1. Module Identification code:	
Name of the institution:	Universidad Autónoma de Nuevo León
Name of the school:	School of Medicine
Name of the degree program:	Clinical Chemistry
Name of the course (learning unit):	Techniques in organic chemistry
Total number of class hours-theory and practice:	80
Class hours per week:	4 horas
Independent study:	10
Course modality:	Face-to-face instruction
Module level:	Fourth semester
Core/elective module:	Core
Curriculum area:	ACFB
UANL credit points:	3
Create date:	28/08/2017
Date of last amendment made:	15/01/2024
Person(s) responsible for the design of module	Dr. C. Jonathan Pérez Meseguer, Dra. Q. Tannya R. Ibarra Rivera

2. Presentation:

One of the guiding principles of the Educational Model at UANL is student-centered learning. In the Techniques in Organic Chemistry learning unit, students have the opportunity to apply the knowledge acquired through the search for necessary information to solve problems and interpret results. This enables them to be competent in this area, demonstrated through the integrative learning product.

The student will begin the learning unit by studying the physicochemical properties of solid and liquid organic compounds. Based on this, they will apply crystallization and distillation techniques to purify these compounds as applicable. They will determine the purity of the separated compounds by measuring their melting and boiling points.

In the second phase, the student will practice the technique of simple, multiple, and selective liquid-liquid extraction, in addition to what was covered in the first phase, to separate more complex mixtures of compounds. In the same phase, the student will apply chromatography techniques to separate and identify natural compounds found in plants and foods. They will also extract and isolate essential oils from plant sources using reflux extraction, Soxhlet extraction, and steam distillation techniques.

In the final phase, as the last graded activity, the student will be able to integrate all the knowledge acquired during the course to extract, purify, and synthesize an organic compound in the laboratory.

At the end of the learning unit, the student will present a written proposal as an integrative learning product (ILP) for the separation and purification of organic compounds present in theoretical problem samples. All of this aims to prepare the student for handling and preparing samples prior to a functional and structural organic analysis.

3. Purpose(s):

This learning unit aims to contribute to achieving the graduate profile by mastering the basic knowledge of laboratory techniques commonly employed in organic chemistry. It seeks to develop the necessary competencies that allow students to integrate their understanding of functional groups so that, after carefully analyzing their physicochemical properties, they can select and apply methods for the separation and/or purification of organic compounds.
Additionally, the unit includes a simple organic synthesis designed under the principles of "green chemistry," which focuses on finding new ways to synthesize chemical substances that are more friendly to health and the environment.
This foundation will prepare students to apply their knowledge in the workplace, enabling them to handle organic samples and achieve the separation and/or purification of analytes of biomedical interest, which can later be subjected to specific analyses in biomedical laboratories.

During this learning unit, students will develop several general competencies, as they will be able to use traditional and cutting-edge research methods and techniques while handling organic compounds of biomedical interest. Additionally, teamwork will be encouraged, fostering a spirit of commitment and respect that allows for full social and labor integration of the students. Within the same teamwork framework, students will develop competencies to resolve conflicts while respecting the abilities and viewpoints of participants, facilitating appropriate decision-making. At the same time, they will develop the specific competency of the graduate profile by applying suitable physicochemical procedures in handling samples to achieve the isolation and purification of analytes of interest, enabling subsequent analysis that contributes to addressing a specific problem.

This learning unit, both in its content and its placement in the fourth semester of the degree program, constitutes a fundamental link within the framework of the QCB curriculum. It is a unit that relates to General Chemistry, Physical Chemistry, and Basic Organic Chemistry, as it utilizes knowledge of the general properties of matter, atomic structure, thermodynamics, kinetics, and functional groups, allowing students to predict and analyze the physicochemical properties of organic compounds and select the appropriate laboratory technique for their purification, as well as the procedure to verify the purity of the compound. Furthermore, it employs knowledge about the chemical reactivity of functional groups acquired in Basic Organic Chemistry to conduct a simple synthesis of an organic compound in the laboratory. This learning unit is also related to the Integral Organic Analysis Laboratory (LIAO), as the knowledge gained about separation techniques forms the basis for the traditional laboratory procedures used in LIAO.

