

Savitribai Phule Pune University

**M.Sc. II Year Biotechnology (CBCS Semester Pattern) Semester III
Revised syllabus w.e.f. June 2020**

Semester III

Course code	Course Title	Credits
Core Compulsory Theory Papers (CCTP)		
MBT- 301	Animal & Stem Cell technology	4 Credits
MBT- 302	Bioprocess engineering	4 Credits
MBT- 303	Bioinformatics & Biostatistics	4 Credits
Core Compulsory Practical Course : CCP-1		
MBT - 304	Laboratory Course IV- Animal Biotechnology, Bioprocess engineering & Bioinformatics & Biostatistics	4 Credits
Choice Based Optional Papers: CBOP (any One)		
MBT - 305	Nano Biotechnology	4 Credits (2T + 2P)
MBT - 306	Agricultural Biotechnology	4 Credits (2T + 2P)
Total		20 Credits

Savitribai Phule Pune University

M.Sc. II Biotechnology (CBCS Semester Pattern) Semester III

Revised syllabus w.e.f. June 2020

Subject Code: MBT- 301

**Subject : Animal and Stem Cell Technology
4 Credit course (Total Lectures:60)**

Unit	Topic	Lecture (Total 60L)
I	Introduction to tissue culture: <ul style="list-style-type: none"> • History, basics of animal tissue culture • Importance of maintenance of sterility and use of antibiotics • Detection of Mycoplasma and viral contaminants • Prevention of Cross contamination, eradication of contaminants • Logic of formulation of tissue culture media: natural, synthetic media, sera and substitutes • Introduction to the balanced salt solutions and simple growth medium. • Role of carbon dioxide in animal cell culture • Cell senescence. 	5
II	Various systems of tissue cultures: Distinguishing features, advantages and limitations. <ul style="list-style-type: none"> • Methodology: i. Primary culture, ii. Explant culture, iii. Suspension culture. Behavior of cells, properties, utility with different examples • Cell lines: Definition, establishment and maintenance, Finite and Continuous Cell line. Normal, Transformed and established cell lines: characteristic features, Contact inhibition, anchorage (in) dependence, Cell and tissue response to various factors 	5
III	Organ culture: <ul style="list-style-type: none"> • Methods, behavior of organ explant, and applications of organ culture. • Histotypic and organotypic cultures: methods and applications • Introduction to organ transplants, tissue engineering, bio-artificial organs 	5
IV	Growth studies: <ul style="list-style-type: none"> • Cell proliferation, cell cycle, mitosis in growing cells • Cryopreservation of cultured cells • Measurement of viability and cytotoxicity, microscopic examination of cultures, subculture of cells (monolayer and suspension cells), passage number • Cell cloning and types, cell synchronization, Cell transformation • Cell Separation: Various method- advantages and limitations; Scaling up, Cell hybridization 	5
V	Application of animal cell culture: <ul style="list-style-type: none"> • For <i>in vitro</i> testing of drugs, production of viral vaccines and pharmaceutical proteins, monoclonal antibodies. • Mass production of biologically important compounds. • Propagation of viruses (viral sensitivity of cell lines). • Harvesting of products, purification and assays. 	5
VI	Stem cells technology –	15

	<ul style="list-style-type: none"> • Concept, characteristics of adult stem cells, embryonic stem cells, embryonic carcinoma cells, induced pluripotent stem cells • Identification, purifications, assessment of proliferation • Long term maintenance and characterization. • Stem cell self-renewal and pluripotency: molecular mechanisms • Cell cycle regulation in stem cells • Concept of Stem cell niche with examples Neural stem cells, Hematopoietic stem cells, mesenchymal stem cells • Applications of stem cells in therapeutics 	
VII	<p>Transgenic animals:</p> <ul style="list-style-type: none"> • Overview of different methods of introduction of a transgene viz. micronuclear injection method, transduction with recombinant viruses, REMI etc. • Targeted gene insertion, gene silencing by RNAi,: • Cre-LoxP recombination for genetic modification • CRISPR/Cas9 for targeted genome editing • Transgenic animals: fish, <i>Xenopus</i>, mammals, • Concept of Knockout mice, methods and application • Mouse models for human genetic disorders, neurodegenerative disorders 	12
VIII	<p>Animal husbandry and reproductive biotechnology:</p> <ul style="list-style-type: none"> • Overview of livestock breed and their productivity in India • Artificial breeding :-Various methods of semen collection, artificial insemination, estrous synchronization, cryopreservation of germ cells, • <i>In vitro</i> fertilization and embryo transfer technology, • Animal cloning: concept and application in conservation 	5
IX	<p>Biosafety issues and Bioethics associated with Animal Tissue culture, developing transgenic animals and human cloning</p>	3

References:

1. R. Ian Freshney. Culture of Animal cells, 5rd Edition, 2010. A John Wiley & Sons, Inc., Publications, USA
2. R.W.Masters. Animal Cell Culture- Practical Approach, 3rd Edithion,2000, Oxford University Press. USA
3. Robert Lanza et al. *Essentials of Stem Cell Biology*”, Academic Press, 2nd edition, 2006.USA
4. Text book of Animal Husbandary, 8th edition, (1998) G.C. Banerjee,Oxford and IBH Publishin co.Pvt. Ltd. India
5. Molecular Biotechnology: 4th edition. (2010), Glick B.R., Pasternak J.J., Patten C. L., ASM press, USA
6. Gene Transfer to Animal Cells, 1st edition (2005), R. M. Twyman, Taylor & Francis USA.

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Subject Code: MBT- 302

Subject : Bioprocess Engineering
4 Credit course (Total Lectures:60)

Sr No	Topic	No. of lectures 60
I	<ul style="list-style-type: none"> • Bioprocess development: An interdisciplinary challenge, Biotechnology & Bioprocess Engineering, Definition of Bioprocess and bioprocess Engineering, over view of bioprocesses with their various components. Aseptic operations and Containment • Types of Fermentations : Solid state fermentation, Dual/Multiple, Aerobic, Anaerobic, batch, fed-batch, continuous • Design of Fermenter/ bioreactors: Overview of types of Bioreactors, Novel Designs of Bioreactors. • Kinetics of operation of bioreactors: Batch, Fed Batch and Continuous processes., Growth Linked and Non growth Linked Products, Kinetic modelling, Model structures, Material balances and energy balances • Isolation, screening and maintenance of industrially important microbes • Strain Improvement: Product formation and inhibition pathways and their regulations, Strain improvement by: Mutation, Protoplast fusion, parasexual cycle and genetic engineering • Inoculum Development: Inoculum Development for bacterial, yeast and mycelial processes, aseptic method of inoculation, achievement and maintenance of aseptic conditions. 	15
II	<ul style="list-style-type: none"> • Media for industrial fermentations: Medium requirements for fermentation processes, carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements, Medium formulation (Statistical design) of optimal growth and product formation, Ingredients for mammalian cell culture and plant cell culture. • Sterilization of media and air: Thermal death kinetics of microorganisms, Del factor, design organism, Design of sterilization process (batch and continuous), sterilization of bioreactor, feed and liquid waste, sterilization of air, exhaust air, theory of depth filter, designing of depth filters. <p>Monitoring of process variables:</p> <ul style="list-style-type: none"> • Types of sensors, Measurement and control of various parameters (pH, Temperature, dissolved oxygen, microbial biomass, inlet and exit gases, fluid flow, Pressure, Foam) P.I. D. control, Computer control of variables. • Scale Up and Scale Down : Importance, parameters involved 	10

