UNIVERSIDAD AUTONOMA DE NUEVO LEON
SCHOOL OF MEDICINE
MODULE DESCRIPTION (ANALYTIC PROGRAM)

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):	Clinical biochemistry
Total number of class hours-theory and practice:	120 hours
Class hours per week:	6 hours
Independent study:	30
Course modality:	Face-to-face instruction
Module level:	Sixth semester
Core/elective module:	Core
Curriculum area:	ACFP-F
UANL credit points:	5
Create date:	September 15th, 2018
Date of last amendment made:	January 21th, 2022
Person(s) responsible for the design and amendment of the module:	Dr. E. Diana Guadalupe Robles Espino

2. Presentation:

The learning unit of Clinical biochemistry is composed of four phases, which integrate and provide the foundations for students to perform adequately in a Clinical biochemistry laboratory.

During phase 1: Basics of Quality Control, students will learn to identify the causes of variability that affect analytical methods in the Clinical biochemistry laboratory. They will also verify the analytical performance of qualitative methods and be able to interpret the results of both internal and external quality control.

Subsequently, in phase 2: Laboratory Tests in the Diagnosis, Control, and Monitoring of Glucose, Lipid, and Protein metabolism disorders, students will analyze the pathophysiological foundations that support these tests as well as the applicable analytical methodologies. At the same time, they will execute traditional manual methods in the Clinical biochemistry laboratory for the determination of glucose, cholesterol, and total proteins. Among the competencies that students will acquire in this phase, they will be able to interpret tests useful in diagnosing disorders of glucose and lipid metabolism and correlate them with the most common diagnoses.

In phase 3: Clinically important enzymes, students will analyze the pathophysiological foundations of enzymes as biochemical markers, as well as the applicable analytical methodologies. They will also carry out traditional manual methods for enzyme determination. In this phase, students will be able to interpret alterations in the results of different enzymes and correlate them with the most likely diagnosis.

Finally, in phase 4: Tests that Evaluate Liver and Kidney Function, Electrolyte Balance, and Acid-Base Status, students will analyze the pathophysiological foundations of tests for diagnosing kidney and liver disease, as well as disorders in electrolyte and acid-base balance. Additionally, they will analyze the methodological foundations of these tests and interpret results and their clinical correlation. They will also execute traditional manual methods for the determination of bilirubin, urea, creatinine, and general urine examination.

To ensure that students achieve these learning objectives, activities will be developed that promote meaningful learning and provide evidence demonstrating the competencies acquired, which in turn will enable them to develop an integrative learning product consisting of solving quality control cases, verifying methods, and interpreting results along with their clinical correlation.

3. Purpose:

Contribute to achieving the graduate profile by developing the necessary professional competencies to perform in the Clinical Laboratory through the execution of biochemical analysis methods, as well as the interpretation and validation of patient results.

This learning unit is related to Biochemistry, which provides the foundations of human metabolism; to Physiology, which offers knowledge of the function of organs and systems in the human body; and to Pathology, which introduces the concepts of disease. All of this knowledge is integrated into Clinical biochemistry to correlate laboratory tests with patient diagnosis. Additionally, it is related to Instrumental Analysis, which provides knowledge about the analytical methodologies on which the various determination methods in the Clinical biochemistry laboratory are based.

Within the learning units of more advanced semesters, there is a connection with Clinical pathology, Selected topics, and Professional practice, providing the necessary knowledge for interpreting and validating patient results, the basics of quality control, and the technical skills required for performing biochemical analyses.

Clinical biochemistry collaborates in promoting three general competencies of UANL; it encourages logical, critical, and proactive thinking by analyzing situations typical of work in the clinical laboratory, allowing for informed decision-making regarding sample management and the quality of laboratory results. During this learning unit, discussion spaces are created around the challenges facing our society in health matters, particularly in laboratory diagnostics, fostering interventions with a critical attitude, human commitment, and professionalism to seek the best alternatives for each situation.

Additionally, it promotes conflict resolution among the multidisciplinary health team through dialogue, negotiation, and mediation via case simulations. It collaborates with specific competencies by executing biochemical analysis of blood and urine samples for clinical diagnosis, interpreting results from biochemical profiles in correlation with patient diagnosis, and applying quality control tools to ensure the reliability of laboratory results.

