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):	Fundamentals of analytical chemistry
Total number of class hours-theory and practice:	140
Class hours per week:	7 hours
Independent study:	40
Course modality:	Face-to-face instruction
Module level:	Third semester
Core/elective module:	Core
Curriculum area:	ACFB
UANL credit points:	6
Create date:	April 12, 2018
Date of last amendment made:	January 25, 2024
Person(s) responsible for the design and amendment of the module:	M.E.S. Angélica Margarita Romero de León, Dra. Rocío Castro Ríos, Dra. Marsela Garza Tapia

	Amendment: Dra. Rocío Castro Ríos, Dra. Marsela Garza Tapia, Dra. Graciela Granados Guzmán, Dra. Magdalena Escobar Saucedo, QCB Alejandra B. Fraga López, Dr. Omar J. Portillo Castillo.

2. Presentation:

The Fundamentals of Analytical Chemistry Learning Unit is offered in the third semester of the Bachelor's degree in Clinical Biology Chemistry. This learning unit deals with the study of Analytical Chemistry as a fundamental science that analyzes: the chemical and physical behavior of pure compounds or in solution, with particular emphasis on equilibrium systems, due to the great importance they have in chemical analysis. To achieve this analysis, this learning unit is reviewed in three phases.

In the first phase, concepts and tools frequently used in Analytical Chemistry, the preparation of solutions and basic laboratory operations are used.

In the second phase, the physicochemical bases of chemical equilibrium that justify the behavior of substances in solution are analyzed.

In the third phase, the principles of chemical equilibrium are applied to different types of equilibrium: acid-base, complexation, redox, and heterogeneous equilibria. This enables the student to interpret and predict the behavior of a wide range of processes of interest.

In the end, all the knowledge acquired will be integrated into the PIA through the solving of comprehensive Analytical Chemistry exercises, where the principles of chemical equilibrium and their applications will be employed.

3. Purpose:

The learning unit "Fundamentals of Analytical Chemistry" contributes to achieving the graduate profile by developing the necessary competencies to interpret the behavior of biochemically relevant compounds. This will enable students to justify, select, and develop laboratory tests applicable to their professional work.

According to the general competencies, in this learning unit, the student will use logical, formal, and mathematical language to interpret chemical reaction systems involving chemical equilibrium and the factors that affect it. The unit encourages students to commit to environmental care through strategies outlined in theoretical classes and during laboratory practices, such as handling and disposing of chemical waste. Additionally, students will adapt to the conditions and regulations of the learning unit for their work in both theoretical sessions and laboratory work.

In this unit, students apply specific competencies both in theory and practice, solving chemical equilibrium problems in different systems. Laboratory work is conducted following Mexican and international official standards to ensure the proper use and disposal of chemical reagents, thus preserving health and the environment.

The "Fundamentals of Analytical Chemistry" unit is offered in the third semester and is mandatory in the curriculum of the Bachelor's Degree in Clinical Chemistry. It applies the competencies of nomenclature, chemical reactions, and stoichiometry acquired in General Chemistry. Moreover, the physical and chemical processes of equilibrium are grounded in the thermodynamic principles previously reviewed in Physicochemistry. It also draws on competencies acquired in the Advanced Mathematics unit, such as algebraic equations and the handling of logarithmic functions, to solve chemical equilibrium problems.

The "Fundamentals of Analytical Chemistry" unit is related to other learning units studied in subsequent semesters, such as Applied Analytical Chemistry, Biochemistry, and Instrumental Analysis, as it provides the foundation for the development of chemical analysis.

4. Competences of the graduate profile

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

- *Instrumental skills::*

2. To use logical, formal, mathematical, iconic, verbal and non-verbal languages according to their stage of life, to understand, interpret and express ideas, feelings, theories and currents of thought with an ecumenical approach.

- *Personal and social interaction skills:*

10. To intervene in the face of the challenges of contemporary society at the local and global level with a critical attitude and human, academic and professional commitment to contribute to consolidating general well-being and sustainable development.