III	<p>Mass transfer, Aeration and agitation of fermentation broth:</p> <ul style="list-style-type: none"> • Mass transfer: Concept of mass transfer, Molecular diffusion and role in bioprocess, Two–film theory, Convective mass transfer, volumetric mass transfer, Liquid-Solid, Liquid-liquid and Gas- liquid mass transfer equations and significance in bioprocess. • Aeration : Oxygen Uptake in cell cultures, Oxygen transfer from Gas bubble to Cell. Gas hold up, KLa importance, Measurement of KLa, Determination of KLa, Factors affecting KLa. • Agitation: Design of impellers and their flow patterns. Fermentation Broth rheology–Newtonian and Non Newtonian fluids, Factors affecting broth rheology, Power requirement for mixing Power number, Reynolds number, Flow regimes in fermentation tank (Laminar, turbulent and transition),Correlation between mass transfer coefficient and operating variables. 	12
IV	<p>Downstream Processing:</p> <ul style="list-style-type: none"> • Bio separation :- filtration, centrifugation, sedimentation, flocculation; Cell disruption (Physical , Chemical and enzymatic methods); • Extraction(Liquid-liquid, Aqueous two phase, Supercritical fluid); Distillation, • Purification by chromatographic techniques; Reverse osmosis and ultra-filtration; Drying; Crystallization, Whole Broth Processing 	8
V	<p>Industrial Production and Recovery process of:</p> <ul style="list-style-type: none"> • Vitamins (Vitamin C), Amino acids (Glutamic acid), Enzymes (Extra and Intra cellular one example each), Antibiotics (Rifamycin), Organic acids (Lactic acid), Recombinant Vaccines, • Biotransformation product(Steroids),Brewing (Beer), Cheese, Exopolysaccharides, Biodiesel. 	10
VI	<p>Quality Control (QC) and Quality assurance(QA) :</p> <ul style="list-style-type: none"> • Roles and responsibilities of QC and QA departments, Common Quality control tests, • Standard Operating Procedures (SOP) & Good Manufacturing Practices (GMP) ,Regulations on use and distribution of Biotechnology products. 	5

References:

1. Stanbury, P. F., Whittaker, A. and Hall, S., (2016) Principles of Fermentation technology, Springer, Third edition
2. Pepler, H. J.,D. Perlman (1979), Microbial Technology, Vol I and II, Academic Press, Second edition (E book by Elsevier)
3. Casida, L. E., (1984), Industrial Microbiology, Wiley Easterbs, New Delhi
4. Casida, L. E., (2019), Industrial Microbiology, New age International, New Delhi, Second Edition.
5. Prescott. S.C and Dunn, C. G., (2004) Industrial Microbiology, CBS Publishers and Distributors, Fourth Edition.
6. A.H. Patel. (2011), Industrial Microbiology, Macmillan India Ltd., Second Edition.
7. Crueger, W. and Crueger, A. (2005) A Text Book of Industrial Biotechnology, Panima,

New Delhi.

8. Satyanarayan U, (2008) Biotechnology, Arunabha Sen Books allied Publishers.
9. Schuler,M. and Kargi,F.Bioprocess Engineering -Basic Concept, Prentice Hall of India, New Delhi.
10. Pauline Doran, (2012), Bioprocess Engineering Principles - Academic Press, second Edition
11. Operational Modes of Bioreactors, BIOTOL series - Butter worth, Heinemann 1992
12. Bioreactor Design & Product Yield, BIOTOL series - Butter worth Heinemann 1992
13. Lydersen B., N. a. D' Elia and K. M. Nelson (Eds.) (1993) Bioprocess Engineering: Systems, Equipment and Facilities, John Wiley and SonsInc.
14. Harrison,R, Todd, P(2006), Bioseparations science and Engineering,Oxford University Press
15. Aydin Berenjian, (2019) Essentials in Fermentation Technology Springer; Kindle edition

Savitribai Phule Pune University
M.Sc. IInd Year Biotechnology (CBCS Semester Pattern) Semester III
Revised syllabus w.e.f. June 2020

Subject Code: MBT- 303

Subject: Bioinformatics and Biostatistics
4 Credit course (Total Lectures:60)

Unit	Topic	No. of lectures 60
I	<p>Major Bioinformatics Resources and Biological databases</p> <ul style="list-style-type: none"> • Computers in Biology and medicine, Database concept • NCBI/EBI/EXPASY • Biological literature databases (PubMed) • Nucleic acid sequence databases (NCBI's GenBank + the European Nucleotide Archive [ENA] + the DNA Data Bank of Japan [DDBJ],) • Protein sequence databases (UniProtKb, SwissPort, TrEMBL). 	4
II	<p>Basic Concepts in Biological sequence Analysis :</p> <ul style="list-style-type: none"> • Biomolecular sequence analysis: Overview and Concepts • Pairwise sequence alignment algorithms (Needleman & Wunsch, Smith & Waterman) • Scoring matrices for Protein and Nucleotide sequences (PAM series and BLOSUM series), Gap Penalty and Penalty Scheme • Database Similarity Searches (BLAST, FASTA) • Multiple sequence alignment algorithms, Methods of MSA (Progressive, Iterative, Block-Based Alignment) (CLUSTALW and CLUSTALX, T-Coffee) • Protein profiles and Hidden Markov Model (HMM) • Application of Multiple sequence alignment (Phylogenetic analysis) 	8
III	<p>Structural Bioinformatics</p> <ul style="list-style-type: none"> • Major Structural Resources (PDB and PMDB) • PDB File Format • Basic Structure Visualization <ul style="list-style-type: none"> ○ Visualization of major secondary structure (helices, beta sheets) and their role in protein structure ○ Visualization of various interactions : Polar (Hydrogen Bonds), Apolar (Hydrophobic, van der Waals, Pi stacking), Other (Salt Bridges, Coordination with ions) in protein structures and their role. • Protein Structure Classification (SCOP and CATH) • Protein Structure Prediction <ul style="list-style-type: none"> ○ Need and Concept of protein structure prediction, protein folding and model generation 	8

	<ul style="list-style-type: none"> ○ protein secondary structure prediction methods (Alignment-based and Single sequence-based secondary structure predictions) ○ Tertiary structure prediction (Homology modeling and Fold Recognition, ab initio methods) ○ Ramchandran Plot 	
IV	Pharmacophore modelling and Chemoinformatics <ul style="list-style-type: none"> ● Chemoinformatics <ul style="list-style-type: none"> ● Chemical Structure representation: 1D, 2D and 3D structures ● Molecular file formats (SMILES, WLN, SDF, MOL,PDB etc) ● Compound library formatting and filtering (Physicochemical and substructure filters) ● Pharmacophore modelling ● Pharmacophore: Definition and classes (HBA, HBD, Aromatic etc.) ● Identification of pharmacophore features 	5
V	Molecular Modeling <ul style="list-style-type: none"> ● Introduction to modelling protein ligand interactions ● Pose Prediction Strategies in molecular Docking: Rigid body docking flexible ligand docking (Conformational search method, Fragmentation method, Database method) ● Scoring Functions: Force field-based, Empirical, Knowledge-based ● Application in Structure Based Drug Designing 	5
	Biostatistics	
I.	Introduction: <ul style="list-style-type: none"> ● Biological variables, parameters of statistical data display. ● Types of scales: linear, power, log, circular (with biological examples) ● Curves and Equations: Linear, saturating, sigmoid, exponential, logistic, power, multinomial, algebraic, differential, partial differential 	4
II	Sampling, distribution and presentation <ul style="list-style-type: none"> ● Sampling methods; Types of sampling; random sampling, Probability and non-probability sampling, stratified sampling, etc. ● Power analysis and sample size calculations ● Statistical data distribution, normal and skewed distribution, coefficient of skewness, moments and Kurtosis ● Data presentation models; covariance models, spatial statistical model, multivariate spatial model, Gaussian and non-gaussian random process models, etc. 	7
III	Hypothesis Testing (with biological examples) <ul style="list-style-type: none"> ● Principles of hypothesis testing, significance level, null hypothesis ● Type I and Type II errors ● Examples of hypothesis testing: comparison of means, t-test, Chi-square test 	5

