



## BIO 361 Biochemistry

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### Course Description

This biochemistry course is designed to be taught over one semester. This implies that design is not intended to teach all current biochemistry with an extreme detail. Better, the idea is to draw attention to essential and fundamental aspects of biochemistry. That does not mean that the level of the course was limited; on contrary the course will pay attention in deep to the most relevant aspects of biochemistry that will allow students to understand in the future, if their career requires it, the most complex aspects of biochemistry and also of specialized fields related with biochemistry as genetics, cell biology, microbiology or molecular biology.

The course begins providing students with some tools related to chemistry and thermodynamics that are essential for understanding the properties of biomolecules, which are studied with a great detail. Following, we are going to afford a major study of enzymes as responsible for chemical reactions developed in the cell, ending with the study of metabolism based on the regulation of enzyme activity.

In the course, theory and practice are linked and coordinated so that both are complementary. The practical sessions are synchronized with the lectures and are designed so that they are a common project aimed at understanding how biochemistry is integrated into the normal life of people.

### Prerequisites

Students should have knowledge or have taken a course related to:

- Chemistry
- Biology
- Cell Biology

In order to check the level of previous knowledge of the students, it will be performed a preliminary exam on basic aspects of biology and chemistry without influence in the final grade.

### Course Goals and Methodology

In general, the aim of the course is to introduce students to the main topics of cell metabolism taking into account the relationship between these processes and the physiology, medicine, health and ecology, in order to show that all questions are linked in one: the life.

### Goals

1. Understand how weak chemical interactions are responsible of the biological activity through the generation of specific structures.
2. Know how cells harness and transfer energy
3. Know how enzymes work
4. Understand the architecture of biochemical networks and how can produce specific phenotypes

## Methodology

At the beginning of the course as starting material, students will have the syllabus and a reference textbook. The rest of the course package will be provided at the Blackboard e-learning platform (<https://campusvirtual.upo.es/>) before its use in class.

The course is divided into nine lessons that usually require two or three days of class.

Each lesson can be prepared using the List of Learning Objectives (LLO). These objectives correspond to the different topics that each student must study and understand at the end of the lesson. The LLO includes also some topics not explained by the teacher that must be reviewed by the student as personal work in order to address the lesson. For each lesson students will be provided with selected readings, the slide show used by the professor in class, notes and in some cases, papers and information from web sites.

Each lesson must be prepared in this way:

- Before the first day of class students should read the LLO and using the material provided in advanced try to find the right answers for each learning objective. If students have doubts it is important prepare a list of question to ask the teacher in class.
- During the first day of class, students must ask to the teacher the doubts found during the preparation of the **first part** of the lesson.
- Before the second day of class student must read the material provided to prepare the **second part** of the lesson.
- During the second (or third) day of class the teacher will explain the topics corresponding to the **second part** of the lesson that includes also problem solving activities.
- When the lesson is over, students must solve a list of problems proposed by the teacher (homework). The list of problem can be done using the information provided in class but in some cases it will be required find extra information not included in class. The answers of the problem list must be hand in to the teacher using the Blackboard e-learning platform (<https://campusvirtual.upo.es/>) according to the dates indicated in the calendar. If the assignment was handed in advanced, is possible a review by the teacher and also several opportunities to hand in the assignment to improve the grade.
- At the Blackboard e-learning platform after each lesson is possible do a quiz based on the LLO **that are not valid for grade**. That quiz is composed by 30-50 questions and it is useful to prepare the Midterm and Final exams.

The course includes 4 practice sessions at the laboratory that must be prepared as follow:

- Before the practice session students must prepare the session using the material provided in the aula virtual (papers and videos). Also must try an online exam about these materials **before the session**.
- During each session students must annotate all data obtained at the laboratory.

- After the last practice session, students must answer to a questionnaire about all practice sessions. It must be hand in to the teacher using the Blackboard e-learning platform (<https://campusvirtual.upo.es/>)

### General Learning Objectives

1. Describe and analyze the structure, origin and function of biomolecules.
2. Describe and differentiate the molecular forces that allow the interaction between biomolecules
3. Interpret and calculate how pH changes affect the stability of molecular interactions
4. Analyze thermodynamics laws in order to explain the biochemical reactions
5. Analyze the structure and properties of enzymes in order to explain its function as catalyst
6. Describe and interpret the regulatory processes of enzymes and its role in metabolism
7. Solve problems about pH, chemical equilibrium, thermodynamics, bioenergetics and enzyme kinetics.

### Required Texts

- Biochemistry 4th By David L. Nelson, Marcy Osgood, Michael M. Cox, Karen Ocorr - W H Freeman & Co (2004) - ISBN 071676203X

The origin of the graphic materials used in slides is the book indicated in the bibliography. The origin of the rest of materials is indicated in the corresponding slide.

### General Course Policies

Please keep your cell phones turned off during class.

It is strictly prohibited **consume food** in class.

