Universitat Autònoma de Barcelona

2018/2019

Industrial Biochemistry

Code: 100909
ECTS Credits: 6

Degree	Type	Year	Semester
2500252 Biochemistry	OB	3	1

Contact

Name: Mohammed Moussaoui
Email: Mohammed.Moussaoui@uab.cat

Use of languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: Yes
Some groups entirely in Spanish: Yes

Teachers

Jaume Farrés Vicén

Prerequisites

There are no compulsory prerequisites. However, part of the contents of some 1st year and 2nd year courses are needed to be able to follow the course correctly. In particular, those of the following courses: Biocatalysis, Molecular Biology, Microbiology and Cell Culture.

Objectives and Contextualisation

The course aims to integrate the knowledge of biochemistry and molecular biology with those of microbiology and biochemical engineering, with emphasis on their application to the biotechnological processes.

Content

THEORY

PART I. INTRODUCTION

1. Introduction to Biotechnology. History of Biotechnology. Definitions of Biotechnology. Traditional biotechnology and modern biotechnology. Historical milestones. Elements of the biotechnological process: raw materials, biological agents and products.

2. Economic and social importance of biotechnology. Products of industrial interest - Potential of Biotechnology. Examples: food, energy, health - Industrial sectors - Creation of biotechnology companies. Business sectors - Protection of intellectual property - Public R & D programs in biotechnology - Biotechnology: perspectives and questions.

PART II. THE BIOTECHNOLOGICAL PROCESS

3. Raw materials. Natural raw materials. Byproducts. Petroleum derivatives. Selection and pretreatment. Examples.

4. Biocatalysis. Biocatalysts - Characteristics of enzymes as biocatalysts - Advantages of using enzymes as biocatalysts - Criteria for the efficiency of enzymes - Strategies for the development of efficient enzymes - Industrial enzymes - Industrial applications of enzymes: food, textiles, paper, detergents, pharmaceutical industry - Disadvantages of using enzymes as biocatalysts.

5. Immobilized biocatalysts (I). Concept, characteristics and industrial utility - Types of immobilization supports - Immobilization methods - Types of bioreactors for immobilized biocatalysts.

6. Immobilized biocatalysts (II). Properties of immobilized enzymes - Substrate specificity - Immobilization effects on enzyme activity and kinetic properties: partition and diffusion rate - Advantages and disadvantages of immobilization of enzymes - Industrial applications of immobilized enzymes - Immobilized cells .

7. Microbial cells (I). Microorganisms of industrial interest - Advantages of microorganisms Elemental composition of microorganisms and culture media - Obtaining, selection and conservation of microorganisms - Collections of type strains.

8. Microbial cells (II). Genetic manipulation and metabolic engineering of microorganisms - Improvement of strains by mutagenesis, gene recombination and recombinant DNA techniques.

9. Fermentations. Concept of fermentation - Operating regimes - Batch, fed-batch, continuous and perfused fermentation - Kinetics of the growth of a discontinuous culture- Kinetic parameters: specific growth rate (μ_m) and Monod constant (K_S), Yield ($Y_{X/S}$), Metabolic quotient (q_S) - Factors affecting growth rate - Kinetics of product formation - Primary and secondary metabolism products - Product yield ($Y_{P/S}$).

10. Continuous fermentation. Advantages and disadvantages of continuous fermentation. Type of continuous fermentation: chemostat and turbidostat. Balance of cell material. Dilution rate (D). Extinction of culture by dilution: wash-out. Balance of nutrient limiting material. Productivity. Enrichment. Contamination.

PART III. BIOREACTORS

11. Bioreactor design. Concept of bioreactor. Type of bioreactors. Working scales. Elements of a bioreactor. Requirements of industrial bioreactors. Auxiliary facilities.

12. Operation of a bioreactor. Aseptic operations. Aseptic inoculation and sampling. Seals and valves. Measurement and control of fermentation conditions: temperature, pH, dissolved oxygen concentration (DO), foaming, consumption and formation of gases and products. Respiratory quotion (RQ). Computer control of the bioreactor. Study of the typical fermentation profile.

13. Sterilization of the bioreactor and culture media. General considerations. Sterilization of the culture medium. Methods of sterilization. Heat sterilization. Theory of heat sterilization. Calculation of the duration of media sterilization. Continuous sterilization. Sterilization by filtration. Air sterilization.

