Learning Outcomes	After completing this course, students should be able to- • explain principle features of marine ecosystems and the microbial diversity in oceans; • describe and discuss marine microbes in terms of physiological capability and their biogeochemical role.	

Programme: M. Sc. Biotechnology

Course Code:GBO-183 **Title of the Course:** Lab IV - Bioprocess Technology

Number of Credits: 2

Effective from AY: 2019-2020

Prerequisites for the course:	No prerequisites required.	
Objective:	The objectives of this laboratory course are to provide hands-on training to students in upstream and downstream unit operations.	
Content:	1. Microbial production of ethanol using yeast sp. 2. Estimating ethanol concentration by Cerric Ammonium nitrate method. 3. Microbial production and estimation of organic acids: Citric acid using *Aspergillus* sp. 4. Microbial production of antibiotics. 5. Immobilization of microbial cells: use of alginate. 6.Fermentation: Batch,Fed-Batch and Continuous 7. Use of fermenter with special reference to scale-up operations. 8. Microfiltrations: separation of cells from broth 9. Bioseperations: Chromatography and extractions (organic acid & antibiotics)	48 hours

	10. Manufacture of ginger ale and estimating the alcohol content. 11. Solid State Fermentation: Mushroom cultivation. 12. Food Microbiology: Preparation of an edible fermented product	
Pedagogy:	lectures/ tutorials/assignments/self-study	
References/Readings	1. Encyclopedia of bioprocess technology. Vol 1-5. (1999). Flickinger, M.C. & Drew, S.W.(Ed). 2. Fermentation technology. (1994). Cassida. 3. Bioprocess engineering: Down stream processing & recovery of bioproducts, safety in biotechnology and regulations. (1990). Behrens, D. & Kramer, P.(Ed). 4. Fundamentals of biotechnology. (1987). Prave, P., Fanst, V., Sitting, W. & Sukatesh, D.A. (Ed.) 5. Comprehensive biotechnology. Vol 2-4. (1985). &Young, M. (Ed) 6. Chemical engineering. (1984). Coulson, J.M. & Richardson, J.F. 7. Principles of fermentation technology. (1984). Stanbury, F. & Whitaker,A. 8. Immobilized enzymes: An introduction & application in biotechnology. (1980). Trevan, M.D. 9. Topics in enzyme & fermentation technology. (1984). Wiseman, A. (Ed). 10. Khramtsov, N., McDade, L., Amerik, A., Yu, E., Divatia, K., Tikhonov,A., ... & Henck, S. (2011). Industrial yeast strain engineered to ferment ethanol from lignocellulosic biomass. Bioresource technology, 102(17), 8310-8313. 11. Moser, A. (2012). Bioprocess technology: kinetics and reactors. Springer Science & Business Media. 12. Tamang, J. P. (Ed.). (2015). Health benefits of fermented foods and beverages. CRC Press. 13. Ray, B., & Bhunia, A. (2013). Fundamental food microbiology. CRC press. 14. Korzybski, T., Kowszyk-Gindifer, Z., & Kurylowicz, W. (2013). Antibiotics: origin, nature and properties. Elsevier. 15. Ngo, T. T. (Ed.). (2013). Molecular interactions in bioseparations. Springer Science & Business	

	Media.	
Learning Outcomes	Students should: • Gain ability to investigate, design and conduct experiments, analyze and interpret data, and apply laboratory skills to solve complete bioprocess technology problems. • Use acquired skills and knowledge in solving problems typical of bio-industry and research.	

Programme: M. Sc. Biotechnology

Course Code: GBO-184 **Title of the Course:** Lab VI- Bioinformatics

Number of Credits: 1

Effective from AY: 2019-2020

Prerequisites for the course:	No prerequisites required.	
Objective:	The aim is to provide practical training in bioinformatics and statistical methods including accessing major public sequence databases.	
Content:	**MODULE I** 1. Using NCBI and Uniprot web resources. 2. Introduction and use of various genome databases. 3. Sequence information resource: Using NCBI, EMBL, Genbank, Entrez, Swissprot/ TrEMBL, UniProt. 4. Similarity searches using tools like BLAST and interpretation of results. 5. Multiple sequence alignment using ClustalW.	24 hours