Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

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

(Affiliated to Savitribai Phule Pune University, Pune)

National Education Policy (NEP)
Choice Based Credit System (CBCS)

Programme Skeleton and Syllabus of

M.Sc. Biotechnology

Implemented from

Academic Year 2023-24

Board of Studies in Biotechnology

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

1. Prologue/Introduction of the programme:

Biotechnology has grown, extensively in last couple of decades. This advanced ‘interdisciplinary’ life science branch encompasses areas viz. molecular biology, genetics, biochemistry, microbiology, immunology, virology, plant and animal tissue culture, chemistry and engineering. It is a fast emerging “cutting edge” science with distinctive advantages as it finds applications in practically all aspects of life.

The subject offers exciting opportunities in various fields from basic research to industry oriented career. Global and local focus has slowly shifted to using knowledge of life Science for innovative technology development that is being used for betterment of human life. Many fundamental research fields from cell biology to molecular biology, from biochemistry to biophysics, from genetic engineering to stem cell research, from bioinformatics to genomics-proteomics, from environmental biology and to biodiversity, from microbiology to bioprocess engineering, from bioremediation to Insilco drug discovery etc. comes under the umbrella of Biotechnology.

The proposed choice based credit curriculum and grading system will cater to the

existing interdisciplinary nature of biotechnology can also offer many courses to the other branches of life science. The generative power of biological data is effectively harnessed by biotechnology like no other field. Economic and social renaissance is staged on biotechnology especially, since it's biomedical and cutting edge technological applications are tremendously powerful in shaping this century and exciting future. Keeping in view the expanse and applications of Biotechnology in every field, there is going to be a perpetual demand for resource personnel with Biotechnology specialization. The post graduate program is aimed to cater to this ever increasing demand and to groom the students to excel in their future career. Education and research sectors require such interdisciplinary trained workforce to develop future generations of science leaders.

2. Programme Outcomes (POs):

After successfully completing this course, the student should be able to:

- Understand the basic knowledge and concepts of biotechnology and other related areas.
- Understand the ability to apply their knowledge for practical which they can conduct independently.
- Apply their knowledge in other advanced subject area like bioinformatics, immunotechnology and animal and plant biotechnology for the betterment and advancement of their professional career.
- Learn the theoretical and practical exposure to the basic and the advanced fields of biotechnology.

9.2 Distribution of credits

Type of Courses	**Total Credits**	**Credits/ Semester**
Discipline-Specific Core Courses (DSC)	54	14 /12
Discipline Specific Elective Courses (DSE)	16	04
Research Methodology (RM)	04	Semester I only
On-Job Training/ Internship (OJT/I	04	Semester II only
Project (PR)	10	Semesters III and IV only
Total	88	22

9.3 Master of Science (M.Sc.) Course Distribution

Class	Semester	Subjects	Courses	DSC		DSE		RM/OJT/ Internship etc.		Project *	Total Credits
				T	P	T	P	T	P		
M. Sc. I	I	01	09	03	03	01	01	01*		00	22
M. Sc. I	II	01	09	03	03	01	01	00	01	00	22
M. Sc. II	III	01	07	02	02	01	01	00	00	01	22
M. Sc. II	IV	01	07	02	02	01	01	00	00	01	22

* RM: Theory and Practical credits in RM paper shall be decided by the Department. The final marks/grade point shall be calculated by considering theory and practical marks.

9.4 Master of Science (M. Sc.) Credit Distribution

Class	Semester	Subjects	Courses	DSC		DSE		RM/OJT/ Internship etc.		Project *	Total Credits
				T	P	T	P	T	P		
M. Sc. I	I	01	09	08	06	02	02	04*		00	22
M. Sc. I	II	01	09	08	06	02	02	00	04	00	22
Exit Option: PG Diploma											
M. Sc. II	III	01	07	08	06	02	02	00	00	04	22
M. Sc. II	IV	01	07	08	04	02	02	00	00	06	22
				32	**20**	**08**	**08**	**02**	**06**	**12**	**88**

9.5 Master of Science (M. Sc.) Distribution of Courses

Class	Semester	Course and their credits in the bracket			
		DSC	DSE	RM/OJT/ Internship etc.	Project *
M. Sc. I	I	DSC -01 (03)	DSE -01 (02)	RM-01(04)	NA
M. Sc. I	I	DSC -02 (03)	DSE -02 (02)		
M. Sc. I	I	DSC -03 (02)			
M. Sc. I	I	DSC -04 (02)			
M. Sc. I	I	DSC -05 (02)			

M. Sc. I	I	DSC -06 (02)			
M. Sc. I	II	DSC -07 (03)	DSE -03 (02)	OJT-01 (04)	NA
M. Sc. I	II	DSC -08 (03)	DSE -04 (02)		
M. Sc. I	II	DSC -09 (02)			
M. Sc. I	II	DSC -10 (02)			
M. Sc. I	II	DSC -11 (02)			
M. Sc. I	II	DSC -12 (02)			
M. Sc. II	III	DSC -13 (04)	DSE -05 (02)	NA	PR-01(04)
M. Sc. II	III	DSC -14 (04)	DSE -06 (02)		
M. Sc. II	III	DSC -15 (03)			
M. Sc. II	III	DSC -16 (03)			
M. Sc. II	IV	DSC -17 (04)	DSE -05 (02)	NA	PR-02(06)
M. Sc. II	IV	DSC -18(04)	DSE -06 (02)		
M. Sc. II	IV	DSC -19 (02)			
M. Sc. II	IV	DSC -20 (02)			

Programme Framework (Courses and Credits): M. Sc. Biotechnology

Sr. No.	Year	Semester	Level	Course Type	Course Code	Title	Credits
1.	I	I	6.0	DSC-01	MS-BT111T	Plant Biotechnology	03
2.	I	I	6.0	DSC-02	MS-BT112T	Advanced Biological Chemistry	03
3.	I	I	6.0	DSC-03	MS-BT113T	Bioinformatics	02
4.	I	I	6.0	DSC-04	MS-BT114P	Practicals in Plant Biotechnology	02
5.	I	I	6.0	DSC-05	MS-BT115P	Practicals in Advanced Biological Chemistry	02
6.	I	I	6.0	DSC-06	MS-BT116P	Practicals in Bioinformatics	02
7.	I	I	6.0	DSE-01	MS-BT117(A)T OR MS-BT117(B)T	Nanotechnology OR Pharmaceutical Biotechnology	02
8.	I	I	6.0	DSE-02	MS-BT118(A)P OR MS-BT118(B)P	Practicals in Nanotechnology OR Practicals in Pharmaceutical Biotechnology	02
9.	I	I	6.0	RM-01	MS-BT119T/P	Research Methodology	04
10.	I	II	6.0	DSC-07	MS-BT121T	Animal Biotechnology	03
11.	I	II	6.0	DSC-08	MS-BT122T	Advanced Bioanalytical Techniques	03
12.	I	II	6.0	DSC-09	MS-BT123T	Bioprocess Engineering	02

