

<b>1. Module identification code.</b>	
Name of the institution:	Universidad Autónoma de Nuevo León
Name of the school:	School of Medicine
Name of the degree program:	Clinical Chemist Biologist
Name of the course (learning unit):	Biochemistry
Total number of class hours-theory and practice:	140
Class hours per week:	7
Independent study:	40
Course modality:	Face-to-face instruction
Module level:	Fourth semester
Core/elective module:	Core
Curriculum area:	ACFB
UANL credit points:	6
Creation date:	August 28 <sup>th</sup> , 2017
Date of last amendment made:	January 26 <sup>th</sup> , 2023
Person(s) responsible for the design and amendment of the module:	Design and amendment: M.Ed. Blanca Esthela Alemán García Amendment: D.Sc. Aurora de Jesús Garza Juárez

## 2. Presentation:

This learning unit is divided into four stages, and each stage will cover the following: **in the first stage**, the fundamentals of biochemistry, chemical composition, and function of the main biomolecules are reviewed, as well as the characteristics of water molecules that allow it to function as the main solvent in the organism, relating the function of vitamins in metabolism.

**In the second stage**, the structure and properties of amino acids, the importance of proteins, their levels of organization, and their functions as biomolecules for oxygen transport or storage, structural and catalytic roles are analyzed, as well as the alterations that occur in their synthesis or degradation.

**In the third stage**, the basic principles of Bioenergetics that explain how energy is obtained for the different processes that require it are reviewed. The structure, function, and metabolism of carbohydrates and lipids of physiological interest and their metabolic alterations are analyzed.

**In the fourth stage**, the process of digestion and absorption of dietary proteins, the degradation of endogenous proteins, the metabolism of amino acids, their alterations, as well as their role as precursors of specialized nitrogenous compounds are analyzed. The integration of the main metabolic pathways that take place in the liver, skeletal muscle, adipose tissue, and brain in the postprandial state and during fasting is carried out with the aim of maintaining homeostasis.

For the **Integrative Learning Product**, the student presents a written proposal for problem-solving and cases where the student applies the interrelation of carbohydrate, lipid, and protein metabolism in different physiological situations.

## 3. Purpose:

The learning unit (LU) of Biochemistry aims to foster in the student the development of professional competencies that allow them to interpret the chemical properties of biomolecules, through knowledge of their structure, function, and metabolism. This will enable the future graduate to participate in solving health problems, as well as to support the design, selection, and interpretation of biochemical analysis tests. This LU is in the fourth semester of the Clinical Biologist Chemist educational program. For its development, it uses the competencies acquired in previous LUs such as Medical Physiology to analyze the functioning of apparatuses and systems of living beings, and Basic Organic Chemistry, applying knowledge of the structure and properties of the main organic compounds that will be useful for understanding the chemical composition and metabolism of the main biomolecules. Among the LUs in more advanced semesters, there is a relationship with Molecular Biology, providing the student with the fundamental biochemical bases for the study and analysis of the main macromolecules of life and the interactions that occur between them. Furthermore, Biochemistry, through the study of the structure, function, and metabolism of the main biomolecules, underlies the biochemical tests used as part of clinical diagnosis, which are studied in depth in the Clinical Biochemistry Learning Unit, as well as in Basic Immunology.

This LU collaborates in promoting general competencies by fostering in the student logical, critical, and proactive thinking to

understand the necessary fundamentals that allow them to integrate the metabolism and regulation of the main biomolecules that constitute living beings, as well as their impact on the functioning of the organism. Also, during this LU, spaces for discussion about the challenges of our society are favored, generating interventions with a critical attitude, human and professional commitment when solving different technical situations that arise in the work area. It contributes to consolidating the general well-being of oneself and one's colleagues, respecting the working conditions in the classroom and in the laboratory when working and executing techniques according to established criteria.

During this LU, the student also develops specific competencies as they solve problems by applying knowledge of the chemical composition of matter in the metabolic processes that take place in the organism. Likewise, they develop competencies for the execution of chemical and/or biological procedures in the analysis of samples that contribute to making a clinical diagnosis.

#### 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:**

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.

## 5. Course roadmap:

### Stage 1: Introduction to Biochemistry

Review the chemical composition and function of the main biomolecules constituting the organism, the role of water as a biological solvent, and the role of vitamins in metabolism.



