BIOCH200

Introduction to Biochemistry

3 Credits

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Introduction to Biochemistry

Calendar Description

An introduction to the fundamental principles of biochemistry. Protein structure and function; lipids and the structure of biological membranes; nucleotides and the structure of nucleic acids; bioenergetics and the metabolism of carbohydrates, lipids, and nitrogen; the integration and regulation of cellular metabolism.

Rationale

BIOCH200 provides a comprehensive overview of biochemistry. BIOCH200 branches out from an introduction to biological molecules, gene transcription and protein synthesis. Topics to be covered include the structure and function of proteins, especially that of enzymes, and of lipid, with special reference to biological membranes. Cellular respiration, the metabolism of carbohydrates, fatty acids and nitrogen are further topics.

BIOCH200 is the basic core course for biochemistry students, and serves as an introduction to biochemistry for students who need basic biochemistry knowledge, especially those in agriculture, arts, education, medicine, dentistry, nursing, pharmacy, science and veterinary medicine.

Prerequisites

CHEM 101 and CHEM 161 or 261.

Co-Requisites

None

Course Learning Outcomes

Upon successful completion of this course, students will be able to (cognitive skills)

1. explain the laws of thermodynamics, the structure and chemical properties of biological molecules, their polymers, and the reactivity of weak acids.
2. epitomize nucleotides as electron and energy carriers, the primary and secondary structure of nucleic acids, the genetic code that specifies the amino acid sequence.
3. relate the structures and sequence of amino acids, to protein folding patterns and
function, emphasizing the example of myoglobin and hemoglobin.
4. outline the catalytic mechanisms, the regulation of enzymes, and the kinetics of enzyme-
catalyses reactions, with special reference to chymotrypsin.
5. describe the structure, function and synthesis of fatty acids and other lipids, especially
those in phospholipid bilayers of biological membranes.
6. distinguish simple and protein-facilitated diffusion from active transport across
membranes, enlisting detailed structural properties that enable selective diffusion.
7. name hormones, growth factors or lipoprotein particles, the structural conformations of
their receptor proteins, and the mode of signal transduction that result in cellular
responses.
8. discuss cellular metabolism in terms of free energy changes, reduction and oxidation
coupled reactions, ATP, electron and proton transport.
9. itemize the events, enzymes and their properties in glycolysis, pentose phosphate
pathway, gluconeogenesis, glycogenolysis, citric acid cycle, oxidative phosphorylation,
and fatty acid oxidation.
10. specify inter-organ metabolism, exemplified by ketone bodies, the Cori and glucose-
alanine cycles, adrenalin, glucagon, and insulin action, and the complications of diabetes.
11. define the steps and enzymes in the synthesis of polysaccharides, saturated and
unsaturated fatty acids, triacyl glycerol, cholesterol, lipoprotein particles, and the danger
of atherosclerosis.
12. quote the mechanisms and enzyme properties involved in nitrogen fixation, assimilation,
transamination, and the synthesis of non-essential and essential amino acids and
nucleotides.
13. specify the ketogenic and glucogenic path of amino acid and nucleotide catabolism,
nitrogen disposal via the urea cycle, uric acid, and urease.

Resource Materials

**Required Text:**

**Reference Text:**
& Sons.

**Reference Materials:**
College.
Conduct of Course

This is a 3 credit course with 3 hours of lecture per week (3-0-0).

Lectures - Lectures are given by two instructors, and are generally supported by PowerPoint, Word, or overhead projection, and whiteboard. Students are expected to take lecture notes, and read in the textbook and additional reference material on a weekly basis. The library can be used for independent studies and to access the biochemistry literature.

Labs - None.

Evaluation Procedures

The student's performance is evaluated in terms of percentage points that reflect the number of correct answers out of the total number of questions. Students must achieve a mark of 50% or higher at the end of the course.

The weighting of the course components is as follows:

- Midterm Exam I (Lecturer I) 25%
- Midterm Exam II (Lecturer II) 25%
- Final Exam (Comprehensive) 50%
- Total 100%

No supplemental assignments or exam re-writes are allowed in the University Transfer Department.