4. Competences of the graduate profile

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

Instrumental skills:
5. To use logical, critical, creative and proactive thinking to analyze natural and social phenomena that allow them to make relevant decisions in their sphere of influence with social responsibility.

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

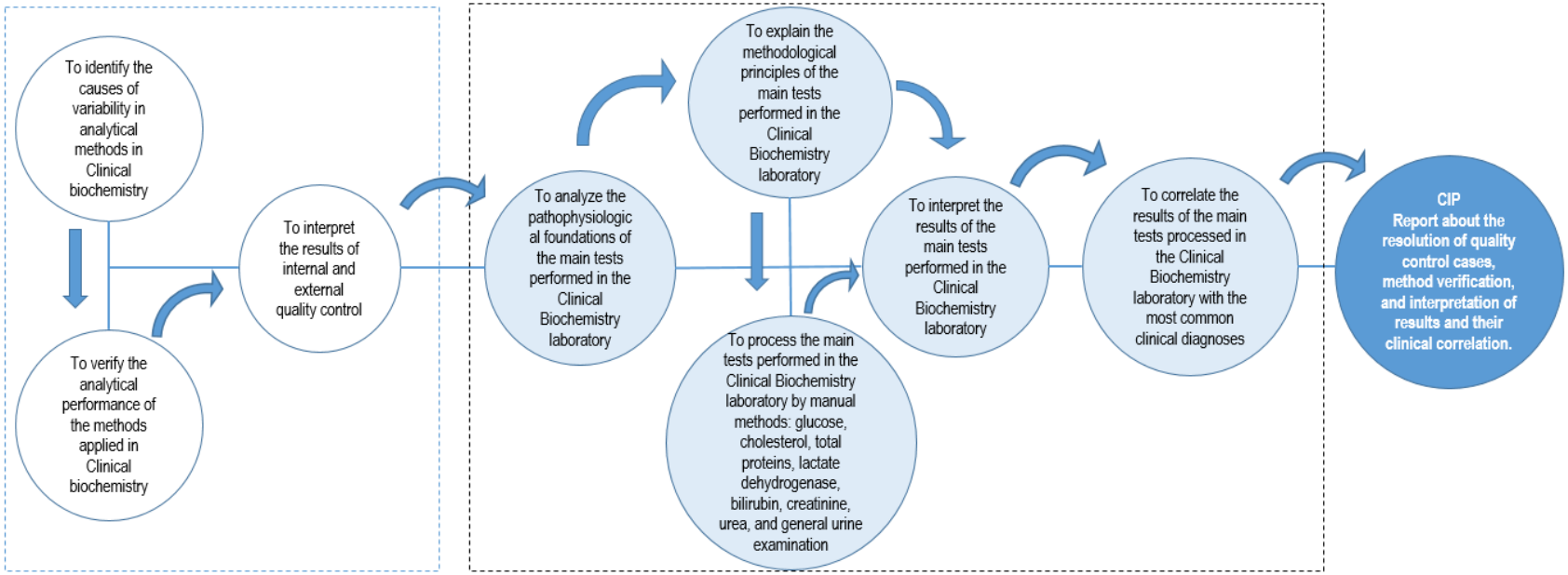
Specific competences of the graduate profile to which this module (learning unit) contributes:

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.

6. To interpret the results of analyses based on established criteria that allow timely and pertinent decision-making in clinical, toxicological, chemical, food, forensic, and environmental diagnosis.

7. To guarantee the reliability of the analytical results obtained by applying quality control guidelines as established by laboratory policies for correct decision-making.

5. Course roadmap:



Phase 1: Basics of Quality Control

Phase 2: Laboratory Tests in the Diagnosis, Control, and Monitoring of Disorders of Glucose, Lipid, and Protein Metabolism.
Phase 3: Clinically Important Enzymes.
Phase 4: Tests that Evaluate Liver and Kidney Function, Electrolyte Balance, and Acid-Base Status

6. Structuring into stages or phases:
Stage 1: Basics of quality control
Component(s) of the competence:

- To interpret the results of internal and external quality control based on the criteria of Westgard rules and an external quality program to identify systematic and random errors, and establish corrective measures that ensure the reliability of laboratory results.
- To verify the analytical performance of quantitative methods applied in the Clinical biochemistry laboratory regarding accuracy, precision, and linearity to evaluate whether they meet the established quality requirements.