### Stage 2: Structure and function of amino acids and proteins

Examine the structure and properties of amino acids, the levels of protein organization, their various functions in the body, as well as the alterations in their synthesis that lead to pathologies



### Stage 3: Bioenergetics and Carbohydrate and Lipid Metabolism

Analyze the principles of Bioenergetics, the structure, function, and metabolism of carbohydrates and lipids of physiological importance, and their relationship with diseases caused by metabolic disorders



### Stage 4: Nitrogen Metabolism and Metabolic Integration

Analyze the process of digestion and absorption of dietary proteins, the degradation of endogenous proteins, the metabolism of amino acids, their role in the synthesis of specialized compounds, and the integration of the main metabolic pathways as a



### Integrative Learning Product

Written proposal for problem-solving and case studies where the student applies the interrelation of carbohydrate, lipid, and protein metabolism in different physiological situations.

## 6. Structuring into stages or phases:

**Stage 1:** Introduction to Biochemistry.

**Competency element(s):** Analyze the fundamentals of biochemistry, the chemical composition and function of the main biomolecules, as well as the properties of water and vitamins to describe the basis of their role in metabolic processes.

Learning Evidence	Performance criteria	Learning activities	Content	Resources
<b>1. Resolution of a questionnaire on clinical cases related to the function and basic concepts of vitamins in metabolism</b>	The questionnaire will be resolved individually, on the date and time established by the professor in the classroom.	<p>The professor provides the course framework with the support of infographics and electronic presentations.</p> <p>The professor explains the basic concepts of biomolecules, water, and the function of vitamins using electronic presentations.</p> <p>The professor encourages group discussions through forums to integrate prior knowledge with new concepts.</p> <p>The student reviews the basic bibliography of the topics corresponding to the phase, as well as available academic audiovisual resources.</p> <p>Students organize themselves into teams, and the professor assigns clinical cases for team-based resolution and group discussion.</p>	<ul style="list-style-type: none"> <li>• Introduction to Biochemistry</li> <li>• Biomolecules</li> <li>• Biochemical reactions</li> <li>• General aspects of metabolism</li> <li>• Water as a solvent: molecular structure, hydrogen bonds in water</li> <li>• Buffers: characteristics, physiological importance</li> <li>• Vitamins: Structure and function in metabolism</li> <li>• Diseases caused by deficiency or excess</li> </ul> <p>Attitudinal Content:</p>	<p>MS FORMS platform</p> <p>MOODLE platform</p> <p>Textbook: <i>Biochemistry</i> Authors: Emine E. Abali, Dr. Susan M. Viselli, Susan D. Cline, David S. Franklin (8th edition, 2021) Chapter 1: Water and pH Chapter 29: Micronutrients: Vitamins Internet</p> <p>Computer equipment</p> <p>Electronic presentations</p> <p>Other Bibliographic Sources: <i>Biochemistry</i>: Herrera and Ramos, 2014 McKee, T. &amp; McKee, J., 2014: Chapter 1: Biomolecules</p> <p>Electronic presentations prepared by the professor</p>

		<p>The student actively participates in the sessions, analyzing the content and individually responding to questions posed by the professor randomly during the class session.</p>	<ul style="list-style-type: none"><li>• Respect for the professor and peers</li><li>• Ability to interact with colleagues or team members</li><li>• Ability to resolve conflicts in a cordial manner</li></ul>	<p>Infographics provided by the professor</p>
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## Stage 2: Structure and Function of Amino Acids and Proteins

### Competency Element(s):

- Analyze the structure and properties of amino acids and proteins in the body, as well as their various functions—structural, transport, catalytic, among others—to understand how alterations in their structure lead to pathologies.

