**Amino Acids, Peptides and Proteins**

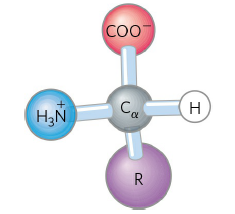
* Cells can produce proteins (enzymes, hormones, antibodies)
* with different properties and activities by joining the same 20 amino acids in many different combinations and sequences.

**Amino Acids**

* Proteins are polymers of amino acids.

**Amino Acids Share Common Structural Features**

* All 20 amino acids are -amino acids.
* They have a carboxyl group and an amino group bonded to the same carbon atom (the carbon).
* They differ from each other in their side chains (**R groups**),
* vary in structure, size and electric charge.
* The common amino acids of proteins have been assigned three-letter abbreviations and one-letter symbols **(Table 3–1)**.
* The  carbon is bonded to four different groups (except glycine)
* a carboxyl group, an amino group, an R group and a hydrogen atom**.**
* is a chiral center.

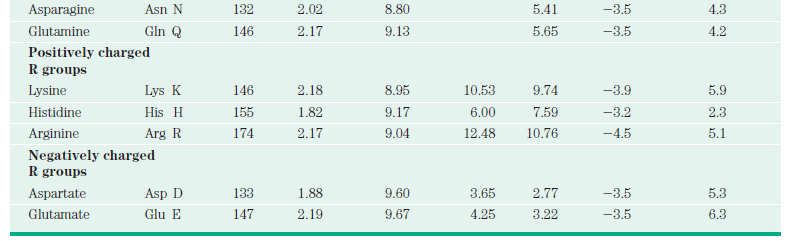
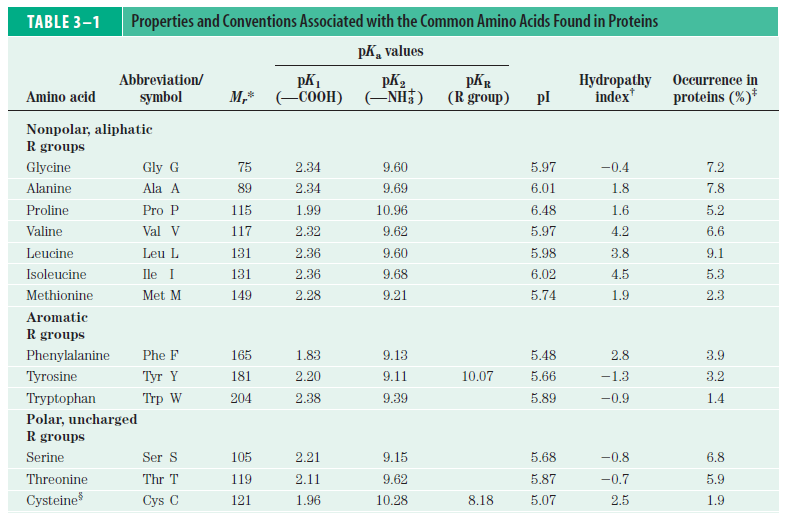
 

* All molecules with a chiral center are also optically active,
* rotate plane-polarized light.

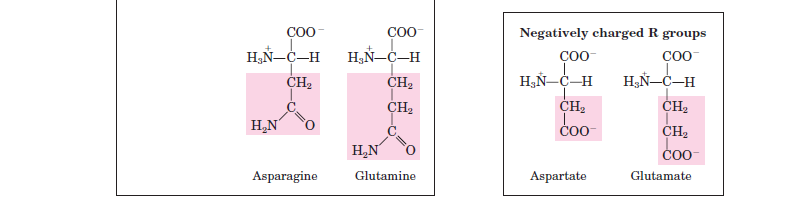
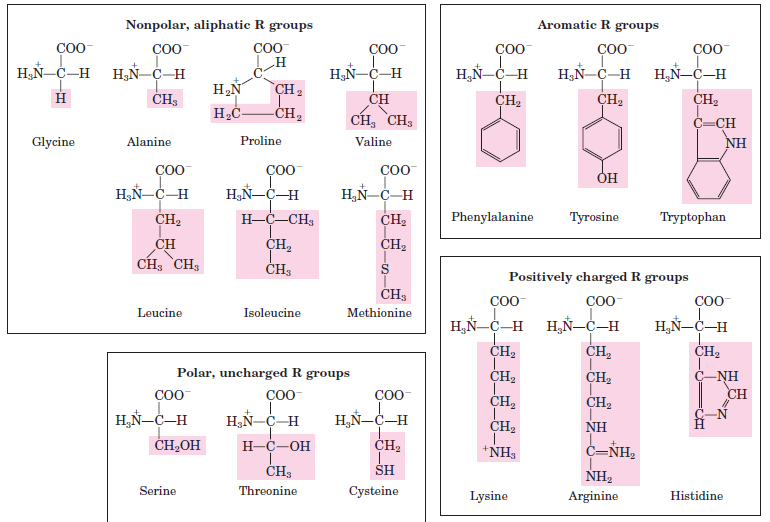
**The Amino Acid Residues in Proteins Are L Stereoisomers**

* The term “residue” reflects the loss of the elements of water when one amino acid is joined to another.
* L stereoisomersrotate plane-polarized light to the left.
* D-amino acids residues have been found only in a few.