IV	Design, correlation and regression analysis <ul style="list-style-type: none"> • Statistical design of experiments, single and multifactorial designs, fractional factorial designs. • Principles of experimental designs; randomization, replication and local control; Complete, incomplete and randomized block designs; • Covariance and correlation, Pearson's, Kendal's and Spearman's correlations, use of correlation and regression in biological analyses • Univariate, Bivariate and Multivariate data; linear, multilinear, and non-linear regression, generalized linear model and other models of regression analysis (nonparametric regression, Bayesian linear regression, etc.) 	8
V	Statistical Methods: <ul style="list-style-type: none"> • Analysis of variance table (ANOVA), • Post hoc Tests- • Tukey's test for pairwise comparison of treatments • Dunnet's test for comparison of treatment means with control • Duncan's multiple range test • Mann–Whitney U test 	6

Reference Books:

1. Mount David W.. Bioinformatics: Sequence and Genome Analysis. Publisher: Cold Spring Harbor Laboratory Press; Latest Edition
2. Baxevanis Andreas D. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Latest Edition. Publisher: New York, John Wiley & Sons, Inc.
3. Teresa Attwood, Parry-Smith David J. Introduction to Bioinformatics. Publisher: Pearson Education (Singapore) Pte.Ltd., Latest Edition
4. Gibas Cynthia, JambeckPer. Developing Bioinformatics Computer Skills. Publisher: Shroff Publishers and distributors O'Reilly Media, Inc., Latest Edition
5. Bourne Philip E., WeissigHelge. Structural Bioinformatics (Methods of Biochemical Analysis, V. 44), 2003. Publisher: Wiley-Liss. ISBN: 0471202002.
6. Forbes Burkowski. Structural bioinformatics: An algorithmic approach. Publisher: CRC Press, 2009. ISBN: 9781584886839.
7. Leach, Andrew. Molecular Modelling: Principles and Applications. Publisher: Prentice Hall. 2001. ISBN: 0582239338
8. Branden ,Tooze John. Introduction to Protein Structure. Publisher: New York, Garland Publishing Inc. 1999. ISBN: 0815323050.
9. Sternberg Michael J. E. Protein Structure Prediction: A Practical Approach. Publisher: USA, Oxford University Press. 1997. ISBN: 0199634953.

10. Gasteiger Johann, Engel Thomas. Chemoinformatics: A Textbook. Publisher: Wiley-VCH; 1st edition. 2003. ISBN: 3527306811.
11. Gasteiger Johann, Handbook of Chemoinformatics: From Data to Knowledge (4 Volumes). Publisher: Wiley-VCH. 2003. ISBN:3527306803.
12. MuthukumarasamyKarthikeyan, Renu Vyas. Practical Chemoinformatics. Publisher: Springer. 2014. ISBN: 9788132217794
13. Lesk, A. M. (2002). Introduction to Bioinformatics . Oxford: Oxford University Press.
14. Lesk, A. M. (2004). Introduction to Protein Science: Architecture, Function, and Genomics. Oxford: Oxford University Press.
15. Billingsley, P. (1986). Probability and Measure. New York: Wiley.
16. Rosner, B. (2000). Fundamentals of Biostatistics . Boston, MA: Duxbury Press
17. Daniel, W. W. (1987). Biostatistics, a Foundation for Analysis in the Health Sciences. New York: Wiley.
18. P.S.S. Sunderrao and J. Richards-An introduction to Biostatistics, Prentice Hall Pvt. Ltd. India
19. Campbell R.C.- Statistics for Biologists, Cambridge University Press, Cambridge.

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M.Sc. IInd Year Biotechnology (CBCS Semester Pattern) Semester III
Revised syllabus w.e.f. June 2020

Subject Code: MBT- 304

Subject: Laboratory Course IV
(4 Credit course)

**(Laboratory course in Animal Biotechnology, Bioprocess Engineering,
 Bioinformatics and Statistics)**

Sr. No.	Animal Biotechnology Practical	No. Of Practical
1.	Initiation of primary culture from chick embryo	1
2.	Subculture and establishment of cell line	2
3.	Growth curve analysis of cell line	1
4.	Demonstration of cryopreservation of cell	1
5.	Chromosome spread preparation from cell line	1
Sr No	Bioprocess Engineering Practical	
1.	Screening and identification (Genus Level) of a production strain (enzyme /antibiotic) from soil samples. Maintenance of the isolated production organism (Agar slants/ glycerol stocks /soil culture/ lyophilization) at least two methods.	2
2.	Medium optimization for laboratory scale production of enzyme/antibiotics.	1
3.	Study of Working of lab bench fermenter (with production of enzyme or antibiotic using screened organism)	1
4.	Recovery and Assay of product formed (Bioassay or Enzyme assay).	1
5.	Solid state fermentation : Lab scale production of a product.	1
6.	Visit to fermentation industry and Report writing	1
Sr. No.	Bioinformatics and Biostatistics Practical	
1.	Using online resources like NCBI, PubMed(GenBank, UniProtKB, PDB)	1
2.	Sequence alignment using BLAST/ Database Similarity searching using BLAST	1
3.	Phylogenetic analysis using Phylip or Mega	1

4.	Basic Structure visualization using DeepView (Performing basic tasks like Selecting and Displaying structures, Colouring, Measuring distances and labeling)	1
5.	Prediction of protein tertiary structure using any method (CPH, MODELLER, SWISS Model, EasyModeler)	1
6.	Molecular Docking using AutoDock and Molecular visualization of docked complexes (using Pymol or Chimera)	1
7.	Biostatistics practical based on theory course :	4
i.	Determination of Karl-Pearson's coefficient of correlation/ Spearman's rank correlation coefficient from the given grouped and ungrouped data.	
ii.	Examples based on t – test , Chi-square test for goodness of fit and independent attributes.	
iii.	Analysis of variance on the given data (ANOVA)	
iv.	Measures of skewness and measures of Kurtosis (grouped and ungrouped data).	