Learning Evidence	Performance criteria	Learning activities	Content	Resources
<b>2. First Written Partial Evaluation</b>	<p>Completes the written partial evaluation.</p> <p>Responds individually to questions and clinical cases from the content of stages 1 and 2.</p> <p>The evaluation will consist of 40 multiple-choice questions on basic concepts and the clinical application of the corresponding topics, with a set time to respond.</p>	<p>The professor, with the support of infographics and electronic presentations, guides the students with comments, examples, and interspersed questions.</p> <p>The student reviews the basic bibliography of the topics corresponding to the phase, as well as available academic audiovisual resources, and actively participates in class by analyzing the content and individually responding to questions posed randomly by the professor during the class session.</p> <p>Students are organized into teams, and the professor assigns clinical cases related to proteins (elastin, collagen, hemoglobin, and abnormal protein folding) for team-based resolution and group discussion (<b>non-weighted activity</b>).</p>	<ul style="list-style-type: none"> <li>Amino Acids:</li> <li>Classification and properties</li> <li>Structure and function of proteins, levels of organization</li> <li>Globular proteins (myoglobin and hemoglobin)</li> <li>Fibrous proteins (collagen and elastin)</li> <li>Enzymes</li> <li>Properties and classification of enzymes</li> <li>Enzyme kinetics:</li> <li>Michaelis-Menten kinetics, Lineweaver-Burk plot, enzyme inhibition</li> <li>Regulation of enzyme activity</li> <li>Enzymes in clinical diagnosis</li> </ul> <p>Laboratory Practices:</p>	<p>MS FORMS platform</p> <p>MOODLE platform</p> <p>Textbook: <i>Biochemistry</i> Authors: Emine E. Abali, Dr. Susan M. Viselli, Susan D. Cline, David S. Franklin (8th edition, 2021) Chapters 2-6</p> <p>Internet</p> <p>Computer equipment</p> <p>Electronic presentations</p> <p>Other Bibliographic Sources:</p> <p><i>Biochemistry</i>: Herrera and Ramos, 2014</p> <p>McKee, T. &amp; McKee, J., 2014</p>



		<p>The student individually resolves clinical cases and general concepts regarding the structure-function relationship of proteins and their alterations (<b>weighted activity 1</b>).</p> <p>The professor describes the basic concepts of enzymes and the fundamentals of enzyme kinetics.</p> <p>Students are organized into teams, calculate <math>K_m</math> and <math>V_{max}</math> from examples provided by the professor, and identify competitive or non-competitive inhibition, participating in class by presenting and discussing the results of their calculations (<b>non-weighted activity</b>).</p> <p>The student prepares an individual report on enzyme kinetics problem-solving, to be submitted in digital format by the deadline set by the professor on the Teams platform (<b>weighted activity 2</b>).</p> <p>The professor fosters discussion through forums to integrate knowledge related to the role of plasma enzymes in clinical diagnosis through laboratory analysis.</p> <p>The professor presents the topics related to lab practices 1, 2, and 3. Students carry out practices</p>	<p>Practice 1:</p> <ul style="list-style-type: none"> <li>Laboratory Regulations</li> <li>Safety measures for working in the lab, use of linear and automatic pipettes</li> </ul> <p>Practice 2:</p> <ul style="list-style-type: none"> <li>Determination of pH and buffer solutions</li> </ul> <p>Practice 3:</p> <ul style="list-style-type: none"> <li>Ionic properties of amino acids</li> </ul> <p>Practice 4:</p> <ul style="list-style-type: none"> <li>Determination of total protein using the Biuret method</li> </ul> <p>Practice 5:</p> <ul style="list-style-type: none"> <li>Determination of hemoglobin concentration in blood</li> </ul> <p>Practice 6:</p> <ul style="list-style-type: none"> <li>Determination of Lactate Dehydrogenase (LDH) activity</li> </ul> <p>Practice 7:</p> <ul style="list-style-type: none"> <li>Determination of transaminase concentration in serum</li> </ul>	<p>Electronic presentations prepared by the professor</p> <p>External Links:</p> <p>Amino Acids</p> <p>RCSB Protein Data Bank. (2013, September 4). <i>What is a Protein? Learn about the 3D shape and function of macromolecules</i> [Video file]. Retrieved from <a href="https://youtu.be/gBRFIMcxZNM">https://youtu.be/gBRFIMcxZNM</a></p> <p>Science Magazine. (2016, July 21). <i>The protein folding revolution</i> [Video file]. Retrieved from <a href="https://youtu.be/cAJQbSLlonI">https://youtu.be/cAJQbSLlonI</a></p> <p>Enzymes</p> <p>RCSB Protein Data Bank. (2017, April 20). <i>How Enzymes Work</i> [Video file]. Retrieved from <a href="https://youtu.be/yk14dOOvwMk">https://youtu.be/yk14dOOvwMk</a></p>
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		<p>1, 2, and 3, analyze the results, and individually prepare lab reports in the practice manual <b>(weighted activity 3)</b>.  Students individually respond to an evaluation through FORMS on the content of practices 1, 2, and 3 <b>(weighted activity 4)</b>.  The professor presents the topics related to lab practices 4, 5, 6, and 7.  Students carry out practices 4, 5, 6, and 7, analyze their results, and individually prepare lab reports in the practice manual <b>(weighted activity 5)</b>.  Students individually respond to an evaluation through FORMS on the content of practices 4, 5, 6, and 7 <b>(weighted activity 6)</b>.</p>		<p>Infographics provided by the professor</p> <p><i>Biochemistry Laboratory Practices Manual</i> (latest edition)</p> <p>Teaching laboratory</p>
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### Stage 3: Bioenergetics and Metabolism of Carbohydrates and Lipids

