



**Maharashtra Education Society's  
Abasaheb Garware College  
(AUTONOMOUS)**

Two Year Degree Program in Biotechnology  
(Faculty of Science & Technology)

Syllabi under Autonomy  
for  
M.Sc. (Biotechnology) Part-II

Choice Based Credit System (CBCS) Syllabus  
To be implemented from Academic Year 2023-2024

**Semester: III**

<b>Course Code</b>	<b>Course Title</b>	<b>Credits</b>	<b>Number of lectures</b>	<b>Marks</b>
<b>Core Compulsory Theory Papers (CCTP)</b>				
<b>PSBT-231</b>	Animal Tissue Culture and Stem Cell Technology	4	60	100 (70 External +30 Internal)
<b>PSBT-232</b>	Bioprocess engineering	4	60	100 (70 External +30 Internal)
<b>PSBT-233A</b>	Bioinformatics	2	30	50 (35 External + 15 Internal)
<b>PSBT-233B</b>	Biostatistics	2	30	50 (35 External + 15 Internal)
<b>Core Compulsory Practical Paper: CCP-1</b>				
<b>PSBTP-234</b>	Laboratory Course III- Animal Biotechnology, Bioprocess engineering, Bioinformatics & Biostatistics	4	30	100 (70 External +30 Internal)
<b>Choice Based Optional Papers: CBOP (any One)</b>				
<b>PSBTELE-235A</b>	Nano Biotechnology	2T	30	50 (35 External +15 Internal)
<b>PSBTELEP-235A</b>	Practicals in Nano Biotechnology	2P	15	50 (35 External +15 Internal)
<b>PSBTELE-235B</b>	Agricultural Biotechnology	2T	30	50 (35 External +15 Internal)
<b>PSBTELEP-235B</b>	Practicals in Agricultural Biotechnology	2P	15	50 (35 External +15 Internal)
	<b>Total Credits</b>		<b>20</b>	
<b>PSCYS3-23</b>	Cyber Security- Module III	1	15	
<b>PSIC-23</b>	Introduction to Constitution- Module I and II	2	30	
<b>PSSD1-23</b>	Skill Development- Module I and II	2	30	

**Semester: IV**

<b>Course Code</b>	<b>Course Title</b>	<b>Credits</b>	<b>Number of lectures</b>	<b>Marks</b>
<b>Core Compulsory Theory Papers (CCTP)</b>				
<b>PSBT-241</b>	Genomics and Proteomics	6	60	100 (70 External +30 Internal)
<b>PSBT-242</b>	Advanced Bio analytical Techniques	4	60	100 (70 External +30 Internal)
<b>Core Compulsory Practical Paper: CCPP-1</b>				
<b>PSBTP-243</b>	Research Project	4		100 (70 External +30 Internal)
<b>Choice Based Optional Papers: CBOP (any Two)</b>				
<b>PSBTELE-244A</b>	Bio entrepreneurship & Start up Designing	4	60	100 (70 External +30 Internal)
<b>PSBTELE-244B</b>	Pharmaceutical Biotechnology & Drug Designing	4	60	100 (70 External +30 Internal)
<b>PSBTELE-244C</b>	Research Methodology & Scientific Communication	4	60	100 (70 External +30 Internal)
<b>PSBTELE-244D</b>	Quality Control, Bio safety & Bioethics	4	60	100 (70 External +30 Internal)
	<b>Total Credits</b>		<b>20</b>	
<b>PSCYS4-24</b>	Cyber Security- Module IV	1	15	
<b>PSSD2-24</b>	Skill Development- Module III and IV	2	30	

**Syllabi under Autonomy**  
**M.Sc. Biotechnology Part – II**

**Semester III**

**Course Code and title: PSBT-231 Animal Tissue Culture and Stem Cell Technology**

**Credits: 04**

**Total Lectures: 60**

**Course Objectives:**

By the end of this course students will able to

1. Understand basics skills in animal tissue culture
2. Understand concept of transgenic animals and different related techniques
3. Know basic information related to stem cells

Units	Topics	Number of Lectures
I	<p><b>Introduction to tissue culture:</b></p> <ul style="list-style-type: none"> <li>• History, basics concepts in animal tissue culture</li> <li>• Importance of maintenance of sterility and use of antibiotics, different types of contaminants</li> <li>• Detection of cryptic contaminants- Mycoplasma and viruses</li> <li>• Cross contamination, eradication of contaminants</li> <li>• Logic of formulation of tissue culture media: natural, synthetic media, sera and substitutes</li> <li>• Introduction to the balanced salt solutions</li> <li>• Role of carbon dioxide in animal cell culture</li> <li>• Different types of tissue culture vessels used</li> </ul>	5
II	<p><b>Various systems of tissue cultures:</b> Distinguishing features, advantages and limitations.</p> <ul style="list-style-type: none"> <li>• <b>Methodology:</b> i. Primary culture, ii. Explant culture, iii. Suspension culture.</li> <li>• Behavior of cells, properties, utility with different examples Concept of Cell senescence.</li> <li>• <b>Cell lines:</b> Definition, establishment and maintenance,</li> <li>• Normal, Transformed and established cell lines: characteristic features, Contact inhibition, anchorage (in) dependence, Cell and tissue response to various factors</li> </ul>	5
III	<p><b>3-D Cultures</b></p> <ul style="list-style-type: none"> <li>• <b>Organ culture:</b> Methods, behavior of organ explant, and applications of organ culture.</li> <li>• Histotypic and organotypic cultures: methods and applications</li> <li>• Introduction to organ transplants, tissue engineering, bio-artificial organs</li> </ul>	5
IV	<ul style="list-style-type: none"> <li>• <b>Growth studies:</b></li> <li>• Cell proliferation, cell cycle, mitosis in growing cells</li> <li>• Cryopreservation of cultured cells</li> <li>• Measurement of viability and cytotoxicity, microscopic examination of cultures,</li> </ul>	5

