



*College of Science*

*Department of Biochemistry*

**Protein Biochemistry (BCH 303)**

**Introduction-Course description**

# BCH 303 PROTEIN BIOCHEMISTRY

- Course Symbol & No. : BCH 303
- Credit Hours : 3 (2+0+2)
- Prerequisite : BCH 202
- Class schedule : Sunday, Tuesday,  
2:00 pm to 3:50 pm.
- Class location : 2B2 building No. 5
- Examinations : Two Continuous Assessment Tests (CAT)
  - Practical (30 Marks)
  - Final (40 Marks)

Course title: Protein Biochemistry	Course number and code: BCH 303
Previous course requirement: BCH 202	Language of the course: English
Course level: 4 <sup>th</sup> Level	Effective hours:3 (2+0+2)

#### ✚ Course description

#### وصف المقرر :

This course covers the structural features of natural amino acids, stereo-isomerism, and configuration; their classification, functional groups and their effect on protein conformation, zwitterion and  $pI$  titration curve; chemical reactions specifying each amino acid, spectroscopic properties, and their biological importance. Peptide bond formation, it is rigid and planar and biologically active peptides. Protein classification, levels of protein structure (primary to quaternary), alpha helix, beta sheet; protein architecture. Physical and chemical properties. Fibrous vs globular proteins; domains and motifs; Different functions of proteins, biosynthesis, folding and the role of molecular chaperons. Protein denaturation and renaturation. Effect of protein structure on ligand binding, ex. Hemoglobin/O<sub>2</sub>, immunoglobulins/antigens. Techniques used in amino acid analysis, peptide synthesis, protein purification, quantification, protein sequencing and its role in elucidating the evolutionary relationships; mass spectrometry.

يغطي هذا المقرر السمات التركيبية للأحماض الأمينية الطبيعية، وتنوع أشكالها الفراغية، وتصنيفها، والمجموعات الوظيفية وتأثيرها على الشكل الفراغي للبروتينات، الأيون ثنائي القطبية، منحنى المعايرة، والتفاعلات الكيميائية المميزة لكل حمض أميني وخصائصها الطيفية، وأهميتها البيولوجية. تكوين الرابطة الببتيدية، وشكلها الصلب المستوي، والببتيدات النشطة بيولوجياً. تصنيف البروتينات، والمستويات التركيبية لها (الشكل الأولي إلى الرباعي الأبعاد)، الحلزون ألفا، ورقة بيتا، بنية البروتين. الخصائص الفيزيائية والكيميائية. البروتينات الليفية والمكورة. الوظائف المختلفة للبروتينات، تخليقها الحيوي، الطي. مسخ البروتينات وإعادة الشكل لطبيعته. تأثير تركيب البروتين على الارتباط بالمتلازم، مثل الهيموجلوبين/O<sub>2</sub>، الجلوبيولين المناعي/الاجسام المضادة. التقنيات المستخدمة في تحليل الأحماض الأمينية، تصنيع الببتيدات معملياً، تنقية البروتينات، والتقدير الكمي، وتسلسل البروتينات، طيف الكتلة و تسلسل البروتين ودورها في توضيح العلاقات التطورية.

<b>List of Topics</b>	<b>No. of Weeks</b>	<b>Contact hours</b>
<b>Introduction</b> Macromolecules; Definitions and introduction	1	2
<b>Amino acids</b> Definitions and types of amino acids Functions of amino acids Properties of amino acids: (Polarity, Stereoisomers, Light absorption, Ionization)	4	8
<b>Structure &amp; Classification of standard amino acids</b> Functional groups in amino acids	2	4
Protein synthesis Post Translation Modification (hydroxylation, phosphorylation, methylation, disulfide bridge, etc) Protein folding	2	4
<b>Protein Structure</b> Peptide Bond (formation, structure, & properties), and terminology: amino acids versus residue versus polypeptide & proteins Protein structure (primary, secondary, tertiary, and quaternary) Misfolding problem Protein denaturation	3	6