#### Competency Element(s):

- Explain the principles of Bioenergetics, the respiratory chain, and oxidative phosphorylation to understand how energy transfer and utilization occur in biological systems.
- Analyze the structure, function, and metabolism of carbohydrates and lipids of physiological importance in a healthy organism to relate them to diseases caused by metabolic disorders.

Learning Evidence	Performance criteria	Learning activities	Content	Resources
3.- Second Partial Evaluation on Bioenergetics, Oxidative Phosphorylation, and Carbohydrate Metabolism	<p>Completes the written partial evaluation.</p> <p>Responds individually to questions and clinical cases related to the content of Bioenergetics, oxidative phosphorylation, and carbohydrate metabolism.</p> <p>The evaluation will consist of 40 multiple-choice questions on basic concepts and the clinical application of the corresponding topics, with a set time to respond.</p>	<p>The professor, with the support of infographics and electronic presentations, guides students with comments, examples, and interspersed questions about the structure, function, and metabolism of carbohydrates.</p> <p>The student analyzes the basic bibliography of the topics corresponding to the phase, as well as the available academic audiovisual resources, and actively participates in class sessions by discussing the content and individually responding to questions posed randomly by the professor during the class session.</p>	<ul style="list-style-type: none"> <li>• Bioenergetics</li> <li>• Electron transport chain and oxidative phosphorylation</li> <li>• Introduction to carbohydrates</li> <li>• Introduction to metabolism and glycolysis</li> <li>• Tricarboxylic acid cycle and pyruvate dehydrogenase complex</li> <li>• Gluconeogenesis</li> <li>• Glycogen metabolism</li> <li>• Metabolism of monosaccharides and disaccharides: fructose, galactose, lactose synthesis</li> </ul>	<p>MS FORMS platform</p> <p>MOODLE platform</p> <p>Textbook: <i>Biochemistry</i> Authors: Emine E. Abali, Dr. Susan M. Viselli, Susan D. Cline, David S. Franklin (8th edition, 2021) Chapters 7-15</p> <p>Internet</p> <p>Computer equipment</p> <p>Electronic presentations prepared by the professor</p> <p>Other Bibliographic Sources:</p> <p><i>Biochemistry</i>: Herrera and Ramos, 2014</p> <p>McKee, T. &amp; McKee, J., 2014</p> <p>Academic Audiovisuals:</p> <p>Electron Transport Chain Harvard University [HarvardX]. (2017, October 9). <i>Electron Transport Chain</i> [Video file].</p>