Evidence of student learning	Performance criteria	Learning activities	Content	Resources
1. Internal and external quality control case study report.	Submit the handwritten report in PDF format by teams on the MS Teams platform: Includes: • Cover page. • Interpretation of Levey-Jennings graphs under the Westgard Rules and the results of external quality control under the criteria of the selected external quality program. • Identification of trends and shifts. • Identification of systematic and random errors. • Corrective actions for the errors identified. • Conclusion about the accuracy, veracity and precision of the assigned cases.	The professor explains the contents of the phase through electronic presentations, infographics and examples of the different topics during the sessions. During the sessions, the professor intersperses questions throughout the presentations to keep the students' attention. The student individually answers the Quality Control booklet provided by the professor outside the classroom. The student individually asynchronously creates a comparative table of the different types of control materials in the format indicated by the professor and submits it on the	• Object of study of Clinical biochemistry. • Disciplines related to Clinical biochemistry. • Types of samples analyzed in Clinical biochemistry exams and collection methods. • Clinical biochemistry laboratory process: pre-analytical, analytical and post-analytical stage. • Precision, veracity and accuracy. Quality Assurance and Quality Control. • Control materials and calibrators. • Parametric statistics: Mean, mode, median, standard deviation and coefficient of variation. • Types of distribution of	Classroom with audiovisual equipment: Projector, overhead projector, computer, audio system. Clinical Laboratory of the University Hospital. Teaching laboratory equipped for laboratory practices. Computer equipment with Microsoft Office and Internet connection. Moodle, ExamSoft and MS Microsoft Teams platform. Free-to-use electronic presentations prepared by the teacher.

	• Bibliographic references. Only one member of the team will upload the evidence to the platform on the established date.	platform indicated by the professor. The student asynchronously and as a team creates a report on the resolution of a statistics problem assigned by the professor and submits it on the platform indicated by the professor. The professor presents cases of interpretation of internal and external Quality Control through electronic presentations and infographics. The student individually participates in group discussions about the interpretation of the cases during class. The professor explains the laboratory practices through infographics and/or audiovisual media. The student individually and asynchronously reviews the laboratory practices and performs them during the corresponding synchronous session. The student individually and asynchronously performs the report of the following laboratory practices and delivers them on the platform indicated by the teacher. • Precision and veracity in the clinical laboratory. (**Accredited learning 1.1**)	data populations. • Internal cuality control. Systematic and random error. • Trends and shifts. • Levey Jennings graphs. • Westgard rules. • External quality control. • External quality assessment programs.	**Video** Chapter 3: Levey-Jennings Charts & Westgard's Rules **Book excerpts:** González (2019). Chapter 1: Preanalytical phase. Obtaining specimens. Basic Lessons on Quality Control in the BIO-RAD Laboratory. **Digital readings:** Internal quality control vs external quality control. **Free reference sources:** QCNet. QC Education. PACAL. Quality assurance program.

		• Measurement of precision in the clinical laboratory. (**Accredited learning activity1.2**) • Preparation of a control serum and construction of a Levey Jennings graph. (**Accredited learning activity1.3**)		

Evidence of student learning	**Performance criteria**	**Learning activities**	**Content**	**Resources**
2. Verification report of quantitative analytical methods.	The verification report is carried out as a team and delivered as a Word or Excel document on the MS Teams platform with a cover page on the date established by the teacher. Must contain: Total Error Calculations. CV Selection Total Error Calculation. Selection of quality requirement for each method. Analysis of the performance of each method in terms of precision, truthfulness and accuracy. Conclusions about what the causes of the	The teacher explains the contents of the phase through electronic presentations, infographics and examples of the different topics during the sessions. The student carries out, as a team and during class, the verification of the performance of truthfulness, precision and accuracy of an analytical method with data provided by the teacher. The teacher explains the laboratory practices through infographics and/or audiovisual media. The student individually and asynchronously reviews the laboratory practices and carries them	Quality requirements and total error. • Verification of quantitative analytical methods in the clinical laboratory. • Accuracy verification. • Verification of truthfulness. • Accuracy check. • Linearity verification.	**Digital readings:** Guide for the validation and verification of quantitative examination procedures used by the EMA clinical laboratory. **Free reference sources:** Westgard QC.

