Definitions of biotechnology

Australia

The devising, optimising, and scaling-up of biochemical and cellular processes for the industrial production of useful compounds and related applications. This definition envisages biotechnology as embracing all aspects of processes which the central and most characteristic feature is the involvement of biological catalysts

(Special Committee of Review, 1981)

European Federation of Biotechnology

The integrated use of biochemistry, microbiology,
and engineering sciences in order to achieve technological (industrial) application of the
capabilities of microorganisms, cultured
tissue cells, or parts thereof

(Bull, Holt and Lilly, 1982)

United Kingdom

The application of biological organisms, systems or processes to manufacturing and service industries

(Advisory Council for Applied Research and Development, The Royal Society, 1980)

OECD

The application of scientific and engineering principles to the processing of materials by biological agents to provide goods and services

(Bull, Holt and Lilly, 1982)

Industrial Microbiology

The exploitation of the synthetic capability of microorganisms to provide products and services

Disciplines

- Microbiology
- Biochemistry
- Biochemical engineering
- Economics

Fermentation

Latin

Fevere; "to be boiling"

In biochemistry

The degradation of organic substrates by organisms or cells to provide chemical energy as ATP in reactions that do not require molecular oxygen.

In industrial microbiology

Describes reactions which are not necessarily anaerobic.
Economic significance of the fermentation industry

Fermentation Products According to Industrial Sectors

Sector	Activities
Food	• Dairy products (cheese; yoghurt) • Beverages (alcoholic; tea;coffee) • Baker's yeast • Food additives (colors; flavors; stabilizers) • Soy sauce; tempe; miso • Mushrooms • Amino acids; vitamins • Glucose; high fructose syrups • Functional modifications of proteins; pectins
Agriculture	• Animal feedstuffs • Veterinary vaccines • Ensilage and composing processes • Microbial biocides • N-fixing bacterial inoculants • Mycorrhizal inoculants • Plant cell and tissue culture
Service Industries	• Water purification • Effluent treatment • Waste management • Oil recovery • Analytical tools

Fermentation Products According to Industrial Sectors 2

Sector	Activities
Chemicals	Organic (Fine) • Enzymes • Perfumeries • Polymers Organic (Bulk) • Ethanol; acetone; butanol • Organic acids Inorganic • Metal beneficiation; bioaccumulation; • bioleaching
Pharmaceuticals	• Antibiotics • Veterinary Diagnostic agents (enzymes; monoclonal antibodies) • Enzyme inhibitors • Steroids • Vaccines
Energy	• Ethanol (gasohol) • Methane • Biomass

Fermentation Products and Processes By Volume and Value

Category		Activities
Volume	Value	
High	Low	• Methanol; ethanol • Biomass and feeds • Water purification; effluent and waste treatment
High	Intermediate	• Amino and organic acids • Food products • Baker's yeast • Acetone; butanol • Polymers
Low	High	• Antibiotics; other pharmaceuticals • Enzymes • Vitamins

Technological Levels in Industrial Microbiology

Category	Input	Output
High Level	• High capital investment. • Sophisticated plant and processes.	• High value-added products. • Health care and food.
Intermediate Level	• Moderate capital investment. • Less complex operations.	• Fermented foods and beverages; enzymes; biocides; waste management.
Low Level	• Small capital investment. • Simple technology, sometimes septic systems.	• Low value products. • Traditional foods and beverages; biogas; mushrooms.

The Historical Development of Industrial Microbiology

1. Production of food and beverages.

- 6000 BC : Beer - Sumarians and Egyptians.
- 4000 BC : Leavened bread - Egyptians.
- Fermented milk products; mushroom cultivation.
- 1680 : Anton Van Leeuwenhoek.
- 1876 : Louis Pasteur.

2. Non-axenic fermentations.

- Late 1800's : Ethanol; organic acids; butanol; acetone.
- Systems open to the environment.
- Control via manipulation of the environment.

The Historical Development of Industrial Microbiology 2

3. Axenic fermentations.

- Contaminating organisms excluded.
- Fermented milk products; mushroom cultivation.
- Penicillin - Discovery and manufacture.
- 1940's : Introduction of sophisticated bioprocessing technology.

4. Applied genetics and recombinant DNA technology.

- New programming of the biological properties of organisms.

Lecture Schedule

Topic 1	**Course Introduction and Statement of Objectives** 1. Introduction
Topic 2	**Overview** 2. From Cell to Commercial Product
Topic 3	**The Cell as an Asset** 3. The cell as a productive unit 4. Strain improvement
Topic 4	**The Culture of Cells** 5. Cell culture 6. Physical processes affecting submerged aerobic culture
Topic 5	**The Bioreactor** 7. Configurations in bioreactors 8. Process control in bioreactors
Topic 6	**Processing** 9. Upstream processing 10. Downstream processing 11. Treatment of processing effluent
Topic 7	**Scale-up of Fermentation Processes** 12. Scale-up

Lecture Schedule 2

Topic 8	**Yield Optimization** 13. Yield improvement by physiological, cultural, and genetic manipulations 14. Yield improvement by the adoption of appropriate cultural mode
Topic 9	**Examples of Fermentation Processes** 15. Where the product is biomass 16. Where the product is biomass-mediated 1 17. Where the product is biomass-mediated 2 18. Where the product is biomass-mediated 3 19. Where the product is non-biomass-mediated
Topic 10	**Developing Technologies** 20. Plant cell culture 21. Animal cell culture
Topic 11	**Fermentation Economics** 22. Macro-economic aspects of fermentation 23. Micro-economic aspects of fermentation

Laboratory Objectives

To familiarize the student with

- The protocol for production using microorganisms.
- The concept of the optimisation of production by manipulating process conditions.
- The preparation of scientific reports.

Experiments

- Enzymatic assay for glucose.
- Studies on the effect of inoculum size, the ratio of flask to culture volume, and flask baffles on shake flask culture of *Vibrio natriegens*
- Determination of the Volumetric Transfer Coefficient.
- The optimization of incubation temperature, sodium chloride concentration, and glucose concentration in bioreactor cultures of *Vibrio natriegens*

Assessment

1. Continuous assessment 50%

Consisting of

- Laboratory proficiency 7%
- Prac test(s) 5%
- Papers on experiments
  - Paper I 15%
  - Paper II 10%
  - Paper III 13%

2. Final written examination 50%