13.	I	II	6.0	DSC-10	MS-BT124P	Practicals in Animal Biotechnology	02
14.	I	II	6.0	DSC-11	MS-BT125P	Practicals in Advanced Bioanalytical Techniques	02
15.	I	II	6.0	DSC-12	MS-BT126P	Practicals in Bioprocess Engineering	02
16.	I	II	6.0	DSE-05	MS-BT127T	Environmental Biotechnology OR Biostatistics	02
17.	I	II	6.0	DSE-06	MS-BT128P	Practicals in Environmental Biotechnology OR Practicals in Biostatistics	02
18.	I	II	6.0	OJT-01	MS-BT129P	-	04
19.	II	III	6.5	DSC-13	MS-BT231T	Genetic Engineering	04
20.	II	III	6.5	DSC-14	MS-BT232T	Advanced Cell and Molecular Biology	04
21.	II	III	6.5	DSC-15	MS-BT233P	Practicals in Genetic Engineering	03
22.	II	III	6.5	DSC-16	MS-BT234P	Practicals in Advanced Cell and Molecular Biology	03
23.	II	III	6.5	DSE-05	MS-BT235T	Stem Cell Technology OR Entrepreneurship and Business Management	02
24.	II	III	6.5	DSE-06	MS-BT236P	Practicals in Stem Cell Technology OR Practicals in Entrepreneurship and Business Management	02
25.	II	III	6.5	PR-01	MS-BT237P	Project	04
26.	II	IV	6.5	DSC-17	MS-BT241T	Bacteriology and Virology	04
27.	II	IV	6.5	DSC-18	MS-BT242T	Genomics and Proteomics	04
28.	II	IV	6.5	DSC-19	MS-BT243P	Practicals in Bacteriology and Virology	02
29.	II	IV	6.5	DSC-20	MS-BT244P	Practicals in Genomics and Proteomics	02
30.	II	IV	6.5	DSE-07	MS-BT245T	Clinical Research OR Agricultural Biotechnology	02
31.	II	IV	6.5	DSE-08	MS-BT246P	Practicals in Clinical Research OR Practicals in Agricultural Biotechnology	02

32.	II	IV	6.5	PR-02	MS-BT247P	Project	06

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Syllabus

M.Sc. Biotechnology (Major)

Title of the Course: Plant Biotechnology								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	**Allotted Marks**		
		Theory	Practical			CIE	ESE	**Total**
DSC-01	MS-BT-111T	03	00	03	45	30	70	**100**

Learning Objectives

1. To study plant tissue culture techniques
2. To study applications of transgenic plants for human welfare.
3. To study different methods of plant transformation.

Course Outcomes (Cos)

1. Students will learn the principles and technical advances behind the in vitro culture of plant cells and rDNA techniques
2. Students will learn the applications of plant transformation for improving the productivity and performance of plants under biotic and abiotic stresses
3. Students will understand the concept of antisense technologies for improvement of crop plants.
4. Students will learn the concept and applications of transgenic plants.

Detailed Syllabus:

Unit I: Plant Tissue culture and its applications **(15)**

Overview of Plant Tissue Culture

Micropropagation-Concept, Stages of micropropagation (stage 0 to stage 4),

Methods/approaches of Micropropagation: a) Axillary bud/shoot proliferation, b) Adventitious bud formation, c) Organogenesis and d) Somatic embryogenesis and artificial seeds, Application of micropropagation

Somaclonal variations

In vitro androgenesis and its applications,

Protoplast isolation, somatic hybridization, cybridization and their applications

Suspension culture: Production of bio-active secondary metabolites by plant tissue culture.

Plant tissue culture for production of disease/virus free plants and superior plant varieties (embryo rescuing) seedless plants (endosperm culture).

Methods and techniques of preservation of plant cultures and its revival

Unit II: Algal and Fungal Biotechnology **(06)**

Qualitative/Quantitative improvement in economically important Algae with one example (Biofuels, Pigments, Single cell proteins)

Qualitative/Quantitative improvement in industrially important Fungi like yeast, mushrooms

Unit III: Methods of Transformation in Plants **(12)**

Direct Methods of transformation: 1. Physical methods of plant Transformation 2. Chemical methods of plant Transformation 3. In planta

Indirect Methods of transformation: Agrobacterium mediated gene transfer: Ti plasmid & Ri Plasmid vectors.

Mechanism of T-DNA transfer to plants

Agro infection, Plant viral vectors.

Selectable markers, Reporter genes and Promoters used in plant vectors and their role in genetic transformation.

Unit IV: Transgenic plants **(12)**

Transgenic plants for biotic (weeds, insects, viruses, fungi and bacteria) and abiotic stress (drought, salt, temperature, and oxidative stress) tolerance

Increase in productivity by manipulation of photosynthesis and nitrogen fixation,

Concept of Synthetic Biology for production of bioactive secondary metabolites

Molecular farming (improvement in protein, lipids, carbohydrates), vaccines, antibodies, therapeutic proteins

Approaches to marker-free transgenics

Debate over GM crops

Suggested Readings:

1. Chawla HC (2004) – Introduction to plant biotechnology (Science Publ)
2. Davies K (Ed) (2004) – Plant pigments and their manipulation – Annual plant reviews, vol 14 (Blackwell Publ)
3. Altman A, Hasegawa PM (Ed) (2012) – Plant Biotechnology and agriculture. Prospects for the 21st century (Academic press).

4. Bhojwani SS. & Razdan MK (1996). - Plant Tissue Culture: Theory &Practice(Elsevier).
5. Slater A, Scott NW, Fowler MR (2008) – Plant Biotechnology: the Genetic Manipulation of plants (Oxford Press)
6. Vasil IK, Thorpe TA (1994) – Plant cell and tissue culture(Springer)
7. H K Das Textbook of Biotechnology 4th edition
8. Plant Cell and Tissue Culture. A Laboratory manual 1994.Reinert J and Yeoman MM Springer
9. Biotechnology in Crop Improvement, H S Chawla. International Book Distributing Company1998
10. Practical Application of Plant Molecular Biology. RJ Henry. Chapman and Hall1997
11. Elements of Biotechnology, P.K. Gupta. Rastogi and Co., Meerut1996
12. A Text Book of Biotechnology, HD Kumar (WE pub.)
13. Gene transfer to Plants 1995, Polykus I and Spongernberg, G. Ed. Springer Scam.
14. Molecular Approaches to Crop Improvement1991. Dennis Liwelly Eds. PP16
15. Plant Biotechnology 1994, Prakash and Perk, Oxford & IBH Publishers Co
16. Plant Cell and Tissue Culture. A Laboratory manual 1994.Reinert J and Yeoman MM Springer.
17. Plant Biotechnology: An Introduction to Genetic Engineering by Adrian Slater, Nigel W. Scott, Mark R. Fowler. Oxford University Press, 2008.
18. Anderson, J.A., S. Chao, and S. Liu, 2007: Molecular breeding using a major QTL for Fusarium head blight resistance in wheat. Crop Sci.4.
19. Rai M (2009) – Fungal Biotechnology (IK International)
20. Handbook of Microalgal Culture: Applied Phycology and Biotechnology, Second Edition Editor(s): Amos Richmond Ph.D., Prof. Emeritus,,Qiang Hu Ph.D.,
21. Algae Biotechnology Products and Processes Editors: Bux, Faizal, Chisti, Yusuf (Eds) Springer
22. Advances In Algal Cell Biology by Heimann K, De Gruyter
23. Heffner, E.L., M.E. Sorrells, and Jannink, J.-L. 2009. Genomic selection for crop improvement. Crop Sc. 49:1-12.

Title of the Course: Advanced Biological Chemistry								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	**Allotted Marks**		
		Theory	Practical			CIE	ESE	**Total**
DSC-02	MS-BT 112T	03	00	03	45	30	70	**100**

Learning Objectives:

1. Learn concept of advanced biological chemistry
2. Learn to apply the basic knowledge of advance biological chemistry
3. Understand significance of proteins, enzymes in diagnostics.

