Universitat de Lleida

DEGREE CURRICULUM

CHEMICAL TECHNOLOGY

Coordination: REY CASTRO, CARLOS

Academic year 2020-21

Subject's general information

Subject name	CHEMICAL TECHNOLOGY
Code	101603
Semester	2nd Q(SEMESTER) CONTINUED EVALUATION
Typology	Degree: Bachelor's Degree in Biotechnology; Course: 2; Character: COMPULSORY; Modality: Attendance-based
Course number of credits (ECTS)	6
Type of activity, credits, and groups	Activity type: PRALAB / PRAULA / TEORIA Number of credits: 0.8 / 1.3 / 3.9 Number of groups: 4 / 2 / 1
Coordination	REY CASTRO, CARLOS
Department	CHEMISTRY
Teaching load distribution between lectures and independent student work	60 classroom hours 90 h of independent work For health&safety reasons related to the COVID-19 epidemic, part of the classroom hours could be taught by videoconference.
Important information on data processing	Consult this link for more information.
Language	75% Spanish 25% English
Distribution of credits	2,28 Master lesson 2,16 Problems and cases 0,68 Seminars 0,44 Laboratory 0,44 Computer Classroom

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
REY CASTRO, CARLOS	carlos.rey@udl.cat	9,7	14:15-16:15h despacho 0.09 (Edif. A, ETSEA)

Subject's extra information

The fundamental aim of this subject is to provide the basic physicochemical and engineering concepts in the processes of bioseparación and purification, as well as the acquisition of the basic skills for their application to case studies of interest in the Degree.

Learning objectives

The student, when passing the subject, must be able to:
1. Understand and know how to use the fundamental concepts of chemical technology and the different methodologies typical of the discipline.
2. Distinguish the different concepts with correctness.
3. Apply the formulas correctly, with their corresponding units, and interpret the results obtained
4. Use existing computer tools to solve problems of a certain mathematical complexity
5.Relate the physicochemical and engineering concepts acquired with those of mathematics, physics and biology.

Significant competences

General competences:

The Biotechnology graduate must:
• Be able to selectively search and use those information sources that are necessary to reach the training objectives.
• Interpret scientific and technical information in a critical sense, and be able to make presentations based on that information.
• Be able to make understandable written and oral reports on the work done, with a justification based on the theoretical and practical knowledge obtained (Strategic competence of the UdL).
• Have teamwork skills, with a multidisciplinary vision and the ability to efficiently and efficiently distribute tasks among team members.
• Use information and communication tools and techniques for data analysis and the preparation of oral and written reports and other training and professional activities (Strategic competence of the UdL)
• Respect the fundamental rights of equality between men and women, the promotion of Human Rights and the values of a culture of peace and democratic values (Strategic competence of the UdL).
• Understand and properly use the scientific and technical vocabulary typical of the different fields of Biotechnology.
• Work in the laboratory applying quality criteria and good practices.
• Know how to use specific software and databases in the different fields of Biotechnology.
• Use the scientific method to analyze data and design experimental strategies with biotechnological applications.
• Be able to carry out a professional activity in accordance with safety and environmental regulations and with ethical criteria.
• Transmit technological strategies and applications to the company, based on the general foundations of the business economy.
• Acquire criteria for choosing the most appropriate analytical techniques for each specific case study.

Specific competences:

• Understand the basic principles of chemical engineering.
• Knowing how to relate structure and reactivity to the functional properties of biomolecules.
• Understand the procedures of sample acquisition and preparation for instrumental chemical analysis.
• Understand the basics, know how to apply and interpret the instrumental techniques of biotechnological application.

Subject contents

Unit 1. Introduction. Basic concepts of bioseparation processes. Bioseparations. Purity and yield.

Unit 2. Filtration. Microfiltration. General theory of filtration: Darcy's law, compressible and incompressible cake. Equipment for conventional filtration. Pretreatment: heating, coagulation and flocculation, adsorption on filters. Continuous rotary filters: formation and washing of the cake.

Unit 3. Sedimentation. Centrifugation. General theory of sedimentation of solids. Centrifuges: tubular centrifuge, disk centrifuge. Scaling of centrifugation. Centrifugal filtration.

Unit 4. Cellular disruption. The cell membrane. Physical methods. Chemical methods: osmotic shock, solubilization. Biological methods. Parameters affecting cell disruption kinetics.

Unit 5. Liquid-liquid extraction. General theory of extraction: basic equations, change of solvent, change of solute by modification of ion pair, change of solute by modification of pH. Extractions in batch system: analytical methods and graphs. Cascade extractions: equipment, analytical methods and graphs. Differential extraction. Fractionated extraction. Two-phase aqueous systems.

Unit 6. Adsorption. Basic theory of adsorption: common adsorbents, adsorption isotherms. Adsorption in batch systems. Continuous adsorption in a stirred tank. Column adsorption.

Unit 7. Ultrafiltration. Reverse osmosis. Dialysis. Electrodialysis. Basic theory: membranes, osmotic pressure, transport equations. Reverse osmosis. Ultrafiltration. Electrodialysis.

Unit 8. Chromatography. Basic principles. Molecular exclusion chromatography. Ion exchange chromatography. Affinity chromatography. Absorbents: classification, properties, stability and regeneration. Yield and purity. Scaling-up.

