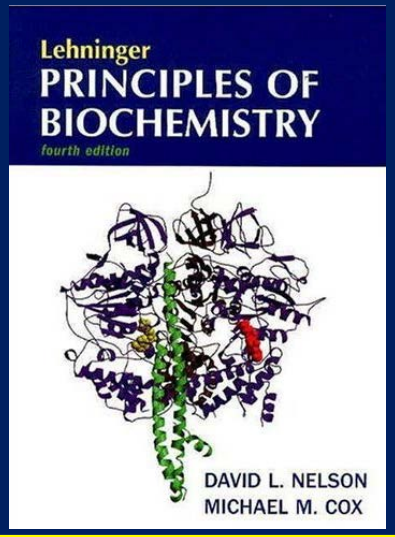


Lehninger Principles of Biochemistry
Fourth Edition

David L. Nelson • Michael M. Cox

Prof. Arthur D. Tinoco
University of Puerto Rico, Rio Piedras Campus
Chemistry 4055
Biochemistry I- Introduction to the Chemistry of the Animal Cell
Spring 2013

Professor Arthur D. Tinoco

- Bioinorganic Chemistry Professor
- Office located in Ciencias Naturales (CN-224)
- Office hours: 9-11 am, Tuesday & Thursday
- Contact information: Arthur.david.tinoco@gmail.com

Course Assistants

- Aideliz Nunez
  - Tutoring at the CREQ (CNL-A316)
  - Wednesday 11 am – 2 pm

- Yamaris Pacheco
  - Will assist with lectures

Course Resources

1. **Textbook**
   - Easy to purchase through online sites
   - www.academia.edu/731505/Lehninger_Principles_Of_Biochemistry_4th_Edition

2. **Website**
   - http://chemistry4055-atinoco.weebly.com/

3. **Facebook group**
   - UPR RP Biochemistry I (Spring 2013)

Additional Resources

Students who receive **Vocational Rehabilitation** services need to communicate with the professor at the start of the semester so that a plan can be devised to provide reasonable accommodation and assistive equipment in accordance with the recommendations of the "Oficina de Asuntos para Personas con Impedimento (OAPI) del Decanato de Estudiantes." Also students with special needs that require additional assistance or accommodation need to communicate with the professor.

Course Lectures

1. Combination of traditional lecture notes and powerpoint slides for visual aid

2. Lecture slides will be made available on course website

3. Lectures may deviate from textbook therefore attendance, though not required, is **IMPORTANT**

4. Follow student interactive pedagogy

Grading Scheme

The course is designed as a very informative overview of Biochemistry and to not be overwhelming. Your grades will be distributed over different assignments to maximize your opportunity to do well in the course.

Homework (5):	**25%**
Exams (4):	**40%**
Short Paper:	**15%**
Final:	**20%**
	100%

Introduction to Biochemstry

Chapter 1 Overview (Pg. 1-26)

1. Define Biochemistry
   - Focus on the biochemistry of the animal cell

2. Define the key structural components of the cell

3. Define the basic chemical properties of the biomolecules to be discussed

What is biochemistry?

Branch of chemistry that explores how the remarkable properties of living organisms arise from the thousands of different lifeless biomolecules.

Properties:

1. High degree of chemical complexity and microscopic organization

2. Systems for extracting, transforming, and using energy from the environment

What is biochemistry?