		<p>The professor guides the discussion with students on the general content of carbohydrate metabolic pathways, supported by audiovisual materials, infographics, comments, presentations, examples, and interspersed questions.</p> <p>The student actively participates in class sessions, analyzing the content of the main carbohydrate metabolic pathways.</p> <p>The student integrates carbohydrate metabolism with the main diseases related to alterations in these pathways, as well as the significant role of the QCB (Clinical Biochemist) in diagnosing these diseases.</p> <p>Students are organized into teams, and the professor assigns clinical cases related to alterations in the following carbohydrate metabolic pathways: glycolysis,</p>	<ul style="list-style-type: none"> <li>• Pentose phosphate pathway and NADPH</li> <li>• Glycosaminoglycans, proteoglycans, and glycoproteins</li> </ul> <p>Laboratory Practices: Practice 8:</p>	<p>Retrieved from <a href="https://youtu.be/LQmTKxl4Wn4">https://youtu.be/LQmTKxl4Wn4</a></p> <p>Glycolysis VCell.ndsu.edu. (2013, February 12). <i>Glycolysis: An Overview</i> [Video file]. Retrieved from <a href="https://youtu.be/8Kn6BVGqKd8">https://youtu.be/8Kn6BVGqKd8</a></p> <p>Tricarboxylic Acid Cycle VCell.ndsu.edu. (2014, March 26). <i>The Citric Acid Cycle: The Reactions</i> [Video file]. Retrieved from <a href="https://youtu.be/cXVleFtzeE">https://youtu.be/cXVleFtzeE</a></p> <p>VCell.ndsu.edu. (2013, November 13). <i>The Citric Acid Cycle: An Overview</i> [Video file]. Retrieved from <a href="https://youtu.be/F6vQKrRjQcQ">https://youtu.be/F6vQKrRjQcQ</a></p> <p>Infographics provided by the professor</p> <p>Biochemistry teaching laboratory</p> <p><i>Biochemistry Laboratory Practices Manual</i> (latest edition)</p>
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		<p>gluconeogenesis, and glycogenolysis <b>(non-weighted activity)</b>.</p> <p>Resolution of clinical cases and basic concepts of glycolysis, glycogenolysis, and gluconeogenesis, through FORMS at the date and time set by the professor <b>(weighted activity 7)</b>.</p> <p>The professor presents in the laboratory the topics corresponding to the content of practices 8 and 9.</p> <p>Students carry out practices 8 and 9, analyze the results obtained, and individually prepare the lab reports for practices 8 and 9 in the practice manual <b>(weighted activity 8)</b>.</p>	<ul style="list-style-type: none"> <li>Biochemical tests for the determination of biologically important sugars</li> </ul> <p>Practice 9:</p> <ul style="list-style-type: none"> <li>Determination of blood glucose levels</li> </ul>	
4. Third Partial Evaluation on Lipid Metabolism	<p>Completes the written partial evaluation.</p> <p>Responds individually to basic concept questions and clinical cases related to the content of this stage.</p> <p>The evaluation will consist of 40 multiple-</p>	<p>The professor, with the support of infographics and electronic presentations, guides students with comments, examples, and interspersed questions about the structure, function, and metabolism of lipids.</p>	<ul style="list-style-type: none"> <li>Metabolism of dietary lipids</li> <li>Metabolism of fatty acids, triacylglycerols, and ketone bodies</li> <li>Metabolism of phospholipids,</li> </ul>	<p>MS FORMS platform</p> <p>MOODLE platform</p> <p>Textbook: <i>Biochemistry</i> Authors: Emine E. Abali, Dr. Susan M. Viselli, Susan D. Cline, David S. Franklin (8th edition, 2021) Chapters 16-19</p>