It is possible use computer or tablets only to follow the class.

Any questions about exams, theory or practical classes can be communicated to the teacher via email, directly in class, tutoring sessions or by participating in the forum of the e-learning platform.

### Course Requirements and Grading

#### Requirements

##### - Exams.

Two exams, Midterm (Lesson 1 to 4) and Final (Lesson 5 to 8) that are composed by three parts: the first (40%) containing 30 multiple choice questions where only one option is correct. The questions will be selected from the quizzes done by students after each lesson. The second part (40%) corresponds to 4 short questions and the third part (20%) correspond to a problem.

##### - Homework. (List of problems).

The homework corresponds to a list of problems related with every lesson that must be handed at the indicated dates.

##### - Online exams.

After each lesson, students must perform several time an online exam composed by 25-50 questions. It is optional and is not valid for grading.

##### - Practice sessions.

Students must perform 4 online exams (1 for each session) before the session (10%) and a final questionnaire about the results of laboratory work (60%).

### **Grading**

1. Midterm Exam, 25%
2. Final Exam, 30%
3. Practice sessions 20%
4. Problems 25%

Assignments dates are indicated in the calendar included below

A good final grade (**A**) may be obtained by timely delivery of all proposed tasks and participating in class whenever grade tests exceed 70%. Additional activities not included in this syllabus will not be accepted to improve the final grade.

### **Attendance and Punctuality**

Attendance is mandatory. More than 3 unexcused absences will result in the lowering of the final grade. Students with more than 2 such absences may not challenge the final grade received. Punctuality is required.

Missed classes will mean a decrease in class participation grade.

### **Missed or Late Work**

Assignments submitted 1 week after the deadline will be graded with a decrease of the grade that is a loss of 25%. After the week the grade will be zero.

### **Academic Dishonesty**

Academic integrity is a guiding principle for all academic activity at Pablo de Olavide University. Cheating on exams and plagiarism (which includes copying from the internet) are clear violations of academic honesty. A student is guilty of plagiarism when he or she presents another person's intellectual property as his or her own. The penalty for plagiarism and cheating is a failing grade for the assignment/exam and a failing grade for the course. Avoid plagiarism by citing sources properly (using footnotes or endnotes and a bibliography).

### **Students with Disabilities**

If you have a disability that requires special academic accommodation, please speak to your professor within the first three (3) weeks of the semester in order to discuss any adjustments. It is the student's responsibility to provide the International Center with documentation confirming the disability and the accommodations required (if you have provided this to your study abroad organization, they have most likely informed the International Center already but please confirm).

### **Behavior Policy**

Students are expected to show integrity and act in a professional and respectful manner at all times. A student's attitude in class may influence his/her participation grade. The professor has a right to ask a student to leave the classroom if the student is unruly or

appears intoxicated. If a student is asked to leave the classroom, that day will count as an absence regardless of how long the student has been in class.

### Class Schedule

#### Time distribution table corresponding to face to face classes

Classroom	24h 00'
Lab	5h 20'
Exams	2h 40'
Course presentation	1h 20'
Class of Review	2h 40'
<b>Total</b>	<b>36h</b>

#### Workload distribution

Lesson	Face to face	Problems	Online	Personal study	Total
1	2h 40'	2h	2h	2h	8h 40'
2	4h	2h	2h	3h	11h
3	2h 40'	2h	2h	2h	8h 40'
4	4h	2h	2h	2h	10h
5	2h 40'	2h	2h	3h	9h 40'
6	4h	3h	2h	4h	13h
7	4h	3h	2h	4h	13h
Lab	5h 20'			4h	9h 20'
<b>Total</b>	<b>29h 20'</b>	<b>16h</b>	<b>14h</b>	<b>24h</b>	<b>83h 20'</b>

#### Lesson 1: Biomolecules and weak interactions

- 1.1. Electronegativity and covalent bonds
- 1.2. Types of covalent bonds
- 1.3. Weak interactions
  - 1.3.1. Electrostatic interactions
  - 1.3.2. Hydrogen bonds
  - 1.3.3. van der Waals forces
  - 1.3.4. Hydrophobic interactions
- 1.4. Biological effect of weak interactions

#### Lesson 2: The energy and the living cells

- 2.1. Cells and thermodynamics laws
- 2.2. Free energy and entropy
- 2.3. Chemical equilibrium and free energy
- 2.4. Coupled reactions
  - 2.4.1. Requirements of coupled reactions
  - 2.4.2. Function of ATP in coupled reactions
- 2.5. Energy storing
  - 2.5.1. ATP
  - 2.5.2. Electrochemical gradients
- 2.6. Redox reactions

### **Lesson 3: Water and buffers.**

- 3.1. Water properties
- 3.2. Interaction of molecules with water
- 3.3. Water ionization and pH
- 3.4. Weak acids and pH
- 3.5. Biological buffers
- 3.6. Biological effect of pH