	<ul style="list-style-type: none"> <li>• subculture of cells (monolayer and suspension cells), passage number</li> <li>• Cell cloning and types, cell synchronization</li> <li>• Cell transformation</li> <li>• Cell Separation: Various methods- advantages and limitations;</li> <li>• Scaling up</li> <li>• Cell hybridization</li> </ul>	
V	<p><b>Application of animal cell culture:</b></p> <ul style="list-style-type: none"> <li>• For <i>in vitro</i> testing of drugs,</li> <li>• Production of viral vaccines and pharmaceutical proteins, monoclonal antibodies.</li> <li>• Mass production of biologically important compounds.</li> <li>• Propagation of viruses.</li> <li>• Harvesting of products, purification and assays.</li> </ul>	3
VI	<ul style="list-style-type: none"> <li>• <b>Stem cells technology</b> –</li> <li>• Concept, characteristics of different types of stem cells- adult stem cells, embryonic stem cells, embryonic carcinoma cells, embryonic germ cells, induced pluripotent stem cells, cancer stem cells</li> <li>• Identification, purifications, assessment of potency and proliferation of stem cells</li> <li>• Long term maintenance and characterization of differentiated cells by Fluorescence microscopy, FACS, RNA-sequencing analysis and microarray.</li> <li>• Molecular mechanisms of stem cell self-renewal and pluripotency</li> <li>• Cell cycle regulation in stem cells</li> <li>• Concept of Stem cell niche with suitable examples</li> <li>• Overview of Neural stem cells, Hematopoietic stem cells, Mesenchymal stem cells</li> <li>• Applications of stem cells in therapeutics- in treatment of diabetes, neurodegenerative diseases, skin burns etc.</li> </ul>	15
VII	<ul style="list-style-type: none"> <li>• <b>Animal husbandry and reproductive biotechnology:</b></li> <li>• Overview of livestock breeds and their productivity in India</li> <li>• Systems of breeding</li> <li>• Artificial breeding:- different methods</li> <li>• Methods of semen collection from bulls, cryopreservation of semen sample, ova and embryos</li> <li>• Estrous cycle, estrous synchronization- different methods, hazards associated</li> <li>• Artificial insemination of cows- various methods with advantages and limitations</li> <li>• <i>In vitro</i> fertilization and embryo transfer technology</li> </ul>	7

	<ul style="list-style-type: none"> <li>• Animal cloning: concept and application in conservation</li> </ul>	
VIII	<p><b>Transgenic animals:</b></p> <ul style="list-style-type: none"> <li>• Overview of different methods of introduction of a transgene viz. micronuclear injection method, transduction with recombinant viruses, REMI etc.</li> <li>• Targeted gene insertion, gene silencing by RNAi,:</li> <li>• Cre-LoxP recombination for genetic modification</li> <li>• CRISPR/Cas9 for targeted genome editing</li> <li>• Transgenic animals: fish, <i>Xenopus</i>, mammals- methods and applications</li> <li>• Concept of Knockout, knockdown mice- methods and application</li> <li>• Mouse models for neurodegenerative disorders, cancer</li> </ul>	15

**References:**

1. R. Ian Freshney. Culture of Animal cells, 7<sup>th</sup> Edition, (2015). A John Wiley & Sons, Inc., Publications, USA
2. R.W.Masters. Animal Cell Culture- Practical Approach, 3<sup>rd</sup> Edition, (2000), Oxford University Press. USA
3. Robert Lanza et al. *Essentials of Stem Cell Biology*”, 3<sup>rd</sup> edition, Academic Press, 2014.USA
4. Text book of Animal Husbandry, 8<sup>th</sup> edition, (2018) G.C. Banerjee, Oxford and IBH Publishing co. Pvt. Ltd. India
4. Molecular Biotechnology: 6<sup>th</sup> edition. (2022), Glick B.R., Pasternak J.J., Patten C. L., ASM press, USA

**Course Code and title: PSBT-232 Bioprocess Engineering****Credits: 04****Total Lectures: 60****Course Outcome:**

By the end of this course students will able to

1. Understand the basics of bioreactor design and operations.
2. Understand the concept of mass transfer and its regulation.
3. Learn the production of different metabolites and processes involved in DSP.
4. Learn the QC and QA of biotechnological product.

Units	Topics	Number of Lectures
I	<p><b>Bioprocess development:</b> Definition of Bioprocess and bioprocess Engineering, over view of bioprocesses with their various components. Aseptic operations and Containment</p> <ul style="list-style-type: none"> <li>• <b>Types of Fermentations</b> : Solid state fermentation, Dual/Multiple, Aerobic, Anaerobic, batch, fed-batch, continuous</li> <li>• <b>Design of Fermenter/ bioreactors:</b> Overview of types of Bioreactors, Novel Designs of Bioreactors.</li> <li>• <b>Kinetics of operation of bioreactors:</b> Batch, Fed Batch and Continuous processes., Growth Linked and Non growth Linked Products, Kinetic modelling, Model structures, Material balances and energy balances</li> <li>• Isolation, screening and maintenance of industrially important microbes</li> <li>• <b>Strain Improvement:</b> Product formation and inhibition pathways and their regulations, Strain improvement by: Mutation, Protoplast fusion, parasexual cycle and genetic engineering</li> <li>• <b>Inoculum Development:</b> Inoculum Development for bacterial, yeast and mycelial processes, aseptic method of inoculation, achievement and maintenance of aseptic conditions.</li> </ul>	15
II	<p><b>Monitoring of process variables:</b></p> <ul style="list-style-type: none"> <li>• Types of sensors, Measurement and control of various parameters (pH, Temperature, dissolved oxygen, microbial biomass, inlet and exit gases, fluid flow, Pressure, Foam)</li> <li>• P.I. D. control, Computer control of variables.</li> <li>• <b>Scale Up and Scale Down</b> : Importance, parameters involved</li> <li>• <b>Media for industrial fermentations:</b> 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.</li> <li>• <b>Sterilization of media and air:</b> 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,</li> </ul>	10