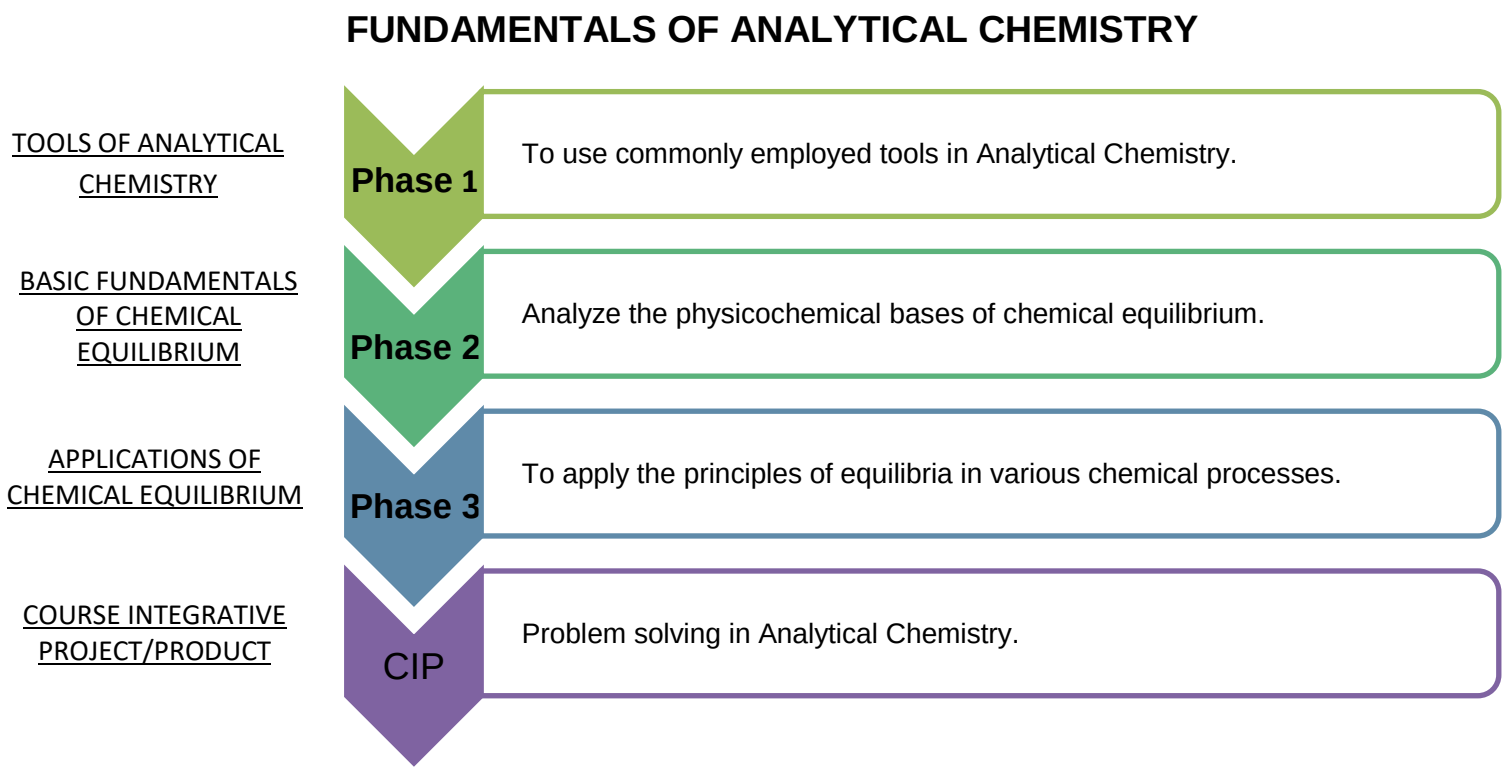
- *Integrative skills:*

15. To achieve the adaptability required by the uncertain social and professional environments of our time to create better living conditions.

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

1. To solve problems by applying knowledge of the chemical composition of matter as well as its physicochemical properties to determine analytes in biological, environmental and food matrices.
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.
3. To handle chemical and biological materials following official Mexican and/or international standards that guarantee their correct use and disposal to preserve health and the environment.

5. Course roadmap:



6. Structuring into stages or phases:

Phase 1: Tools of analytical chemistry

Phase 2: Basic fundamentals of chemical equilibrium

Phase 3. Applications of chemical equilibrium

Phase: 1

Component(s) of the competence:

To use the theoretical and practical tools commonly employed in Analytical Chemistry for the determination of analytes.