	verification results may be. Only one team member will upload the evidence to the platform on the established date.	out during the corresponding synchronous session. The student individually and asynchronously completes the report of the following laboratory practices and delivers them on the platform indicated by the teacher. • Characteristics of a prototype spectrophotometric method used in Clinical Biochemistry. **(Accredited learning activity1.4)** • Measuring linearity in a quantitative analytical method in Clinical Biochemistry. **(Accredited learning activity 1.5)** The student individually completes the content knowledge exam corresponding to phase 1 on the date indicated by the teacher. **(Accredited learning activity 1.6)**		

Phase 2: Laboratory tests in the diagnosis, control and monitoring of glucose, lipid and protein metabolism diseases.
Component(s) of the competence:
Interpret the results of tests for the diagnosis of glucose, lipid and protein metabolism diseases, considering the patient's clinical picture, clinical sensitivity and specificity and the analytical methodologies used, to correlate laboratory findings with the most probable clinical diagnoses.

Evidence of student learning	Performance criteria	Learning activities	Content	Resources
3. Case report on clinical resolution of glucose, lipid and protein metabolism diseases.	Performed as a team. Complete the case in the format provided by the teacher. Includes cover with team member information. Answer in handwriting each of the criteria established in the case format, digitize it and upload it to the MS Teams platform on the date assigned by the teacher. Consider clinical data and laboratory results for clinical correlation of results. Only one team member will upload the evidence to the platform on the established date.	The teacher explains the contents of the phase through electronic presentations, infographics and examples of the different topics during the sessions. During the sessions, the teacher intersperses questions throughout the presentations to keep the students' attention. The student participates individually in group discussions about the interpretation of the cases during class. The teacher explains the laboratory practices through infographics and/or audiovisual media. The student individually and asynchronously reviews the laboratory practices and carries them out during the	• Generalities of glucose and metabolism. • Colorimetric and enzymatic methods for determining blood glucose. • Oral glucose tolerance test. • Postprandial glucose. • Glycosylated hemoglobin. • Glucose in urine. • Clinical importance of glucose and glycosylated hemoglobin determination. • Hyperglycemia and hypoglycemia. • Criteria for the diagnosis of Diabetes Mellitus and Gestational Diabetes.	Classroom with audiovisual equipment: Projector, overhead projector, computer, audio system. Clinical Laboratory of the University Hospital. Teaching laboratory equipped for laboratory practices. Computer equipment with Microsoft Office and Internet connection. Moodle, ExamSoft and MS Microsoft Teams platform. Free-to-use electronic presentations prepared by the teacher.

		corresponding synchronous session. The student individually and asynchronously completes the report of the following laboratory practices and delivers them on the platform indicated by the teacher: • Determination of glucose. **(Accredited learning activity 2.1)** • Determination of cholesterol. **(Accredited learning activity 2.2)** • Protein determination. **(Accredited learning activity 2.3)** The student individually completes the content knowledge exam corresponding to phase 2 on the date indicated by the teacher. **(Weighted Activity 2.4)**	• Generalities of protein chemistry and metabolism. • Total protein and albumin function, normal values and clinical significance. • Determination of proteins by methods: Kjeldahl, Biuret and refractive index. • Determination of albumin by dye fixation methods. • Estimation of total proteins and albumin in other body fluids: urine and cerebrospinal fluid. • Generalities of chemistry and metabolism of triglycerides and cholesterol. • Principles for lipid analysis. • Determination of triglycerides, cholesterol and their clinical importance: • Serum lipoproteins, their determination and clinical importance. • Dyslipidemias	Book excerpts: Gonzalez (2019). Chapter 14: Glucose metabolism: diabetes mellitus. Hypoglycemia. Chapter 15. Lipid metabolism. Dyslipidemias. Chapter 16. Study of serum proteins. **Digital readings:** Canalizo (2013). Diagnosis and treatment of dyslipidemias. González (2013). Hemoglobin A1c: A reliable and accurate test for diabetes care? A prospective study in Mexico. Revista Salud Pública de México

Phase 3. Enzymes of clinical importance.
Component(s) of the competence:
Interpret the results of clinically important enzymes according to their sensitivity and specificity, considering the patient's clinical picture and the analytical methodologies used, to correlate laboratory findings with the most probable clinical diagnoses.