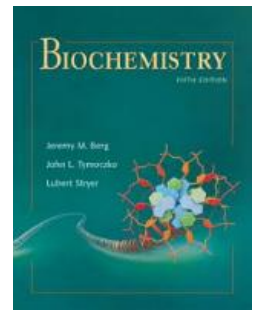
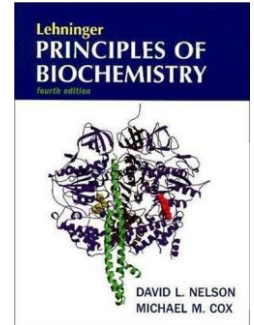
<b>List of Topics</b>	<b>No. of Weeks</b>	<b>Contact hours</b>
Structural classification of proteins: (Fibrous proteins and Globular proteins: representatives of all-alpha, all-beta, and alpha/beta proteins)	3	6
<b>Protein function</b> Functional classifications: enzymes, immunoglobulins, transport (O <sub>2</sub> , fatty acids), regulatory (hormones etc), structural, & movement, with examples. complex proteins (metal ions, cofactors, lipids, carbohydrates, etc) Introduction to enzymes and metabolism	1	2
<b>Introduction to metabolism</b> Overall Metabolic pathways for protein Urea cycle	1	2
<b>Proteins general methods</b> Protein purification Protein quantification Amino Acid Analysis Protein Sequencing Mass Spectrometry and Proteomics	3	6

# THE MAIN PURPOSE FOR THIS COURSE

- This course aims to familiarize students with basic knowledge of protein biochemistry needed for higher level courses.
- It covers the following:
  - Details of amino acid as the building blocks of protein.
  - Protein synthesis and folding, protein structure, structural and functional classification of proteins,
  - Introduction to enzymes and metabolism.
  - Techniques in protein chemistry and analysis, including Protein purification, Protein quantification, Amino Acid Analysis, Protein Sequencing, Mass Spectrometry and
  - The practical part will focus on technical skills in biochemistry and will include amino acids detection, protein preparation, analysis of protein structure and some enzymatic assays.

# TEXT BOOKS

- **Lehninger: Principles of Biochemistry**
- by DL. Nelson and MI. Cox (latest edition)
  
- **Stryer, L; Biochemistry**, W.H. Freeman and company.
- New York
  
- **Protein Biochemistry and Proteomics**, ISBN 012088545X  
9780120885459
  
- **Proteins: Biochemistry and Biotechnology**, 2nd Edition, Gary Walsh, ISBN : 978-0-470-66985-3
- Wiley Blackwell



# INTRODUCTION TO BIOLOGICAL MACROMOLECULES

There are 4 major macromolecules (polymers) in the cell formed by condensation of smaller building blocks (monomers) :

Macromolecule (polymers)	Building blocks (monomers)	Name of bond
Carbohydrate	Monosaccharides	Glycosidic bond
Proteins	Amino acids	Peptide bond
Nucleic acids	Nucleotides	Phospho diester bond
Lipids	Fatty acids + alcohol	Ester bond



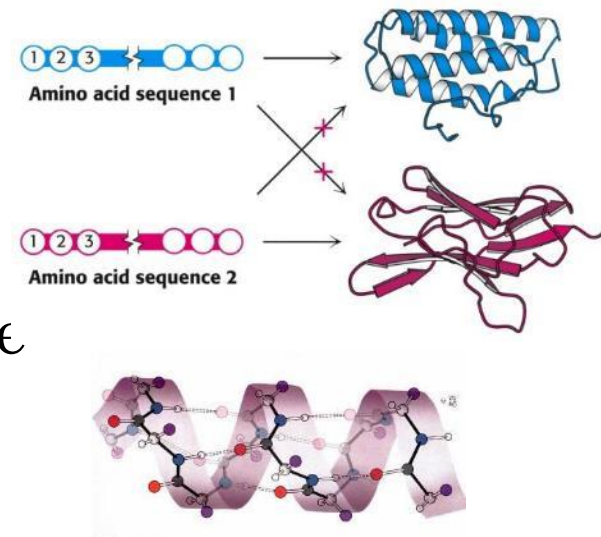
# CHARACTERISTICS OF BIOLOGICAL MOLECULES