4. Competences of the graduate profile

General competencies to which this module (learning unit) contributes:

- *Instrumental skills*:

8. To use traditional and cutting-edge research methods and techniques for the development of their academic work, the exercise of their profession and the generation of knowledge..

- *Personal and social interaction skills*:

9. To maintain an attitude of commitment and respect towards the diversity of social and cultural practices that reaffirm the principle of integration in the local, national and international context in order to promote environments of peaceful coexistence.

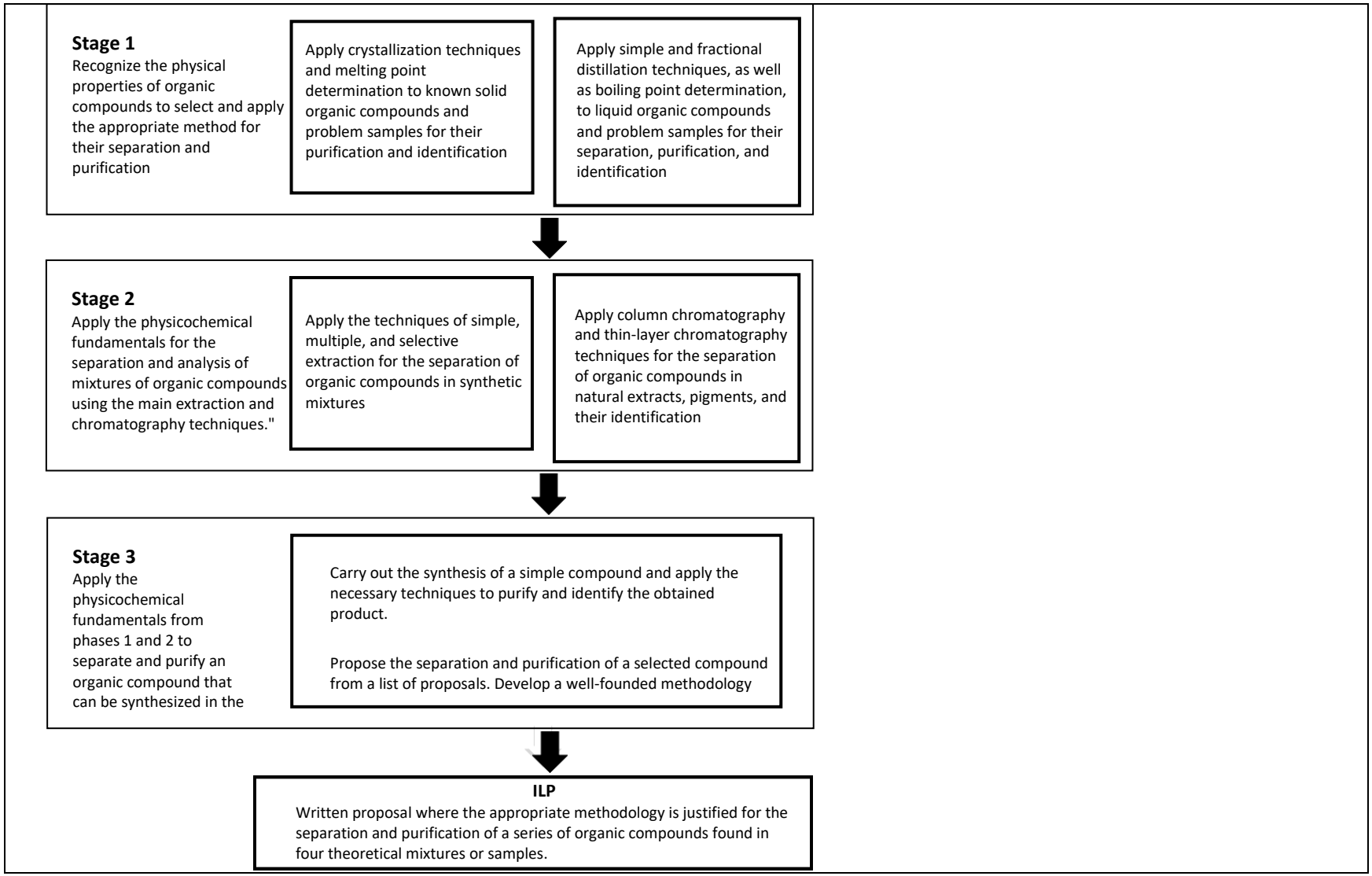
- *Integrative skills:*

14. To resolve personal and social conflicts, in accordance with specific techniques in the academic field and in their profession for appropriate decision-making.

Specific competences of the graduate profile to which this module (learning unit) contributes:

2. To execute physical, chemical and/or biological procedures in the collection, handling, storage and analysis of samples to contribute to a reliable clinical, toxicological, chemical, food, forensic and environmental diagnosis.

5. Course roadmap:


Stage 1
Recognize the physical properties of organic compounds to select and apply the appropriate method for their separation and purification
Apply crystallization techniques and melting point determination to known solid organic compounds and problem samples for their purification and identification
Apply simple and fractional distillation techniques, as well as boiling point determination, to liquid organic compounds and problem samples for their separation, purification, and identification
Stage 2
Apply the physicochemical fundamentals for the separation and analysis of mixtures of organic compounds using the main extraction and chromatography techniques."
Apply the techniques of simple, multiple, and selective extraction for the separation of organic compounds in synthetic mixtures
Apply column chromatography and thin-layer chromatography techniques for the separation of organic compounds in natural extracts, pigments, and their identification
Stage 3
Apply the physicochemical fundamentals from phases 1 and 2 to separate and purify an organic compound that can be synthesized in the