Evidence of student learning	Performance criteria	Learning activities	Content	Resources
4. Portfolio of enzymes of clinical importance.	Create a portfolio as a team that includes: • **Conceptual map of the assigned topic** Key concepts of the topic. Hierarchy of concepts. • **Summary of the topic** Includes: Cover, index, introduction, content: (pathophysiology, basis of the analysis method, sample collection conditions, analysis procedure, clinical correlation, conclusions, and bibliography) Submit the conceptual map and the summary in a single document in PDF format, on the MS Teams platform on the date indicated by the teacher.	The teacher explains the contents of the phase through electronic presentations, infographics and examples of the different topics during the sessions. During the sessions, the teacher intersperses questions throughout the presentations to keep the students' attention. The student asynchronously and as a team, prepares the portfolio of enzymes of clinical importance. The student individually and asynchronously completes the readings recommended by the teacher.	• Sensitivity and specificity of enzymes. • Determination of enzyme activity in the clinical laboratory. • Origin, reaction it catalyzes, isoenzymes, determination method, interferences, sample conditions, reference values and clinical correlation of: Lactate dehydrogenase (LDH), Aspartate aminotransferase (AST), Alanine aminotransferase (ALT), Acid	Classroom with audiovisual equipment: Projector, overhead projector, computer, audio system. Clinical Laboratory of the University Hospital. Teaching laboratory equipped for laboratory practices. Computer equipment with Microsoft Office and Internet connection. Moodle, ExamSoft and MS Microsoft Teams platform. Free-to-use electronic presentations prepared by the teacher. Free-to-use electronic presentations prepared by students. **Book excerpt** González (2019). Chapter 17. Enzymes. Digital readings:

	• **Seminar Presentation:** Create a digital presentation with a maximum of 12 slides that includes the points highlighted in the summary, which is uploaded to the MS Teams platform one day before the presentation. Present in the classroom on the date and time indicated by the teacher within a maximum time of 15 minutes. Only one member of the team will upload the evidence to the platform on the established date.	The teacher explains the laboratory practice through infographics and/or audiovisual media. The student individually and asynchronously reviews the laboratory practice and performs it during the corresponding synchronous session. The student individually and asynchronously completes the laboratory practice report and submits it on the platform indicated by the teacher. • Determination of Lactate dehydrogenase LDH (**Accredited learning activity 3.1)** The student individually solves the content knowledge exam corresponding to phase 3 **(Accredited learning activity 3.2)**	phosphatase (ACP), Alkaline phosphatase (ALP), Lipase (LIP), Amylase (AMY), Gamma glutamyltransferase (GGT) and Creatine kinase (CK).	**Video** Enzyme kinetics

Phase 4. Tests that evaluate liver and kidney function, electrolyte and acid-base balance.

Component(s) of the competence:
Interpret the results of tests that evaluate liver and kidney function, electrolyte and acid-base balance, considering the patient's clinical picture, the clinical sensitivity and specificity of the tests and the analytical methodologies used, to correlate laboratory findings with the most likely clinical diagnoses.

Evidence of student learning	Performance criteria	Learning activities	Content	Resources
5. Case report on clinical resolution of tests evaluating liver and kidney function, electrolyte and acid-base balance.	Complete the project as a team and submit it in PDF format on the MS Teams platform on the date scheduled by the teacher. Includes in the report: • Front page • Identification of abnormal parameters identified in the case, both clinical and laboratory. • Definition of medical terms found in the case. • Probable diagnosis and its pathophysiological basis. • Highlights the tests that allow diagnosis considering clinical	The teacher explains the laboratory practices through infographics and/or audiovisual media. The student individually and asynchronously reviews the laboratory practices and carries them out during the corresponding synchronous session. The student individually and asynchronously completes the report of the following laboratory practices and delivers them on the platform indicated by the teacher: • Determination of bilirubin. **(Accredited learning activity 4.1)**	• **Liver Function** Overview of liver function and metabolism. • Biochemical study of liver function and integrity. Liver function tests. (LFT) • Bilirubin and its determination in the laboratory by Maloy-Evelyn, Jendrassik-Groff methods and direct spectrophotometry (bilirubinometers). • Determination of bilirubin in urine. Urinary and fecal urobilinogen. • **Kidney Function** Kidney function overview.	Classroom with audiovisual equipment: Projector, overhead projector, computer, audio system. Clinical Laboratory of the University Hospital. Teaching laboratory equipped for laboratory practices. Computer equipment with Microsoft Office and Internet connection. Moodle, ExamSoft and MS Microsoft Teams platform. Free-to-use electronic presentations prepared by the teacher. **Book excerpts:** Gonzalez (2019): Chapter 6: Water and electrolytes.