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Subject Code: MBT- 305 Subject: Nanobiotechnology
(4 Credit Course: 2 Credit Theory + 2 Credit Practical)

Units	Topic	Lectures(30)
I	Introduction to Nanobiotechnology: <ul style="list-style-type: none"> • History of nanotechnology and its emergence, Concept of Nanobiotechnology, • Types of nanoparticles and Their Properties: Quantum dots, Polymeric nanoparticles, • Metal nanoparticles, metal oxide nanoparticles, Dendrimers, Composites. 	4
II	Methods for synthesis of Nanomaterials: <ul style="list-style-type: none"> • Physical, Chemical, biological methods: Chemical precipitation and coprecipitation, polyol, and borohydrate reduction methods, Sol-Gel synthesis; Microemulsions synthesis, Hydrothermal, Solvothermal synthesis methods, Microwave assisted synthesis; Sonochemical assisted synthesis, Core-Shell nanostructure, Organic-Inorganic hybrid nanocomposites, Quantum dot (QDs) synthesis. • Microbial/plant mediated Nanoparticle Production: Overview and concept of microbial/plant mediated nano-particle production; Methods of microbial/plant mediated nano-particle production 	9
III	Physiochemical characterization of Nanomaterials: <ul style="list-style-type: none"> • Optical (UV-Vis/Fluorescence), X-ray diffraction, Imaging and size (Electron microscopy- TEM, SEM; light scattering- DLS, NTA; Zeta potential), 	5
IV	A. Applications of Nanomaterials in: <ul style="list-style-type: none"> • Proteins - Lipids - RNA and DNA; • Protein Targeting - Small Molecule/Nanomaterial - Protein Interactions; Nanomaterial-Cell interactions-Manifestations of Surface Modification (Polyvalency). Nanomaterials and Diagnostics/Drug Delivery and Therapeutics: <ul style="list-style-type: none"> • Peptide/DNA Coupled Nanoparticles; Lipid Nanoparticles For Drug Delivery; Inorganic Nanoparticles For Drug Delivery; Metal/Metal Oxide Nanoparticles (antibacterial/anti fungal/anti viral activities); Anisotropic and Magnetic Particles (Hyperthermia). MRI, Imaging Surface Modified Nanoparticles; MEMS/NEMS based on Nanomaterials; B. Applications of Nanobiotechnology: <ul style="list-style-type: none"> • Nanomedicines • Nanoparticles for diagnostics and imaging • Food Science (Food Processing, Food Packaging, detection of pathogens) • Nanosensors • Nanotechnology for water remediation and purification, 	10

	<ul style="list-style-type: none"> • Nanotechnology in agriculture. • Green Nanotechnology 	
V	Concerns of Nanomaterials/Nanobiotechnology:: <ul style="list-style-type: none"> • Fate of nanomaterials, environmental and health impact of nanomaterials, Genotoxicity and cytotoxicity evaluation of Nanomaterials ,eco-toxicology 	2

Reference Books:

1. The Chemistry of Nanomaterials: Synthesis, Properties and Applications, 2 Volume Set C. N. R. Rao (Editor), Achim Müller (Editor), Anthony K. Cheetham (Editor), 2004. Wiley Publisher.
2. Nanobiotechnology: Concepts, Applications and Perspectives, Christof M. Niemeyer (Editor), Chad A. Mirkin (Editor) , Wiley Publishers, April 2004.
3. Nanotechnology: A Gentle Introduction to Next Big Idea, Mark Ratner and Daniel Ratner, Low Price edition, Third Impression, Pearson Education.
4. Nanoparticles: From theory to applications – G. Schmidt, Wiley Weinheim , 2004
5. Nanochemistry: A Chemical Approach to Nanomaterials – Royal Society of Chemistry, Cambridge UK 2005.

Subject Code: MBT- 305

**Subject: Nanobiotechnology
(2 Credit Practical Course)**

Sr. No.	Laboratory Course - Nanobiotechnology	No. Of Practical
1.	Synthesis of metal/metal oxide Nanoparticles by: <ol style="list-style-type: none"> a. Chemical b. Microbial and c. Plant based method 	3
2.	Characterization of nano-materials by spectroscopic method: <ol style="list-style-type: none"> i. Analysis of absorption spectra of thin films of Nanomaterials ii. Determination of absorption coefficient for different wavelength 	2
3.	Biological activities of nanoparticles: <ol style="list-style-type: none"> 1. Antimicrobial activities of synthesized nanoparticles (MIC/MBC determination) 2. Cytotoxicity testing of nanoparticles using MTT/Tryphan blue assay 	2

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Subject Code: MBT- 306

Subject : Agricultural Biotechnology

(2 Credit Course)

Unit	Topics	Lectures 30L)
I	<ul style="list-style-type: none"> • Introduction to agricultural Biotechnology • Importance of Agriculture at national economy • Advantages of biotechnological methods over conventional methods of crop improvement. • <i>In-Vitro</i> Plant propagation- a) Virus indexing, virus free plants, b) fruit crop c) flower crops d) Cereals and e) oil seeds plants • Endosperm culture & production of triploids for production of seedless plant varieties with examples • Use of bioreactors in plant production & Scale-up for Commercialization • Beneficial microorganisms in Agriculture: Biofertilizer (Bacterial Cyanobacterial and Fungal), microbial Bio insecticides • Major pest and diseases of horticultural crops and their control by Biotechnological methods 	10 L
II	<p>Crop improvement –</p> <ul style="list-style-type: none"> • Improvement of crop quality (FlavrSavr tomato, Golden rice) • Chloroplast manipulations for production of therapeutic proteins, vaccines, antibodies and increased production, 	3L
III	<p>Recent advances –</p> <ul style="list-style-type: none"> • Plant genotyping by different methods PCR, Plant fingerprinting, Microsatellite, Nanotechnology. • Homogenous assays – Qualitative Real Time PCR assays, applications • CRISPR based technology: Introduction, techniques, and its application in plants • Plant DNA Barcoding- Introduction, Barcoding Markers (matK, rbcL, ITS, tm HpsbA), Recent advances in plant bar coding Benefits, Limitations 	8L
IV	<ul style="list-style-type: none"> • Development and formulation (with various carrier materials) of bioinoculants, for better Agricultural productivity, using: <ol style="list-style-type: none"> i. Growth promoting , ii. Nitrogen fixing, iii. Phosphate solubilizing, iv. Metal chelating, (siderophores) v. Growth hormone producing microorganisms • Agricultural biotechnology and agribusiness • Opportunities in the Agriculture Biotechnology 	8L

References :

1. Plant molecular breeding, (2009), Newbury HJ, John Wiley and Sons.,USA.
2. Ashwani Kumar, Shekhawat NS (2009) – Plant tissue culture and molecular
a. Markers :their role in improving crop productivity (IK International)
3. Biotechnology, 4th edition, (2010), H K Das, Wiley India Pvt. Limited, India
4. Chawla HC (2004) – Introduction to plant biotechnology
(SciencePubl)
5. Plant Biotechnology: the genetic manipulation of plants (Oxford Press) (2008) –
Slater A,Scott NW,
6. Fowler MR Green MR & Sambrook J. (2014) Molecular Cloning: A Laboratory
Manual. 4th Ed. Vol. I, II & III. Cold Spring Harbor Laboratory Press.
7. Plant Genetic Engineering (2012) Grierson D Springer Netherlands.
8. Principles of Gene Manipulation and Genomics (2006) Primose SB & Twyman RM.
7th Ed. Blackwell Publishing.
9. Molecular Cloning: A Laboratory Manual (2001) Sambrook J. and Russel D, 3rd Ed
Cold Spring Harbor Laboratory Press.
10. Plant cell tissue and organ culture: fundamental methods by C. L. G. C. Philips and
L.R. Wetter 1995. National Research council, Canada, PRL, Saskatoon.
11. Plant Biotechnology and Agriculture (2011) : Arie Altman and Paul Hasegawa
Elsevier Publications (1st Ed)
12. Agriculture A.K. 2006. Flower crops: Cultivation and Management. New India
Publishing Agency, IPA. .
13. Shanmugavelu, K. G. Production Technology of Fruit Crops.
14. Kunte, Y.N., Kawthalkar, M. P. And Yawalkar, K .S. 1997. Principles of
Horticulture and Fruit Growing. 3rd Edn.
15. Textbook of Agricultural Biotechnology Paperback – 2008 by Nag and Ahindra
16. Handbook on Agriculture, Biotechnology and Development(2014) : By Daved Castle
17. Biocatalysis and Agricultural Biotechnology: Fundamentals, Advances, and ...By
Anjali Priyadarshini, Perna Pandey (2017).
18. Agricultural Biotechnology (2006) By Varun Metha)Book by Varun Mehta
19. Agricultural Biotechnology (2016) :Vivian Laura