Carry out the synthesis of a simple compound and apply the necessary techniques to purify and identify the obtained product.
Propose the separation and purification of a selected compound from a list of proposals. Develop a well-founded methodology
ILP
Written proposal where the appropriate methodology is justified for the separation and purification of a series of organic compounds found in four theoretical mixtures or samples.

6. Structure in stages:
Stage 1: Physical properties of organic compounds. Stage 2: Separation and purification of organic compounds. Stage 3: Synthesis and purification of organic compounds.

Stage 1: Physical properties of organic compounds.

Competency Element(s):
Analyze the physical properties of organic compounds in the laboratory and through teamwork to select the appropriate method for their purification, determine the degree of purity, and identify them.

Evidence of student learning	**Performace criteria**	**Learning activities**	**Content**	**Resources**
Weighted Activity 1: Report on the purification, qualitative determination of the degree of purity, and identification of solid compounds, along with questionnaires.	Analyze the digital and audiovisual material provided individually, and obtain the experimental data in the laboratory necessary to respond to reports 1-3 from the laboratory manual. Demonstrate the ability to purify a solid compound of unknown identity using the criteria	The professor carries out the framing of the course. The analytical program of the Organic Techniques learning unit is reviewed. The importance of organic techniques in the separation, purification, identification, and synthesis of organic compounds is recognized. The student receives a schematic outline of how to create a flowchart for integration into all practice reports.	Laboratory Performance. Safety and Hygiene Regulations. Theoretical Framework for the Following Procedures: Selection of Solvent for Crystallization. Recrystallization. Determination of Melting Point. Determination of the Purity of Solid Compounds. Identification of a	* Laboratory Manual * Laboratory equipped for the separation, analysis, and simple synthesis of organic compounds. * Whiteboard * Various laboratory materials * Reagents specified in the manual for each practical session * Digital platforms Moodle or Microsoft Teams * University email