	theory of depth filter, designing of depth filters.	
III	<p><b>Mass transfer, Aeration and agitation of fermentation broth:</b></p> <ul style="list-style-type: none"> <li>• <b>Mass transfer:</b> Concept of mass transfer, Molecular diffusion and role</li> <li>• in bioprocess, Two–film theory, Convective mass transfer, volumetric</li> <li>• mass transfer, Liquid-Solid, Liquid-liquid and Gas- liquid mass transfer</li> <li>• equations and significance in bioprocess.</li> <li>• <b>Aeration</b> : Oxygen Uptake in cell cultures, Oxygen transfer from Gas</li> <li>• bubble to Cell. Gas hold up, KLa importance, Measurement of KLa,</li> <li>• Determination of KLa, Factors affecting KLa.</li> <li>• <b>Agitation:</b> Design of impellers and their flow patterns. Fermentation</li> <li>• 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.</li> </ul>	12
IV	<p><b>Downstream Processing:</b></p> <ul style="list-style-type: none"> <li>• Bio separation :- filtration, centrifugation, sedimentation, flocculation;</li> <li>• Cell disruption (Physical, Chemical and enzymatic methods).</li> <li>• Extraction(Liquid-liquid, Aqueous two phase, Supercritical fluid);</li> <li>• Distillation,</li> <li>• Purification by chromatographic techniques; Reverse osmosis and ultrafiltration; Drying; Crystallization, Whole Broth Processing</li> </ul>	8
V	<p><b>Industrial Production and Recovery process of:</b></p> <ul style="list-style-type: none"> <li>• Vitamins (Vitamin C), Amino acids (Glutamic acid), Enzymes (Extra and Intra cellular one example each), Antibiotics (Rifamycin), Organic acids (Lactic acid), Recombinant Vaccines,</li> <li>• Biosimilars</li> <li>• Biotransformation product (Steroids), Brewing (Beer), Cheese, Exopolysaccharides, Biodiesel.</li> </ul>	10
VI	<p><b>Quality Control (QC) and Quality assurance (QA) :</b></p> <ul style="list-style-type: none"> <li>• Roles and responsibilities of QC and QA departments, Common quality control tests,</li> <li>• Standard Operating Procedures (SOP) &amp; Good Manufacturing Practices (GMP), Regulations on use and distribution of Biotechnology products.</li> </ul>	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., (2019), Industrial Microbiology, New age International, New Delhi, Second Edition.
4. Prescott. S.C and Dunn, C. G., (2004) Industrial Microbiology, CBS Publishers and Distributors, Fourth Edition.
5. A.H. Patel. (2011), Industrial Microbiology, Macmillan India Ltd, Second Edition.
6. Crueger, W. and Crueger, A. (2005) A Text Book of Industrial Biotechnology, Panima, New Delhi.
7. Satyanarayan U, (2008) Biotechnology, Arunabha Sen Books allied Publishers.
8. Schuler, M. and Kargi, F. Bioprocess Engineering -Basic Concept, Prentice Hall of India, New Delhi.
9. Pauline Doran, (2012), Bioprocess Engineering Principles - Academic Press, second Edition
10. Operational Modes of Bioreactors, BIOTOL series - Butter worth, Heinemann 1992
11. Bioreactor Design & Product Yield, BIOTOL series - Butter worth Heinemann 1992
12. Lydersen B., N. a. D' Elia and K. M. Nelson (Eds.) (1993) Bioprocess Engineering: Systems, Equipment and Facilities, John Wiley and Sons Inc.
13. Harrison, R, Todd, P (2006), Bioseparations science and Engineering, Oxford University Press
14. Aydin Berenjian, (2019) Essentials in Fermentation Technology Springer; Kindle edition

**Course Code and title: PSBT-233 A Bioinformatics****Credits: 02****Total Lectures: 30****Course Outcome:**

By the end of this course students will able to

1. Understand the basics of bioinformatics and various databases.
2. Learn the theoretical aspect and sequence analysis.
3. Understand the molecular visualization of structure and various parameter involved.
4. Learn the concept of docking.

<b>Units</b>	<b>Topics</b>	<b>Number of Lectures</b>
I	<b>Major Bioinformatics Resources and Biological databases</b> <ul style="list-style-type: none"> <li>• Computers in Biology and medicine, Database concept</li> <li>• NCBI/EBI/EXPASY</li> <li>• Biological literature databases (PubMed)</li> <li>• Nucleic acid sequence databases (NCBI's GenBank + the European Nucleotide Archive [ENA] + the DNA Data Bank of Japan [DDBJ],)</li> <li>• Protein sequence databases (UniProtKb, SwissPort, TrEMBL).</li> </ul>	4
II	<b>Basic Concepts in Biological sequence Analysis:</b> <ul style="list-style-type: none"> <li>• Biomolecular sequence analysis: Overview and Concepts</li> <li>• Pairwise sequence alignment methods: Dot plot, Dynamic programming (Needleman &amp; Wunsch, Smith &amp; Waterman) and K-tuple based (BLAST and FASTA)</li> <li>• Scoring matrices for Protein and Nucleotide sequences (PAM series and BLOSUM series), Gap Penalty and Penalty Scheme</li> <li>• Multiple sequence alignment algorithms, Methods of MSA (Progressive, Iterative, Block-Based Alignment) (CLUSTALW and CLUSTALX,T-Coffee)</li> <li>• Application of Multiple sequence alignment (Phylogenetic analysis)</li> </ul>	8
III	<b>Structural Bioinformatics</b> <ul style="list-style-type: none"> <li>• Major Structural Resources (PDB and PMDB)</li> <li>• PDB flat File Format</li> <li>• Basic Structure Visualization:</li> <li>• Visualization of major secondary structure (helices, beta sheets) and their role in protein structure.</li> <li>• 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.</li> <li>• Protein Structure Classification (SCOP and CATH)</li> <li>• Protein Structure Prediction:</li> <li>• Need and Concept of protein structure prediction, protein folding and model generation.</li> <li>• Protein secondary structure prediction methods (Alignment based and Single sequence-based secondary structure predictions.</li> </ul>	8

	<ul style="list-style-type: none"> <li>• Tertiary structure prediction (Homology modeling and Fold Recognition, ab initio methods).</li> <li>• Ramchandran Plot.</li> </ul>	
IV	<b>Pharmacophore modelling and Chemoinformatics</b> <b>Pharmacophore modelling</b> <ul style="list-style-type: none"> <li>• Pharmacophore: Definition and classes (HBA, HBD, Aromatic etc.)</li> <li>• Identification of pharmacophore features</li> </ul> <b>Chemoinformatics</b> <ul style="list-style-type: none"> <li>• Chemical Structure representation: 1D, 2D and 3D structures</li> <li>• Molecular file formats (SMILES, WLN, SDF, MOL,PDB etc)</li> <li>• Compound library formatting and filtering (Physicochemical and substructure filters)</li> </ul>	5
V	<b>Molecular Modeling</b> <ul style="list-style-type: none"> <li>• Introduction to modelling protein ligand interactions</li> <li>• Pose Prediction Strategies in molecular Docking: Rigid body docking flexible ligand docking (Conformational search method, Fragmentation method, Database method)</li> <li>• Scoring Functions: Force field-based, Empirical, Knowledge-based</li> <li>• Application in Structure Based Drug Designing</li> <li>• Molecular dynamics and simulations</li> </ul>	5

**References:**

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., Weissig Helge. 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. Muthukumarasamy Karthikeyan, Renu Vyas. Practical Chemoinformatics. Publisher: Springer. 2014. ISBN: 9788132217794
13. Lesk, A. M. (2002). Introduction to Bioinformatics . Oxford: Oxford University Press. Press.