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Subject Code: MBT- 306

Subject : Agricultural Biotechnology

(2 Credit Practical Course)

Sr. No.	Laboratory Course - Agricultural Biotechnology	No. Of Practical
1.	Production of virus free plants Virus indexing- ELISA and PCR, (Demonstration)	2
2.	Suspension culture and study the parameters to scale-up the production of in-vitro plants Monitoring of growth and differentiation of cells,	2
3.	Endosperm culture for regeneration of seedless plants Hardening /Acclimatization of regenerated plants, Transfer to soil	2
4.	Non gel techniques for plant genotyping and CRISPR based technology (Demonstration using web resources)	1
5.	Preparation, formulation (using suitable carrier material) and application (pot trials) of bio inoculants (Nitrogen fixing and Phosphate solubilising Microorganisms)	1

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Semester IV
(CBCS Semester Pattern)
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Semester IV

Course code	Course Title	Credits
Core Compulsory Theory Papers (CCTP)		
MBT- 401	Genomics and Proteomics	4 Credits
MBT- 402	Advanced Bio analytical Techniques	4 Credits
Core Compulsory Practical Paper : CCPP-1		
MBT- 403	Research Project	4 Credits
Choice Based Optional Papers: CBOP (any Two)		
MBT - 404	Bio entrepreneurship & Start up Designing	4 Credits
MBT - 405	Pharmaceutical Biotechnology & Drug Designing	4 Credits
MBT - 406	Research Methodology & Scientific Communication	4 Credits
MBT - 407	Quality Control, Bio safety & Bioethics	4 Credits
Total		20 Credits

Savitribai Phule Pune University
M. Sc. Biotechnology IIInd Year,
Semester IV
(CBCS Semester Pattern)

Revised syllabus w.e.f. June 2020

Subject code : MBT-401

Subject – Genomics and Proteomics

(4 Credit Course)

Total Lectures=60 (4 C)

Units	Topic	Lectures
	Genomics	
I	<ul style="list-style-type: none"> • Genomics and Proteomics overview, omes and omics, • Concepts and applications Genome overview with model organisms example • Whole Genome sequencing – Methods, Assembly and Analysis, NGS Platforms • Comparative genomics - Goals, bioinformatics of genome annotation, methods and limitations. • Structural genomics –Goals, methods, applications. • Functional genomics –Goals, methods, applications. 	8L
II	<p>Transcriptomics and Microarray</p> <ul style="list-style-type: none"> • Introduction to transcriptomics and expression profiling DNA and RNA Microarray –Preparation, working and analysis • Investigative techniques –EST, SAGE, SNP, MPRA • DNA and RNA Microarray –Preparation, working and analysis. Microarray databases and bioinformatics tools. 	10 L
III	<p>Applications of genomics</p> <ul style="list-style-type: none"> • Metagenomics • Toxicogenomics • Pharmacogenomics • Basic research • Medical Genetics 	12L
	Proteomics	
IV	<p>Introduction & concept of proteomics, Protein structure-function relationship,</p> <p>Types of Proteomics:</p> <ul style="list-style-type: none"> • Protein expression proteomics • Structural Proteomics, • Functional Proteomics 	5 L
V	<p>Techniques in Proteomics:</p> <ul style="list-style-type: none"> • Protein Isolation and Separation techniques • Structural analysis of proteins- X-ray crystallography and NMR spectroscopy • 2 D electrophoresis • Peptide mapping & sequencing • Protein structure prediction- homology 	12L

	modelling <ul style="list-style-type: none"> • Mass Spectrometry: MALDI_TOF, ESI Tandem, Ion Trap, Peptide mass fingerprinting • LC-MS, (SILAC) - Chemical tagging, fluorescence, radio-labeling 	
VI	Applications of Proteomics <ul style="list-style-type: none"> • Protein expression profiling • Protein-protein & Protein-DNA interaction (Chip Technique) • Methods for detection of protein-protein interactions - Yeast 1, 2 and 3 `hybrid systems – Phage display – • Proteomics and Protein microarrays, databases and allied bioinformatics tools. 	8
VII	Applications <ul style="list-style-type: none"> • Health care, Biomarkers in disease diagnosis, -Biomarker, drug development and their target identification • Identification and characterization of novel proteins 	5

Reference Books:

1. Daniel C. Liebler, Introduction to Proteomics. Humana Press.
2. Twyman RM, Principle of Proteomics. BIOS Scientific Publishers. (2004).
3. Kamp RM, Methods
4. in Functional Genomics: Protein Structure Analysis.
5. Birkhauser (2000).
6. Hubert Rehn. (2006). Protein Biochemistry and Proteomics, Academic Press.
7. Liebler Humana. (2002). Introduction to proteomics: Tools for new Biology, W.CBS Pub.,
8. Apweiler R. (2000). Protein sequence databases, Adv. Protein Chem. 54: 31-71
9. Pearson WR. (1996). Effective protein sequence comparison, Methods Enzymol., 266: 227-258.
10. Spang R and Vingron M. (1998). Statistics of large scale sequence searching. Bioinformatics. in Proteome and Proteome Analysis. Springer. (2004).
11. Baker D and Sali A. (2001). Protein structure prediction and structural genomics, Science, 294: 93-96.
12. Stekel D. (2003). Microarray bioinformatics, Cambridge University Press, Cambridge, UK.
13. Huynen MA, Snel B, Mering C and Bork P. (2003). Function prediction and protein Networks, Curr. Opin. Cell Biol., 15: 191-198.
14. Bioinformatics - From Genomes to Drugs (2001) (editor) WileyVCH; 1st edition
15. Bioinformatics-Sequence and Genome Analysis (2004) David W Mount Cold Spring Harbor Laboratory Press; 2nd edition
16. Comparative Genomics Webb Miller et al Annu. Rev .Genomics Hum. Genet 2004, 5, 15-56.
17. P Baldi and G W Hatfield DNA microarrays and gene expression (2002) Cambridge University Press
- 16 Functional Genomics : Methods and Protocols (2003) M J Brownstein, A B Khodursky Humana Press
- 17 Genome analysis and bioinformatics (2009) Sharma T R I.K. International Publishing House Pvt. Limited

Savitribai Phule Pune University
M. Sc. II Biotechnology (CBCS Semester Pattern) Semester IV
Revised syllabus wef. June 2020

Subject Code: MBT- 402

Subject: Advanced Bio-analytical Techniques

(4 Credit Course)