Course Outcomes (Cos)

1. Students will recall and correlate specific biomolecules, their structure and function.
2. Students will understand the concept of secondary metabolites and phytochemical investigation.
3. Students will be able to infer basic concept of metabolomics, nutritional disorders, inborn errors of metabolism

Detailed Syllabus:

Unit I: Overview of Biomolecules: **(02)**
Carbohydrate, lipid, nucleic acid, protein

Unit II: **Protein Chemistry** **(10)**
Structure of proteins - Primary, Secondary, Tertiary, Quaternary, Ramchandran plot, Supersecondary structure, protein-protein interaction, protein-DNA interaction
Protein folding mechanisms and pathways - Molten globule, chaperons.
Protein misfolding and diseases

Unit III: Enzyme **(15)**
Concept of active site, ES complex formation, Enzyme activity & various factors influencing enzyme activity, enzyme inhibition and its types, Enzyme regulation- allosteric enzyme, Isoenzymes, ribozyme and abzyme

Enzyme kinetics, steady state enzyme kinetics, Michaelis -Menten equation form and derivation

Significance of Vmax and Km, K/cat, graphical procedures in enzymology - Lineweaver Burke's Plot, Ediee Hofstee plot

Unit IV: **Metabolomics** **(04)**

Overview of metabolism, Integration of metabolism

The Metabolome, Metabolic flux, metabolic flux analysis, Metabolic engineering

Unit V: Disorders of metabolism **(06)**

Inborn errors of metabolism: Obesity metabolic disorders- Diabetes, Protein -PKU, Alkaptonuria

Carbohydrates – Pomes' disease, cori's disease

Lipids- Atherosclerosis

Nucleic acids- Gout, Lesch nyhan syndrome

Unit VI: Phytochemistry **(08)**

Introduction to secondary metabolism, primary metabolite as precursors of secondary metabolite

Study of secondary Metabolite- 1. Alkaloids, 2. Phenolics, 3.Terpenoids

Biosynthetic pathways for secondary metabolite: 1. Mevalonate pathways 2. Shikimate Pathway 3. Malonic pathway

Suggested Readings/Material:

1. Proteins: Biotechnology and Biochemistry, 1st edition (2001), Gary Walsch, Wiley, USA
2. Phytochemical Method, 3 rd edition (1998), A.J. Harborne, Springer, UK.
3. Pharmacognosy, 14th edition, (2008), Dr. C. K. Kokate, A. P. Purohit, S. B. Gokhale, Nirali Prakashan, India.
4. Trease and Evans' Pharmacognosy, 16th edition (2009), William Charles Evans, Saunders Ltd. USA.
5. Enzymes: Biochemistry, Biotechnology & Clinical chemistry, (2001) Palmer Trevor, Publisher: Horwood Pub. Co., England.

Title of the Course: Bioinformatics								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	**Allotted Marks**		
		Theory	Practical			CIE	ESE	**Total**
DSC-03	MS-BT113T	02	00	02	30	15	35	**50**

Learning Objectives:

1. To learn about biological databases and its use.
2. Learning of sequence alignment methods and its applications.
3. Understand concept of protein structure prediction and drug designing.

Course Outcomes (Cos)

1. Students will learn about the bioinformatics databases, data format and data retrieval from the online resources
2. Students will get in-depth knowledge about alignment methods and its applications.
3. Students will able to understand the structure prediction methods for protein.
4. Students will learn the concept of chemoinformatic and drug designing.

Detailed Syllabus:

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

Unit II: Biological Databases **(06)**

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

Unit III: Biological Sequence Analysis **(08)**

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

Unit IV: Structural Bioinformatics **(08)**

PDB file format, Visualization of major secondary structure (helices, beta sheets), Protein structure prediction, Need and concept of protein structure prediction, Protein secondary structure prediction methods, tertiary structure prediction, Ramchandran plot

Unit V: Molecular Modeling and Chemoinformatics (06)

Structure based drug designing. Compound library formatting and filtering (physicochemical and substructure filters). Pose prediction strategies in molecular docking: Rigid body docking, flexible ligand docking (conformational search method, fragmentation method, database method), pharmacophore modelling

Suggested Readings/Material:

1. Lesk, A. M. 2002. Introduction to Bioinformatics. Oxford: Oxford University Press.
2. Mount, D. W. 2001. Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
3. Baxevanis, A. D., & Ouellette, B. F. 2001. Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins. New York: Wiley-Interscience.
4. Pevsner, J. 2015. Bioinformatics and Functional Genomics. Hoboken, Wiley-Blackwell, NJ.
5. Bourne, P. E., & Gu, J. 2009. Structural Bioinformatics. Hoboken, NJ: Wiley-Liss.
6. Lesk, A. M. 2004. Introduction to Protein Science: Architecture, Function, and Genomics. Oxford: Oxford University Press.

Title of the Course: Practicals in Plant Biotechnology								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	**Allotted Marks**		
		Theory	Practical			CIE	ESE	**Total**
DSC-04	MS-BT114P	00	02	02	60	15	35	**50**

Learning Objectives

1. To study different techniques plant tissue culture.
2. To study effect of plant growth regulators on in vitro response of explants
3. To study artificial seed preparation.

Course Outcomes (Cos)

1. Students will acquire the knowledge about the techniques of Plant Tissue Culture, Lab. organization & measures adopted for aseptic manipulation and nutritional requirements of cultured tissues.

2. Students will learn the techniques of culturing tissues, single cells, protoplasts & anther culture, germplasm conservation and cryobiology.

3. Students will understand the large scale clonal propagation of plants through various micropropagation techniques, Production of secondary metabolites under in vitro conditions.

4. Students will learn the concepts of r-DNA technology, methods of gene transfer, molecular markers and marker assisted selection.

Detailed Syllabus: (Any 12)

1. *Chlorella* or *Spirulina* culture establishments and study of its growth using suitable parameters and biochemical analysis of it — 2
2. Effect of plant growth regulators on in vitro response of explants. — 2
3. Induction of *in vitro* Androgenesis — 1
4. Preparation of artificial seeds — 1
5. Protoplast isolation and Fusion from plant material — 2

6.	Micropropagation: initiations, multiplication and subculture	2
7.	Initiation of suspension culture and identification of common secondary metabolites production	2
8.	Initiation maintenance and confirmation of Hairy root culture	2
9.	Visit to tissue culture laboratory/seed company and report writing	1

Title of the Course: Practicals in Advanced Biological Chemistry								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	**Allotted Marks**		
		Theory	Practical			CIE	ESE	**Total**
DSC-05	MS-BT 115P	00	02	02	60	15	35	**50**

Learning Objectives:

1. Learn to perform purification of protein by column chromatography
2. To study effect of different parameters on enzyme activity.
3. Learn to extract phytochemicals from different plant sources

Course Outcomes (Cos)

1. Students can isolate and can purify enzyme from suitable source.
2. Students can study enzyme kinetics and can determine Km and Vmax of any enzyme.
3. Students can use techniques like salt/solvent precipitation, dialysis and chromatography for protein/enzyme purification.
4. Students can characterize protein/enzyme by SDS/Native PAGE
5. Students can extract phytochemicals from suitable plant source and can perform their qualitative detection and quantitative estimation.

