MB 401: Fermentation Technology

Objective: This paper provides the knowledge of basic principle of fermentation process, which help students to design, develop and operate industrial level fermentation process. This fundamental knowledge is essential for the students to make their career in industry based on bioprocess.

UNIT 1: Screening and strain improvement.	12
UNIT 2: Fermentation media and sterilization	10
UNIT 3: Bioreactor design	10
UNIT 4: Upstream and downstream processing	12

Unit – 1 Screening and strain improvement.

1.1 Introduction to fermentation process **Ref. Stanbury**
1.2 Important characteristics of microbes used in industrial microbiology **Ref. Okafor**
1.3 Screening for new metabolites. **Ref. Crueger**
1.4 Over production of metabolite of industrial microorganisms. **Ref. Okafor**
1.5 Strain improvement of industrially important microorganism. **Ref. Bailey, Crueger**
1.5 Preservation of cultures after strain improvement programme. **Ref. Moo young**

Unit - 2 Fermentation media and sterilization

2.1 Medium design. **Ref. Moo young**
2.2 Media for industrial fermentation. **Ref. Stanbury**
2.3 Media for cell culture. **Ref. Rehm**
2.4 Industrial sterilization. **Ref. Stanbury**

Unit – 3 Bioreactor design

3.1 Bioreactor: Design, operation and application. **Ref. El-mansi**
3.2 Fermentation kinetics. **Ref. El-mansi**
3.3 System for fermentation process control. **Ref. Moo young**

Unit – 4 Upstream and downstream processing. **Ref. Stanbury**

4.1 Development of inoculum for industrial fermentation.
4.2 Downstream processing of fermentation product
4.3 Fermentation economics

References:

1. Rehm H.J., Reed G., Puhler A and Stadler P., (1993) *Biotechnology*, 2nd ED, VCH Publishers Inc., New York, USA.

2. Stanbury P.F., Whitaker A., Hall S.J.,(1997) *Principles of fermentation technology*. 2nd ED, Aditya books(P) Ltd, New Delhi.

3. El-mansi E.M.T., Bryce C.F.A., Demain A.L., Allman A.R., (2009) *Fermentation microbiology and biotechnology*, 2nd ED,CRC Press.

4. Crueger W. and Crueger A. (2003) *Biotechnology: A textbook of industrial microbiology*, 2nd ED, Panima publishing corporation, New delhi.

5. Okafor N. (2007) *Modern industrial microbiology and biotechnology*, Science publishers, USA.

6. Moo-Young M. (2004) Comprehensive biotechnology, Vol- 1 to 4, Pergamon press Ltd, England.

7. Bailey J. S. and Bhatia S.C. (2009) Biochemical engineering. Vol – 1&2. CBS publishers & distributors, India.

MB 402: Bioprocess Engineering

Objective: This course is designed to impart the knowledge of basic engineering principles, rheological behavior of fluids and mass transfer. Further the students are enriched to apply these principles to bioprocessing units.

