rd Edition, Science Publishers*(2009)
10. Hirvani. R, Patents in "Plant Breeding: Guarding the Green Gold" *Biotech News issue vol 4* (2009)
11. Ganguli Prabuddh, "Intellectual Property Rights" *Tata McGraw-Hill Publishing Company Ltd.*(2001)
12. Website http://www.wipo.int/portal/index.html.en(Unit III, IV)

SEMESTER IV

MBTT 404A: ANIMAL BIOTECHNOLOGY

Learning objective:

- Students will learn concept of animal cell line, their establishment and subculture.
- Students will understand different media required for animal cell culture.
- Students will learn concepts of concept of organogenesis.
- Students will understand the concept of stem cell and various animal models.

Credits=4	**SEMESTER-III** **MBTT 404A: ANIMAL BIOTECHNOLOGY**	**No. of hours per unit/ Credits**
Credit –I **UNIT I**	**Introduction to tissue culture:**	**(15)**
	A) Definition, principle and significance of tissue culture, Maintenance of sterility and use of antibiotics, Detection of Mycoplasma and viral contaminants. Prevention of Cross contamination Logic of formulation of tissue culture media: natural, synthetic media, and sera. B) Sterilization of cell culture media and reagents. Introduction to the balance salt solutions and simple growth medium. C) Role of carbon dioxide in animal cell culture. Various systems of tissue cultures with distinguishing features, advantages and limitations. D) Methodology: i. Primary culture: Behavior of cells, properties, utility with different examples ii. Explant culture, iii. Suspension culture. E) Cell lines: Definition, establishment and maintenance. F) Normal and established cell lines: Their characteristic features and utility, Characteristics of cells in culture.	
Credit –I	**Organ culture:**	**(15)**

UNIT II		
	A) Methods, behavior of organ explant, and utility of organ culture, Histotypic and organotypic cultures. Growth studies: Cell proliferation, cell cycle, mitosis in growing cells. B) Freeze storing of cells and transport of cultures, Measurement of viability and cytotoxicity. C) Cell cloning and types of cloning, cell synchronization, micromanipulation, Cell transformation. Separation of cell types: Various methods: advantages and limitations;Flow cytometry. D) Nuclear transplantation, Cell hybridization, Transfection studies. Growing cells in serum free media, scaling up. E) Propagation of viruses (viral sensitivity of cell lines). F) Application of animal cell culture for *in vitro* testing of drugs, in production of human and animal viral vaccines and pharmaceutical proteins.	
Credit –1 UNIT III	**Stem cells**	**(15)**
	A) Stem cells – adult, embryonic, induced pluripotent stem cells: Concept, principles for identification, purifications, assessment of proliferation long-term maintenance and characterization. **B)** Overview-livestock breed and their productivity, artificial breeding methods and hazards, marker assisted breeding of livestock,	
Credit –1 UNIT IV	**Transgenic animals**	**(15)**
	A) Transgenic animals: artificial breeding – in vitro fertilization and embryo transfer technology, artificial insemination, germ cell storage B) Genetic modifications – methods, transgenic fish and mammals	

	(Mice) C) Gene targeting: Targeted gene transfer. Mouse models for human, genetic disorders, Knockout mice, Study of animalmodels (Mice)	

Learning outcome:

The student should understand:

- Concept and different types in animal culture.
- Uses of molecular biology techniques genetically engineer the animal to improve sustainability, productivity and suitability for pharmaceutical, agriculture and industrial applications.
- Concept and different types in animal culture.
- Use of molecular biology techniques genetically engineering the animal to improve sustainability, productivity and suitability for pharmaceutical, agriculture and industrial applications.

References:

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SEMESTER IV

MBTT 404 B: FOOD BIOTECHNOLOGY

Learning Objective:

- Students will aware about different methods of food processing.
- Students will aware of food preservation techniques.
- Students will learn different quality control aspects. GMP & GLP guidelines
- Students will aware of food standards laws and legislations.

Credits=4	**SEMESTER-III** **MBTT 404 B: FOOD BIOTECHNOLOGY**	**No. of hours per unit/ Credits**
Credit –I **UNIT I**	**Food processing:**	**(15)**
	A) Starter cultures and their biochemical activities; production of alcoholic beverages; production of Single cell protein and Baker's yeast; Mushroom cultivation B) Food and dairy products: Cheese, bread and yogurt. C) Fermented vegetables – Saurkraut; Fermented Meat – Sausages	
Credit –I **UNIT II**	**Food preservation:**	**(15)**
	A) Food preservation by heating: drying, osmotic dehydration, blanching, canning, pasteurization, B) Sterilization, extrusion cooking. C) Non-thermal preservation: Hydrostatic pressure, dielectric heating, microwave processing, hurdle technology, membrane technology, irradiation. D) Food preservation by low-temp: Refrigeration, freezing and freeze-drying.	
Credit –1 **UNIT III**	**Quality assurance:**	**(15)**

	A) Microbiological quality standards of food**,** B) Intellectual property rights and animal welfare, Government regulatory practices and policies. FDA, EPA, HACCP, ISI C) Risk analysis; consumer and industry perceptions	
Credit –1 UNIT IV	**Food standards and laws:**	**(15)**
	A) International – Concept of Codex alimentarius, HACCP, GMP, GHP, USFDA, ISO 9000, ISO 22000, ISO 14000. B) National – Introduction of BIS/IS, Food Safety and standards – 2006, Food Safety and standard regulation 2010, FPO, MPO, MMPO, Agmark. C) Prevention of food adulteration Act: Food Adulteration: i. Definition ii. Common adulterants in different foods iii. Contamination, methods of detection. D) Food additives and legislation; i. Coloring matter ii. preservatives iii. poisonous metals iv. antioxidants and emulsifying and stabilizing agents v. Insecticides and pesticides. E) PFA specification for food products, Nutritional labeling	

Learning Outcomes:

- Students will learn about different methods of food processing.
- Students will be aware of food preservation techniques.
- Students will acquire knowledge of different quality control aspects.
- Students will understand food standards and laws.

References:

1. Casida L E, *Industrial Microbiology*, New Delhi: New age international (P) Limited, 1st Ed. (2005).

2. William Frazier and Dennis Westhoff, *Food Microbiology* (Sie): Frazier McGraw-Hill Companies.4th edition,(2008)

3. Early, R. *Guide to Quality Management Systems for Food Industries*. New York: Springer Science+Business Media, LLC, (1995).

4. Krammer A & Twigg B A. *Quality Control in Food Industry*. AVI Publication, Vol. I, II. 1973.

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6. P. Fellows, and Ellis H. *Food Processing and Nutrition*. London: Academic Press, (1990).

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