**Course Code and title: PSBT-233 B Biostatistics****Credits: 02****Total Lectures: 30****Course Outcome:**

By the end of this course students will able to

1. Collect, classify, analyse and present data sets.
2. Apply hypothesis testing to the data and perform appropriate statistical tests.
3. Develop skills in analysis of qualitative and quantitative data.

<b>Units</b>	<b>Topics</b>	<b>Number of Lectures</b>
I	<b>Introduction:</b> <ul style="list-style-type: none"> <li>• Biological variables, parameters of statistical data display.</li> <li>• Types of scales: linear, power, log, circular (with biological examples)</li> <li>• Curves and Equations: Linear, saturating, sigmoid, exponential, logistic, power, multinomial, algebraic, differential, partial differential</li> </ul>	4
II	<b>Sampling, distribution and presentation</b> <ul style="list-style-type: none"> <li>• Sampling methods; Types of sampling; random sampling, Probability and non-probability sampling, stratified sampling, etc.</li> <li>• Power analysis and sample size calculations</li> <li>• Statistical data distribution, normal and skewed distribution, coefficient of skewness, moments and Kurtosis</li> </ul>	7
III	<b>Hypothesis Testing (with biological examples)</b> <ul style="list-style-type: none"> <li>• Principles of hypothesis testing, significance level, null hypothesis</li> <li>• Type I and Type II errors</li> </ul>	5
IV	<b>Design, correlation and regression analysis</b> <ul style="list-style-type: none"> <li>• Statistical design of experiments, single and multifactorial designs, fractional factorial designs.</li> <li>• Principles of experimental designs; randomization, replication and local control; Complete, incomplete and randomized block designs;</li> <li>• Covariance and correlation, Pearson's, Kendal's and Spearman's correlations, use of correlation and regression in biological analyses</li> <li>• 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.)</li> </ul>	8
V	<b>Statistical Methods:</b> <ul style="list-style-type: none"> <li>• T-test family and Z-test,</li> <li>• Chi-square test</li> <li>• Analysis of variance table (ANOVA) and Kruskal Wallis test</li> <li>• Mann-Whitney U test</li> <li>• Post hoc Tests-</li> </ul>	6

	<ul style="list-style-type: none"><li>• Tukey's test for pairwise comparison of treatments</li><li>• Dunnet's test for comparison of treatment means with control</li><li>• Duncan's multiple range test</li><li>• Spearman and Pearson Correlation</li></ul>	
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Reference books:

1. Billingsley, P. (2012). Probability and Measure. New York: Wiley. 3rd edition
2. Rosner, B. (2015). Fundamentals of Biostatistics . Boston, MA: Duxbury Press 8th edition
3. Daniel, W. W. (2018). Biostatistics, a Foundation for Analysis in the Health Sciences. New York: Wiley. 11th edition
4. P.S.S. Sunderrao and J. Richards-An introduction to Biostatistics, Prentice Hall Pvt. Ltd. India
5. Campbell R.C.- Statistics for Biologists, Cambridge University Press, Cambridge.

**Course Code and Title: PSBTP-234** Laboratory Course III- Animal Biotechnology, Bioprocess engineering, Bioinformatics & Biostatistics

**Credits: 04**

**Total Practicals:30**

**Course Outcomes:**

By the end of this course students will able to

1. study the techniques of establishment, maintenance and preservation of cell lines
2. get hands on for parameter optimization for fermentation processes. Also will be able to perform production of few metabolites.
3. To understand the concept of MSA, phylogenetic analysis, tertiary structure prediction and docking.
4. Students will learn to perform data analysis using statistics tools.

Units	Topics	Number Of Practicals
	<b>Animal Biotechnology Practical</b>	
I	Preparation, sterilization of media	1
II	Initiation of primary culture from chick embryo Enumeration of isolated cells	2
III	Subculture and maintenance of cell line	2
IV	Growth studies of cell line	2
V	Chromosome spread preparation from cell line	1
	<b>Bioprocess Engineering Practical</b>	
I	Screening and identification (Genus Level) of a production strain (enzyme /antibiotic) from soil samples.	3
II	Maintenance of the isolated production organism (Agar slants/ glycerol stocks /soil culture/ lyophilization) at least two methods.	1
III	Medium optimization for laboratory scale production of enzyme/antibiotics.	2
IV	Study of Working of lab bench fermenter ( with production of enzyme or antibiotic using screened organism)	1
V	Recovery and Assay of product formed (Bioassay or Enzyme assay).	1
VI	Solid state fermentation : Lab scale production of a product.	1
VII	Visit to fermentation industry and Report writing	1
	<b>Bioinformatics Practical</b>	
I	Using online resources like NCBI, PubMed (GenBank, UniProtKB, PDB)	1

II	Sequence alignment using BLAST/ Database Similarity searching using BLAST	1
III	Multiple sequence alignment by using Clustal/Bioedit	1
IV	Phylogenetic analysis using Phylip or Mega	1
V	Basic Structure visualization using DeepView (Performing basic tasks like Selecting and Displaying structures, Colouring, Measuring distances and labeling)	1
VI	Prediction of protein tertiary structure using any method (MODELLER/ SWISS Model)	1
VII	Molecular Docking using AutoDock and Molecular visualization of docked complexes (using Pymol or Chimera)	2
	<b>Biostatistics practical based on theory course:</b>	
I	Determination of Karl-Pearson's coefficient of correlation/ Spearman's rank correlation coefficient from the given grouped and ungrouped data.	1
II	Examples based on t – test , Chi-square test for goodness of fit and independent attributes.	1
III	Analysis of variance on the given data (ANOVA).	1
IV	Measures of skewness and measures of Kurtosis (grouped and ungrouped data).	1