Unit – 1 Components of Bioreactor

1.1 Introduction to bioprocess engineering. **Ref. Shuler**

1.2 Component of bioprocess reactor. **Ref. Martin**

1.2.1 Vessels.

1.2.2 Agitation system design.

1.2.3 Transfer lines.

1.2.4 Valves.

1.2.5 Pipes.

1.2.6 Gassing devices.

1.2.7 Mechanical foam separator.

Unit – 2 Heat transfer and fluid mixing **Ref. Doran**

2.1 Heat transfer equipments.

2.2 Mechanism of heat transfer.

2.3 Heat transfer between fluids.

2.4 Design equation for heat transfer systems.

2.5 Classification of fluids.

2.6 Fluids in motion

2.7 Viscosity.

2.8 Newtonian and non-newtonian fluid.

2.9 Rheological properties of fermentation broth.

2.10 Factors affecting broth viscosity.

2.11 Mixing equipment.

2.12 Power requirment for mixing.

2.13 Scale-up of mixing system.

Unit – 3 Mass transfer **Ref. Doran**

3.1 Molecular diffusion.

3.2 Role of diffusion in bioprocessing.

3.3 Convection mass transfer.

3.4 Oxygen uptake in cell culture.

3.5 Mass transfer correlation.

3.6 Measurement of Kla.

Unit – 4 Bioprocess monitoring and control

4.1 Basic components of on-line process monitoring and control. **Ref. Mansi & Bryce**

4.2 Application of biosensor. **Ref. Mansi & Bryce**

4.3 Methods of measuring process variables. **Ref. Bailey**

4.4 Bioprocess control systems. **Ref. Stanbury**

4.5 Recent trends in bioreactor control. **Ref. Mansi & Bryce**

References:

1. Shuler M. L. and Kargi F. (2003) *Bioprocess engineering Basic concepts*, 2nd ED, Pearson education Pvt Ltd, India.

2. Stanbury P.F., Whitaker A., Hall S.J.,(1997) *Principles of fermentation technology*. 2nd ED, Aditya books(P) Ltd, New Delhi.

3. El-mansi E.M.T.and Bryce C.F.A. (2004) *Fermentation microbiology and biotechnology*, Taylor & Francis Inc, USA.

4. Martin K. (2007) Ullmann's biotechnology and biochemical engineering. Vol-1&2. Wiley – VCH verlag gmbh and Co, Weinheim.

5. Bailey J. S. and Bhatia S.C. (2009) *Biochemical engineering*. Vol – 1&2. CBS publishers & distributors, India.

6. Doran P.M. (2008) *Bioprocess engineering principles*, Academic press, California.

MB 403: Economic Microbiology

Objectives: This paper explains products of economic interest produced by microbial cells or systems.

	No. of Lectures
UNIT 1: Microbial production of health care products	14
UNIT 2: Microbial production of food and beverage	08
UNIT 3: Microbial production of food additives and enzymes	12
UNIT 4: Modern trends in microbial production	10

Unit 1 : Microbial production of Health care products

1.1 Anticancer agents **Ref: M. Moo-Young**
1.2 Insulin **Ref: Flickinger**
1.3 Erythropoietin **Ref: Flickinger**
1.4 Vaccine technology **Ref: Flickinger**
1.5 Hybridoma – Antibody production **Ref: Flickinger**
1.6 Antibiotics- Cephalosporins **Ref: Flickinger**
1.7 Biotransformations
- 1.7.1 Introduction **Ref : Ratledge**
- 1.7.2 Biocatalyst selection **Ref : Ratledge**
- 1.7.3 Biocatalyst immobilization and performance **Ref : Ratledge**
- 1.7.4 Synthesis of chemicals **Ref : Ratledge**
- 1.7.5 Immobilized enzyme reactors **Ref : Ratledge**
- 1.7.6 Biocatalysis in non-conventional media **Ref : Ratledge**
- 1.7.7 Commercial scale bioprocess
  - 1.7.7.1 Nitrile hydratase **Ref: Flickinger**
  - 1.7.7.2 Optically active 1,2-diols, microbial production by stereoinversion **Ref: Flickinger**

Unit 2 : Microbial production of Food and Beverages **Ref: Prescott & Dunn**

2.1 Cheese
2.2 Yogurt
2.3 Fermented Soy products **Ref: Flickinger**
2.4 Traditional Indian fermented food: Idli
2.5 Wine

Unit 3: Microbial production of food additives and enzymes

3.1	Food grade pigments	**Ref: Dufossé L.**
3.2	Organic acids	**Ref: Ratledge**
3.3	Amino acids, production processes	**Ref: Flickinger**
3.4	Enzymes for flavor production	**Ref: Flickinger**
3.5	Protease	**Ref: Prescott & Dunn**