	established in the laboratory manual regarding melting point. Identify an organic solid compound of unknown identity using the melting point, based on the criteria established in the laboratory manual. Submit the results of the three virtual sessions through the MS Teams platform in PDF format on the established date and manner. These reports must include a flowchart, results and observations, discussion, conclusions, annexes on the toxicity and physicochemical properties of the reagents used, and a completed questionnaire for each	The student reviews in groups the safety regulations and waste management procedures included in the laboratory manual. The student asynchronously reviews the digital resources and bibliographic references on the topics provided by the professor on the scheduled dates. The student reviews in groups the digital material provided by the professor, whether in the form of videos, presentations, or other resources, for the sessions on: Selection of crystallization solvent. Recrystallization. Melting point. The student discusses the results obtained in groups. The student analyzes the experimental data obtained to respond to reports 1-3	Solid Compound by Mixed Melting Point.	* Computer or smart device * Chem Draw Program * Merck Index * Digital, audiovisual, and reading resources provided * Instructional guide

	practice.	from the laboratory manual.		
Weighted Activity 2 Report on the purification, determination of the degree of purity, and identification of liquid compounds, along with a questionnaire.	Attend the laboratory session on the scheduled date and time. Demonstrate the separation of two liquids using both types of distillation based on the criteria established in the laboratory manual. Illustrate the effectiveness of the distillation techniques through graphs comparing the volume of distillate against boiling temperature. Demonstrate the identification of a	The professor provides digital resources and bibliographic references on the topics to be reviewed on the scheduled dates. The student analyzes what the professor has presented regarding the processes of simple distillation, fractional distillation, and the boiling point of liquid organic compounds through an online explanation. The student reviews the laboratory manual individually and in advance for the sessions on: 1.- Simple and fractional distillation 2.- Boiling point. The student obtains the experimental data in the	Theoretical Framework for the Following Procedures: Simple and fractional distillation. Determination of the boiling point of the separated liquids. Identification of liquid compounds. Application of the aforementioned procedures for addressing practical problems in the purification, determination of purity, and identification of organic compounds.	* Laboratory Manual * Laboratory equipped for the separation, analysis, and simple synthesis of organic compounds. * Whiteboard * Various laboratory materials * Reagents specified in the manual for each practical session * Digital platforms Moodle or Microsoft Teams * University email * Computer or smart device * Chem Draw Program * Merck Index * Digital, audiovisual, and reading resources

	pure compound and its boiling point through experimental data obtained from the provided digital material. Report the results of the three virtual sessions through the MS-Teams platform in PDF format on the established date and in the required manner. The reports must include a flowchart, results and observations, discussion, conclusions, annexes regarding the toxicity and physicochemical properties of the reagents used, and a resolved questionnaire for each practice.	laboratory necessary to respond to the practice reports for each session.		provided * Instructional guide
Stage 2: Separation and purification of organic compounds.				

Competency Element(s):
Apply the physicochemical fundamentals for the separation and analysis of mixtures of organic compounds using the main techniques of extraction and chromatography.

Evidence of student learning	Performace criteria	Learning activities	Content	Resources
Weighted Activity 3 Report on simple and multiple extraction and questionnaire.	Attend the laboratory session on the scheduled date and time. Demonstrate the extraction process by separating iodine according to the criteria established in the laboratory manual. Analyze the provided digital and audiovisual material and obtain the experimental data necessary to determine which type of extraction is the most efficient for obtaining the greatest amount of the compound in question (iodine).	The professor provides digital resources and bibliographic references on the topics to be reviewed on the scheduled dates. The student attends the professor's explanation regarding the process of simple and multiple extraction of organic compounds based on their physicochemical properties during the laboratory session. The student individually reviews the laboratory manual beforehand for the sessions on simple and multiple extraction. The student obtains the experimental data in the laboratory necessary to respond to the practice reports for each session.	Theoretical Framework for the Following Procedures: Simple Extraction. Multiple Extraction. Application of the Described Procedures for the Extraction of Compounds in Aqueous/Organic Phase. Determination of the Highest Extraction Efficiency Based on the Yield Obtained.	* Laboratory Manual * Laboratory equipped for the separation, analysis, and simple synthesis of organic compounds. * Whiteboard * Various laboratory materials * Reagents specified in the manual for each practical session * Digital platforms Moodle or Microsoft Teams * University email * Computer or smart device * Chem Draw Program * Merck Index * Digital, audiovisual, and reading resources provided * Instructional guide