Detailed Syllabus:

1. Extraction of enzyme, determination of enzyme activity and specific activity. **(01)**
2. Precipitation of enzyme (salt and solvent) **(01)**
3. Desalting by dialysis **(01)**
4. Purification of enzyme by column Chromatography (Gel filtration/ Ion exchange /Affinity) **(02)**
5. Characterization of enzyme by Native / SDS-PAGE **(02)**
6. Effect of pH and temperature on enzyme activity **(01)**
7. Effect of incubation time on enzyme activity **(01)**
8. Effect of various Substrate concentration on enzyme activity and determination of Km and Vmax by LB plot **(01)**
9. Extraction of phytochemicals (aqueous & organic solvents) **(01)**

10. Qualitative detection – analysis of phytochemicals **(01)**

Suggested Readings/Material:

1. Introduction to Practical Biochemistry, (2000), S. K. Sawhney, Randhir Singh Narosa, 2000.
2. Practical Enzymology, 2 nd edition (2011), HansBiss Wanger, Wiley-Blackwell, USA.
3. Biochemical Calculations, 2nd Ed., (1997) Segel Irvin H., Publisher: John Wiley and Sons, New York.

Title of the Course: Practicals in Bioinformatics								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	**Allotted Marks**		
		Theory	Practical			CIE	ESE	**Total**
DSC-06	MS-BT116P	00	02	02	60	15	35	**50**

Learning Objectives:

1. To learn about data mining and retrival of data from biological databases.
2. Learning of sequence alignment tools and its applications.
3. Protein structure prediction and drug designing.

Course Outcomes (Cos)

1. Students will learn to access bioinformatics databases and data retrieval from the online sources.
2. Students will get in-depth knowledge about alignment methods and database similarity searching.
3. Students will able to predict three dimensional structure of protein.
4. They will learn molecular docking for Protein and ligand.

Detailed Syllabus:

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

2. Pairwise sequence alignment using NEEDLE, WATER **(01)**

3. Database similarity searching using BLAST /FASTA **(01)**

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

4. Multiple sequence alignment and phylogenetics analysis using Clustal/Tcoffee/Mega **(01)**

5. Basic structure visualization using DeepView (Performing basic tasks like selecting and displaying structures, colouring, measuring distances and labeling) **(01)**

6. Energy minimization, amino acid mutation and Ramchandran Plot analysis using swiss PDB Viewer **(01)**

7. Prediction of protein tertiary structure using any method (MODELLER, SWISS

Model, EasyModeler) **(02)**

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

Suggested Readings/Material:

1. Kaiser O and Muller R. 2004, Pharmaceutical Biotechnology: Drug Discovery andClinical Application, Wiley VCH publisher.

2. Vyas and Dixit, 1991, Pharmaceutical Biotechnology, New Delhi, CBS Publisher.

3. GuptaP. K.2004, Elements of Biotechnology, 10th edition, Rastogi Publication.

4. PurohitS.S, 2002, Biotechnology Fundamentals and Applications, Agro bios Publisher.

5. Daan J. A. and Crommelin, 1997, Pharmaceutical Biotechnology: An Introduction for Pharmacists and Pharmaceutical Scientists, 2-nd edition, Taylor & Francis.

6. Gary Walsh, 1992, Pharmaceutical Biotechnology: Concepts and Applications, Wiley.

Title of the Course: Nanobiotechnology								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	**Allotted Marks**		
		Theory	Practical			CIE	ESE	**Total**
DSE-01	MS-BT117(A)T	02	00	02	30	15	35	**50**

Learning Objectives:

1. To learn about nanobiotechnology and synthesis of nanoparticles.
2. Learning the characterization techniques and applications of nanoparticles.

Course Outcomes (COs)

1. This course facilitates better understanding nanobiotechnology field.
2. Students will able to characterize nanoparticles using standardized methods.
3. Students will able to understand applications of nanomaterials in various field.
4. Students will learn techniques of nanoparticle analysis using X-ray diffraction, Electron microscope etc.

Detailed Syllabus:

Unit I: Introduction to Nanobiotechnology: (03)

History of nanotechnology, Types of nanoparticles and their properties: quantum dots, polymeric nanoparticles, lipid nanoparticles, metal nanoparticles, metal oxide nanoparticles, composite, concept of nanobiotechnology

Unit II: Methods for synthesis of Nanomaterials: (07)

Chemical methods - Chemical precipitation and coprecipitation, Sol-Gel synthesis, Micro emulsions synthesis, hydrothermal, solvothermal synthesis methods Physical methods: Microwave assisted synthesis, core-shell nanostructure, quantum dot (QDs) synthesis Biological methods: Overview and concept of microbial/plant mediated nano-particle production; methods of microbial/plant mediated nanoparticle production

Unit III: Characterization of Nanomaterials: (05)

Optical (UV-Vis/Fluorescence), X-ray diffraction, imaging and size determination (Electron microscopy- TEM, SEM)

Unit IV: Applications of Nanomaterials: (05)

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

Unit V: Applications of Nanobiotechnology: (05)

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

Unit VI: Concerns of Nanomaterials / Nanobiotechnology: (05)

Environmental and health impact of nanomaterials. Genotoxicity and cytotoxicity evaluation of nanomaterials. Ecotoxicology

Suggested Readings:

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

Title of the Course: Pharmaceutical Biotechnology								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	**Allotted Marks**		
		Theory	Practical			CIE	ESE	**Total**
DSE-01	MS-BT117(B)T	02	00	02	30	15	35	50

Learning Objectives:

1. To learn about mechanism of action of drug.
2. Learning the entire process of clinical trials.
3. Understand role of regulatory authorities and approval of new drug.

Course Outcomes (Cos)

1. Students will learn the action mechanism of drug
2. Students will understand the process of clinical trials
3. Students will gain the knowledge of regulatory authorities

Detailed Syllabus: Example

Unit I: Introduction to Pharmaceutical Biotechnology and Drug discovery: (08)

Drug targets structure and functions; Physicochemical properties of drugs; Drugs from natural sources. Pharmacodynamics, pharmacokinetics and drug metabolism, drug tolerance & intolerance, drug allergy, drug induced side effects with examples.

Unit II: Drug action and Resistance: (08)

Mechanism of action of anti-diabetic (Insulin), anticancer (Daunorubicin), anti-inflammatory (Diclofenac) and antibiotics (Ciprofloxacin), Phases of clinical trials for drug testing

Unit III: Biopharmaceuticals: (06)

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

Unit IV: Role of Regulatory Authorities in Drug Approvals: (08)

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

Suggested Readings:

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

Title of the Course: Practicals in Nanobiotechnology								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	**Allotted Marks**		
		Theory	Practical			CIE	ESE	**Total**
DSE-2	MS-BT118(A)P	00	02	02	60	15	35	**50**

Learning Objectives:

1. To learn nanoparticle synthesis and its characterization.
2. Evaluating various activities of nanoparticles and its applications.
3. To study genotoxicity and cytotoxicity evaluation on nanomaterials.

Course Outcomes (Cos)

1. Students will understand the methods of nanoparticle synthesis.
2. Students will able to characterize nanoparticles using standardized methods.
3. Students will able to investigate genotoxicity and cytotoxicity evaluation of nanomaterials.