Unit 4 : Modern trends in microbial production

4.1	PHA: Separation, purification, and manufacturing methods	**Ref: Flickinger**
4.2	Xanthan gum	**Ref: Flickinger**
4.3	Biosurfactant	**Ref: Lederberg J.**
4.5	Biohydrogen from biorenewable feedstock	**Ref: Demirbas A.**
4.6	Microbial lipids	**Ref: Lederberg J.**

References:

1. Moo-Young, M. *et al* (1985) *Comprehensive Biotechnology: The Practice of Biotechnology: Current Commodity Products.* Pergamon.
2. Flickinger, M. & Drew, S.(1999) *Encyclopedia of Bioprocess Technology,(Volumes 1 - 5)* Wiley-Interscience.
3. Ratledge, C. & Kristiansen, B.(2006) *Basic Biotechnology 3Ed.* New Delhi: Cambridge University Press.
4. Lederberg, J. (2000) *Encyclopedia of Microbiology, 2Ed (Volumes 1 to 4).Academic Press.*
5. Reed, G.(1981) *Prescott and Dunn's Industrial Microbiology.* Chapman & Hall.
6. Dufossé, L.(2006): *Food Grade Pigments.* Food Technol. Biotechnol. 44 (3) 313–321.

MB 404: Pharmaceutical Microbiology

Objective: The paper intends to deal applied aspects of pharmaceutical industry pertaining to microbiology specialization.

UNIT 1: MICROBIAL CONTAMINATION AND ITS CONTROL

1.1 Microbial contamination: spoilage and hazard
1.2 The design of controlled environments
1.3 Microbiological considerations for biotechnological products
1.4 Microbiological considerations in the production of medical devices

UNIT 2: MONITORING MICROBIOLOGICAL QUALITY

2.1 Good manufacturing practice (GMP) and good industrial large scale practice (GLSP) **Ref. Flickinger**
2.2 Monitoring microbiological quality: Conventional testing methods
2.3 Monitoring microbiological quality: Application of rapid methods

UNIT 3: STERILIZATION AND PRESERVATION

3.1 Principles of sterilization
3.2 Sterilization methods
3.3 Assurance of sterility by process validation
3.4 Antimicrobial preservatives and their properties
3.5 Official methods of preservative evaluation and testing

UNIT 4: REGULATORY ASPECTS

4.1 Regulation of Small-Molecule Drugs Versus Biologicals Versus Biotech Products **Ref. Gad**
4.2 Microbial standards for pharmaceuticals
4.3 Risk management and microbiological auditing
4.4 Laws and Regulations for the Protection of Biotechnological Inventions **Ref. Barredo**

Text Reference:

Denyer, S. P. and Baird, R. M. (2008). *Guide to microbiological control in pharmaceuticals and medical devices*. 2nd Edition, CRC Press, Boca Raton.

Supplementary References:

1. Flickinger, M. C. and Drew, S. W. (1999). *Encyclopedia of Bioprocess Technology.* Wiley-Interscience, New Jersey.
2. Barredo, J. L. (2005). *Microbial Processes and Products.* Humana Press, New Jersey.
3. Gad, S. C. (2007). *Handbook of Pharmaceutical Biotechnology.* Wiley-Interscience, New Jersey.

M.Sc. MICROBIOLOGY PRACTICALS

SEMESTER 4

1. Screening of Citric acid / lactic acid producing microorganisms.
2. Screening of alkaline protease / alpha amylase producing microorganisms.
3. Batch cultivation of bacteria in laboratory fermentor; Determine specific growth rate and growth yield (Y x/s) and Ks.
4. Partial purification of enzyme by ammonium chloride precipitation.
5. Monitoring of dissolved oxygen during aerobic fermentation.
6. Determination of *KLa* of laboratory fermenter.
7. Laboratory scale microbial production of wine.
8. Laboratory scale microbial production of protease.
9. Detection of pyrogen in pharmaceutical product using LAL Assay.
10. Sterility testing of pharmaceutical product.