	sensitivity and specificity. • Indicates tests that are not relevant to the diagnosis. • Mention other useful tests for diagnosis that have not been performed. • Literature. • Only one team member will upload the evidence to the platform on the established date.	• Determination of urea. **(Accredited learning activity 4.2)** • Creatinine determination. **(Accredited learning activity 4.3)** • General Urine Examination. **(Accredited learning activity 4.4)** The student individually completes the content knowledge exam corresponding to phase 4 on the date indicated by the teacher. **(Accredited learning activity 4.5)**	• Tests that measure glomerular filtration: inulin, creatinine and urea clearance. Non-protein blood nitrogen: urea nitrogen, creatinine, uric acid. • Tests that measure tubular function: Pamnihippurate clearance, phenolsulfophthalein (PSP) test, specific gravity, osmolarity, and concentration and dilution tests. Calcium and phosphate. • Characteristics of urine. General urine examination and its importance in clinical diagnosis. • **Electrolytes:** • Methods for determining sodium, chlorine and potassium in blood, urine and body fluids. • Sampling conditions for electrolyte determination. Clinical significance	Chapter 7: Blood gases and acid-base balance. Chapter 9: Biochemical study of renal function. Chapter 23: Biochemical study of liver function and integrity. Laboratory results reports.

			of electrolyte determination. • **Acid-base balance and arterial gases:** Respiratory and metabolic alkalosis and acidosis. • Blood gas analysis and sampling conditions. Determination of blood gases and their clinical utility.	

7. Summative evaluation:

Phase	Evidence and accredited learning activities	Weighing
Phase 1 28%	**Evidence 1.** Internal and external quality control case study report.	**4 points**
	Evidence 2. Verification report of quantitative analytical methods.	**4 points**
	Accredited learning activity 1.1 Practice report: Precision and accuracy in the clinical laboratory.	**2 points**
	Accredited learning activity 1.2 Practice report: Measuring precision in the clinical laboratory.	**2 points**
	Accredited learning activity 1.3 Practice report: Preparation of a control serum and construction of a Levey - Jennings graph.	**2 points**
	Accredited learning activity 1.4 Practice report: Characteristics of a prototype spectrophotometric method used in Clinical Biochemistry.	**2 points**
	Accredited learning activity 1.5 Practice report: Measurement of linearity in a quantitative analytical method of Clinical Biochemistry.	**2 points**
	Accredited learning activity 1.6 Phase 1 Knowledge test	**10 points**
Phase 2 18%	**Evidence 3.** Report on the resolution of clinical cases of glucose, lipid and protein metabolism diseases.	**4 points**
	Accredited learning activity 2.1 Practice report: Determination of glucose.	**2 points**
	Accredited learning activity 2.2 Practice report: Determination of cholesterol.	**2 points**
	Accredited learning activity 2.3 Practice report: Determination of total proteins.	**2 points**
	Accredited learning activity 2.4 Phase 2 Knowledge test	**8 points**
Phase 3 14%	**Evidence 4.** Portfolio of enzymes of clinical importance.	**4 points**
	Accredited learning activity 3.1 Practice report: Determination of lactate dehydrogenase	**2 points**
	Accredited learning activity 3.2 Phase 3 Knowledge test	**8 points**

Phase 4 20%	**Evidence 5:** Report of resolution of a clinical case of tests that evaluate liver and kidney function, electrolyte and acid-base balance.	**4 points**
	Accredited learning activity 4.1 Practice report: Determination of Bilirubin.	**2 points**
	Accredited learning activity 4.2 Practice report: Determination of urea.	**2 points**
	Accredited learning activity 4.3 Practice report: Creatinine determination.	**2 points**
	Accredited learning activity 4.4 Practice Report: General Urine Examination	**2 points**
	Accredited learning activity 4.5 Phase 4 Knowledge test	**8 points**
PIA 20 %	Assessment of quality control case resolution, method verification and interpretation of results and clinical correlation.	**20 points**
	Total	**100 points**

8. Course integrative project/product:
Assessment of quality control case resolution, method verification and interpretation of results and clinical correlation.