Detailed Syllabus:

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

a. Physical

b. Chemical

c. Microbial

d. Plant based method

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

i. Analysis of absorption spectra of thin films of Nanomaterials

ii. Determination of absorption coefficient for different wavelength

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

3. Applications of nanoparticles: (04)

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

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

3. Cytotoxicity testing of nanoparticles using onion root tip assay

Suggested Readings/Material:

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

Title of the Course: Practicals in Pharmaceutical Biotechnology								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	**Allotted Marks**		
		Theory	Practical			CIE	ESE	**Total**
DSE-02	MS-BT118(B)P	00	02	02	60	15	35	**50**

Learning Objectives:

1. Understand the principles and application of diagnostic assays (ELISA and LAL) for disease detection and drug safety assessment.
2. Acquire practical skills in isolating and purifying active pharmaceutical ingredients from medicinal plants.
3. Evaluate the potency, toxicity, and therapeutic properties of drugs through testing and analysis.

Course Outcomes (Cos)

1. Demonstrate proficiency in performing diagnostic assays for the detection of diseases and assessment of drug safety.
2. Apply isolation and purification techniques to obtain active pharmaceutical ingredients from medicinal plants.
3. Analyze and interpret data to evaluate the efficacy, safety, and therapeutic potential of drugs.

Detailed Syllabus: (Any 12 Practicals)

1. Enzyme Linked Immunosobent Assay for diagnosis of HIV/Hepatitis/Dengue (01)
2. LAL test for pyrogen detection in drug sample (01)
3. Study of physicochemical properties of common drugs (01)
4. Isolation and purification of active pharmaceutical ingredient from medicinal plants (03)
5. Testing antibacterial potential of isolated drug (02)
6. Determination of IC50/ LD50 values for the drug sample (02)

7. Determination of anti-inflammatory property of isolated compound (02)
8. Patent filling of the new drug in Indian Patent Filling format (01)
9. Visit to Pharmacuetical company/Diagnositic Laboratory (02)

Suggested Readings:

1. Chatterjee S, Chatterjee A, and Bhattacharjee A. 2016, Introduction to Pharmaceutical Biotechnology, CRC Press.
2. Walsh G. 2014, Biopharmaceuticals: Biochemistry and Biotechnology, John Wiley & Sons.
3. Rathore AS and Pathak Y. 2013, Pharmaceutical Biotechnology: Fundamentals and Applications, CRC Press.
4. Gaur R, Gupta V, and Srivastava S. 2018, Principles and Applications of Pharmaceutical Biotechnology, Elsevier.
5. Singh RS, Kaur N, and Kennedy JF. 2017, Pharmaceutical Biotechnology: Fundamentals and Applications, Wiley-Scrivener.
6. Gutiérrez AH and Trelles JA. 2014, Biotechnology for Beginners, Elsevier.
7. Singh BN. 2019, Pharmaceutical Biotechnology: Concepts and Applications, Wiley.

Title of the Course: Research Methodology								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	**Allotted Marks**		
		Theory	Practical			CIE	ESE	**Total**
RM-01	MS-BT119T/P	02	02	04	30 + 60	30	70	**100**

Learning Objectives:

1. To learn to write a research or review paper
2. To learn and experience to present scientific research paper
3. To use data analysis software like Excel/SPSS

Course Outcomes (COs):

1. Students will learn the concept of research communication.
2. Students will study different types of scientific methods to analyze and write research articles.
3. Students will able to understand the methods of data collection and analysis.
4. Students will learn the concept of ethics and plagiarism.

Detailed Syllabus:

Unit I: Introduction to Research Methods: (05)

Types of research philosophies (positivist, interpretivist, pragmatist and realistic), various steps in scientific research. Scientific temper and attitude. experimental design, defining controls; reductionist and holistic approaches of scientific research.

Unit II: Scientific Methodology: (03)

Problem identification, critical thinking, hypothesis formulation and hypothesis testing (power analysis), types of reasoning, theory and scientific law

Unit III: Data Collection and analysis: **(08)**

Types of data, methods and techniques of data collection, methods of primary data collection (observation/ experimentation/ questionnaire/ interviewing/ case/ pilot study) methods of

secondary data collection (internal/ external), schedule method

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

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

Unit IV: Research in Practice: (04)

Literature review, journals, conference proceedings, journal impact factor, citation index, h, g, h-g index.

Unit V: Research Ethics: (03)

Social implications of research, bio-safety issues, Animal experimentation ethics and human experimentation ethics. Plagiarism and scientific misconduct. Ethics in scientific communication, patent submissions. Use of URKUND, Turnitin and iThenticate software

Unit VI: Scientific Communication: (07)

Importance of scientific communication. Types of scientific communications.

Different modes of scientific communication:

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

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

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

Suggested Readings:

1. Hofmann H., 2010, Scientific Writing and Communication Papers, Proposals, and Presentations. New York: Oxford University Press.
2. Ferris T. L. J., Sitnikova E., and Duff A. H., 2010, Building graduate capabilities to communicate research and plans successfully, Int. J. Eng. Educ., vol. 26, no. 4, pp. 891–

899.

3. Michael Alley, 2018, The Craft of Scientific Writing, fourth edition, Springer.
4. Stephen B. Heard, 2018, The Scientists Guide To Writing, Princeton University Press.
5. Graziano A. M., Raulin M. L. 2012, Research Methods: A Process of Inquiry Pearson Publication, Delhi.
6. Barass R., 2002, Scientists Must Write: A Guide to Better Writing for Scientists, Engineers and Students, Routledge Publication, UK.
7. Resnik D. B., 1998, The Ethics of Science: An Introduction, Routledge Publication, UK.
8. Fisher R A, 1971, The Design of Scientific Experiment, Collier Macmillan Publishers, London.

Practicals:

Detailed Syllabus

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

Suggested Reading:

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

Title of the Course: Animal Biotechnology								
Year: I				**Semester: II**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	**Allotted Marks**		
		Theory	Practical			CIE	ESE	**Total**
DSC-07	MS-BT-121T	03	00	03	45	30	70	**100**

Learning Objectives:

1. To learn the concept of animal tissue culture
2. To learn various systems of tissue culture
3. To learn the establishment and handling of cell lines
4. To use the cell lines for various applications

Course Outcomes (COs):

1. Students will introduce to the concept of animal tissue culture.
2. Students will study the exact mechanism as well as technique to establish cell lines.
3. Students will able to understand the growth pattern of normal and transformed cells.
4. Students will learn the concept of transgenic animals and their applications.
5. Students will introduce to the animal husbandry and reproductive biotechnology along with concerned bioethics.

Detailed Syllabus:

Unit I: Overview of Animal Tissue Culture: (05)

History, basics of animal tissue culture. Importance of maintenance of sterility and use of antibiotics. Detection of Mycoplasma and viral contaminants. Prevention of cross contamination, eradication of contaminants. Formulation of tissue culture media: natural, synthetic media, sera and substitutes.

Unit II: Various Systems of Tissue Cultures: (04)

Distinguishing features, advantages and limitations. Methodology: i. Primary culture, ii. Explant culture, iii. Suspension culture.

Unit III: Concept, establishment and maintenance of cell lines: (04)

Finite and Continuous Cell lines. Established normal and transformed cell lines: examples and features. Maintenance of Cell Lines: Feeding and subculturing - criteria and methodology, passage number.