### References:

- 1.R. Ian Freshney. Culture of Animal cells, 5<sup>th</sup> Edition, 2010. A John Wiley & Sons, Inc., Publications, USA
- 2.R. W. Masters. Animal Cell Culture- Practical Approach, 3<sup>rd</sup> Edition, 2000, Oxford University Press. USA
3. Operational Modes of Bioreactors, BIOTOL series - Butter worth, Heinemann 1992
4. Bioreactor Design & Product Yield, BIOTOL series - Butter worth Heinemann 1992
5. Baxevanis Andreas D. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Latest Edition. Publisher: New York, John Wiley & Sons, Inc.
6. Bourne Philip E., Weissig Helge. Structural Bioinformatics (Methods of Biochemical Analysis, V. 44), 2003. Publisher: Wiley-Liss. ISBN: 0471202002.
7. Forbes Burkowski. Structural bioinformatics: An algorithmic approach. Publisher: CRC Press, 2009. ISBN: 9781584886839.
8. Sternberg Michael J. E. Protein Structure Prediction: A Practical Approach. Publisher: USA, Oxford University Press. 1997. ISBN: 0199634953.
9. Gasteiger Johann, Handbook of Chemoinformatics: From Data to Knowledge (4 Volumes). Publisher: Wiley-VCH. 2003. ISBN:3527306803.
10. Muthukumarasamy Karthikeyan, Renu Vyas. Practical Chemoinformatics. Publisher: Springer. 2014. ISBN: 9788132217794
11. Billingsley, P. (2012). Probability and Measure. New York: Wiley. 3rd edition
12. Rosner, B. (2015). Fundamentals of Biostatistics . Boston, MA: Duxbury Press 8th edition
13. Daniel, W. W. (2018). Biostatistics, a Foundation for Analysis in the Health Sciences. New York: Wiley. 11th edition

**Course Code and title: PSBTELE-235A Nanobiotechnology**

**Credits: 02**

**Total Lectures: 30**

**Course outcome:** By the end of this course students will able to

1. Students will learn basics of nanotechnology, synthesis of nanoparticles, characterization of nanoparticles and applications of Nanobiotechnology

Units	Topic	Lectures (30)
I	<p><b>Introduction to Nanobiotechnology:</b></p> <ul style="list-style-type: none"> <li>• History of nanotechnology and its emergence, Concept of Nano-biotechnology,</li> <li>• Types of nanoparticles and Their Properties: Quantum dots, Polymeric nanoparticles,</li> <li>• Metal nanoparticles, metal oxide nanoparticles, Dendrimers, Composites.</li> </ul>	05
II	<p><b>Methods for synthesis of Nanomaterials:</b></p> <p><b>Physical method:</b></p> <ul style="list-style-type: none"> <li>• Introduction</li> <li>• Mechanical method</li> <li>• Sputter deposition</li> <li>• Electric arc deposition</li> <li>• Methods based on evaporation</li> </ul> <p><b>Chemical method:</b></p> <ul style="list-style-type: none"> <li>• Introduction</li> <li>• Colloids and colloids in solutions</li> <li>• Microemulsion</li> <li>• Sol- Gel Method</li> </ul> <p><b>Biological method:</b></p> <ul style="list-style-type: none"> <li>• Introduction</li> <li>• Synthesis using microorganisms</li> <li>• Synthesis using plant Extracts</li> <li>• Use of Proteins and DNA Templates</li> </ul>	10
III	<p><b>Physiochemical characterization of Nanomaterials:</b></p> <ul style="list-style-type: none"> <li>• Optical (UV-Vis/Fluorescence)</li> <li>• X-ray diffraction, Imaging and size</li> <li>• FTIR</li> <li>• Electron microscopy- TEM, SEM,</li> <li>• light scattering- DLS, NTA; Zeta potential</li> </ul>	08
IV	<p><b>Applications of Nanobiotechnology:</b></p> <ul style="list-style-type: none"> <li>• Nanomedicines(Health and disease - infectious and chronic)</li> <li>• Nanoparticles for diagnostics and imaging</li> <li>• Food Science ( Food Processing, Food Packaging, detection of pathogens)</li> <li>• Nanosensors</li> <li>• Nanotechnology for water remediation and purification</li> <li>• Nanotechnology in agriculture.</li> </ul>	06



V	<b>Concerns of Nanomaterials/Nanobiotechnology:</b> <ul style="list-style-type: none"> <li>• Fate of nanomaterials, environmental and health impact of nanomaterials, Genotoxicity and cytotoxicity evaluation of Nanomaterials, eco-toxicology</li> </ul>	01
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**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, Christ of 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.
6. Nanotechnology in Biology and Medicine: Methods, Devices, and Applications.
7. Nanotechnology: Principles and Practices, Sulbha Kulkarni, Capital publishing company

**Subject Code: PSBTELEP-235A** Practicals in Nanobiotechnology

**Credits: 02**

**Total practicals: 15**

**Course outcome:**

Students will learn basics of nanotechnology, synthesis of nanoparticles, characterization of nanoparticles and Biological activity of Nanobiotechnology.

Sr. No.	Laboratory Course - Nanobiotechnology	No. Of Practical
I	<b>Synthesis of metal/metal oxide Nanoparticles by:</b> a. Chemical b. Microbial and c. Plant based method	5
II	<b>Characterization of nano-materials by spectroscopic method:</b> i. Analysis of absorption spectra of thin films of Nanomaterials ii. Determination of absorption coefficient for different wavelength	5
III	<b>Biological activities of nanoparticles:</b> 1. Antimicrobial activities of synthesized nanoparticles (MIC/MBC determination) 2. Cytotoxicity testing of nanoparticles using MTT/Tryphan blue assay	5

**References:**

1. Bauer, A. W., W. M. M. Kirby, J. C. Sherris, and M. Turck. 1966.
2. Antibiotic susceptibility testing by a standardized single disk method. Am. J. Clin. Pathol. 36:493-496.
3. Clinical Laboratory Standards Institute. 2006. Performance standards for antimicrobial disk susceptibility tests; Approved standard— 9th ed. CLSI document M2-A9. 26:1. Clinical Laboratory Standards Institute, Wayne, PA.
4. Mosmann T. 1983. Rapid colorimetric assay for cellular growth and survival: Application to proliferation and cytotoxicity assays. Journal of Immunological Methods. 65(1-2):55-63.