- All macromolecules have a “Sense” or Directionality
  - DNA : -ATC-  $\neq$  -CTA-
  - Protein: -Gly-Ser-  $\neq$  -Ser-Gly-
  - Carbohydrate: -Glu-Gal  $\neq$  -Gal-Glu-

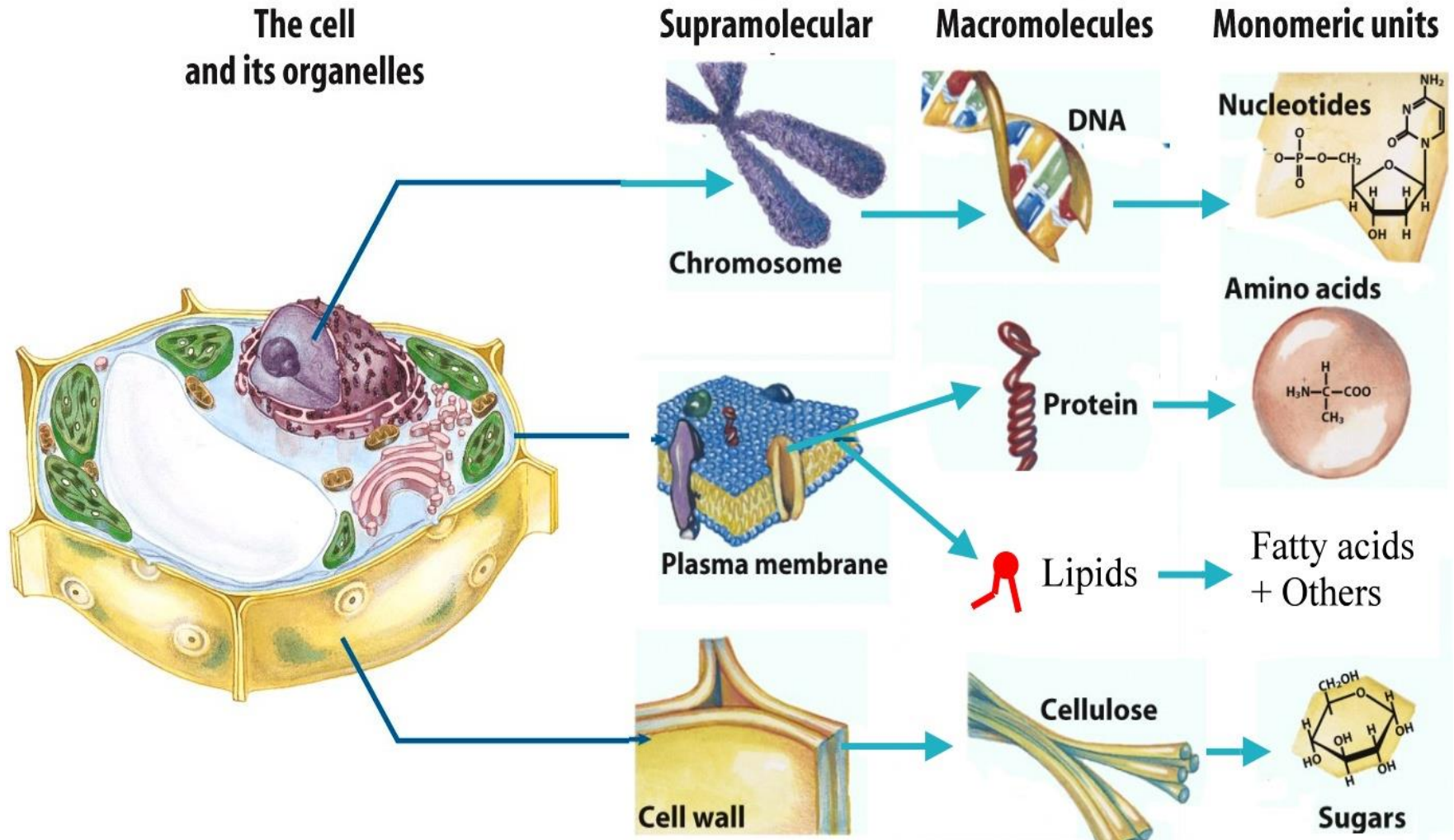
- Macromolecules are Informational:
  - Examples: AUC=Ile; ACU=Thr; UAC=Tyr