Evidence of student learning	Performance criteria	Learning activities	Content	Resources
Evidence 1 Tools commonly used in Analytical Chemistry activities and exercises portfolio	●Submit the portfolio assignments or exercises by team, on the date and time indicated by the teacher, through the corresponding platform. ●Includes complete team member identification data	**Before class:** ● Prior to the session, the student reads the Support Manual and Student Guide for Phase 1 as well as the recommended bibliography on the Tools of Analytical Chemistry. **In the classroom:** ● The teacher presents the course: program, methodologies used and	●Historical evolution and general concepts of Analytical Chemistry. Classifications and fields of application. ●Role of Analytical Chemistry in the professional performance of the Clinical Chemistry. ●Concentration units (% p/p, %p/v, %v/v, M, ppm, ppb), conversion of units and dilutions.	***Teaching resources*** ● Computer ● Internet connection ● UANL email ● Moodle platform of the Faculty of Medicine, UANL

	and correct file identification. ● Include the statements of the questions as well as reactions, assumptions and calculations made, in the digital document. ● Structure the document in an organized and readable manner, ensuring that the images presented in the digital document are clear and legible.	forms of evaluation of the Learning Unit. ● The student answers a diagnostic quiz. ● The teacher presents the theoretical concepts of the phase. ● The students participate by answering questions inserted by the facilitator, these can be orally or by digital applications. ***In the laboratory*** ***Carrying out laboratory practices:*** "Introduction to the Analytical Chemistry Laboratory" **(Accredited activity 1.1)** "Using the analytical balance" **(Accredited activity 1.2)**	● Activity and activity coefficient.. ● Laboratory notebook management. ● Weighing instruments: structure, calibration and use. ● Volumetric glassware: calibration and use. ● Preparation of solutions.	● Microsoft Teams ● Microsoft Forms ● Support manual and student guide for Phase 1 of the current school year. ● Textbooks ● Reference books ● Fundamentals of Analytical Chemistry Lab Manual

Evidence 2 Integrative written assessment : Tools commonly used in Analytical Chemistry.	● Submit the written assessment individually ● Respect the established schedule ● Respond completely and clearly ● Perform the required calculations	"Volumetric material. Description and use" **(Accredited activity 1.3)** "Workshop on calculations for the preparation of solutions" **(Accredited activity 1.4)** "Preparation of reagents" **(Accredited activity 1.5)** For laboratory activities, the following activities are carried out: ● The student reads the corresponding practices in the laboratory manual outside of class. ● The student prepares, outside of class, the flow chart of the practice that he/she will carry out and researches the additional information requested and delivers it via platform		

		before the deadline, the closing date. ● The student participates in the session guided by the professor on the assigned day and time. ● The student, at the beginning or at the end of the session, as indicated, answers quiz on the fundamentals of the practice. ● The professor leads a group discussion on the practice. ● The student answers questions inserted by the professor during the development of the practice, orally or using digital applications. ● The student performs the practices according to the manual (individually or in teams, according to the teacher's instructions) and		

		complies with the laboratory regulations. ● The student prepares a report of the practice in the established format and delivers it via the platform before the deadline, the closing date.		

Phase: 2

Component(s) of the competence: To analyze the principles of chemical equilibrium as applied to substances in aqueous solution, in order to predict their chemical behavior.

Evidence of student learning	**Performance criteria**	**Learning activities**	**Content**	**Resources**
Evidence 3. Principles of chemical equilibrium activities and exercises portfolio	●Submit the portfolio assignments or exercises by team, on the date and time indicated by the teacher, through the	**Before class:** ●Prior to the session, the student reads the Support Manual and Student Guide for Phase 2 as well as the recommended	Fundamental bases for the study of chemical equilibrium: ● Reaction speed. Activation energy. Types of collisions.	**Teaching resources** ● Computer ● Internet connection

	corresponding platform. ● Includes complete team member identification data and correct file identification. ● Include the statements of the questions as well as reactions, assumptions and calculations made, in the digital document. ● Structure the document in an organized and readable manner, ensuring that the images presented in the digital document are clear and legible.	bibliography on the principles of chemical equilibrium. **In the classroom:** In the session ● The teacher presents the theoretical concepts of the phase ● The students participate by answering questions inserted by the facilitator, these can be orally or using digital applications. ● The students carry out a group discussion, guided by the teacher, of the fundamental concepts. ● The students solve, with the teacher's guidance, exercises on chemical equilibrium ***In the laboratory***	● Factors that determine the reaction speed. ● Law of Mass Action. ● Chemical equilibrium. Equilibrium constant in a system. ● Factors that influence an equilibrium. LeChatelier's principle. ● Types of chemical equilibrium that exist in solution.	● UANL ● Moodle platform of the Faculty of Medicine, UANL ● Microsoft Teams ● Microsoft Forms ● Support manual and student guide for Phase 2 of the current school year. ● Khan Academy, Youtube ● Textbooks ● Reference books ● Fundamentals of Analytical Chemistry Lab Manual