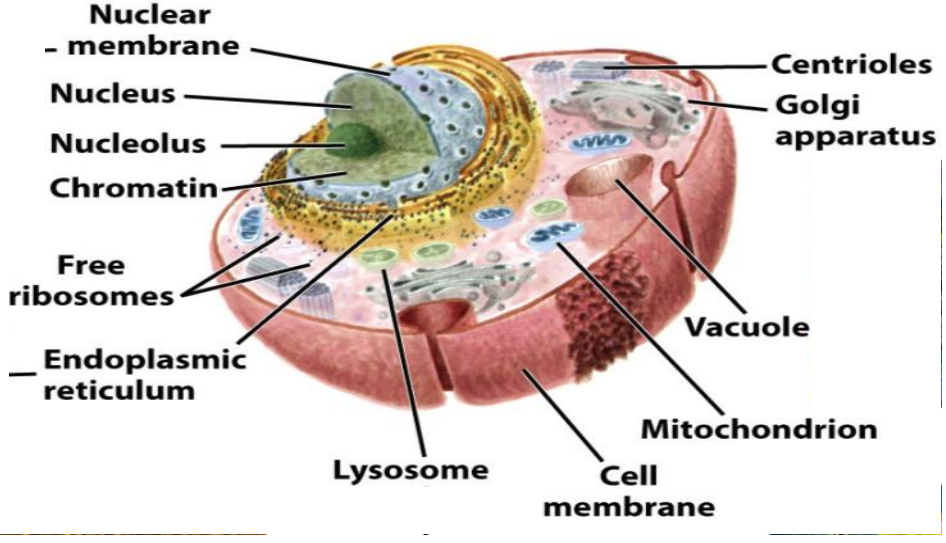
1. Capacity for precise self-replication and self-assembly

2. Mechanisms for sensing and responding to changes in their surroundings

3. Defined functions for each of their components and regulated interactions among them

4. A history of evolutionary change

The Animal Cell is the focal point of our study.



The animal cell is a eukaryotic cell (multicellular):

1. Diameter of 10-100 μm
2. Contain diverse organelles with specialized functions
3. Contain cell membrane for transport

Composition of biomolecules of interest.

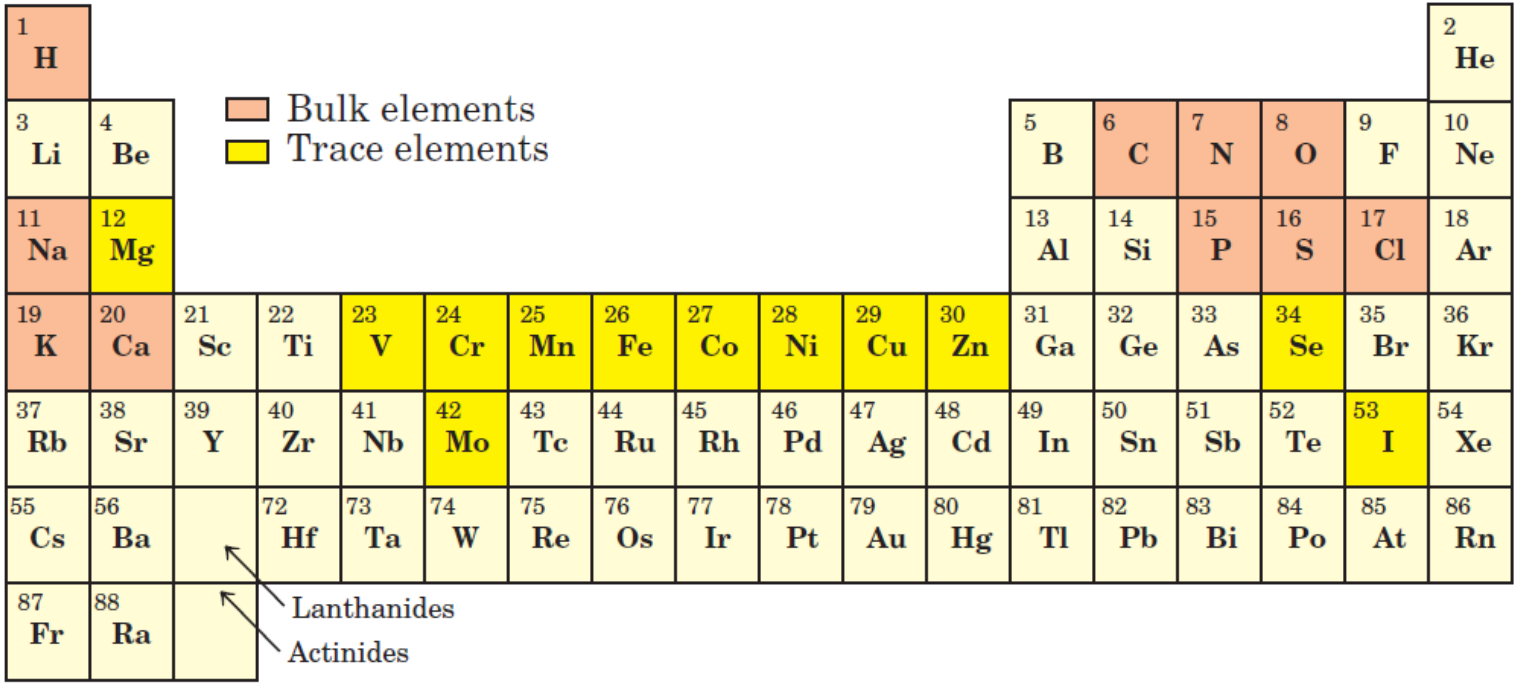
Table 1-1 Most Abundant Elements in the Human Body[a]