Unit IV: Organ Culture: (05)

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

Unit V: Growth Studies: (05)

Cell proliferation, cell cycle. Measurement of viability and cytotoxicity. Cell cloning and types. Cell synchronization. Cell transformation.Cryopreservation of cultured cells

Unit VI: Application of Animal Cell Culture: (07)

For *in vitro* testing of drugs, production of viral vaccines and pharmaceutical proteins, monoclonal antibodies. Mass production of biologically important compounds. Propagation of viruses (viral sensitivity of cell lines). Harvesting of products, purification and assays. Stem cells and their therapeutic applications

Unit VII: Transgenic Animals: (08)

Overview of different methods of introduction of a transgene viz. microinjection method, embryonic stem cell mediated gene transfer, retrovirus mediated gene transfer, etc. CRISPR/Cas9 for targeted genome editing. Transgenic animals: fish, sheep, pig, etc. Concept of Knockout technology: methods and application. Mouse models for human genetic disorders, neurodegenerative disorders.

Unit VIII: Animal Husbandry and Reproductive Biotechnology: (05)

Overview of livestock breed and their productivity in India. Artificial breeding: artificial insemination, estrous synchronization, cryopreservation of germ cells. *In vitro* fertilization and embryo transfer technology. Animal cloning: concept and application in conservation.

Unit IX: Biosafety Issues and Bioethics: (02)

associated with animal tissue culture, developing transgenic animals and human cloning.

Suggested Readings:

1. Freshney I. R. 2010, Culture of Animal cells, A John Wiley & Sons, Inc. Publications,USA.
2. Masters R.W. 2000, Animal Cell Culture, Oxford University Press. USA.
3. Lanza R. 2006, Essentials of Stem Cell Biology, Academic Press, USA.
4. Banerjee G.C. 1998, Text book of Animal Husbandry, Oxford and IBH Publishing Co. Pvt.Ltd. India
5. Glick B.R., Pasternak J.J., Patten C. L., 2010, Molecular Biotechnology, ASM press, USA
6. Twyman R. M., 2005, Gene Transfer to Animal Cells, Taylor & Francis USA.

Title of the Course: Advanced Bioanalytical Techniques								
Year: I				**Semester: II**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	**Allotted Marks**		
		Theory	Practical			CIE	ESE	**Total**
DSC-08	MS-BT122T	03	00	03	45	30	70	**100**

Learning Objectives:

1. To learn different electrophysiological techniques and their applications.
2. To study radioisotopes used in biology.
3. To understand knowledge about different spectroscopic techniques.

Course Outcomes (Cos)

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

Detailed Syllabus:

Unit I: Microscopic Techniques: (08)

Overview of types of microscopy, Staining and visualization of cells and subcellular components by light microscopy, cryotomy, scanning and transmission microscopes, different fixation and staining techniques for electron microscope, freeze-etch and freeze fracture methods for EM, confocal microscopy

Unit II: Radiolabeling techniques and electrophysiological methods: (10)

Overview of immunotechniques

Radiolabeling techniques - Detection and measurement of different types of radioisotopes normally used in biology, Incorporation of radioisotopes in biological tissues and cells

Electrophysiological methods – patch-clamp recording, ECG, brain activity recording, lesion and stimulation of brain, PET, MRI, fMRI

Unit III: Advanced Applications of Spectroscopy: (10)

UV visible spectrophotometer, fluorescence spectroscopy, NMR, IR spectroscopy,Molecular structure determination using X-ray diffraction and X ray crystallography, Molecular analysis using light scattering, Mass spectrometry and LC-MS

Unit IV: Advanced Chromatography and Electrophoretic technique: (12)

Introduction, principle and applications of HPTLC, HPLC, GLC, GC, IF and 2D electrophoresis, capillary electrophoresis, DGGE (Denaturing gradient gel electrophoresis)

Unit V: Advanced Bio-analytical Techniques and Automated Systems: (05)

Advances in PCR technology and its applications (modifications), Next Generations Sequencing (NGS), automated microbial identification system, Automated DNA/RNA microarray systems

Suggested Readings/Material

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

Title of the Course: Bioprocess Engineering								
Year: I				**Semester: II**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	**Allotted Marks**		
		Theory	Practical			CIE	ESE	**Total**
DSC-09	MS-BT123T	02	00	02	30	15	35	**50**

Learning Objectives:

1. To cover important topics in the development, production, recovery, and analysis of products produced by biotechnology.
2. To traces the path of a biological product from the cell through the production facility, the final processing, and formulation.
3. To discuss the growth characteristics of the organisms used to produce biological compounds, the techniques used in product recovery and purification analysis.

Course Outcomes (Cos)

1. Students will learn and understand cell growth, goals of fermentation and relate it to a real-life example.
2. Students will learn the different types of bioreactor, auxiliary equipment and applications.
3. Students will understand how parameters such as pH, temperature, aeration, and agitation that affects the fermentation.
4. Students will learn methods for product oriented isolation of microbes.
5. Students learn the industrial production of certain metabolites and their recovery.

Detailed Syllabus:

Unit I: Introduction to Bioprocess Engineering (01)

Definition of a Bioprocess, Important concepts in bioprocess. Biotechnological applications of bioprocess

Unit II: Types of Fermentation (05)

Solid state fermentation, submerged, Aerobic, Anaerobic, batch, fed-batch, continuous, Fermentation based on type of product formation- type I, II, III.

Unit III: Bioreactor and bioprocess monitoring (08)

Components of the fermenters, Fermenter construction material, Ideal fermenter characters, Types of Bioreactors- stirred tank reactors, airlift, bubble column, fluidized bed, packed bed, tower reactors, drum reactors, photobioreactors;, types of impellers/ agitator, aerator, temperature regulation, pH monitoring, foam sensing.

Unit IV: Media formulation, optimization and sterilization (05)

Types of media- synthetic and crude media, Enrichment media, Selective media, Media components, Conventional and classical methods of optimization (any one method in detail), Principles of Media Sterilization, Batch & Continuous sterilization techniques, Air sterilization. Fermentation process- inoculum build up, pre-fermentation, product fermentation.

Unit V: Screening, strain development, culture collection and preservation (05)

Isolation of microbes, Primary screening and Secondary screening, Need for strain development, Methods of strain development (any two methods in detail), culture collection centers, preservation of microbes.

Unit VI: Downstream Processing (06)

Solid-liquid separation (Flocculation, Filtration, Centrifugation), Cell disruption (Physical, chemical and enzymatic), Extraction, Precipitation, Distillation, Evaporation, Chromatographic separation, Adsorption, Concentration, spray drying.

Suggested Readings/Material:

1. P. F. Stanbury. A. Whitaker and S.J. Hall. Principles of Fermentation Technology. 2nd ed, Edinburgh: Butterworth Heinemann Press, 2003
2. Industrial Microbiology & Biotechnology by Arnold L. demain & Julian E. Davis. (2004) ASM Press.
3. Fermentation Microbiology & Biotechnology by Emt.el-Mansi & CFA. Bryce (2004). Taylor & Francis Ltd.
4. M. D. Pauline. Bioprocess Engineering Principles. 2nd ed, London: Academic Press, 2000.
5. Zhong, Jian-Jiang. Biomanufacturing. New York: Springer-Verlag Heidelberg, 2004.
6. U. Sathyanarayana. Biotechnology. Books and Allied (P) Ltd, Kolkota: 2008.

7. S.N. Jogdand. Environmental Biotechnology. 3rd ed, India: Himalaya Publication House, 2001.
8. B.D. Singh. Biotechnology. 2nd ed, New Delhi: Kalyani Publishers, 2007.