Evidence 4. Integrative written assessment : Principles of chemical equilibrium	● Submit the written assessment individually ● Respect the established schedule ● Respond completely and clearly ● Perform the required calculations	***Carrying out laboratory practices:*** "Factors that Affect Chemical Equilibrium" **(Accredited activity 2.1)** For laboratory activities, the following activities are carried out: ● The student reads the corresponding practices in the laboratory manual outside of class. ● The student prepares, outside of class, the flow chart of the practice that he/she will carry out and researches the additional information requested and delivers it via platform before the deadline, the closing date. ● The student participates in the session guided by the		

		professor on the assigned day and time. ● The student, at the beginning or at the end of the session, as indicated, answers quiz on the fundamentals of the practice. ● The professor leads a group discussion on the practice. ● The student answers questions inserted by the professor during the development of the practice, orally or using digital applications. ● The student performs the practices according to the manual (individually or in teams, according to the teacher's instructions) and complies with the laboratory regulations.		

		● The student prepares a report of the practice in the established format and delivers it via the platform before the deadline, the closing date. ● At the end of the session, the student (individually or in a team, as instructed) disposes of waste appropriately.		

Phase: 3

Component(s) of the competence: Applying the principles of chemical equilibrium to various types of reactions—acid-base, complex ion formation, precipitation, and redox reactions—helps us understand and predict how compounds behave under different conditions.

Evidence of student learning	Performance criteria	Learning activities	Content	Resources
Evidencia 5. Applications of chemical equilibrium in acid-base, complexation, heterogeneous, and redox systems activities and exercises portfolio	●Submit the portfolio assignments or exercises by team, on the date and time indicated by the	Before class: ● Prior to the session, the student reads the Support Manual and Student Guide for phase 3 as well as the recommended bibliography on acid-base, complexation,	**a) Acid-base equilibrium** ● Concepts, Arrhenius, Brønsted-Lowry, Lewis theories, acid-base reactions, conjugate	**Teaching resources** ● Computer ● Internet connection ● UANL

	teacher, through the corresponding platform. ●Includes complete team member identification data and correct file identification. ●Include the statements of the questions as well as reactions, assumptions and calculations made, in the digital document. ●Structure the document in an organized and readable manner, ensuring that the images presented in the digital	heterogeneous, and redox equilibrium. ***In the classroom:*** In the session ● The teacher presents the theoretical concepts of the phase ● The students participate by answering questions inserted by the facilitator, these can be orally or using digital applications. ● The students carry out a group discussion, guided by the teacher, of the fundamental concepts. ● The students solve, with the teacher's guidance, exercises on applications of chemical equilibrium in acid-base, complexation, heterogeneous, and redox systems.	acid-base pair, protolytes, ampholytes ● Autoprotolysis of water, pH scale, pH and pOH relationship, pH for other solvents ● Relative strength of acids and bases, ionization of strong acids and bases, ionization of weak acids and bases, acidity and basicity constant in monoprotic and polyprotic systems, degree of dissociation, zones of dominance, qualitative pH prediction ● Prediction of reactions in acid-base systems ● Calculations in acid-base systems: strong acids and bases, monoprotic and polyprotic weak acids	● Moodle platform of the Faculty of Medicine, UANL ● Microsoft Teams ● Microsoft Forms ● Support manual and student guide for Phase 2 of the current school year. ● Páginas electrónicas: Khan Academy, Youtube ● Textbooks ● Reference books ● Fundamentals of Analytical Chemistry Lab Manual

Evidencia 6. Integrative written assessment : Applications of chemical equilibrium in acid-base, complexation, heterogeneous, and redox systems	document are clear and legible. ● Submit the written assessment individually ● Respect the established schedule ● Respond completely and clearly ● Perform the required calculations	***In the laboratory*** ***Carrying out laboratory practices:*** "Acidity and basicity properties" **(Accredited activity 3.1)** "Buffer Solutions Preparation Workshop" **(Accredited activity 3.2)** "Buffer Solutions" **(Accredited activity 3.3)** "Complexation equilibrium" **(Accredited activity 3.4)** "Equilibrium in Heterogeneous Systems – Solubilization" **(Accredited activity 3.5)** "Equilibrium in Heterogeneous Systems – Precipitation" **(Accredited activity 3.6)** "Redox equilibrium" **(Accredited activity 3.7)**	and bases, ampholytes, salts, mixtures ● Buffer solutions: mechanism, requirements, preparation, buffering capacity **b) <u>Complexation equilibrium:</u>** ● Coordination compounds: Nomenclature and properties. ● Complex ions, chelates and successive complexes. ● Application of chemical equilibrium to complex ion systems. ● Calculation of equilibrium constants. ● Calculation of the concentration of	