Element	Dry Weight (%)
C	61.7
N	11.0
O	9.3
H	5.7
Ca	5.0
P	3.3
K	1.3
S	1.0
Cl	0.7
Na	0.7
Mg	0.3

[a]Calculated from Frieden, E., *Sci. Am.* **227**(1), 54–55 (1972).

The elements **C, N, O, H, Ca, P, K, and S** comprise nearly 97% of the human body (dried weight).

Elements important to life.



Recently titanium (Ti) and cadmium (Cd) have been shown to be biologically important.

Biomolecules (and their components) that we will study

1. Water as solvent and as source of structure and function
2. Proteins (Amino acids)
3. DNA (Nucleic acids, sugars, and phosphates)
4. Lipids
5. Molecules important for cellular respiration

Important functional groups in biomolecules.

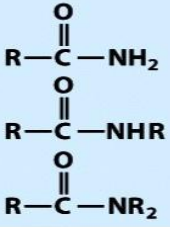
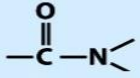
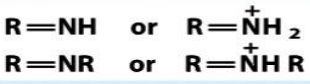
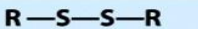
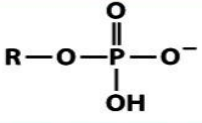
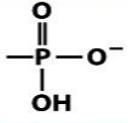
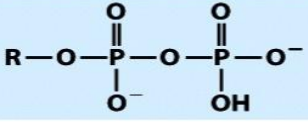
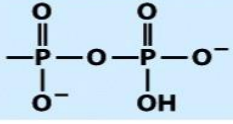
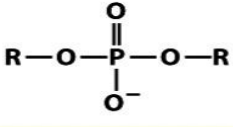
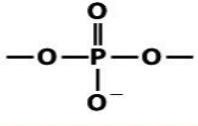
Table 1-2 Common Functional Groups and Linkages in Biochemistry

Compound Name	Structure[a]	Functional Group or Linkage
Amine[b]	RNH_2 or $R\overset{+}{N}H_3$ R_2NH or $R_2\overset{+}{N}H_2$ R_3N or $R_3\overset{+}{N}H$	$-N<$ or $-\overset{+}{N}-$ (amino group)
Alcohol	RO H	—OH (hydroxyl group)
Thiol	RSH	—SH (sulfhydryl group)
Ether	RO R	—O— (ether linkage)
Aldehyde	$R-C(=O)-H$	$-C(=O)-$ (carbonyl group)
Ketone	$R-C(=O)-R$	$-C(=O)-$ (carbonyl group)
Carboxylic acid[b]	$R-C(=O)-OH$ or $R-C(=O)-O^-$	$-C(=O)-OH$ (carboxyl group) or $-C(=O)-O^-$ (carboxylate group)
Ester	$R-C(=O)-OR$	$-C(=O)-O-$ (ester linkage) $R-C(=O)-$ (acyl group)[c]
Thioester	$R-C(=O)-SR$	$-C(=O)-S-$ (thioester linkage) $R-C(=O)-$ (acyl group)[c]

[a] R represents any carbon-containing group. In a molecule with more than one R group, the groups may be the same or different.
[b] Under physiological conditions, these groups are ionized and hence bear a positive or negative charge.
[c] If attached to an atom other than carbon.

