Universitat de Lleida

DEGREE CURRICULUM

CHEMICAL TECHNOLOGY

Coordination: REY CASTRO, CARLOS

Academic year 2022-23

CHEMICAL TECHNOLOGY 2022-23

Subject's general information

<table>
<tr><td>Subject name</td><td>CHEMICAL TECHNOLOGY</td></tr>
<tr><td>Code</td><td>101603</td></tr>
<tr><td>Semester</td><td>2nd Q(SEMESTER) CONTINUED EVALUATION</td></tr>
<tr><td>Typology</td><td>
<table>
<tr><th>Degree</th><th>Course</th><th>Character</th><th>Modality</th></tr>
<tr><td>Bachelor's Degree in Biotechnology</td><td>2</td><td>COMPULSORY</td><td>Attendance-based</td></tr>
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<tr><td>Course number of credits (ECTS)</td><td>6</td></tr>
<tr><td>Type of activity, credits, and groups</td><td>
<table>
<tr><th>Activity type</th><td>PRALAB</td><td colspan="2">PRAULA</td><td>TEORIA</td></tr>
<tr><th>Number of credits</th><td>0.8</td><td>1.2</td><td>0.1</td><td>3.9</td></tr>
<tr><th>Number of groups</th><td>6</td><td>2</td><td>1</td><td>1</td></tr>
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<tr><td>Coordination</td><td>REY CASTRO, CARLOS</td></tr>
<tr><td>Department</td><td>CHEMISTRY</td></tr>
<tr><td>Teaching load distribution between lectures and independent student work</td><td>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.</td></tr>
<tr><td>Important information on data processing</td><td>Consult this link for more information.</td></tr>
<tr><td>Language</td><td>75% Spanish
25% English</td></tr>
<tr><td>Distribution of credits</td><td>2,28 Master lesson
2,16 Problems and cases
0,68 Seminars
0,44 Laboratory
0,44 Computer Classroom</td></tr>
</table>

CHEMICAL TECHNOLOGY 2022-23

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
BRATKIC , ARNE	arne.bratkic@udl.cat	1,2	
HERNANDEZ JIMENEZ, ANA	ana.hernandez@udl.cat	1,2	
LODEIRO FERNÁNDEZ, PABLO MANUEL	pablo.lodeiro@udl.cat	2,4	
REY CASTRO, CARLOS	carlos.rey@udl.cat	6,4	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.

Competences

General skills:

The Biotechnology graduate must:

CT1 Being able to produce comprehensible written and oral reports on the work carried out, with a justification based on the theoretical-practical knowledge obtained.

CT3 To use information and communication tools and techniques for data analysis and the preparation of oral and written reports and other training and professional activities.

GC1 Being able to selectively search for and use sources of information necessary to achieve the training objectives.

GC2 Interpret scientific-technical information with a critical sense, and be able to make presentations based on this information.

GC3 Working in a team, with a multidisciplinary vision and with the ability to make a rational and efficient distribution of tasks among team members.

GC4 Knowing and adequately using the scientific and technical vocabulary of the different areas of Biotechnology.

GC5 Working in the laboratory applying criteria of quality and good practice.

GC6 Knowing and knowing how to use the specific software and databases in the different fields of biotechnology.

GC7 Using the scientific method to analyze data and design experimental strategies with biotechnological applications.

GC9 Being able to carry out a professional activity in accordance with safety regulations and respect for the environment and with ethical criteria.

GC10 Transmitting strategies and technological applications to the company, based on the general foundations of business economics.

GC11 Acquiring criteria for choosing the most appropriate analytical techniques for each specific practical case.

Specific skills:

CE1 To know and understand the fundamentals of general, analytical and organic chemistry.

CE2 To know and understand the chemical fundamentals of biotechnological processes.

CE3 To know how to handle the essential instruments of a chemical laboratory.

CE4 To know the principles of physical chemistry and being able to solve problems related to the kinetics of chemical reactions.

CE5 To know the basic principles of chemical engineering.

CE6 To know how to relate the structure and reactivity with the functional properties of biomolecules.

SC7 To know the procedures for acquiring and preparing samples for instrumental chemical analysis.

CE8 To know the fundamentals, how to apply and interpret the instrumental techniques of biotechnological application.

CE9 Achieve a satisfactory command of concepts and procedures related to integral differential calculus and linear algebra.

CE10 Be able to apply mathematical procedures to scientific-technical situations necessary throughout the studies and in the future exercise of the profession.

CE11 To know how to use the basic concepts of the statistical method, being able to statistically analyze the results of studies and interpret them critically.

CE13 To know and understand the physical-mathematical foundations of biotechnological processes.

CE31 Be able to calculate, interpret and rationalize bioindustrial processes based on the relevant parameters in transport phenomena and thermodynamic balances.

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 (taught in english)
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.