Total Lectures=60

Units	Topic	Lectures
I	Microscopic Techniques: <ul style="list-style-type: none"> • Staining and Visualization of cells and subcellular components. • Cryotomy, Scanning and Transmission microscopes, different fixation and staining techniques for EM • Freeze-etch and freeze- fracture methods for EM, Image processing methods in microscopy, confocal microscopy, single cell imaging. 	13
I	Histochemical and Immunotechniques <ul style="list-style-type: none"> • Antibody generation, Detection of antigen using ELISA, RIA, Western blot • Immunoprecipitation, Flow cytometry and FACS • Detection of antigens in living cells (Stem Cell Markers) • <i>in situ</i> localization by techniques such as FISH and GISH. 	12
II	Advanced Application of Spectroscopy <ul style="list-style-type: none"> • UV visible spectrophotometer, Fluorescence spectroscopy, Circular dichroism, NMR , IR and ESR spectroscopy , • Molecular structure determination using X-ray diffraction and X ray crystallography • Molecular analysis using light scattering, Mass spectrometry and LC-MS and surface plasma resonance methods. 	15
IV	Advanced Chromatography and Electrophoretic technique: <ul style="list-style-type: none"> • Introduction, principle and applications of HPTLC, HPLC, GLC,GC • Affinity chromatography: Principle, types, Application, • IF and 2 D electrophoresis, Capillary Electrophoresis, DGGE (Denaturing gradient gel electrophoresis) 	12
V	<ul style="list-style-type: none"> • Advanced Bio-analytical Techniques and Automated Systems • Advances in PCR technology & its applications (modifications), • Next Generations Sequencing (NGS): Principles and instrumentation, NGS data procession tools, • Automated microbial identification system, Automated DNA/RNA Microarray systems. 	08

Reference Books :

1. Principles and Techniques of Biochemistry and Molecular Biology, 7th edition, (2010), Wilson K.M., Walker J.M., Cambridge University Press, UK
2. Biophysics. 1st edition (2002), Pattabhi V and Gautham N. Kluwer Academic

- Publisher, USA.
3. Biochemical spectroscopy. Vol 46 of Methods in Enzymology. (1995) Kenneth Sauer. Academic Press, USA
 4. Modern experimental biochemistry. 3rd edition. (2000) Rodney Boyer. Prentice Hall Publisher, USA.
 5. Analytical Biochemistry, 3rd edition, (1998), David Holmes, H.Peck , Prentice Hall, UK.
 6. Willard and Merrit, Instrumental Methods and Analysis
 7. Ewing GW, Instrumental Methods of Chemical analysis.
 8. Vogel's, Text Book of Quantitative Chemical Analysis, 6th Edition, 2004.
 9. Raymond P. W. Scott, Techniques and Practice of Chromatography –Vol. 70.
 10. Sethi P.D, DilipCharegaonkar, Chromatography –2nd Edition.
 11. Hanes, Gel Electrophoresis of Proteins- A Practical Approach,
 12. Biophysical chemistry by Upadhyay, Upadhyay and Nath, Himalaya publication house.
 13. Next Generation Sequencing Methods and Protocols: Editors: Head, Steven R., Ordoukhanian, Phillip, Salomon, Daniel R. (Eds.) 2018.
 14. Statistical Analysis of Next Generation Sequencing Data: Editors Somnath DattaDan Nettleton.
 15. Next-Generation Sequencing Data Analysis 1st Edition by Xinkun Wang. CRC Press 2020.
 16. Google search for Unit V contents

Savitribai Phule Pune University
M. Sc. II Biotechnology (CBCS Semester Pattern) Semester IV
Revised syllabus wef. June 2020

Subject Code: MBT- 403

Subject : Research Projects
(4 Credit Course)

Project work , Thesis Submission & presentation

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

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Revised syllabus wef. June 2020

Subject Code: MBT - 404 Subject : Bio-entrepreneurship & Start up Designing
(4 Credit Course)

Total Lectures=60

Unit	Title	Lectures 60
I	Introduction to Entrepreneurship	Lectures
	<ul style="list-style-type: none"> • Meaning Knowledge and concept of entrepreneurship, • Need and Importance of entrepreneurship • The history of entrepreneurship development, • Skills and characteristic of successful entrepreneurs; • Entrepreneurship process; • Factors impacting emergence of entrepreneurship • Role of entrepreneurship in economic development, • Evolution and Growth of Entrepreneurship in India 	10
II	An Entrepreneur and an Entrepreneurship Journey	
	<ul style="list-style-type: none"> • Types of Entrepreneurs • Ethical Entrepreneurship • Entrepreneurial Value: Values, Attitudes and Motivation. • The entrepreneurial decision process, and role models, • Self Assessment of Qualities, • Skills, Resources and Dreams. • Role of Society and Family in the growth of an entrepreneur. 	11
	Activity : Motivational games to boost the decision power, accuracy and Attitude of the students	
III	Starting the venture:	11
	Generating business idea – <ul style="list-style-type: none"> • Sources of new ideas, • Methods of generating ideas, • Creative problem solving, • Opportunity recognition and assessment • Environmental scanning, • Competitor and industry analysis; • Feasibility study : <ul style="list-style-type: none"> - Market feasibility:-Marketing plan: marketing research for the new venture, Steps in preparing marketing plan, - Technical/operational feasibility, - Financial feasibility. 	
	Activity : 1. Organization of ‘Brain Storming’ session for generating Creative Business idea 2. Market survey/Marketing Strategy	
IV	Preparing a Business Plan:	11
	<ul style="list-style-type: none"> • Introduction to Business and its Environment • Components of a business plan, • Meaning and significance of a business plan • Challenges of New Venture Strategies 	

	<ul style="list-style-type: none"> • Start-up Policy Framework and Incentives • drawing business plan • Preparing project report; • Business Plan Preparation • Presenting business plan to investors • Execution of Business Plan • Business Incubation Centres 	
	Activity : Presentation on Business plan /Start-up business plan	
V	Entrepreneurship as Problem Solving	6
	<ul style="list-style-type: none"> • Entrepreneurs- as problem solvers. • Risk taking-Concept; types of business risks. • Barriers to Entrepreneurship. • Support structure for promoting entrepreneurship (various government schemes). 	
VI	Dimensions of Entrepreneurship	6
	<ul style="list-style-type: none"> • Entrepreneurial Culture • Entrepreneurial Society • Women Entrepreneurship • Rural Entrepreneurship 	
VII	Strategic Frameworks for Decision	5
	<ul style="list-style-type: none"> • Vision, Mission, Objective and Goal • Porter's 5-Forces Model • SWOT Analysis • Competitive Strategies • Value Chain Analysis 	

Reference Books:

1. Entrepreneurship, Hisrich, Robert D., Michael Peters and Dean Shepherded, , Tata McGraw Hill, ND
2. Entrepreneurship, , Brace R., and R., Duane Ireland, , Pearson Prentice Hall, New Jersey (USA).
3. Entrepreneurship, Lall, Madhurima, and ShikhaSahai, , Excel Book, New Delhi.
4. Entrepreneurship Development and Small Business Enterprises, Charantimath, Poornima, Pearson Education, New Delhi.
5. Entrepreneurship : New Venture Creation – David H. Holt
6. Entrepreneurship : Hisrich Peters
7. The Culture of Entrepreneurship- Brigitter Berger
8. Dynamics of Entrepreneurship development and Management: Entrepreneurship, Project Management, Finances, Programmes, and Problems – Vasant Desai (2009)
9. Entrepreneurship Development – Dr. P.C. Shejwalkar
10. Thought Leader : Shrinevas Pandit
11. Leadership and new Science : Margrat wheatly
12. Handbook of Entrepreneurship Research: An Interdisciplinary Survey and Introduction (International handbook series on Entrepreneurship) (2003) : Zolten J ACs, David B. Audretch

13. Knowledge-Driven Entrepreneurship (2009) : The Key to Social and Economic Transformation By Martin Curley, Piero Formica and Thomas Anderson
14. Entrepreneurship (3rd ed) Steven Brandt
15. The Entrepreneurial Connection – Gurmit Narula
16. Business Guru Speak –S.N. Canary
17. Dhirubhai Ambani: Against All Odds: A Story of Courage, Perseverance and Hope Paperback – 1 July 2017 : by A G Krishnamurthy
18. Mythbreaker: Kiran Mazumdar-Shaw and the Story of Indian Biotech Hardcover – 29 April 2016 by Seema Singh
19. The Entrepreneur's Guide to a Biotech Startup: Peter Kolchinsky
20. The Anatomy of your Creativity : Chris Grady

