Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore

Shri Vaishnav Institute of Science
Department of Life Science
B.Sc. (Major - Biotechnology)

SEMESTER VIII

COURSE CODE	Category	COURSE NAME	TEACHING & EVALUATION SCHEME								
			THEORY			PRACTICAL		Th	T	P	CREDITS
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
BSCBT801	**Major**	**Bioprocess Technology and Down-stream Processing**	60	20	20	30	20	4	-	2	6

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment shall be based following components: Quiz / Assignment / Project / Participation in Class, given that no component shall exceed more than 10 marks.**

Course Objectives:

1. To equip students with theoretical and practical understanding of bioreactors, their types and different aspects of fermentation processes.
2. To develop skill set regarding exploitation of microorganisms and their processes in the manufacture of microbial products.
3. To appreciate quality control and regulatory framework of bioprocess industries.

Student Learning Outcomes

Students should be able to:

1. Gain understanding of variety of the fermentation and subsequent processing approaches available for manufacture of biological products and the design and operation of these systems.
2. Discover new useful microorganisms, store them reliably for later use, specify models of their growth.
3. Critically analyze any bioprocess for quality control and also from an economics / market point of view

UNIT – I: Fundamentals of Fermentation Processes

Fermentation Processes – conventional fermentation v/s Biotransformation; Solid State and Submerged fermentation, Batch, fed-batch and Continuous Fermentation. Bioreactors – types and designs; Operational Kinetics, Growth linked and Non-growth linked products; Isolation, Screening and Maintenance of Industrially important microbes; Strain improvement; Culture Preservation and Inoculum Development

UNIT – II: Upstream Processing

Medium formulation for optimal growth of microbes and product formation in fermentation; Design of sterilization process, sterilization of bioreactor, sterilization of media, Maintenance

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of aseptic conditions; Monitoring of process variables; Types of Sensors, aeration and agitation; Scale-up and scale-down

UNIT – III: Down Stream Processing
Bio separation: filtration, centrifugation, sedimentation, flocculation; Cell disruption; Extraction; Distillation, Purification by chromatographic techniques; Reverse osmosis and ultrafiltration; Drying; Crystallization, Whole Broth Processing.

UNIT -IV: Industrial Production and Recovery process:
Microbial enzymes, Biofuels, Health care products, Food and beverage fermentations, Microbial biomass production, biotransformation, Recombinant Vaccines, Large scale animal and plant culture cultivation; Cell immobilization.

UNIT- V: Quality Control (QC), Quality assurance (QA) and Fermentation Economics
Roles and responsibilities of QC and QA departments; Common Quality control tests; Standard Operating Procedures (SOP) & Good Manufacturing Practices (GMP); Market analysis, equipment and operational costs.

PRACTICAL
1. Screening and identification (Genus Level) of a production strain (enzyme /antibiotic) from soil samples. Maintenance of the isolated production organism (Agar slants/ glycerol stocks /soil culture/ lyophilization)
2. To Estimate the Monod Parameters for microbial growth kinetics.
3. Quantitative estimation of ethanol produced during Yeast fermentation.
4. To determine the residence time distribution (RTD) in Biochemical reactor.
5. To Determine the Oxygen transfer coefficient (KLa) in CSTR.
6. Isolation, screening and optimization of conditions for production:
   • Solid state fermentation: enzymes, alcohol
   • Submerged fermentation: enzymes, exopolysaccharide, organic acids and antibiotics
7. Rheological study of culture broth by Brookfield viscometer
8. Estimation, recovery and purification of fermentation products-enzymes, antibiotics, organic acids, exopolysaccharide
9. Immobilization of yeast biomass in sodium alginate gel.
10. Bio-separations

BSCBT801 Bioprocess Technology and Down-stream Processing

Recommended Books

1. Shuler, M. L., & Kargi, F. (2002) Bioprocess Engineering: Basic Concepts. Upper Saddle River, NJ: Prentice Hall.
2. Stanbury, P. F., & Whitaker, A. (2010) Principles of Fermentation Technology. Oxford: Pergamon Press.
3. El-Mansi, M., & Bryce, C. F. (2007). Fermentation Microbiology and Biotechnology. Boca Raton: CRC/Taylor & Francis.
4. Arvind H Patel (2016). Industrial Microbiology (2nd Ed) Laxmi Publications.
5. Casida L E (2019) Industrial Microbiology (2nd Ed) New Age International Publisher
6. Demain A. L. & Davies J. E. (2nd Ed.) Manual of Industrial Microbiology and Biotechnology (1999)

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BSCBT802	**Major**	**Bioinformatics**	60	20	20	30	20	4	-	2	6

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment shall be based following components: Quiz / Assignment / Project / Participation in Class, given that no component shall exceed more than 10 marks.**

Course Objectives:
1. Basics of Bioinformatics and data bases
2. Applications of Bioinformatics
3. Concepts in statistics and their application in biological studies

Course Outcomes:
1. Construction of molecular designs using the tools of bioinformatics
2. Understanding the tools of bioinformatics
3. Understanding the methods in statistics and their applications to biological problems