### **Lesson 4: Biomolecules**

- 4.1. Carbohydrates
  - 4.1.1. Definition and classification
  - 4.1.2. Isomers
  - 4.1.3. The glycosidic bond
  - 4.1.4. Disaccharides
  - 4.1.5. Polysaccharides
- 4.2. Lipids
  - 4.2.1. Definition and properties
  - 4.2.2. Functions and classification
  - 4.2.3. Fatty acids
  - 4.2.4. Saponifiable lipids
  - 4.2.5. Isoprenoids
  - 4.2.6. Lipid transport
- 4.3. Nucleotides and nucleic acids
  - 4.3.1. Definition and function of nucleotides
  - 4.3.2. Structure of nucleotides
  - 4.3.3. Derivate of nucleotides
  - 4.3.4. Synthesis and degradation of nucleotides
  - 4.3.5. Classification of nucleic acids
- 4.4. Aminoacids
  - 4.4.1. Definition, structure and functions
  - 4.4.2. Isomers

- 4.4.3. Classification of proteogenic amino acids
- 4.4.4. Post-translational modifications
- 4.4.5. Ionization

## **Lesson 5 Proteins**

- 5.1. The peptide bond
- 5.2. Polypeptides and proteins
  - 5.2.1. Structure of proteins
  - 5.2.2. Alpha-helix
  - 5.2.3. Beta-sheet
  - 5.2.4. Collagen helix
  - 5.2.5. Beta-turn
- 5.3. Tertiary structure
  - 5.3.1. Structural domain
  - 5.3.2. Functional domain
- 5.4. The folding process

## **Lesson 6: Enzymes as catalysts**

- 6.1. Characteristics of enzymes
  - 6.1.1. Classification
  - 6.1.2. Definition of enzymatic activity
  - 6.1.3. Enzyme as catalysts
  - 6.1.4. Mechanisms of enzymatic activity
- 6.2. Enzyme kinetic
  - 6.2.1. Michaelis-Menten kinetic
  - 6.2.2.  $K_m$  and  $V_{max}$  calculation
  - 6.2.3. Biological sense of kinetics parameter
- 6.3. Enzymatic inhibition
  - 6.3.1. Classification of inhibitors
  - 6.3.2. Allosteric inhibitors
- 6.4. Working with enzymes
  - 6.4.1. Enzymatic assays
  - 6.4.2. The spectrophotometer and the Lambert-Beer law

## **Lesson 7: Metabolic regulation**

- 7.1. Components of metabolism
- 7.2. Main metabolic pathways
- 7.3. Energetic coupling of reactions
- 7.4. Regulation by modulation of enzymatic activity
- 7.5. Regulation models
- 7.6. Models of coupling of metabolic regulation and cell signaling

## **Laboratory work**

1. Mitochondrial functionality test

- a. Drop cultures in YPG
- 2.** Purification of yeast mitochondria
  - a. Protein quantification
- 3.** Mitochondrial respiratory chain activity
  - a. Complex I+III activity
- 4.** Respiratory mutant detection by PCR
  - a. Genomic DNA purification
  - b. PCR
  - c.** TBE Agarose gel separation



**CALENDAR**

<b>Class</b>	<b>Date</b>	<b>Location</b>	<b>Activity</b>	<b>Assignment Date</b>
1	26/01/17		Course Presentation	
2	31/01/17		Lesson 1 A: Biomolecules and weak interactions	14/02/17
3	2/02/17		Lesson 1 B	
4	7/02/17		Lesson 2 A: The energy and the living cells	23/02/17
5	9/02/17		Lesson 2 B	
6	14/02/17		Lesson 2 C	
7	16/02/17		Lesson 3 A: Water and buffers	2/03/17
8	21/02/17		Lesson 3 B	
9	23/02/17		Lesson 4 A: Biomolecules	14/03/17
10	2/03/17		Lesson 4 B	
11	7/03/17		Lesson 4 C	
12	9/03/17		Lesson 5 A	28/0317
13	14/03/17		Problems Class (I)	
<b>13</b>	<b>16/03/17</b>		<b>Mid Term Exam</b>	
15	21/03/17		Lesson 5 B	28/03/17
16	23/03/17		Lecture 6 A: Enzymology	18/04/17
17	28/03/17	B23 Lab4	LAB 1	
18	30/03/17		Lecture 6 B	18/04/17
19	4/04/17		Lecture 6 C	18/04/17
20	6/04/17	B23 Lab5	LAB 2	
21	18/04/17		Lecture 7 A: Metabolic Regulation	9/05/17
22	20/04/17	B23 Lab5	LAB 3	
23	25/04/17		Lecture 7 B	9/05/17
24	27/04/17		Lecture 7 C	9/05/17
25	9/05/17	B23 Lab4	LAB 4	
26	11/05/17	B23 Lab4	LAB 5 + Problem Class	16/05/17