	Report through the MS-Teams platform in PDF format, the results of the virtual session on the established date and manner. These reports must include a flow diagram, results and observations, discussion, conclusions, annexes regarding the toxicity and physicochemical properties of the reagents used, and a resolved questionnaire for each practice.			
Weighted Activity 4 Report on Selective Extraction and Questionnaire.	Attend the laboratory session on the scheduled date and time. Demonstrate your understanding of the separation and obtaining of the three compounds that are part of the mixture using the	The professor provides digital resources and bibliographical references for the topics to be reviewed on the scheduled dates. The student attends the professor's explanation regarding the selective liquid-liquid extraction process of organic compounds based on their acid-base properties	Theoretical framework of the following procedures: Selective liquid-liquid extraction. Application of the described procedure for the separation and purification of a mixture of three	* Laboratory Manual * Laboratory equipped for the separation, analysis, and simple synthesis of organic compounds. * Whiteboard * Various laboratory materials * Reagents specified in the manual for each

	criteria established in the lab manual. Analyze the digital and audiovisual material provided and obtain the experimental data necessary to: 1.- Determine each phase in a selective extraction based on the pH change, 2.- Separate and/or purify each of the three compounds, and 3.- Determine their degree of purity. Report through the MS-Teams platform and in PDF format the results of the virtual session on the established date and manner. This report must include a flow diagram, results and observations, discussion,	through an online presentation. The student individually reviews the laboratory manual for the selective extraction session. The student obtains the necessary experimental data in the laboratory to respond to the practice reports for each session.	compounds with different acid-base properties.	practical session * Digital platforms Moodle or Microsoft Teams * University email * Computer or smart device * Chem Draw Program * Merck Index * Digital, audiovisual, and reading resources provided * Instructional guide

	conclusions, appendices on the toxicity and physicochemical properties of the reagents used, and the resolved questionnaire for each practice.			
Evidence 1. Partial evaluation of the achievement of the competency elements from Phase 1 and part of Phase 2, which correspond to: separation, purification, qualitative determination, and extraction of solid and liquid organic compounds.	Respond to the partial evaluation virtually on the date and time indicated by the professor. Write the evaluation individually within the time established by the professor.	The student will complete the written evaluation at the scheduled time and date.	Consider the content covered in the laboratory sessions: Crystallization Melting Point Simple and Fractional Distillation Boiling Point Simple and Multiple Extraction Selective Extraction	• Pencil • Eraser • Pen
Weighted Activity 5: Report on Chromatographic Separation and Questionnaire.	Attend the laboratory session on the scheduled date and time. Demonstrate the ability to separate plant pigments from	The teacher provides digital resources and bibliographic references on the topics to be reviewed on the scheduled dates. The student attends the teacher's explanation	Theoretical framework for the following procedures: Thin-layer chromatography Column	• Laboratory Manual • Laboratory equipped for the separation, analysis, and simple synthesis of organic compounds.

	a plant according to the criteria established in the laboratory manual. Perform column chromatography with plant pigments. Conduct thin-layer chromatography with food colorants. Demonstrate the separation of colorants found in foods according to the criteria established in the laboratory practices manual. Report and discuss the results obtained in the laboratory manual. Sketch the chromatogram obtained and calculate the retention factors of the separated compounds.	regarding the process of separating organic compounds using chromatographic techniques based on their physicochemical properties through an online presentation. The student individually reviews the laboratory manual for the selective extraction session. The student carries out the chromatographic techniques in the laboratory according to the descriptions in the digital material and the explanations provided by the teacher. The student obtains the necessary experimental data for their report through the chromatograms obtained and discusses their observations during the session.	chromatography Application of the procedures described above for the separation of plant pigments and colorants using chromatographic techniques.	• Whiteboard • Various laboratory materials • Reagents specified in the manual for each practice session • Digital platform (Moodle or Microsoft Teams) • University email • Computer or smart device • Chem Draw program • Merck Index • Digital, audiovisual, and reading resources provided • Instructional guide • Plant-based colorants, markers, spinach, and/or ground paprika • Ethyl alcohol • Reference: Setting Up an Educational Column Chromatography Experiment from Home. DOI:

