

Objective: To acquaint students with technical and biological aspect of microbial utilisation for production of metabolites.

Credits Earned: 6 Credits

Course Outcomes: After completion of this course, student will be able to

- Designing of bioreactors and control necessary for maximising production.
- Select and optimise media for maximum production of microbial metabolites.
- Designing of protocols for strain improvement and separation of molecules after fermentation process.

Pre-requisite of course: N.A.

Teaching and Examination Scheme

Teaching Scheme (Hours)			Credits	Theory Marks			Tutorial/ Practical Marks		Total Marks
Theory	Tutorial	Practical		ESE (E)	Mid Sem (M)	Internal (I)	Viva (V)	Practical (PR)	
5	0	2	6	50	30	20	25	25	150

Microbiology
Contents:

Unit	Topics	Contact Hours
1	Introduction to bioprocess technology: Basic principle components of fermentation technology. Types of microbial culture and its growth– Batch, Fedbatch and Continuous culture. Inoculum preparation for bacterial and fungal fermentation processes.	15
2	Media Formulation for Fermentation Process: Natural Media (Conventional); Synthetic media. Variation in sources of components of media and other chemicals required to carry out fermentation process. Study of Process parameters: measurement of temperature; pressure and pH; dissolved Oxygen; foam etc. Strain Improvement: By mutation and screening of improved cultures; Strategic screening for production of primary and secondary metabolite production with examples.	15
3	Types of Fermentation: Solid Substrate fermentation and submerged fermentation. Design and construction of a Fermentors: Body construction; construction material; Aeration and agitation systems; Stirrer glands and bearings; Baffles; Valves and steam traps; Pressure-control valves. Waldhof type fermenter, tower fermenter, air lift fermenter, deep-jet fermenter, rotating disc fermenter. Specialized bioreactors: membrane bioreactors; tower bioreactors; fluidized bed bioreactors; Immobilized system and packed bed reactors and Photo bioreactors.	15
4	Downstream Processing: Techniques for the separation of Biomass; Centrifugation, Filtration, Flocculation. Cell disintegration techniques; Physical, Chemical and Enzymatic. Product Recovery: Phase separation (Solid/Liquid), Purification techniques for microbial products. Design of Bioprocess using automation and application of computers; Recombinant products and its examples. Preservation and maintenance of industrially important microorganisms.	15
	Total Hours	60

Microbiology
References:

- Peter F Stanbury, Allan Whitaker, Stephen J Hall. *Principles of Fermentation Technology*. (2016) Butterworth-Heinemann Press. UK.
- H. J. Peppler, D. Perlman. *Microbial Technology: Fermentation Technology*. (2014). Academic Press.
- T. El-Mansi, C. Bryce, Arnold L. Demain, A.R. Allman. *Fermentation Microbiology and Biotechnology*. Second Edition. (2006). CRC Press, USA.
- Hongzhang Chen. *Modern Solid State Fermentation: Theory and Practice*. (2013). Springer Press, Germany.
- John E. Smith. *Biotechnology*. (2009). Cambridge University Press. UK.
- Celeste M. Todaro, Henry C. Vogel. *Fermentation and Biochemical Engineering Handbook*. (2014). William Andrew Press. Norwich, NY.
- G. Lancini, R. Lorenzetti. *Biotechnology of Antibiotics and other Bioactive Microbial Metabolites*. (2014). Springer publications, Germany.

Suggested Theory distribution:

The suggested theory distribution as per Bloom's taxonomy is as per follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process.

Distribution of Theory for course delivery and evaluation					
Remember	Understand	Apply	Analyze	Evaluate	Create
20%	20%	30%	15%	10%	5%

Instructional Method:

- a. The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, etc.
- b. The internal evaluation will be done on the basis of continuous evaluation of students in the class-room in the form of attendance, assignments, verbal interactions etc.
- c. Students will use supplementary resources such as online videos, NPTEL videos, e-courses, Virtual Laboratory.

List of Practicals:

1	Isolation and Preservation (Agar plate, Slant, Glycerol stock) of economically important strain of microorganisms.
2	Study of Upstream Processing (a) Preparation of Inoculum for Scale up. (b) Strain Improvements by random mutagenesis (Physical/Chemical/UV). (c) Study of Growth curve of Microorganisms.
3	Effect of media supplements on growth of microorganisms and production of metabolite.
4	Production of ethanol using submerged fermentation.
5	Production of citric acid using submerged fermentation.
6	Optimisation, isolation and purification of Enzyme using submerged/ solid state fermentation.
7	Immobilisation of enzyme.
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