- Macromolecules Have Characteristic Three-Dimensional Architecture

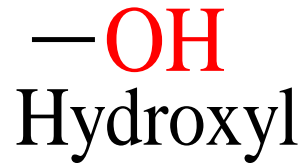
- Weak forces maintain biological structure and determine biomolecular interactions



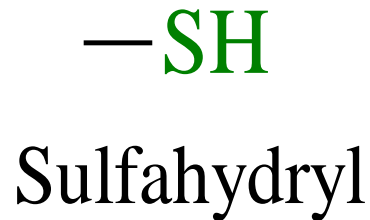
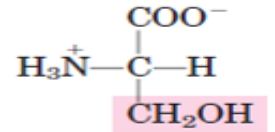
# STRUCTURAL LEVELS OF CELL MOLECULES



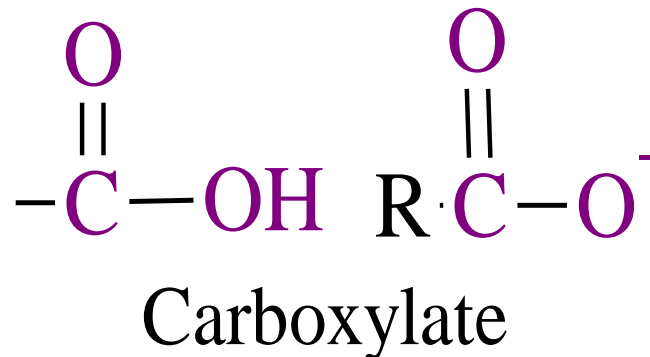
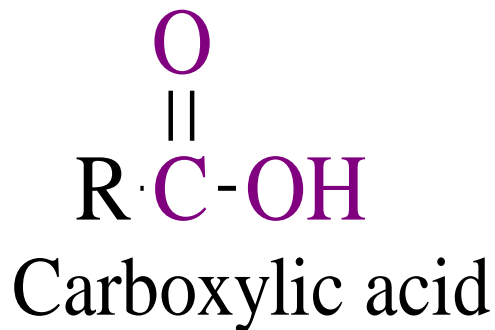
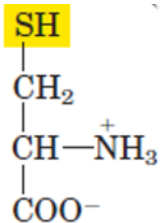
# FUNCTIONAL GROUPS IN BIOCHEMISTRY



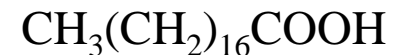
Example:  
amino acid  
(serine)



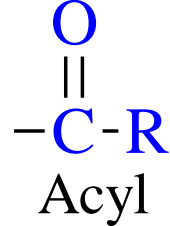
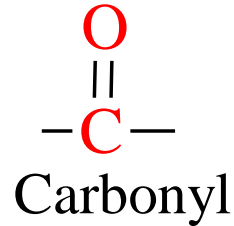
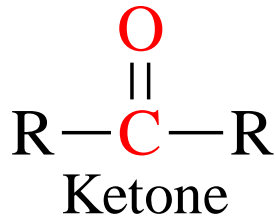
Example:  
amino acid  
(cysteine)



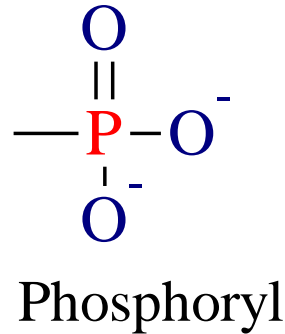
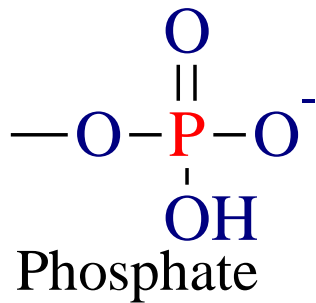
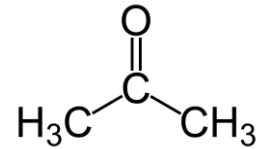
Example:  
fatty acid  
(Palmitic acid)