9. References:

Bishop, M. (2019). *Química Clínica: Principios, procedimientos y correlaciones*. Estados Unidos. McGraw-Hill.

González, A. (2019). *Principios de Bioquímica Clínica y Patología Molecular*. España: editorial Elsevier.

Fernández - Espina, C. y Mazziota, D. (2005). *Gestión de la Calidad en el Laboratorio Clínico*. Argentina: editorial Médica panemericana.

Henry, J.B. (2007). *El Laboratorio en el Diagnóstico Clínico*. España: Editorial Marbán. Hickman, P.E. (Ed). (2009).

Methods in clinical chemistry. [CD-ROM]. EUA: Pesce Kaplan Publishers.

Kaplan, L.A. y Pesce, A.J. (1993). *Química clínica: técnicas de laboratorio, fisiopatología, métodos de análisis: teoría, análisis y correlación.* Argentina: editorial Médica panamericana.

Robles, D.G. y Sánchez, M. (2020). *Manual de Prácticas de Bioquímica Clínica*. México: Facultad de Medicina, UANL.

Open resources:

Bio-Rad QC. (Video). Chapter 3: Levey-Jennings Charts & Westgard´s Rules. Recuperado 07 de diciembre 2020 de: https://youtu.be/6rPE2iFqTtI

Canalizo-Miranda, E., Favela-Pérez, E. A., Salas-Anaya, J. A., Gómez-Díaz, R., Jara-Espino, R., del Pilar Torres Arreola, L., y Viniegra-Osoriof, A. (2013). *Diagnóstico y tratamiento de las dislipidemias*. Revista Médica Instituto Mexicano del Seguro Social, vol.51, núm. 6, pp.700-709. Instituto Mexicano del Seguro Social, México. Recuperado 16 de abril 2017 de: http://www.medigraphic.com/pdfs/imss/im-2013/im136t.pdf

Carlos, F. (2018). (Video). Cinética enzimática. Recuperado el 07 de diciembre de 2020 en: https://www.youtube.com/watch?v=wkyF67IfFlw

González-González, J. G., Rodríguez-Gutiérrez, R., Lavalle-González, F.J.; González-Cantú, A., Taméz-Pérez, H.E., González-Saldívar, G. y Villarreal-Pérez, J.Z. (2013). *Hemoglobin A1c: A reliable and accurate test for diabetes care? A prospective study in Mexico. Revista Salud Pública de México*, vol. 55, núm. 5, septiembre-octubre, 2013, pp. 462-468 Instituto Nacional de Salud Pública Cuernavaca, México. Recuperado 16 de abril 2017 de: http://scielo.unam.mx/pdf/spm/v55n5/v55n5a2.pdf

EMA. (2008). *Guía para la validación y la verificación de los procedimientos de examen cuantitativos empleados por el laboratorio clínico*. Recuperado el 07/12/2020 de http://consultaema.mx:75/pqtinformativo/GENERAL/Clinicos/Carpeta_2_Criterios_evaluacion/CLINICOS_Validacion-

Verificacion.pdf

QCNet. *QC Education*. https://www.qcnet.com/la/

Prada, E. y otros. (2016). *Control interno de la calidad vs control externo de la calidad*. Revista de laboratorio clínico, 9(2):54-59. Recuperado 7 de diciembre 2020, de: https://www.elsevier.es/es-revista-revista-del-laboratorio-clinico-282-pdf-S1888400816300071

Secretaría de Salud. (2012). NOM-037-SSA2-2012, Para la prevención, tratamiento y control de las dislipidemias. México: Diario oficial de la federación. Recuperado 16 de abril 2017, de http://dof.gob.mx/nota_detalle.php?codigo=5259329&fecha=13/07/2012

Westgard QC. www.westgarg.org