Title of the Course: Practicals in Animal Biotechnology								
Year: I				**Semester: II**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	**Allotted Marks**		
		Theory	Practical			CIE	ESE	**Total**
DSC-10	MS-BT-124P	00	02	02	60	15	35	**50**

Learning Objectives:

1. To learn the media preparation and its filtration
2. To establish animal cell line
3. To learn the maintainance of cell line
4. To perform growth studies and cytotoxicity of cell cultures

Course Outcomes (COs):

1. Students will prepare the medium for animal cell culture and filter sterilize it.
2. Students will establish the primary cell culture from chick embryo.
3. Students will learn to prepare chromosomes from cell lines.
4. Students will able to perform cytotoxicity of drugs.

Detailed Syllabus:

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

Suggested Readings

1. R. Ian Freshney. 2010, Culture of Animal cells, 5th Edition, A John Wiley & Sons, Inc., Publications, USA
2. R.W.Masters. 2000, Animal Cell Culture - Practical Approach, 3rd Edition, Oxford University Press. USA
3. Banerjee G.C. 1998, Text book of Animal Husbandry, Oxford and IBH Publishing Co. Pvt. Ltd. India

Title of the Course: Practicals in Advanced Bioanalytical Techniques								
Year: I				**Semester: II**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	**Allotted Marks**		
		Theory	Practical			CIE	ESE	**Total**
DSC-11	MS-BT125P	00	02	02	60	15	35	**50**

Learning Objectives:

1. To Understand techniques like ion exchange and gel filtration chromatography
2. To learn the knowledge about HPLC.
3. To study PCR analysis.

Course Outcomes (Cos)

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

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

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

Detailed Syllabus:

1. Separation of mixture of proteins by gel filtration chromatography. **(02)**
2. Separation of mixture of amino acids by ion exchange chromatography. **(02)**
3. Amplification of DNA/RNA by PCR and analysis of PCR product. **(02)**
4. Quantitative detection of antigen by Sandwich ELISA **(02)**
5. Affinity chromatography - separation of IgG from Serum by protein A sepharose chromatography **(02)**
6. Separation of secondary metabolites by thin layer chromatography **(01)**
7. Demonstration of HPLC technique **(01)**

Suggested Readings/Material:

1. Jayaram T. 1981. Laboratory manual in Biochemistry, Wiley Estern Ltd. New Delhi.

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

Title of the Course: Practicals in Bioprocess Engineering								
Year: I				**Semester: II**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	**Allotted Marks**		
		Theory	Practical			CIE	ESE	**Total**
DSC-12	MS-BT126P	02	02	02	60	15	35	**50**

Learning Objectives:

1. To elaborate screening techniques
2. To study different fermentation process
3. To work on microbial product extraction and purification

Course Outcomes (Cos)

1. Students will understand screening methods for primary and secondary metabolite.
2. Students will learn working of lab bench fermenter.
3. Students will study effect of environmental factors on fermentation.
4. Students will perform production, harvesting and purification of primary and secondary metabolite.
5. Students learn the industrial production of certain metabolites and their recovery.

Detailed Syllabus:

1. Preparation of crude media, Enrichment media, Selective media and its sterilization (1)
2. Primary screening of primary and secondary metabolite (2)
3. Secondary screening for Primary and Secondary metabolite (2)
4. Effect of pH, Temperature on growth of microorganism (1)
5. Isolation of auxotrophic mutant (1)
6. Production, recovery and analysis of primary metabolite (2)
7. Production, recovery and analysis of secondary metabolite (2)

8. Visit to fermentation industry and report writing (1)

Suggested Readings:

1. Handbook of Laboratory culture media, Reagents, Stains and Buffers by N. Kannan (2003), Panima Publishers, New Delhi.
2. Microbiology. A laboratory manual by J. G. Cappuccino and N. Sherman (2004). Pearson Education

Title of the Course: Environmental Biotechnology								
Year: I				**Semester: II**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	**Allotted Marks**		
		Theory	Practical			CIE	ESE	**Total**
DSE-05	MS-BT127TA	02	00	02	30	15	35	**50**

Learning objectives

1. To study basics of bioenergy resources and their exploitation and impact on environment.
2. To learn about different threats to environment, climate change and its global scenario.
3. To know about the biotechnological approach for waste management.
4. To know different rules and laws for regulation of environment monitoring in India and globe.

Course Outcomes

1. The student will be able to evaluate the potential of biodegradation of organic pollutants, taking microbial and physical/chemical environments, as well as the chemical structure of the compound itself, into consideration.
2. Students will understand the phenomenon of phytoremediation for the decontamination of soil and water, wetlands as treatment processes, biofilms/biofilters for vapor-phase wastes, and composting.
3. Students will learn about the environmental quality evaluation, monitoring, and remediation of contaminated environments.
4. Students will learn about the use of biosensors in environmental analysis, environmental engineering.

Detailed Syllabus:

Unit I: Energy and Environment **(06)**

- Introduction to environmental Science
- Bio-energy resources and their exploitation: Overview of biomass as an energy source, Thermal characteristics of biomass as a fuel.
- Scientific aspects and prospects of biofuel production (Biodiesel, bioethanol, biogas)

Unit II: Threats to Environment **(08)**

- Global and regional threats to the environment
- Environmental Pollution (Air, Water and Soil) and its impact on environment (biotic & abiotic), transport, diffusion and monitoring of pollutants
- Future scenarios of the global environment, causes and consequences of climate change (greenhouse effect and global warming, Ozone hole, Sea level rise)
- Carbon foot prints, Carbon sequestration (biological) and Carbon credit
- Role of biotechnology in biodiversity conservation

Unit III: Waste management **(08)**

- Waste water (Sewage) management: Sources of waste water and its impact on environment
- Biological waste water treatment methods
- Solid waste management: Sources and types, Impact of solid waste disposal, Recycle, Reuse and Recovery solutions (Solid waste management with composting, vermicomposting)
- Bioremediation: Removing Pollutants from Environments
- Introduction to use of biological agents in pollution control, Advantages, limitations and application Principle
- Types of Bioremediation and Factors affecting: Natural, Engineered, Ex-situ and in-situ Principles and methods in: Bioaugmentation, Biostimulation, Phytoremediation
- Xenobiotic degradation, Biomining/Bioleaching, Biomethanation

Unit IV: Environment monitoring and Environmental Laws and Policies **(08)**

- Applications of Remote sensing and GIS in environmental monitoring
- Environmental Impact Assessment: Introduction, Objectives, Classification, Guidelines. Case Study
- International and Indian Eco-standards
- ISO 14000 series overview
- International: In the view of global concerns, objectives of laws/regulations, importance: Stockholm conference, Montreal protocol, Rio conference and Kyoto protocol
- India: In the view of national concerns, objectives of laws/regulations, importance etc.
- The Environment Protection Act 1986, the Hazardous Wastes (Management, Handling and Transboundary Movement) Rules

Suggested Readings:

1. Advanced Renewable Energy Sources (2012) Gopal Nath Tiwari and R K Mishra, RSC Publishing, London.
2. Agenda 21: Guidelines for Stakeholders Patwardhan & Gunale, Pune.
3. Air Pollution (2004) HVN Rao and M N Rao Tata McGraw-Hill, , New Delhi
4. Air Pollution Control CP Mahajan, Capital Publishing Co, New Delhi
5. Air Pollution Engineering Manual (2000) Wayne T Davis (editor), Air and Waste Management Association, Wiley Interscience,, New Jersey
6. An Introduction To Geographic Information Technology (2009) Suchandra Choudhury I K International Pvt Ltd., New Delhi
7. Bioremediation (1994) Baker, K.H and Herson, D.S.Mc Graw Hill, Inc. New York
8. Biotreatment of Industrial & Hazardous Waste (1993) M.V.Levin and Gealt, M.A McGraw Hill. Inc, New York
9. Concepts and Techniques of Geographic Information Systems (2009) C.P.Lo.Albert and K.W.Yeung 2nd edition, Prentice Hall, Inc., New Jersey
10. Ecology and environmental biology (2011) Saha T K Books & Allied (p) Ltd, Delhi