	Report through the MS-Teams platform and in PDF format the results of the two virtual sessions on the scheduled date and in the established format. This report must include a flowchart, results and observations, discussion, conclusions, annexes of the toxicity and physicochemical properties of the reagents used, and a resolved questionnaire for each practice.			10.1021/acs.jchemed.0c00532.
Weighted Activity 6 Digital Report on the Extraction and Isolation of Natural Products and Questionnaire.	Attend the laboratory session on the scheduled date and time. Demonstrate the extraction of essential oils and extracts from a plant source using reflux, Soxhlet extraction, and	The professor provides digital resources and bibliographic references for the topics to be reviewed on the scheduled dates. The student attends the professor's explanation in the laboratory session regarding the process of obtaining essential oils using three different extraction techniques.	Theoretical Framework of the Following Procedures: Steam Distillation (Direct and Indirect) Soxhlet Extraction Reflux Extraction Application of the previously described procedures for	• Whiteboard • Various laboratory materials • Reagents specified in the manual for each practice session • Digital platform (Moodle or Microsoft Teams) • University email • Computer or smart

	steam distillation techniques. Report and discuss the results in the digital format. Submit the report through the MS-Teams platform in PDF format, detailing the results of the virtual session on the specified date and in the established format. This report must include a flowchart, results and observations, discussion, conclusions, annexes on the toxicity and physicochemical properties of the reagents used, and the resolved questionnaire for each practice.	The student individually reviews the laboratory manual to understand the different isolation techniques and to solve a proposed experimental case. The student obtains the necessary experimental data in the laboratory to respond to the practice report.	obtaining extracts and essential oils from plants using the three extraction techniques.	device • Chem Draw program • Merck Index • Digital, audiovisual, and reading resources provided • Instructional guide
Stage 3: Synthesis and Purification of an Organic Compound.				

Element of Competence:
To synthesize an organic compound in the laboratory using simple chemical reactions, and then to separate, purify, and identify the synthesized compound by selecting from the techniques acquired during the course, those that best address the compound based on its physical and chemical properties.

Evidence of student learning	Performace criteria	Learning activities	Content	Resources
Weighted Activity 7 Digital Report on the Synthesis and Purification of Acetylsalicylic Acid and Questionnaire.	Attend and perform the practice in the scheduled session. Demonstrate the synthesis of dibenzylacetone from cinnamaldehyde, using a simple synthesis established in the laboratory manual; extract it from the reaction medium, purify, and identify it. Report and discuss the results obtained from the melting point, yield, and chromatography in the laboratory manual.	The student prepares a graphical representation in the form of a flowchart of the procedures to follow in the synthesis, purification, and identification of dibenzylacetone, as described in the laboratory manual. The flowchart is created following the guidelines indicated by the professor at the beginning of the learning unit. The professor explains the synthesis of dibenzylacetone, its extraction, and purification based on its physicochemical properties for subsequent identification. The professor illustrates the procedures to be followed in the synthesis,	Theoretical Framework of the Following Procedures: Synthesis of dibenzylacetone. Application of the methods described during the development of this learning unit for the separation of the compound from the reaction medium, its purification, and identification using chromatographic methods and its melting point.	• Whiteboard • Various laboratory materials • Reagents specified in the manual for each practice session • Digital platform (Moodle or Microsoft Teams) • University email • Computer or smart device • Chem Draw program • Digital, audiovisual, and reading resources provided • Instructional guide