**Course Code and Title: PSBTELE-235B Agricultural Biotechnology**

**Credits: 2**

**Total Lectures: 30**

**Course outcome:**

1. Students will get exposure to various biotechnological methods used in the field of agriculture.
2. Students will learn molecular assays used for characterising and improvement of crops.

Units	Topics	Number of Lectures
I	<p><b>Introduction to agricultural Biotechnology</b></p> <ul style="list-style-type: none"> <li>• Importance of Agriculture at national economy</li> <li>• Advantages of biotechnological methods over conventional methods of crop improvement.</li> <li>• <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</li> <li>• Endosperm culture &amp; production of triploids for production of seedless plant varieties with examples</li> <li>• Use of bioreactors in plant production &amp; Scale-up for Commercialization</li> <li>• Beneficial microorganisms in Agriculture: Biofertilizer (Bacterial Cyanobacterial and Fungal), microbial Bio insecticides</li> <li>• Major pest and diseases of horticultural crops and their control by Biotechnological methods</li> </ul>	10
II	<p><b>Crop improvement</b></p> <ul style="list-style-type: none"> <li>• Improvement of crop quality (FlavrSavr tomato, Golden rice)</li> <li>• □ Chloroplast manipulations for production of therapeutic proteins, vaccines, antibodies and increased production</li> </ul>	3
III	<ul style="list-style-type: none"> <li>• <b>Recent advances</b></li> <li>• Plant genotyping by different methods PCR, Plant fingerprinting, Microsatellite, Nanotechnology.</li> <li>• Homogenous assays – Qualitative Real Time PCR assays, applications</li> <li>• CRISPR based technology: Introduction, techniques, and its application in plants</li> <li>• Plant DNA Barcoding- Introduction, Barcoding Markers (matK, rbcL, ITS, tm HpsbA), Recent advances in plant bar coding Benefits, Limitations</li> </ul>	9
IV	<p><b>Development and formulation (with various carrier materials) of bioinoculants, for better Agricultural productivity, using:</b></p> <ol style="list-style-type: none"> <li>i. Growth promoting ,</li> <li>ii. Nitrogen fixing,</li> <li>iii. Phosphate solubilizing,</li> <li>iv. Metal chelating, (siderophores)</li> <li>v. Growth hormone producing microorganisms</li> </ol>	7

	Agricultural biotechnology and agribusiness Opportunities in the Agriculture Biotechnology	
V	Impact of GMOs on environment	1

**Reference Books:**

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. 4<sup>th</sup> 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. 7<sup>th</sup> 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 (1<sup>st</sup> 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. 3<sup>rd</sup> 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, Prerna Pandey (2017).
18. Agricultural Biotechnology (2006) By Varun Metha) Book by Varun Mehta
19. Agricultural Biotechnology (2016): Vivian Laura

**Course Code and title: PSBTELEP-235B** Practicals in Agricultural Biotechnology

**Credits: 02**

**Total Practicals: 15**

**Course outcome:**

- 1) The learners will gain hands on experience of plant culture techniques.

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

**Reference Books:**

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. 4<sup>th</sup> 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. 7<sup>th</sup> Ed. Blackwell Publishing.
9. Molecular Cloning: A Laboratory Manual (2001) Sambrook J. and Russel D, 3<sup>rd</sup> 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 (1<sup>st</sup> Ed)

**Semester IV**

**Course Code and title: PSBT-241 Genomics and Proteomics**

**Credits: 04**

**Total Lectures: 60**

**Course outcome:** By the end of this course students will able to

1. Learn various genomics approaches with appropriate examples.
2. Study different types of microarrays and their applications.
3. Learn various proteomics approaches with appropriate examples.
4. Study different types of techniques used in proteomics.

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

	<ul style="list-style-type: none"> <li>• Peptide mapping &amp; sequencing.</li> <li>• Protein structure prediction- homology modelling.</li> <li>• Mass Spectrometry: MALDI_TOF, ESI Tandem, Ion Trap, Peptide mass fingerprinting.</li> <li>• LC-MS, (SILAC) - Chemical tagging, fluorescence, radiolabeling.</li> </ul>	
	<p><b>Applications of Proteomics</b></p> <ul style="list-style-type: none"> <li>• Protein expression profiling.</li> <li>• Protein-protein &amp; Protein-DNA interaction (Chip Technique)</li> <li>• Methods for detection of protein-protein interactions -Yeast 1, 2 and 3 hybrid systems, Phage display.</li> <li>• Proteomics and Protein microarrays, databases and allied bioinformatics tools.</li> <li>• Health care, Biomarkers in disease diagnosis, Biomarker-drug development and their target identification.</li> <li>• Identification and characterization of novel proteins</li> </ul>	13

**Reference Books:**

1. Basic Concepts of Genomics and Bioinformatics, De Sachinandan & Biswajit Brahma, 1st edition (2022), I B P S S.
  2. Genomes 4. T. A. Brown, 4th edition (2018), Garland Science.
  3. Introduction To Genomics, Arthur M. Lesk, 2nd (2015) Oxford University Press.
  4. Genetics Analysis Of Genes And Genomes, Daniel L. Hartl, Bruce Cochrane, 1st Edition (2017), Jones & Barlett Publishing.
  5. Genomics And Proteomics Principles Technologies And Applications, Devarajan Thangadurai Jeyabalan Sangeetha, 1st edition (2015), Apple Academic Press Inc.
- 
1. Genomics, Proteomics And Vaccines, Nelson R, 2022, Kaufman Press Exclusive.
  2. Proteomics: From Protein Sequence to Function by S. R. Pennington M. J. Dunn, 2017, Viva Books Pvt Ltd.
  3. Microbial Genomics and Proteomics, Niyaz Ahmed, 2016, Intelliz Press LLC.
  4. Genomics And Proteomics Principles Technologies And Applications, Devarajan Thangadurai Jeyabalan Sangeetha, 1st edition , 2015, Apple Academic Press Inc.
  5. Proteomic Profiling: Methods and Protocols, Anton Posch, 2nd edition, 2021, Humana Press.

**Course Code and Title: PSBT-242 Advanced Bioanalytical Techniques**

**Credits: 4**

**Total Lectures: 60**

**Course Outcome:** By the end of this course students will able to

1. Learning techniques will enhance the knowledge of principles and applications of various instruments.

2. Comprehensive understanding of Bioanalytical techniques will make the students capable of working in areas of research & development, industries.