14. Aeration of the bioreactor. General considerations. Transfer of gas-liquid matter. Specific rate of oxygen uptake. Critical oxygen concentration (C_{CRIT}). Oxygen transfer rate. Considerations that affect the oxygen transfer rate. Experimental determination of k_{La}. Elements used in aeration: types and efficiency. Hold-up: concept and distribution in stirred bioreactors.

15. Stirring of the bioreactor. Geometry and types of agitators. Required power for stirring: power number and Reynolds number. Power required for stirred and aerated bioreactors: aeration number. Power required for stirring and aeration of Newtonian and non-Newtonian fluids.

PART IV. BIOTECHNOLOGICAL PRODUCTS

16. Bioseparations. Processing of fermentation products. Process design and scale changes. Cost evaluation of the process according to the purity and performance requirements. Design of industrial type appliances and applications. Homogenization. Centrifugation. Filtration. Chromatography. Dehydration. Freeze-drying.

17. Production of enzymes on an industrial scale. Inactivating agents of the enzymes. Stabilization of enzyme preparations. Additives. Effect of ions. Evaluation of quality and safety of enzyme preparations.

18. Biological products of industrial interest. Products of primary and secondary metabolism. Production of ethanol, acetone-butanol, glycerol, lactic acid and glutamate.

19. Production of antibiotics. Main antibiotic types. Natural and semi-synthetic antibiotics. Mechanisms of resistance to antibiotics. Penicillin production.

20. Products of the food and beverage industry. Introduction to the production of food and fermented beverages. Authorized microorganisms (GRAS). Biochemistry of the production of alcoholic beverages. Biochemistry of the production of lactic and meat products. Biochemistry of bread fermentation. Biochemistry of food additives. Quality assurance.

21. Products of agriculture and livestock. Transgenic plants. Resistance of plants to herbicides, pesticides, insects and extreme environmental conditions. Bioinsecticides. Improvement of the product final quality. Transgenic animals as bioreactors. Application to the production of milk and pharmaceutical drugs.

SEMINARS

Proposed topics:

1. Biosensors. Concept. Structure and operation. Types: electrochemical, redox, FET, thermometric, optical, immunosensors. Biochips. Applications in clinical, agri-food sector and environmental control.

2. Biological purification of wastewater. Aerobic and anaerobic processes. Biological oxygen demand (BOD). Wastewater treatment: treatment plant scheme. Phases of treatment. Settling and activated sludge. Composting.

3. Bioenergy. Biomass as a source of renewable resources. Ethanol production. Raw Materials. Production of methane (biogas). Anaerobic digestion. Hydrogen production.

4. Biomining and bioremediation. Metal leaching. Oil degradation and heavy metal recovery.

5. Proteins and enzymes of extremophile organisms of industrial interest. Psychrophiles. Thermophiles and hyperthermophiles. Halophiles. Acidophiles and alkalophiles. Industrial applications.

6. Biopolymers. Classification. Microbial polysaccharides. Dextrans. Polyhydroxyalkanoates. Polyhydroxybutyrate (PHB). Biodegradable plastics. Industrial applications.

7. Quality assurance and control in biotechnological products. Good laboratory practices (GLP) and good manufacturing practices (GMP). Standard operating procedures (SOP). ISO 9000 standard. Quality assurance and auditing unit. Development of new pharmaceutical drugs. Phases of R & D and pre-clinical. Clinical trials in humans.

8. Release of genetically manipulated organisms into the environment. Controlled release: field tests. Environmental impact. "Suicidal" organisms. Genetic or molecular labeling methods. Biosecurity. Risk evaluation. Regulations. Labeling.

9. Patents in Biotechnology. Conditions of patentability. Procedure for patent filing. Patentability of genes and organisms. Examples of important patents and patent "wars". Economic impact. Leading companies in patent benefits.

10. Bioethics and Legislation in Biotechnology. Medical, social and economic impact of biotechnology. Biotechnology practices posing ethical-social problems. Information derived from the Human Genome project.

Gene and cell therapy. Stem cells. Use of embryos for biomedical research. Transplantation of embryonic cells. Xenotransplantation. Tissue generation from stem cells. Bioethics Committees. Regulations, recommendations and legislation.