	Work as a team in the laboratory following the guidelines established in the safety and waste management regulations. Report through the MS-Teams platform and in PDF format the results of the practical session on the established date and manner. This report must include a flowchart, calculations, results and observations, discussion, conclusions, annexes on the toxicity and physicochemical properties of the reagents used, and a completed questionnaire for each practice.	purification, and identification of dibenzylacetone through drawings. The student carries out the practice according to the description in the manual and the explanations provided by the professor. They work as a team using the necessary materials and reagents. The student asynchronously reports the results obtained during their practical session within their manual. This includes a flowchart, results, calculations, discussion, conclusions, annexes on the toxicity and physicochemical properties of the reagents used, and a questionnaire.		
Evidence 2	Respond to the	The student completes the	The assessment	• Materials:

Partial assessment of the achievement of the competency elements from the second part of Phase 2, which corresponds to: isolation, chromatography, and synthesis.	partial assessment virtually on the date and time indicated by the professor. Answer the assessment in writing individually during the time established by the professor.	written assessment on the scheduled date and time set by the professor.	includes topics covered in the laboratory sessions on: Thin-layer chromatography. Column chromatography. Reflux extraction. Soxhlet extraction. Steam distillation. Synthesis, purification, and identification.	• Pencil • Eraser • Pen

7. Comprehensive Evaluation of Processes and Products:

STAGES	Evidencias y actividades Ponderadas	Ponderación
Stage 1	Weighted Activity 1: Digital report on the purification, qualitative determination of the degree of purity, and identification of solid compounds, along with questionnaires.	10 %
	Weighted Activity 2: Digital report on the purification, determination of the degree of purity, and identification of liquid compounds, along with questionnaires.	5 %
Stage 2	Weighted Activity 3: Digital report on simple and multiple extractions, along with questionnaires.	5 %
	Weighted Activity 4: Digital report on selective extraction, along with questionnaires.	5%
	Evidence 1: Evaluation of the achievement of the competency elements of Phase 1 and part of Phase 2 related to the purification and determination of the degree of purity and extraction of solid and liquid organic compounds.	15%
	Weighted Activity 5: Digital report on chromatographic separation, along with questionnaires.	10%
	Weighted Activity 6: Digital report on the extraction and isolation of natural products, along with questionnaires.	5%
Stage 3	Weighted Activity 7: Digital report on the synthesis and purification of dicinamacetone, along with questionnaires.	10%
	Evidence 2: Evaluation of the achievement of the competency elements of part of Phase 2 and Phase 3 related to chromatography, isolation, and synthesis of organic compounds.	15%
ILP	Written proposal: A justification of the appropriate methodology for separating and purifying different organic compounds present in various theoretical mixtures.	20%
TOTAL		100%

8. Integrative learning product:

Written proposal: A justification of the appropriate methodology for separating and purifying different organic compounds present in various theoretical mixtures.

9. Sources of Support and Reference:

1) Pérez Meseguer, Ibarra Rivera, Pérez López, Rivas Galindo, Waksman de Torres. (2020). Prácticas de Técnicas Orgánicas. Monterrey, N.L.: UANL.
2) Shriner. (2013). Identificación sistemática de compuestos orgánicos. México DF: Limusa Wiley.
3) Grupo de Síntesis Orgánica. (2017). Fisicoquímica orgánica. agosto 2017, de Universidad Jaume I Sitio web: http://www.sinorg.uji.es/Docencia/FUNDQO/TEMA11FQO.pdf
4) Antonio Valiente Balderas. (1996). Historia de la destilación. Educación química, VII, 76-82.
5) Tannya R. Ibarra-Rivera*, Cecilia Delgado-Montemayor, Fernando Oviedo-Garza, Jonathan Pérez-Meseguer, Verónica M. Rivas-Galindo, Noemi Waksman-Minsky, and Luis Alejandro Pérez-López. Setting Up an Educational Column Chromatography Experiment from Home. J. Chem. Educ. 2020, 97, 9, 3055–3059.
6) Tannya R. Ibarra-Rivera, Fátima B. García-Sánchez, Jonathan Pérez-Meseguer, Verónica M. Rivas-Galindo, Rocío Álvarez-Román. Síntesis Sustentables para la Enseñanza de Química Orgánica.