UNIT – I
Introduction to Bioinformatics and its Applications. Central Dogma of Molecular Biology, Biological Databases and Sequence Analysis, NCBI, EBI, ExPASy Entrez & SRS System; Primary Sequence & Structure Databases: Genbank, ENA, DDBJ, SwissProt/Uniprot, EMBL, PIR, PDB, KEGG;
Secondary Databases of Sequences and structure: Prosite, Pfam, SCOP, CATH, DSSP, FSSP, RNAbase; Genome Databases (at NCBI, EBI), High-throughput genomics sequence (EST, STS, GSS), ENSEMBL. Bioinformatics Resources, Sequence File formats: fasta, genbank, embl, Swiss-prot, pdb, nbrf, pir and multiple sequences formats (Aln, Mega, Pileup, phylip etc.); Sequence Similarity

UNIT–II: Basics:
Similarity, Identity, Homology, Scoring, Selectivity/Sensitivity, Gap cost, Linear and Affine Gap Penalty, Basic of scoring system and matrices (PAM, BLOSUM, GONNET ClustalW and ClustalX). Pairwise sequence alignment: Brute Force method, Dot matrix method, Global (Needleman-Wunsch) and Local Alignment (Smith-Waterman) using Dynamic programming; BLAST and FASTA, Theory and Algorithms, variants of BLAST and FASTA, PSI-BLAST; Statistical, Significance; Sequence Pattern and Profiles: Concepts of motif, pattern and profile;

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UNIT–III:

Similarity Searching Tools and Phylogenetics Multiple sequence alignment (MSA) algorithms, Methods of MSA (Progressive, Iterative, Block- Based Alignment); Protein profiles and Hidden Markov Model (HMM); Phylogenetics prediction methods: Basics, molecular clock, Substitution Models of evolution; Tree reconstruction methods: Distance based, character based method, statistical; Bootstrapping; Software and programs for sequence comparison and analysis; Phylogenetic analysis software.

UNIT–IV: Structural Bioinformatics

Major structural resources (PDB and PMDB); PDB File Format; Basic Structure Visualization-Visualization of major secondary structure and their role in protein structure, Visualization of various interactions: Polar (Hydrogen Bonds), Apolar (Hydrophobic, van der Waals, Pi stacking), Other (Salt Bridges, Coordination with ions) in protein structures and their role; Protein Structure Classification (SCOP and CATH); Protein Structure Prediction-Need and Concept of protein structure prediction, protein folding and model generation; Protein secondary structure prediction methods (Alignment-based and Single sequence-based secondary structure predictions); Tertiary structure prediction (Homology modeling and Fold Recognition, ab initio methods); Ramachandran Plot.

Introduction to modeling; Protein-ligand interactions; Pose prediction strategies in molecular docking: Rigid body docking, Flexible ligand docking (Conformational search method, Fragmentation method, Database method); Scoring Functions: Force field-based, Empirical, Knowledge-based; Application in Structure Based Drug Designing.

UNIT – V: Fundamentals of Biostatistics

Sampling methods; Types of sampling- random sampling, probability and non-probability sampling, stratified sampling; Statistical data distribution- normal and skewed distribution, coefficient of skewness, moments and kurtosis; Data presentation models- covariance models, spatial statistical model, multivariate spatial model, gaussian and non-gaussian random process models; Principles of hypothesis testing, significance level, null hypothesis; Comparison of means, t-test, Chi-square test; Covariance and correlation, use of correlation and regression in biological analyses; Analysis of variance (ANOVA).

PRACTICAL [Bioinformatics]

1. Exploration of online resources like NCBI, PubMed.
2. Designing primers for PCR.
3. Bioedit as sequence handling tool.
4. Key word and accession number based database search and downloading bioinformatics data:

a. Downloading DNA sequence data (Genbank/DDBJ/ENA)
b. Downloading protein sequence data (Uniprot)
c. Downloading protein structure data (PDB/MMDB) and visualization
d. Downloading bioinformatics data from FTP servers (NCBI)

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5. Pairwise (global and local) alignment of DNA and protein sequences.
6. Multiple sequence alignment of DNA and protein sequences and finding conserved sequences.
7. Searching similar sequences in databases using BLASTp, BLASTt and BLASTn.
8. Similarity Search using BLAST and Interpretation of Results
9. Alignment of two Sequences and determination of BLOSUM Scoring Matrix
10. Alignment of two Sequences and determination of PAM Scoring Matrix

BOOKS:

1. Andrew, L. (2001). Molecular Modelling: Principles and Applications. (2nd Ed.). Publisher: Prentice Hall.
2. Baxevanis, A. D., Bader, G. D., & Wishart, D. S. (2020). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. (4th Ed.). Publisher: New York, John Wiley & Sons, Inc.
3. Burkowski, F. (2009). Structural bioinformatics: An algorithmic approach. (1st Ed.). Publisher: CRC Press.
4. Gu, J., & Bourne, P. E. (2003). Structural Bioinformatics (Methods of Biochemical Analysis). (2nd Ed.). Publisher: Wiley-Liss.