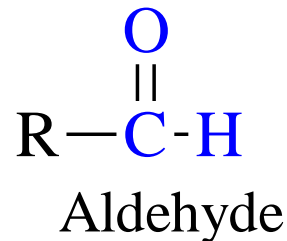
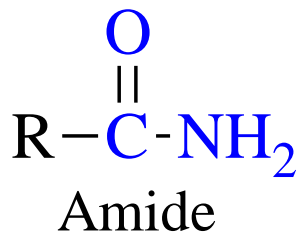
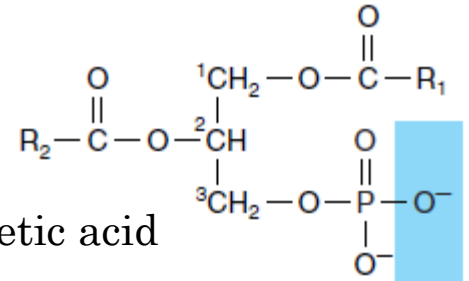
# FUNCTIONAL GROUPS IN BIOCHEMISTRY (CONT.)



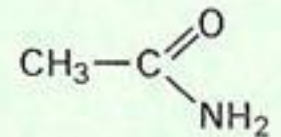
Example:  
acetone



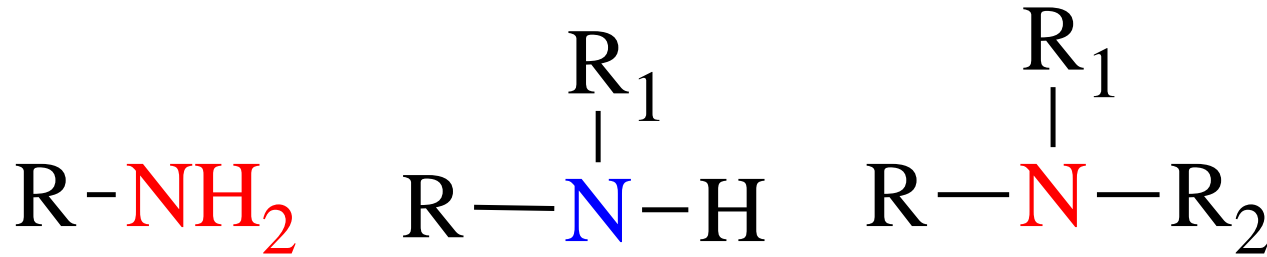
Example:  
Phosphatetic acid



Example:  
acetamide



# FUNCTIONAL GROUPS IN BIOCHEMISTRY (CONT.)

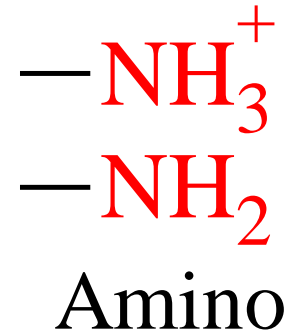


Primary

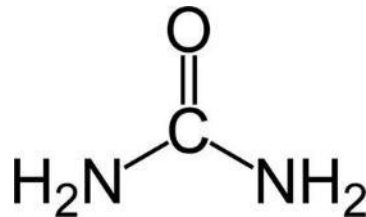
Secondary

Tertiary

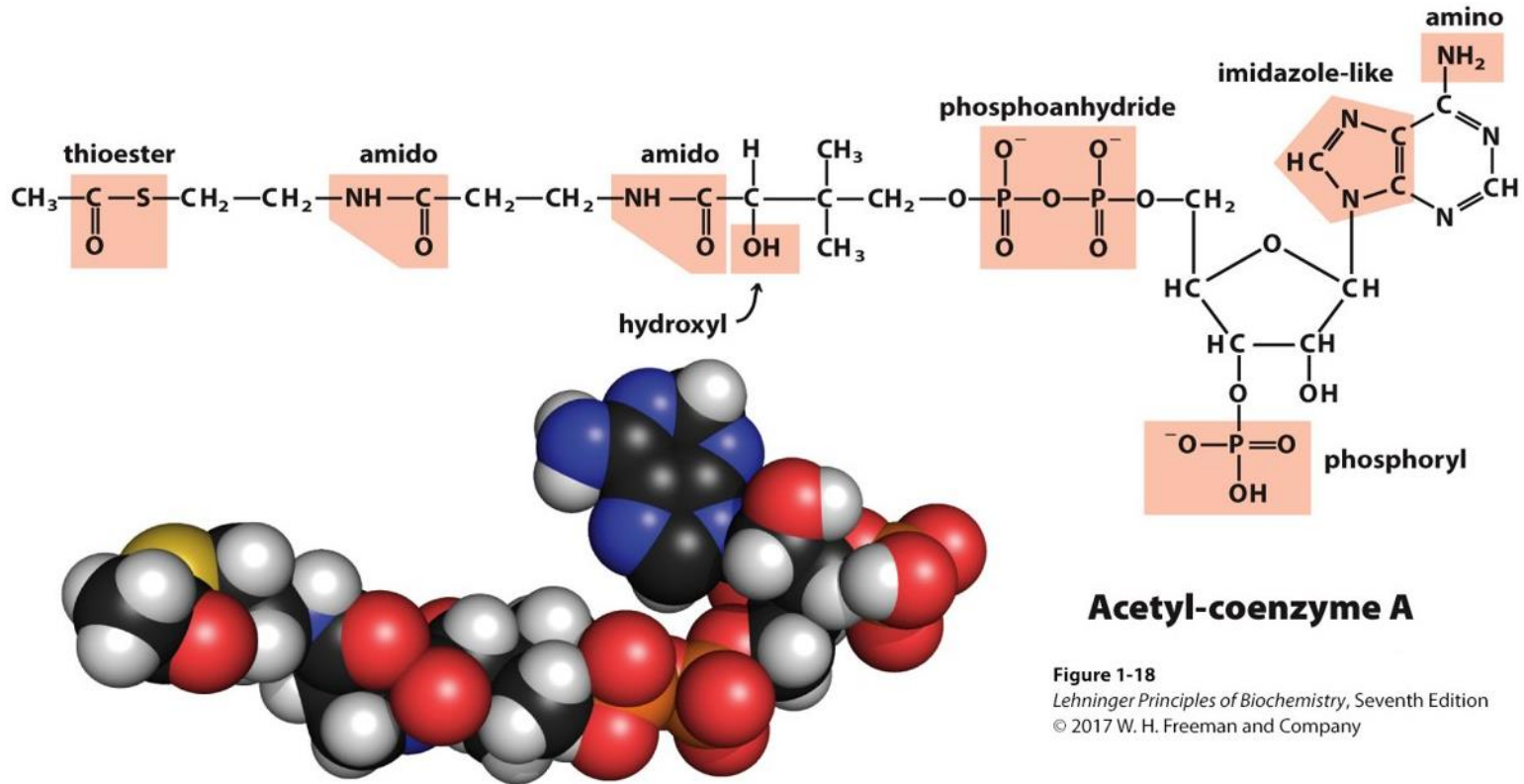
Amines



Example:  
Urea



# BIOLOGICAL MOLECULES TYPICALLY HAVE SEVERAL FUNCTIONAL GROUPS



## Acetyl-coenzyme A

Figure 1-18  
*Lehninger Principles of Biochemistry, Seventh Edition*  
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**Several common functional groups in a single biomolecule.** Acetyl-coenzyme A (often abbreviated as acetyl-CoA) is a carrier of acetyl groups in some enzymatic reactions. The functional groups are screened in the structural formula. As we will see in Chapter 2, several of these functional groups can exist in protonated or unprotonated forms, depending on the pH. In the space-filling model, N is blue, C is black, P is orange, O is red, and H is white. The yellow atom at the left is the sulfur of the critical thioester bond between the acetyl moiety and coenzyme A.