Important functional groups in biomolecules.

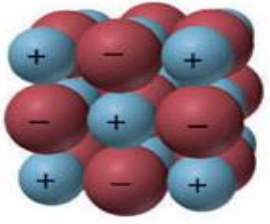
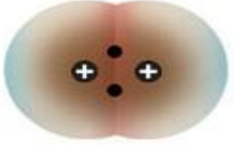
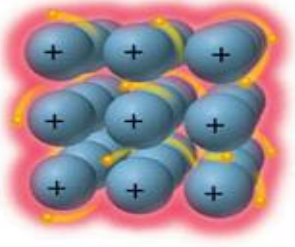
Table 1-2 Common Functional Groups and Linkages in Biochemistry

Compound Name	Structure[a]	Functional Group or Linkage
Amide		 (amido group)  (acyl group)[c]
Imine (Schiff base)[b]		 (imino group)
Disulfide		 (disulfide linkage)
Phosphate ester[b]		 (phosphoryl group)
Diphosphate ester[b]		 (phosphoanhydride group)
Phosphate diester[b]		 (phosphodiester linkage)

[a] R represents any carbon-containing group. In a molecule with more than one R group, the groups may be the same or different.
[b] Under physiological conditions, these groups are ionized and hence bear a positive or negative charge.
[c] If attached to an atom other than carbon.

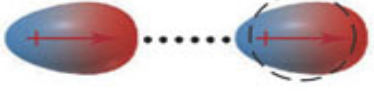
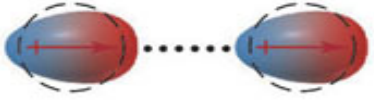
Important intramolecular forces that stabilize biomolecules.

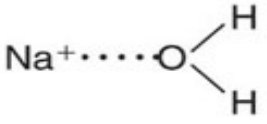
Table 12.2 Comparison of Bonding and Nonbonding (Intermolecular) Forces

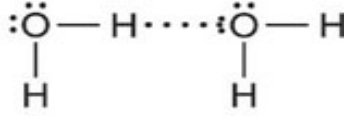
Force	Model	Basis of Attraction	Energy (kJ/mol)	Example
Bonding				
Ionic		Cation–anion	400–4000	NaCl
Covalent		Nuclei–shared e^- pair	150–1100	H—H
Metallic		Cations–delocalized electrons	75–1000	Fe

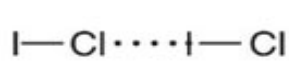
Important inter/intramolecular forces that stabilize biomolecules.

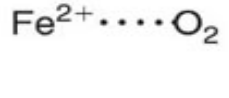
Nonbonding

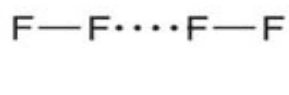
Ion-dipole		Ion charge–dipole charge	40–600
H bond		Polar bond to H–dipole charge (high EN of N, O, F)	10–40
Dipole-dipole		Dipole charges	5–25
Ion–induced dipole		Ion charge–polarizable e⁻ cloud	3–15
Dipole–induced dipole		Dipole charge–polarizable e⁻ cloud	2–10
Dispersion (London)		Polarizable e⁻ clouds	0.05–40











Reactions of biomolecules are thermodynamically driven.

1. Biochemical reactions obey the three laws of thermodynamics

2. The majority of these reactions involve the acquisition and utilization of energy

3. The spontaneity of these reactions is defined by ΔG
   - $\Delta G = \Delta H - T\,\Delta S$

     (**Good Hamburgers Make Tasty Supper!**)
   - $\Delta G < 0$ indicates a spontaneous reaction; exergonic reaction

The Decomposition of Hydrogen Peroxide

A thermodynamically favorable process is kinetically very slow.

$$2\,H_2O_2 \xrightarrow{k} O_2(g) + 2\,H_2O\,(l)$$

Nature is the best chemist!!!