	<p>choice questions, with a set time to respond.</p>	<p>The student analyzes the basic bibliography of the topics related to lipid metabolism, as well as the available academic audiovisual resources.</p> <p>The student resolves clinical cases related to cholesterol metabolism and plasma lipoproteins through the FORMS platform (<b>weighted activity 9</b>).</p> <p>In the laboratory session, the professor presents the topics corresponding to the content of practices 10-12. Students perform the practices, analyze the results obtained, and individually prepare the lab report in the practice manual (<b>weighted activity 10</b>).</p> <p>Students individually respond to an evaluation through FORMS on the content of practices 8-12 on the date indicated by the professor (<b>weighted activity 11</b>).</p>	<p>glycosphingolipids, and eicosanoids</p> <ul style="list-style-type: none"> <li>Metabolism of cholesterol, lipoproteins, and steroids</li> </ul> <p>Laboratory Practices:</p> <p>Practice 10:</p> <ul style="list-style-type: none"> <li>Determination of total lipids in blood serum</li> </ul> <p>Practice 11:</p> <ul style="list-style-type: none"> <li>Determination of triacylglycerols in blood serum</li> </ul> <p>Practice 12:</p> <ul style="list-style-type: none"> <li>Determination of blood cholesterol</li> </ul>	<p>Internet</p> <p>Computer equipment</p> <p>Electronic presentations</p> <p>Other Bibliographic Sources:</p> <p><i>Biochemistry</i>: Herrera and Ramos, 2014 Chapter 12: Fatty acids and triacylglycerols</p> <p>McKee, T. &amp; McKee, J., 2014</p> <p>Academic Audiovisuals: LDL and HDL Cholesterol   Good and Bad Cholesterol Nucleushealth [Nucleus Medical Media]. (2015, April 17) [Video file]. Retrieved from <a href="https://youtu.be/0U7YHRW5dyc">https://youtu.be/0U7YHRW5dyc</a></p> <p>Fats, Biochemistry Nucleushealth [Nucleus Medical Media]. (2015, April 17). [Video file]. Retrieved from <a href="https://youtu.be/BVxeeiR7JB0">https://youtu.be/BVxeeiR7JB0</a></p> <p>Lipid Overview   Macromolecules   Biology [Video file]. Retrieved from <a href="https://youtu.be/Ezp8F7XJHWE">https://youtu.be/Ezp8F7XJHWE</a></p> <p>Infographics provided by the professor</p> <p>Biochemistry teaching laboratory</p> <p><i>Biochemistry Laboratory Practices Manual</i> (latest edition)</p>
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#### Stage 4: Nitrogen Metabolism and Metabolic Integration

##### Competency Element(s):

- Analyze the degradation process of exogenous and endogenous proteins and amino acid metabolism in order to integrate the essential metabolic processes that occur between different tissues to maintain homeostasis in the body.

Learning Evidence	Performance criteria	Learning activities	Content	Resources
5.- Fourth Partial Evaluation on Nitrogen Metabolism and Metabolic Integration	<p>Completes the written partial evaluation.</p> <p>Responds individually to questions and clinical cases related to the content of the stage.</p> <p>The evaluation will consist of 40 multiple-choice questions, with a set time to respond.</p>	<p>The professor, with the support of infographics and electronic presentations, guides students with comments, examples, and interspersed questions about the global nitrogen metabolism.</p> <p>The student analyzes the basic bibliography of topics related to global nitrogen metabolism and the formation of specialized products from amino acids. Additionally, the student reviews available academic audiovisual resources.</p> <p>Students create a diagram of the urea cycle, highlighting the precursors, the regulatory enzyme of the pathway, and diseases related to the altered function of any of the enzymes involved. A discussion forum is created based on the information</p>	<ul style="list-style-type: none"> <li>Amino acids: Nitrogen elimination</li> <li>Amino acid degradation and synthesis</li> <li>Conversion of amino acids into specialized products</li> <li>Nucleotide metabolism</li> <li>Metabolic integration in the fed and fasting states</li> <li>Enzyme changes in the postprandial state</li> <li>The liver as a nutrient distribution center</li> <li>Adipose tissue as an energy storage site</li> <li>Skeletal muscle at rest</li> <li>The brain during the absorption state</li> </ul>	<p>MS TEAMS platform</p> <p>MS FORMS platform</p> <p>MOODLE platform</p> <p>Textbook: <i>Biochemistry</i> by Emine E. Abali, Dr. Susan M. Viselli, Susan D. Cline, David S. Franklin (8th edition, 2021) Chapters 20-23 and 25</p> <p>Internet</p> <p>Computer equipment</p> <p>Electronic presentations prepared by the professor</p> <p>Other Bibliographic Sources: <i>Biochemistry</i>: Herrera and Ramos, 2014</p> <p>McKee, T. &amp; McKee, J., 2014 Chapter 16: Mammalian Metabolism, Feeding and Fasting Cycle</p> <p>External Links: Metabolic States Universidad de los Andes. (2013, August 23). <i>Nutritional Metabolic States</i> [Video file].</p>