Unit 9. Precipitation. Crystallization. Precipitation by addition of a solvent. Precipitation by salt addition. Precipitation by effect of temperature. Large-scale precipitation: initial mixing, nucleation, growth and flocculation. Crystallization: Saturation, purity, nucleation and growth of the crystal. Crystalline size distribution: population density, crystals generated in continuous processes, dominant size. Crystallization in batch systems: cooling curve, scaling. Recrystallization.

Unit 10. Drying. Freeze-drying and evaporation. Drying basics: water content, evaporation and heating rates, unwanted effects. Drying Equipment: Driving Drying, Adiabatic Drying. Freeze-drying basics: freezing, sublimation (or primary drying) and desorption (or secondary drying). Freeze drying equipment.

Unit 11. Purification sequences applied to the biotechnology industry. Analysis of available separation techniques and their interaction with production processes. Examples: commercial enzyme production, polysaccharide recovery, antibiotics, organic acids, and ethanol. Combined operations: immobilization, processing of harvest broth and recirculation. Additional operations: water quality, solvent recovery, waste removal and safety.

Practical activities
Practice 1. Separation of ion mixtures through an ion exchange column.
Practice 2. Separation of mixtures by adsorption on activated carbon in a batch system.

Methodology

Activity	Description	Face-to-face activity		Independent work		Evaluation	Total time
		Objectives	**Hours**	**Student work**	**Hours**	**Hours**	**Hours**
Master class	Master class (Classroom)	Explanation of the main concepts	**21**	Study: Understand, understand and synthesize knowledge	**32**	4	**57h /2.28 ECTS**
Problems and cases	Interactive lesson (Classroom)	Problem solving/group discussion	**18**	Learn to solve problems and cases	**32**	**4**	**54h /2.16 ECTS**
Seminar	Interactive lesson (Small workgroup)	Discussion and application activities	**8**	Solve problems. Debate	**8**	1	**17h/ 0.6 ECTS**
Laboratory	Laboratory tutorial (Small workgroup)	Understanding phenomena, measuring	**8**	Study and write reports	**2**	1	**11 h/0.44 ECTS**
Computer classroom	Computer lab tutorial (Small workgroup)	Understanding phenomena, measuring, modelling	**5**	Study and write reports	**5**	1	**11 h/0.44 ECTS**
Total			**60**		**79**	11	**150h/ 6 ECTS**

Development plan

Activity	Description	Classroom activity		Independent work		Evaluation	Total time	
		Objectives	**Hours**	**Student work**	**Hours**	**Hours**	**Hours**	**ECTS**
Master class	Master class (Classroom)	Explanation of main concepts	**21**	Study: Understand and summarize knowledge	**32**	**4**	**57**	**2.28**
Problems and cases	Interactive classroom (Classroom)	Problem solving	**18**	Learn how to solve problems and cases	**32**	**4**	**54**	**2.16**
Seminar	Interactive classroom (Small workgroup)	Debate and application activities	**8**	Learn how to solve problems and cases. Debate	**8**	1	**17**	**0.68**
Laboratory	Lab tutorial (Small workgroup)	Understanding phenomena, measuring.	**8**	Study and write reports	2	1	**11**	**0.44**

Computer classroom	Computer lab tutorial (Small workgroup)	Understanding phenomena, measuring, modelling.	**5**	Study and write reports	**5**	1	**10**	**0.44**
Total			**60**		**79**	**11**	**150**	**6**

Evaluation

Theoretical exam	Lab tutorials	Case and problem analysis	Activities
40%	10%	40%	10%

Activity	Evaluation		Weight
	Procedure	**number**	
Master class	Written tests on the subject content	2	**40 %**
Problems and cases	Written tests on the subject content	2	**40 %**
Laboratory	Delivery of reports, written and oral tests	1	**10 %**
Seminar	written and oral tests	2	**5 %**
Computer classroom	Delivery of reports, written and oral tests	3	**5 %**
Assignment	Delivery of report	0	**0**
Total			**100**

Bibliography

- Bailey, J. E., Ollis, D. F. 1986. Biochemical Engineering Fundamentals. McGraw Hill, New York, EEUU.

- Belter, P. A., Cussler, E. L., Wei-Shou H. 1988. Bioseparations: Downstream Processing for Biotechnology. John Wiley and Sons, New Cork, EEUU.

- Doran P. M. 1995. Principios de Ingeniería de los Bioprocesos. Editorial Acribia, Zaragoza, España.

- Gòdia, F., López, J. (Editores). 1998. Ingeniería Bioquímica. Editorial Síntesis, Madrid, España.

- Harrison R.G., Todd P., Rudge S.R., Petrides D.P. 2015. Bioseparations Science and Engineering, 2nd Ed. Oxford University Press, EEUU.

- Recasens F. 2018. Procesos de separación de biotecnología industrial. Publicacions acadèmiques UPC, Barcelona.

- Ahuja, S. (Editor). 2000. Handbook of bioseparations. Academic Press, San Diego, EEUU.

- Asenjo, J. A. (Editor). 1990. Separation processes in biotechnology. Marcel Dekker Inc. New York, EEUU.

- Goldberg, E. (Editor). 1997. Handbook of downstream processing. Blackie Academic & Professional, Cambridge, Reino Unido.

- Ladisch M.R. 2001. Bioseparations Engineering. Principles, Practice and Economics. Wiley Interscience, EEUU.

- Verrall, M. (Editor). 1996. Downstream processing of natural products: a practical handbook. John Wiley & Sons, Chichester, Reino Unido.