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M. Sc. II Biotechnology (CBCS Semester Pattern) Semester IV

Revised syllabus w e f June 2020

Subject Code: MBT - 405

Subject : Pharmaceutical Biotechnology &
Drug Designing

(4 Credit Course)

Total Lectures=60

Units	Topic	Lectures
I	Introduction : <ul style="list-style-type: none"> • Introduction to Pharmaceutical Biotechnology and Drug discovery. • Drug targets: Structure and functions; Physiochemical properties of drugs; drugs from natural sources. • Pharmacodynamics, pharmacokinetics and drug metabolism, Drug tolerance & intolerance, drug allergy, drug induced side effects with examples. • Screening and isolation of bioactive compounds 	8L
II	Drug action and Resistance <ul style="list-style-type: none"> • Mechanism of action of anti-diabetic, anticancer, anti-inflammatory and antibiotics (any two drugs of each) • Mechanisms of drug resistance to antibiotics and anticancer drugs with examples • MDR, XDR or PDR • Assay of drug potency- bioassay and immunoassay 	8L
III	Process of Drug Development <ul style="list-style-type: none"> • Target identification and validation. • Pre-clinical studies- -Toxicity (Cytotoxicity, Genotoxicity, Reproductive toxicity, Carcinogenicity, Mutagenicity, and other tests) • Animal models for <i>in vivo</i> activity of drugs testing • Clinical trials: Phase I,II,III and IV 	8L
IV	Biopharmaceuticals : <ul style="list-style-type: none"> • Introduction and scope of Biopharmaceutical industry • Biotherapeutics: Various categories of therapeutics like Vitamins, Antibiotics, Hormones, Enzymes, Hematopoietic Growth Factors and Coagulation Factors, Interferon's and Cytokines for Anti-infective and Cancer Therapy. • Biopharmaceuticals Manufacturing: Overview of upstream & downstream processing • Production of Biopharmaceuticals using Synthetic Biology Approach (eg. Artemisinin) 	10 L
V	Computer aided drug design (CADD) <ul style="list-style-type: none"> • Introduction to CADD • Identification drug targets using molecular modeling, combinatorial libraries and high-throughput screening (HTS) • Methods of drug designing: 	18 L

	<p>1. Structure based drug design</p> <ul style="list-style-type: none"> • Molecular docking: Types and principles, Semi-flexible docking, Flexible docking; Ligand and protein preparation, Macromolecule and ligand optimization, • Analysis of docking results and validation with known information. • Use of Small-molecule libraries, Natural compound libraries for virtual high throughput screenings. • Commonly used docking software <p>2. Ligand based drug design</p> <ul style="list-style-type: none"> • Quantitative structure activity relationships; Introduction to chemical descriptors like 2D, 3D and Group-based • Pharmacophore modeling, Pharmacophore-based screenings of compound library, analysis and experimental validation. • Concept of quantitative drug design using Quantitative structure-activity relationship models (QSAR models) • Types of molecular modelling for proteins 	
VI	<p>Role of Regulatory Authorities in Drug Approvals</p> <ul style="list-style-type: none"> • The Food and Drug Administration (FDA), Investigational new drug application, New drug application; • European regulations National regulatory, authorities, European medicines agency and the new EU drug approval system, Centralized procedure, Mutual • Indian drug regulations, & pharmacopeia • Market issues of drug patenting and licencing in Pharma industry 	8L

Reference Books:

1. Olive Kaiser ,Rainer Muller, Pharmaceutical Biotechnology: Drug Discovery and Clinical Application, Wiley VCH publisher, 2004
2. Vyas and Dixit Pharmaceutical Biotechnology, 1 st CBS Publisher New Delhi, 1991
3. P. K. Gupta, Elements Of Biotechnology, Rastogi Publication, 10 th edition, 2004
4. S.S. Purohit, Biotechnology Fundamentals and Applications Student edition Agrobios Publisher;2002
5. K. Sambamurthy, Ashutosh Kar, Pharmaceutical Biotechnology, 2nd edition New AGE International (LP) Limited, 2007
6. Hermann Dugas, Bioorganic Chemistry: A chemical Approach to Enzyme action by Springer New York, 1999.
7. Kerns, E.H.; Di, L. Drug-Like Properties: Concepts, Structure Design and Methods:from ADME to Toxicity Optimization, Academic Press, Oxford, 2008
8. M. E. Wolff, John Wiley & Sons Burger's Medicinal Chemistry and Drug Discovery, 7th Edition, Vol. 1-6. Principles and Practice, edited by: New York, 2010.
9. Foye's Principles of Medicinal Chemistry, 7th Edition, edited by T.L. Lemke, D. A.Williams, V. F. Roche, and S.W. Zito, Williams and Wilkins: Philadelphia, 2013.
10. Edward C. Olson, Christoffersen Editor, Ralph E. Computer-assisted drug design / 2009, American Chemical Society.
11. Martin YC, Marcel Deckker Quantitative Drug Design - A Critical Introduction by

- Inc. New York.
12. Veerapandian, "Structure Based Drug Design". Taylor and Francis, 1997.
 13. Drug Design, V.M. Kulkarni, K.G. Bothara, Nirali Prakashan
 14. Graham L. Patrick An Introduction to Medicinal Chemistry, ,Oxford University Press1995
 15. Richard B. Silverman The Organic Chemistry of Drug Design & Drug Action, , Elsevier Academic Press, 2014.
 16. Natanya Civjan, Chemical Biology: Approaches to Drug Discovery and Development to Targeting Disease, Edited by Wiley (2012).
 17. Biology For Engineers 2019 Edition by SINGAL R, CBS Publishers and Distributors

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M. Sc. II Biotechnology (CBCS Semester Pattern) Semester IV
Revised syllabus wef. June 2020

Subject Code: MBT - 406 Subject: Research Methodology & Scientific Communication

(4 Credit Course)
Total Lectures=60

Sr No	Topic	No. of lectures
1.	Introduction to Research Methods: <ul style="list-style-type: none"> • Types of research philosophies (positivist, interpretivist, pragmatist and realistic), various steps in scientific research, Scientific temper and attitude, Experimental Design, Defining Controls, deductive and inductive reasoning; reductionist and holistic approaches of scientific research. 	5
2	Scientific Methodology: <ul style="list-style-type: none"> • Problem identification, Critical thinking, hypothesis formulation and hypothesis testing (Power analysis) • Difference between hypothesis, reasoning, theory and scientific law 	5
3	Data Collection and analysis: <ul style="list-style-type: none"> • Types of Data, Methods and Techniques of data collection • Methods of primary data collection (observation/ experimentation/ questionnaire/ interviewing/ case/ pilot study) Methods of secondary data collection (internal/ external), schedule method Research data organization: <ul style="list-style-type: none"> • Creating, Analyzing, Formatting Data & Content using Spreadsheets Insert, View, Edit etc. • Managing Lab Work books, Data tabulation, Calculations, Equations and analyzing biological Data using statistical tools. Data Analysis: <ul style="list-style-type: none"> • Data distributions, Statistical tests for comparison of sample means and sample variance-t-test, non-parametric tests, Correlation and Regression, F, t and Z distribution; goodness of fit, chi-square. • Introduction to multivariate analysis Mathematical models Simulation as a tool to test these models. • Software for data processing: Multidimensional Use of Excel; Sigmastat; GraphPad Prism; SPSS, SAS, R software. 	20
4	Research in Practice: <ul style="list-style-type: none"> • Literature review, Journals, Conference Proceedings, Journal Impact factor, Citation Index, h, g, h-g index, Reading a scientific paper. 	5
5	Research Ethics: <ul style="list-style-type: none"> • Social implications of research, bio-safety issues Animal experimentation ethics, wild-life ethics and human experimentation ethics • Data fudging and plagiarism: Use of URKUND, Turnitin and iThenticate software 	5
6	Scientific Communication: <ul style="list-style-type: none"> • Importance of scientific communication, Types of scientific communications, Logical organization of scientific data and 	20