		<p>analyzed in the class session. <b>(Non-weighted activity)</b></p> <p>The student individually resolves clinical cases related to amino acid catabolism disorders. <b>(Weighted activity 12)</b></p> <p>The student analyzes the suggested literature beforehand and actively participates in class sessions, responding to questions posed by the professor, as well as in the discussion forum.</p> <p>The professor guides the student through the integration of knowledge during the feeding and fasting cycle with the support of electronic presentations in the classroom.</p> <p>The student analyzes and discusses, under the professor's guidance, the metabolic changes that occur in the liver, adipose tissue, skeletal muscle, and brain during both the fed and fasting states, using interspersed questions and case resolution. <b>(Non-weighted activity)</b></p> <p>Students individually create a comparative</p>	<ul style="list-style-type: none"> <li>• The liver during fasting</li> <li>• Adipose tissue during fasting</li> <li>• Skeletal muscle during fasting</li> <li>• Skeletal muscle at rest during fasting</li> <li>• The brain during fasting</li> <li>• The kidney during prolonged fasting</li> </ul>	<p>Retrieved from <a href="https://youtu.be/DMiazwPD0yw">https://youtu.be/DMiazwPD0yw</a></p> <p>Infographics provided by the professor</p> <p>Biochemistry teaching laboratory</p> <p><i>Biochemistry Laboratory Practices Manual</i> (latest edition)</p>
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		<p>chart of the exchange of metabolic substrates between tissues during the fasting and fed states, and submit it via the MS-TEAMS platform by the date set by the professor. <b>(Weighted activity 13)</b></p> <p>In the laboratory session, the professor presents the topics corresponding to the content of practices 13, 14, 15, and 16.</p> <p>Students perform the practices, analyze the results obtained, and individually prepare the laboratory reports in the practice manual corresponding to practices 13, 14, 15, and 16. <b>(Weighted activity 14)</b></p> <p>Students individually respond to an evaluation through FORMS on the content of practices 13-16 by the date set by the professor. <b>(Weighted activity 15)</b></p> <p>Students organize into teams and prepare a written assignment on a research topic assigned by the professor, related to specific metabolic</p>	<p>Laboratory Practices:</p> <ul style="list-style-type: none"> <li>• Practice 13: Determination of urea nitrogen in blood</li> <li>• Practice 14: Determination of total and direct bilirubin concentration in blood serum</li> <li>• Practice 15: Determination of uric acid in blood</li> <li>• Practice 16: General urinalysis</li> </ul>	
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		disorders. This assignment must be presented orally in front of a plenary session through a scheduled meeting. <b>(Weighted activity 16)</b>		
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SCHOOL OF MEDICINE  
MODULE DESCRIPTION (ANALYTIC PROGRAM)



**7. Comprehensive Evaluation of Processes and Products:**

Stage		Weight
1	<b>Evidence 1: Questionnaire on clinical cases related to the function and basic concepts of vitamins in metabolism</b>	2%
2	<b>Evidence 2: Written, theoretical partial evaluation 1 on the content of stages 1 and 2</b>	12%
	<b>Weighted activity 1:</b> Report on the resolution of case analysis regarding the structure-function relationship of proteins: alterations	1%
	<b>Weighted activity 2:</b> Report on problem-solving in enzyme kinetics	2%
	<b>Weighted activity 3:</b> Written laboratory reports in the practice manual (1 to 3	1.5%

	<b>Weighted activity 4:</b> Written evaluation of the content of practices 1 to 3	1.5%
	<b>Weighted activity 5:</b> Written laboratory reports in the practice manual (4, 5, 6, and 7)	2%
	<b>Weighted activity 6:</b> Written evaluation of the content of practices 4, 5, 6, and 7	2%
3	<b>Evidence 3: Written, theoretical partial evaluation 2 on Bioenergetics and carbohydrate metabolism</b>	12%
	<b>Weighted activity 7:</b> Resolution of clinical cases and basic concepts of glycolysis, glycogenolysis, and gluconeogenesis	2%
	<b>Weighted activity 8:</b> Written laboratory reports for practices 8 and 9 in the manual	1%
4	<b>Evidence 4: Written, theoretical partial evaluation 3 on lipid metabolism</b>	10%
	<b>Weighted activity 9:</b> Report on the resolution of clinical cases related to cholesterol metabolism and plasma lipoproteins	1%
	<b>Weighted activity 10:</b> Written laboratory reports in the practice manual (10, 11, and 12)	1.5%
	<b>Weighted activity 11:</b> Written evaluation of the content of practices (8-12)	2.5%
5	<b>Evidence 5: Written, theoretical partial evaluation 4 on nitrogen metabolism and metabolic integration</b>	10%
	<b>Weighted activity 12:</b> Report on the resolution of clinical cases related to amino acid catabolism disorder	1%
	<b>Weighted activity 13:</b> Comparative chart on the exchange of metabolic substrates between tissues during fasting and the absorption state	1%
	<b>Weighted activity 14:</b> Written laboratory reports for practices 13-16 in the manual	2%
	<b>Weighted activity 15:</b> Written evaluation of the content of practices 13-16	2%
	<b>Weighted activity 16:</b> Written report and oral presentation on a research topic assigned by the professor regarding specific metabolic disorders	10%
	<b>Learning Integration Product</b>	<b>20%</b>
	<b>Total</b>	<b>100</b>