Grade Equivalents and Course Pass Requirements

A minimum grade of D (50%) (1.00) is required to pass this course.

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Students must maintain a cumulative grade of C (GPA - Grade Point Average of 2.00) in order to qualify to graduate.
Attendance

Regular attendance is essential for success in any course. Absence for any reason does not relieve a student of the responsibility of completing course work to the satisfaction of the instructors. Poor attendance may result in the termination of a student from a course.

If you do not meet the established attendance requirements, your instructors will recommend that the Registrar withdraw you from the course. A failing grade of RW (Required to Withdraw) will appear on your transcript.

In case of repeated absences due to illness, the student may be requested to submit a medical certificate.

*Instructors have the authority to require attendance at classes.*

Course Units/Topics

**Lecturer 1**

(1.) Introduction (Lecture 1-2)
1. Format of BIOCH200 with two lecturers: exams; mark distribution; textbook.
2. Biological molecules and biopolymers. Thermodynamics, water polarity and acid-base reactions.

(2.) Nucleic Acids and Nucleotides (Lecture 3)

(3.) Protein Structure and Function (Lectures 4-5)
1. Amino acids and their side chains.
4. Tertiary structure of proteins (*e.g.* myoglobin: oxygen binding).
5. Quaternary structure of proteins (*e.g.* hemoglobin).
6. Cooperativity and allosteric proteins (hemoglobin: oxygen binding and amino acid substitution: sickle cell anemia, fetal hemoglobin).

(4.) Enzymes (Lectures 6-8)
1. What are enzymes? Classification and function of enzymes.
2. Catalytic mechanisms, substrate binding, transition state, coenzymes, vitamins.
3. Enzyme regulation, competitive inhibition, allosteric enzymes.

(5.) Lipids and Biological Membranes (Lectures 9-11)
1. Structure of fatty acids, triacyl glycerols, membrane phospholipids, other lipids, phospholipid bilayers and membrane fluidity.
2. Membrane proteins, fluid mosaic model, types of trans-membrane transporters (e.g. Na-glucose transporter), active transport (e.g. Na-K ATPase).
3. Hormones, receptors and signal transduction (e.g. via cyclic AMP).

(6.) The Metabolism of Fats and Fatty Acids (Lectures 12-13)
2. The oxidation of fatty acids. (Energy yields from fatty acid oxidation).
3. Plants, but not mammals, can convert fat to carbohydrate. Ketone bodies. (The use of fatty acids as a fuel in aerobic exercise).
4. Anabolism of fatty acids: fatty acid synthesis. Regulation of fatty acid synthesis.

(7.) The Synthesis and Transport of Cholesterol (Lectures 14)
1. The synthesis and transport of cholesterol, other steroids and icosanoids.

(8.) Nitrogen Metabolism (Lectures 15-16)
1. Nitrogen fixation, nitrogen assimilation and transamination reactions.
2. Synthesis of non-essential and essential amino acids, amino acid catabolism; nitrogen disposal: The urea cycle, uric acid, and urease.

Lecturer 2
(9.) Introduction to Carbohydrate Metabolism (Lectures 17-18)
2. Oxidation and reduction, free energy changes, glycogenolysis.

(10.) Glucose Metabolism (Lectures 18-20)
1. Glucose, glycolysis, and the fate of pyruvate. (Glycogen breakdown and the Cori cycle during anaerobic exercise.)
2. Gluconeogenesis and glycogen synthesis.

(11.) The Citric Acid Cycle and Oxidative Phosphorylation (Lecture 21-23)
1. Conversion of pyruvate to acetyl-coenzyme A, reactions of the citric acid cycle.
2. Regulation of the citric acid cycle, catabolism, anabolism anapleurotic reactions.

(12.) The Integration of Carbohydrate and Lipid Metabolism (Lecture 24-26)
1. (Organ specialization and inter-organ metabolism)
   The Cori cycle and the glucose-alanine cycle.
2. The action of insulin, glucagon, and adrenalin (Diabetes).