		For laboratory activities, the following activities are carried out: ● The student reads the corresponding practices in the laboratory manual outside of class. ● The student prepares, outside of class, the flow chart of the practice that he/she will carry out and researches the additional information requested and delivers it via platform before the deadline, the closing date. ● The student participates in the session guided by the professor on the assigned day and time. ● The student, at the beginning or at the end of the session, as indicated, answers quiz on the fundamentals of the practice.	species in complex ion systems. ● Effect of the common ion in complex ion systems ● Masking of metal ions. **c) <u>Heterogeneous equilibrium:</u>** ● Application of chemical equilibrium to precipitation reactions. ● Calculation of the solubility product constant (Kps). ● Calculation of the concentration of species in heterogeneous systems. ● Precipitation, fractional precipitation. ● Factors affecting the solubility of poorly soluble solids: common ion effect, formation of complex ions and pH.	

		● The professor leads a group discussion on the practice. ● The student answers questions inserted by the professor during the development of the practice, orally or through the use of digital applications. ● The student performs the practices according to the manual (individually or in teams, according to the teacher's instructions) and complies with the laboratory regulations. ● The student prepares a report of the practice in the established format and delivers it via the platform before the deadline, the closing date. ● At the end of the session, the student (individually or in a team, as instructed) disposes of waste appropriately.	**d) <u>Redox equilibrium:</u>** ● Fundamental concepts in redox systems: oxidation-reduction processes, oxidant, reducer, polyoxidant, polyreducer, ampholytes ● Balancing redox equations ● Chemical and electrochemical redox reactions ● Cell and electrode potential ● Normal hydrogen electrode, normal potential, relative strength of oxidants and reducers.	

			● Effect of concentration on cell potential and Nernst equation ● Prediction of redox reactions: potential scale, equilibrium constant ● Oxidation-reduction behavior of water. ● Calculations in redox systems.	

7. Summative evaluation:

PHASE 1		
Evidence 1	**Tools commonly used in Analytical Chemistry activities and exercises portfolio**	**2%**
Evidence 2	**Integrative written assessment: Tools commonly used in Analytical Chemistry.**	**9%**
	Accredited activity (1.1 a 1.5) of phase 1 lab practices 1.1 “Introduction to the Analytical Chemistry Laboratory” 1.2 “Using the analytical balance” 1.3 “Volumetric material. Description and use” 1.4 “Workshop on calculations for the preparation of solutions” 1.5 “Preparation of reagents”	**10%**
PHASE 2		
Evidence 3	**Principles of chemical equilibrium activities and exercises portfolio**	**2%**
Evidence 4	**Integrative written assessment : Principles of chemical equilibrium**	**9%**
	Accredited activity (1.1 a 1.5) of phase 2 lab practices 2.1 "Factors that Affect Chemical Equilibrium"	**3%**
PHASE 3		

Evidence 5.	**Applications of chemical equilibrium in acid-base, complexation, heterogeneous, and redox systems activities and exercises portfolio**	**4%**
Evidence 6	**Integrative written assessment : Applications of chemical equilibrium in acid-base, complexation, heterogeneous, and redox systems**	**32%**
	Accredited activity (3.1 a 3.7) of phase 1 lab practices 3.1 “Acidity and basicity properties” 3.2 “Buffer Solutions Preparation Workshop” 3.3 “Buffer Solutions” 3.4 “Complexation equilibrium” 3.5 “Equilibrium in Heterogeneous Systems – Solubilization” 3.6 “Equilibrium in Heterogeneous Systems – Precipitation” 3.7 “Redox equilibrium”	**17%**
CIP		**12 %**
	TOTAL	**100%**

8. Course integrative project/product:
Solving Integral Problems in Analytical Chemistry Using Chemical Equilibrium.

9. References:

Brown, T. L. y Lemay E. H. (2013). ***Química la Ciencia Central***. México: editorial Pearson.
Buttler, J. (1998) ***Ionic Equilibrium, Solubility and pH calculations***. EUA: editorial Wiley Interscience.
Christian, G. (2009) *QuímicaAnalítica*. México: editorial McGraw Hill Interamericana.
Harris, D.C. (2007) ***Análisis Químico Cuantitativo***. España: editorial Reverté
Sánchez-Batanero, P., Gómez del Río, M. l. (2002) ***Química Analítica General Volumen I****, Equilibrios en disolución y métodos analíticos*. España: editorial Síntesis.
Silva, M. y Barbosa, J. (2002) ***Equilibrios iónicos y sus aplicaciones analíticas***. España: editorial Síntesis.
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