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

**References:**

- Principles and Techniques of Biochemistry and Molecular Biology, 7<sup>th</sup> edition, (2010), Wilson K.M., Walker J.M., Cambridge University Press,



UK

2. Biophysics. 1<sup>st</sup> 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. 3<sup>rd</sup> edition. (2000) Rodney Boyer. Prentice Hall Publisher, USA.
5. Analytical Biochemistry, 3<sup>rd</sup> edition, (1998), David Holmes, H.Peck , Prentice Hall, UK.
6. Vogel's, Text Book of Quantitative Chemical Analysis, 6th Edition, 2004.
7. Raymond P. W. Scott, Techniques and Practice of Chromatography –Vol. 70.
8. Biophysical chemistry by Upadhyay, Upadhyay and Nath, Himalaya publication house.
9. Next Generation Sequencing Methods and Protocols: Editors: Head, Steven R., Ordoukhanian, Phillip, Salomon, Daniel R. (Eds.) 2018.

**Course Code and title: PSBTP-243** Research Project

**Credits: 04**

**Course outcome:**

- 1) Learners will gain knowledge on research and will gain hands on experience on any selected topics in the field of biotechnology.

**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.

**References:**

- 1) Gavora, J., D. F. Gerson, J. Luong, A. Storer, and J. H. Woodley, eds. *Biotechnology research and applications*. Springer Science & Business Media, 2012.
- 2) Gurumani, N. *Scientific thesis writing and paper presentation*. MJP Publisher, 2019.

**Course Code and Title: PSBTELE-244A** Bioentrepreneurship & Start up Designing

**Credits: 4****Total Lectures: 60****Course outcome:**

This course will help the students;

1. to Understand various aspects of entrepreneurship.
2. to implement the generated ideas in proper protocols.
3. in development of business plans and problem solving in entrepreneurship.

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

IV	<p><b>Preparing a Business Plan:</b></p> <ul style="list-style-type: none"> <li>• Introduction to Business and its Environment</li> <li>• Components of a business plan,</li> <li>• Meaning and significance of a business</li> <li>• Challenges of New Venture Strategies</li> <li>• Start-up Policy Framework and Incentives</li> <li>• drawing business plan</li> <li>• Preparing project report;</li> <li>• Business Plan Preparation</li> <li>• Presenting business plan to investors</li> <li>• Execution of Business Plan</li> <li>• Business Incubation Centres</li> </ul> <p><b>Activity :</b> Presentation on Business plan /Start-up business plan</p>	11
V	<p><b>Entrepreneurship as Problem Solving</b></p> <ul style="list-style-type: none"> <li>• Entrepreneurs- as problem solvers.</li> <li>• Risk taking-Concept; types of business risks.</li> <li>• Barriers to Entrepreneurship.</li> <li>• Support structure for promoting entrepreneurship (various government schemes).</li> </ul>	6
VI	<p><b>Dimensions of Entrepreneurship</b></p> <ul style="list-style-type: none"> <li>• Entrepreneurial Culture</li> <li>• Entrepreneurial Society</li> <li>• Women Entrepreneurship</li> <li>• Rural Entrepreneurship</li> </ul>	6
VII	<p><b>Strategic Frameworks for Decision</b></p> <ul style="list-style-type: none"> <li>• Vision, Mission, Objective and Goal</li> <li>• Porter's 5-Forces Model</li> <li>• SWOT Analysis</li> <li>• Competitive Strategies</li> <li>• □ Value Chain Analysis</li> </ul>	5

**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 Shikha Sahai, 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

**Course Code and title: PSBTELE-244B Pharmaceutical Biotechnology & Drug Designing**  
**Credits: 04** **Total Lectures: 60**

**Course outcome:**

- 1) The learners will gain knowledge on pharmaceuticals, drug development, drug discovery and drug designing
- 2) The learners will gain knowledge on drug designing approaches and role of regulatory authorities in drug approval

Units	Topic	Lectures
<b>I</b>	<b>Introduction:</b> <ul style="list-style-type: none"> <li>• Introduction to Pharmaceutical Biotechnology and Drug discovery.</li> <li>• Drug targets: Structure and functions; Physiochemical properties of drugs; drugs from natural sources.</li> <li>• Pharmacodynamics, pharmacokinetics and drug metabolism, Drug tolerance &amp; intolerance, drug allergy, drug induced side effects with examples.</li> <li>• Screening and isolation of bioactive compounds</li> </ul>	8
<b>II</b>	<b>Drug action and Resistance</b> <ul style="list-style-type: none"> <li>• Mechanism of action of anti-diabetic, anticancer, anti-inflammatory and antibiotics (any two drugs of each)</li> <li>• Mechanisms of drug resistance to antibiotics and anticancer drugs with examples</li> <li>• MDR, XDR or PDR</li> <li>• Assay of drug potency- bioassay and immunoassay</li> </ul>	8
<b>III</b>	<b>Process of Drug Development</b> <ul style="list-style-type: none"> <li>• Target identification and validation.</li> <li>• Pre-clinical studies—Toxicity (Cytotoxicity, Genotoxicity, Reproductive toxicity, Carcinogenicity, Mutagenicity, and other tests)</li> <li>• Animal models for <i>in vivo</i> activity of drugs testing</li> <li>• Clinical trials: Phase I, II, III and IV</li> </ul>	8
<b>IV</b>	<ul style="list-style-type: none"> <li>• <b>Biopharmaceuticals:</b></li> <li>• Introduction and scope of Biopharmaceutical industry</li> <li>• 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.</li> <li>• Biopharmaceuticals Manufacturing: Overview of upstream &amp; downstream processing</li> <li>• Production of Biopharmaceuticals using Synthetic Biology Approach (eg. Artemisinin)</li> </ul>	10