## 8. Learning Integration Product:

Comprehensive resolution of basic concepts and clinical cases where the student applies the interrelation of key biomolecules, water properties, the metabolic role of vitamins, and the interrelationship of amino acid, protein, carbohydrate, and lipid metabolism in different physiological situations.

## 9- Sources for Support and Reference:

- Baynes, Dominickz. *Medical Biochemistry*. (2015) 4th ed. Mexico: Elsevier (2015)
- Textbook: Emine E. Abali, Dr. Susan M. Viselli; Susan D. Cline; David S. Franklin. (8th edition, 2021)
- *Biochemistry*. Mexico: Lippincott Williams & Wilkins
- Feduchi, Romero, Yañez, Blasco, and García-Hoz. 2nd ed. (2015). Mexico: Editorial Panamericana
- Harper (2014). *Illustrated Biochemistry*. Mexico: McGraw Hill Education
- <http://bq.facmed.unam.mx/revista-de-educacion-bioquimica.html>
- *International Federation for Clinical Chemistry and Laboratory Medicine*. Retrieved from <http://www.ifcc.org/>
- *Biochemistry Laboratory Manual*. Updated edition. Edited by the Biochemistry Department
- *Journal of Biochemical Education* (2015). Retrieved from [http://www.facmed.unam.mx/publicaciones/ampb/numeros/2015/02/REB34\(2\)junio2015.pdf](http://www.facmed.unam.mx/publicaciones/ampb/numeros/2015/02/REB34(2)junio2015.pdf)
- *Spanish Society of Biochemistry and Molecular Biology* (September 2016). *The Challenge of Future Nutrition*: Spanish Society of Biochemistry and Molecular Biology No. 189, September 2016 ISSN:1696-473X. Retrieved from <http://www.sebbm.es/revista/pdf.php?id=16&isrevista=1>
- *The Journal of Biological Chemistry*. F1000. Retrieved from <http://www.jbc.org/browserellinks>

### Open Access Resources:

- Enzymes  
RCSB Protein Data Bank. (2017, April 20). *How Enzymes Work* [Video file]. Retrieved from <https://youtu.be/yk14dOOvwMk>
- Glycolysis  
VCell.ndsu.edu. (2013, February 12). *Glycolysis: An Overview* [Video file]. Retrieved from <https://youtu.be/8Kn6BVGqKd8>
- LDL and HDL Cholesterol | Good and Bad Cholesterol  
Nucleushealth [Nucleus Medical Media]. (2015, April 17). [Video file]. Retrieved from <https://youtu.be/0U7YHRW5dyc>
- Fats, Biochemistry  
Nucleushealth [Nucleus Medical Media]. (2015, April 17). *LDL and HDL* [Video file]. Retrieved from <https://youtu.be/BVxeeiR7JB0>
- Lipid Overview | Macromolecules | Biology  
[Video file]. Retrieved from <https://youtu.be/Ezp8F7XJHWE>
- Citric Acid Cycle  
VCell.ndsu.edu. (2014, March 26). *The Citric Acid Cycle: The Reactions* [Video file]. Retrieved from <https://youtu.be/cXVleFtzeE>

VCell.ndsu.edu. (2013, November 13). *The Citric Acid Cycle: An Overview* [Video file]. Retrieved from <https://youtu.be/F6vQKrRjQcQ>

- Metabolic States

Universidad de los Andes. (2013, August 23). *Nutritional Metabolic States* [Video file].