Title of the Course: Biostatistics								
Year: I				**Semester: II**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	**Allotted Marks**		
		Theory	Practical			CIE	ESE	**Total**
DSE-05	MS-BT127TB	02	00	02	30	15	35	**50**

Learning Objectives:

1. To understand the concept of biostatistics
2. To summarize and categorize the statistical data
3. To use specific statistical test to specific data
4. To learn the interpretation of results and its application in biological sciences

Course Outcomes (COs)

1. Students will understand the importance of statistics in Biological sciences.
2. Students will learn to summarize and categorize statistical data.
3. Students will apply appropriate statistical tests on different types of data.
4. Students will learn the interpretation of results and its application in biological systems.

Detailed Syllabus:

Unit I: Introduction to Statistics **(06)**

Measures of central tendency – mean, mode, median and their properties

Measures of dispersion – variance, standard deviation, coefficient of variance

Symmetry and skewness, measures of skewness, kurtosis

Sampling and sampling distributions – concept of sample and population, statistic, methods of sampling, standard error

Unit II: Correlation and regression **(09)**

Bivariate correlation, positive correlation, negative correlation

Measures of correlation – Scatter diagram, Karl-Pearson's coefficient of correlation, Spearman's rank correlation coefficient

Regression – Equations of regression lines using least square method, regression estimate and its standard error

Unit III: Experimental Statistics - Design of experiments **(06)**

Principles of design – randomization, replication, local control, treatment group and control group

Guidelines for designing the experiments, size of plot, number of replications

Completely randomized design (CDR), randomized block design (RBD)

Unit IV: Testing of hypothesis and analysis of variance **(09)**

Hypothesis, statistical hypothesis, critical region, level of significance, p-value, normal distribution

T-test: t-test for mean, equality of two means, paired t-test, unpaired t-test

chi-square test: chi square test for goodness of fit, independence of attributes,

Analysis of variance table (ANOVA)

Introduction to statistical analysis software- e.g. SPSS

Suggested Readings:

1. Billingsley, P. (1986). Probability and Measure. New York: Wiley.
2. Rosner, B. (2000). Fundamentals of Biostatistics. Boston, MA: Duxbury Press.
3. Daniel, W. W. (1987). Biostatistics, a Foundation for Analysis in the Health Sciences. New York: Wiley.
4. Sunderrao P.S. and Richards J. An introduction to Biostatistics, Prentice Hall Pvt. Ltd. India.
5. Campbell R.C. Statistics for Biologists, Cambridge University Press, Cambridge.

Title of the Course: Practicals in Environmental Biotechnology								
Year: I				**Semester: II**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	**Allotted Marks**		
		Theory	Practical			CIE	ESE	**Total**
DSE-06	MS-BT128P	00	02	02	60	15	35	**50**

Learning objectives

1. To gain practical experience in conducting experiments to assess the toxic effects of pollutants on biological systems.
2. To learn and apply the techniques of isolating microorganisms capable of degrading pollutants from polluted environments.
3. To acquire the knowledge and practical skills required to analyze water quality parameters such as Total Suspended Solids (TSS), Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), and Chemical Oxygen Demand (COD).
4. To Execute Biodegradation of Pollutants using Plants or Microbes
5. To implement practical experiments to carry out biodegradation of pollutants using either plants or microbes

Course Outcomes

1. Learn to isolate the microorganism from polluted soil.

2. Estimate TSS, DO, BOD and COD of waste water.

3. Interpretation of "Google Earth" images for the known and unknown area for land use.

4. Understand the method of estimation of biodegradation of pesticide/ insecticide/fungicide.

Detailed Syllabus:

1	Genotoxicity assay on polluted water- Onion root tip and pollen germination assay.	(2)
2	Isolation of microorganisms from different habitats/niches and	(2)

	enumeration of its bioremediation potential	
3	Removal/estimation of pollutant from soil/water samples by biostimulation/bioaugmentation/phytoremediation	(1)
4	Qualitative estimation of biodegradation of pesticide/insecticide/fungicide.	(1)
5	Estimation of Total suspended solids of waste water	(1)
6	Determination of dissolved oxygen concentration of water sample	(1)
7	Determination of chemical oxygen demand (COD) of sewage sample.	(1)
8	Determination of biological oxygen demand (BOD) of sewage sample	(1)
9	Acquisition of "Google Earth" images for the known and unknown area for land use - land cover mapping.	(1)
10	Review on EIA case study.	(1)

Suggsted Readings:

1. Bioremediation (1994) Baker, K.H and Herson, D.S.Mc Graw Hill, Inc. New York
2. Biotreatment of Industrial & Hazardous Waste (1993) M.V.Levin and Gealt, M.A McGraw Hill. Inc, New York
3. Concepts and Techniques of Geographic Information Systems (2009) C. P. Lo. Albert and K. W. Yeung 2nd edition, Prentice Hall, Inc., New Jersey
4. Ecology and environmental biology (2011) Saha T K Books & Allied (p) Ltd, Delhi

Title of the Course: Practicals in Biostatistics								
Year: I				**Semester: II**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	**Allotted Marks**		
		Theory	Practical			CIE	ESE	**Total**
DSE-06	MS-BT128P	00	02	02	60	15	35	**50**

Learning Objectives

1. To understand and calculate measures of central tendencies
2. To collect the primary and secondary data for analysis
3. To calculate kurtosis, skewness and correlation for data sets.
4. To learn the application of various statistical tests to given data

Course Outcomes (COs)

1. Students will understand the measures of central tendencies and their applications.
2. Students will able to collect the data relating to dependent and independent variable/variables.
3. Students will able to calculate kurtosis, skewness and correlation from different data sets.
4. Students can apply hypothesis testing via some of the statistical distributions.

Detailed Syllabus:

1. Measurement of central tendency (mean, mode and median) **(1)**
2. Measure of variance, standard deviation, coefficient of variance and standard error **(1)**
3. Measures of skewness and measures of Kurtosis **(1)**
4. Determination of Karl-Pearson's/ Spearman's rank coefficient of correlation from the given data. **(2)**
5. Determination of regression lines and calculation of correlation coefficient – grouped and ungrouped data. **(2)**
6. Drawing a simple random sample with the help of table of random numbers. **(1)**
7. Chi-square test for goodness of fit and independent attributes **(1)**
8. Analysis of variance on the given data (ANOVA) **(2)**
9. Hypothesis testing of data using t test. **(1)**

Suggested Readings:

1. Billingsley, P. (1986). Probability and Measure. New York: Wiley.
2. Rosner, B. (2000). Fundamentals of Biostatistics. Boston, MA: Duxbury Press.
3. Daniel, W. W. (1987). Biostatistics, a Foundation for Analysis in the Health Sciences. New York: Wiley.
4. Sunderrao P.S. and Richards J. An introduction to Biostatistics, Prentice Hall Pvt. Ltd. India.
5. Campbell R.C. Statistics for Biologists, Cambridge University Press, Cambridge.