V	<ul style="list-style-type: none"> <li>• <b>Computer aided drug design (CADD)</b></li> <li>• Introduction to CADD</li> <li>• Identification drug targets using molecular modeling, combinatorial libraries and high-throughput screening (HTS)</li> <li>• Methods of drug designing:</li> <li>• <b>Structure based drug design</b> <ul style="list-style-type: none"> <li>• Molecular docking: Types and principles, Semi-flexible docking, Flexible docking; Ligand and protein preparation, Macromolecule and ligand optimization,</li> <li>• Analysis of docking results and validation with known information.</li> <li>• Use of Small-molecule libraries, Natural compound libraries for virtual highthroughput screenings.</li> <li>• Commonly used docking software</li> </ul> </li> <li>• <b>Ligand based drug design</b> <ul style="list-style-type: none"> <li>• 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.</li> <li>• Concept of quantitative drug design using Quantitative structure-activity relationship models (QSAR models)</li> </ul> </li> <li>• Types of molecular modeling for proteins</li> </ul>	18
VI	<p><b>Role of Regulatory Authorities in Drug Approvals</b></p> <ul style="list-style-type: none"> <li>• The Food and Drug Administration (FDA), Investigational new drug application, New drug application;</li> <li>• European regulations National regulatory, authorities, European medicines agency and the new EU drug approval system, Centralized procedure, Mutual</li> <li>• Indian drug regulations, &amp; pharmacopeia Market issues of drug patenting and licencing in Pharma industry</li> </ul>	8

**References:**

1. Olive Kaiser ,Rainer Muller, Pharmaceutical Biotechnology: Drug Discovery and Clinical Application, Wiley VCH publisher, 2004
2. Vyas and Dixit Pharmaceutical Biotechnology, 1<sup>st</sup> CBS Publisher New Delhi, 1991
3. P. K. Gupta, Elements Of Biotechnology, Rastogi Publication, 10<sup>th</sup> edition, 2004
4. S.S. Purohit, Biotechnology Fundamentals and Applications Student edition Agrobios Publisher; 2002
5. K. Sambamurthy, Ashutosh Kar, Pharmaceutical Biotechnology, 2<sup>nd</sup> 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. Veerapandian, "Structure Based Drug Design". Taylor and Francis, 1997.
12. Drug Design, V.M. Kulkarni, K.G. Bothara, Nirali Prakashan
13. Graham L. Patrick An Introduction to Medicinal Chemistry, ,Oxford University Press 1995
14. Richard B. Silverman The Organic Chemistry of Drug Design & Drug Action, , Elsevier Academic Press, 2014.
15. Natanya Civjan, Chemical Biology: Approaches to Drug Discovery and Development to Targeting Disease, Edited by Wiley (2012).
16. Biology For Engineers 2019 Edition by SINGAL R, CBS Publishers and Distributors

**Course Code and Title: PSBTELE-244C Research Methodology & Scientific Communication**

**Credits: 4**

**Total Lectures: 60**

**Course outcome:**

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

- Demonstrate ability to read, present, and show applications of research in the field as presented through various types of scientific communications.
- Develop ability to choose correct research methodology and understand limitations of particular methodology.
- Collect, organize, analyse and present scientific data.
- Understand importance research ethics and appropriate scientific conduct.

Units	Topics	Number of Lectures
I	<p><b>Introduction to Research Methods:</b></p> <ul style="list-style-type: none"> <li>• 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</li> </ul>	10
II	<p><b>Scientific Methodology:</b></p> <ul style="list-style-type: none"> <li>• Problem identification, Critical thinking, hypothesis formulation and hypothesis testing (Power analysis)</li> <li>• Difference between hypothesis, reasoning, theory and scientific law</li> </ul>	10
III	<p><b>Data Collection and analysis:</b></p> <ul style="list-style-type: none"> <li>• Types of Data, Methods and Techniques of data collection</li> <li>• Methods of primary data collection (observation/ experimentation/ questionnaire/ interviewing/ case/ pilot study) Methods of secondary data collection (internal/ external), schedule method</li> </ul> <p><b>Research data organization:</b></p> <ul style="list-style-type: none"> <li>• Creating, Analyzing, Formatting Data &amp; Content using Spreadsheets Insert, View, Edit etc.</li> <li>• Managing Lab Work books, Data tabulation, Calculations, Equations and analyzing biological Data using statistical tools.</li> </ul>	10
IV	<p><b>Research in Practice:</b></p> <ul style="list-style-type: none"> <li>• Literature review, Journals, Conference Proceedings</li> <li>• Research Metrics - Journal Impact factor, Citation Index, h, g, h-g index.</li> </ul>	5
V	<ul style="list-style-type: none"> <li>• <b>Research Ethics:</b></li> <li>• Social implications of research, bio-safety issues Animal experimentation ethics, wild-life ethics and human experimentation ethics</li> <li>• Data fudging and plagiarism: Use of URKUND,</li> </ul>	5



	Turnitin and iThenticate software	
VI	<p><b>Scientific Communication:</b></p> <ul style="list-style-type: none"> <li>• Importance of scientific communication, Types of scientific communications, Logical organization of scientific data and 20 documentation</li> </ul> <p><b>Different modes of scientific communication:</b></p> <ul style="list-style-type: none"> <li>• <b>Scientific Writing:</b> Characteristic of good scientific writing, Structure and content, Style, Literature references,</li> <li>• <b>Report Writing:</b> 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)</li> <li>• <b>Oral forms of scientific Communication-</b> 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 &amp; Delivering Presentations</li> <li>• <b>Legal forms of communication in science:</b> Plagiarism and scientific misconduct, Ethics in scientific communication, patent submissions.</li> </ul>	20

Internal examination of this paper should be based on following activities

1. Review writing/ Report writing
2. Scientific presentation of research paper from reputed journal.
3. Research Data collection and analysis

**Reference Books:**

1. Michael Alley, The Craft of Scientific Writing, fourth edition, Springer, 2018.
2. Stephen B. Heard, The Scientists Guide To Writing, Princeton University Press, 2018.
3. Anthony M. Graziano, Michael L. Raulin, Research Methods: A Process Of Inquiry (2012) 8th Edition, Pearson Publication, Delhi
2. Barass Robert,
4. David B. Resnik, The Ethics of Science: An Introduction (1998), Routledge Publication,UK5.
5. John D'Angelo, Ethics in Science: Ethical Misconduct in Scientific Research (2012), CRC Press, USA

**Subject code and Title: PSBTELE 244D** Quality Control, Biosafety & Bioethics

**Credits: 4****Total Lectures: 60****Course outcome:** By the end of this course students will able

- 1.To gain deep knowledge of quality control and documentation required in industry
- 2.To understand ethical aspects of research
3. To introduce the importance of biosafety guidelines to be followed in research

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

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