	<p>documentation</p> <p>Different modes of scientific communication:</p> <ul style="list-style-type: none"> • Scientific Writing: Characteristic of good scientific writing, Structure and content, Style, Literature references, • Report Writing: Types of research reports, guidelines for writing a report, report format, Details of research Proposal writing, Research paper writing, Thesis writing(Introduction, Literature review, Materials and Methods, Results, Discussion, Conclusion and Implications, conflict of interest) • Oral forms of scientific Communication-Popular and Scientific talks, Poster presentations, Organizing Presentation Material , Use of audio visual aids in presentation elements of presentation preparation: objective, subject, audience, Length of talk Managing & Delivering Presentations • Legal forms of communication in science: Plagiarism and scientific misconduct, Ethics in scientific communication, patent submissions. • Internal examination of this paper should be based on following activities <ol style="list-style-type: none"> 1. Review writing/ Report writing 2. Scientific presentation of research paper from reputed journal. 3. Research Data collection and analysis 	
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References:

1. H. Hofmann, Scientific Writing and Communication Papers, Proposals, and Presentations. New York: Oxford University Press, 2010, pp. xv–xvi.
2. T. L. J. Ferris, E. Sitnikova, and A. H. Duff, “Building graduate capabilities to communicate research and plans successfully,” *Int. J. Eng. Educ.*, vol. 26, no. 4, pp. 891–899, 2010
3. Michael Alley, *The Craft of Scientific Writing*, fourth edition, Springer, 2018.
4. Stephen B. Heard, *The Scientists Guide To Writing*, Princeton University Press, 2018.
5. Anthony M. Graziano, Michael L. Raulin, *Research Methods: A Process Of Inquiry* (2012) 8th Edition, , Pearson Publication, Delhi. 2. Barass Robert, *Scientists Must Write: A Guide to Better Writing for Scientists, Engineers and Students* (2002), Routledge Publication, UK. 3.
6. David B. Resnik, *The Ethics of Science: An Introduction* (1998), Routledge Publication, UK. 5.
7. Fisher R A, *The Design of Scientific Experiment* (1971) 9th edition, Collier Macmillan Publishers, London
8. Ganguli Prabuddh, *Intellectual Property Rights* (2001), Tata McGraw-Hill Publishing Company Ltd., Delhi. 7.
9. John D'Angelo, *Ethics in Science: Ethical Misconduct in Scientific Research* (2012), CRC Press, USA
10. Kuhn Thomas, *The Structure of Scientific Revolution* (2012) 50th anniversary edition, Chicago University Press, USA
11. Martha Davis, *Scientific Papers And Presentations* 2nd edition (2004), Academic Press
12. Medawar, P. B. And Medawar, J. S., *The Life Science: Current Ideas of Biology* (1977), Wildwood House, London
13. Peter Raven et al, *Biology* 9th edition (2010), McGraw-Hill Education, Singapore

14. Popper Karl, *The Logic of Scientific Discovery* (2004), Routledge Publication, UK
15. Richard P. Feynman, *The Meaning Of It All: Thoughts Of A Citizen-Scientist* (2005), Basic Books, New York
16. Richard P. Feynman, *The Pleasure of Finding Things Out: The Best Short Works Of Richard P. Feynman* (1999), Edited By Jeffrey Robbins, Perseus Books, USA

Savitribai Phule Pune University
M. Sc. Biotechnology (CBCS Semester Pattern)
Revised syllabus w.e.f. June 2019

Subject code: MBT- 407

Subject – Quality Control, Biosafety & Bioethics
(4 Credit Course)
Total Lectures=60 (4 C)

Units	Topic	Lectures
	Quality Control	
I	<ul style="list-style-type: none"> • Quality Standard & Quality assurances: Concept of quality Assurance & Quality control their function and advantage, Quality assurance and quality management in Biotech Industry • Critical quality point in different stages of production including raw materials & processing material • Types of validation in pharma industry, Importance of validation Elements of validation (Q, OQ, PQ, DQ) Toxicity, clinical trials, studies, clinical research & clinical data management, • Export, Import of product, Rules & Regulations for start up companies GMP , cGMP 	10
II	Essential Documents & Regulatory Submission, Compliance And Audits – <ul style="list-style-type: none"> • Preparation, production and quality control of regulatory documents, creating editorial timelines and work flow specifications, SOP • Scheduling and tracking documents, writing and proofreading. • Development and updates on specifications for the design, tracking of regulatory documents and artwork used in regulatory document • Regulatory requirements for Biotech/pharma product development 	10
	Bioethics	
III	Introduction <ul style="list-style-type: none"> • Introduction to Ethics and Bioethics, Framework for ethical Decision Making • National Ethical Guidelines for biomedical and health research. • Bioethical issues related to Healthcare & medicine Food & agriculture Genetic engineering 	10
IV	Ethical Issues: <ul style="list-style-type: none"> • Animal cloning & human cloning • Human genome project, biopiracy, biowarfare • Public education of producing transgenic organism • Legal & socioeconomic impacts of Biotechnology • Hazardous materials used in biotechnology: Handling & disposal • Experimenting on Animals: Animal right activities Blue cross in India- society for prevention of cruelty against 	10

	<p>Animals. CPCSEA committee, Ethical limits of Animal use.</p> <ul style="list-style-type: none"> • Publication ethics and regulations • Biodiversity 	
	Biosafety	
V	<p>Biosafety</p> <ul style="list-style-type: none"> • Introduction, Biosafety in Laboratory & Institution, Laboratory associated infections & other hazards. • Introduction to Biological Safety Cabinets, Primary Containment for Biohazards • Biosafety Levels, Biosafety Levels of Specific Microorganisms, Recommended Biosafety Levels for Infectious Agents and Infected animals • Safety & hazards: Chemical & radiation hazards Control of exposure to radiation, Fire prevention methods • Industrial Hygiene & toxicology: Introduction , evaluation & control, Personal protective equipment • Risk Analysis, Risk Assessment, Risk management and communication 	14
VI	<p>Biosafety guidelines –</p> <ul style="list-style-type: none"> • Guideline & regulations(National & International) • GMOs & LMOs Guidelines of India • Environmental release issues of GMOs, • Risk Analysis, assessment, risk management and communication • Roles of Institutional Biosafety Committee RCGM, GEAC etc 	6

Reference Books:

1. Deepa Goel & Shomni Parashar IPR, Biosafety and Bioethics, , published by Pearson Education India
2. M K Sateesh Bioethics and Biosafety. Jeffrey M. Gimble, Academia to Biotechnology, Elsevier Academic Press.
3. Rajmohan Joshi (Ed.). 2006. Biosafety and Bioethics. Isha Books, Delhi.
4. Sasson A, Biotechnologies and Development, UNESCO Publications.
5. Senthil Kumar Sadasivam and Mohammed Jaabir M. S. (2008). IPR, Biosafety and Biotechnology Management, Jasen Publications, Ind