**Amino Acids Can Be Classified by R Group**

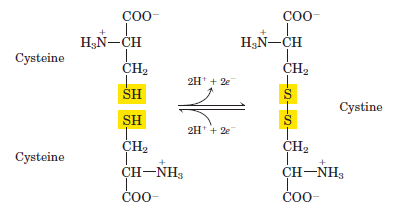


* They differ from each other in their side chains (R groups)
  + vary in structure, polarity, size, electric charge
  + are grouped into five classes **(Fig. 3-5)**.





* **Nonpolar, aliphatic** R groups stabilize protein structure by hydrophobic interactions.
* proline has a distinctive cyclic structure.
* **Aromatic** R groups participate in hydrophobic interactions and hydrogen bonds
* absorb ultraviolet light at 280 nm.
* **Polar, uncharged** R groupsformhydrogen bonds.
* cysteine is oxidized to form cystine by a disulfide bond (**Fig. 3-7)**.



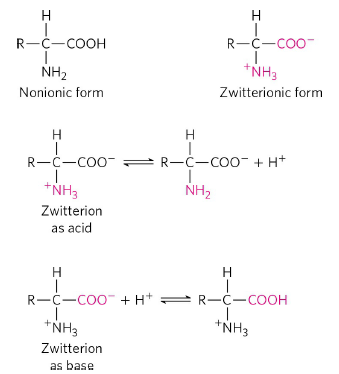
* **Positively charged (basic)** R groups participate in ionic interactions and hydrogen bonds.
* **Negatively charged (asidic)** R groups participate in ionic interactions and hydrogen bonds.

**Uncommon Amino Acids Also Have Important Functions**

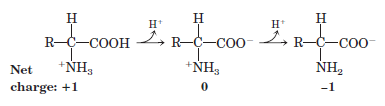
* In addition to the 20 common amino acids, proteins may contain residues created by modification of common residues.
* some of them are 4-hydroxyproline, 5-hydroxylysine, ornithine, citrulline
* 300 additional amino acids have been found in cells.

**Amino Acids Can Act as Acids and Bases**

* When an amino acid lacking an ionizable R group is dissolved in water at neutral pH
* it exists as dipolar ion or **zwitterion**
* a zwitterion can act as either an acid or a base **(Fig. 3-9)**.

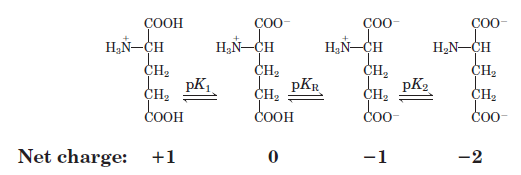


* Alanine, is a diprotic acid when fully protonated
* the —COOH group and the —NH3+ group can yield protons**.**



**Amino Acids Differ in Their Acid-Base Properties**

* Amino acids with an ionizable R group have more complex titration curves.



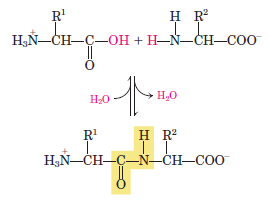
* Only histidine has an R group (pKa = 6.0) providing significant buffering power near the neutral pH
* usually found in the intracellular and extracellular fluids of most animals and bacteria.

**Peptides and Proteins**

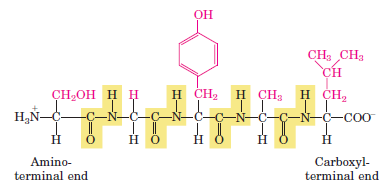
* Peptides and proteins are polymers of amino acids.

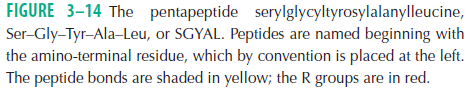
**Peptides Are Chains of Amino Acids**

* Two amino acids are covalently joined
* **peptide bond** is formed to yield a dipeptide **(Fig. 3-13)**.



* When a few amino acids are joined, the structure is called an **oligopeptide**.
* When many amino acids are joined, the product is called a **polypeptide**.
* The structure of a pentapeptideis shown in **(Fig. 3-14)**.

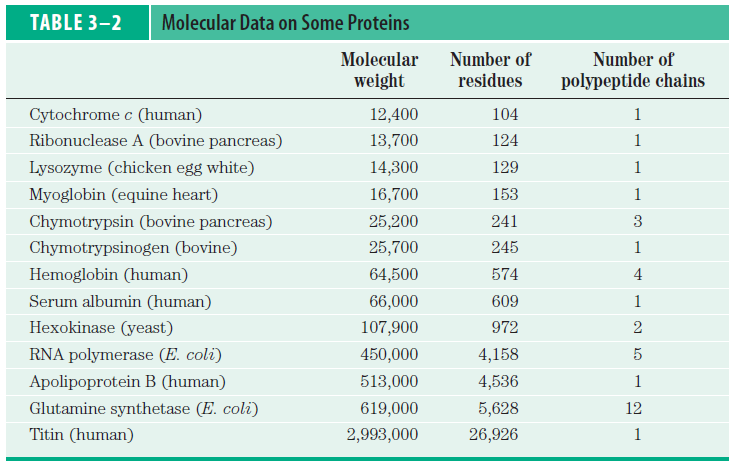




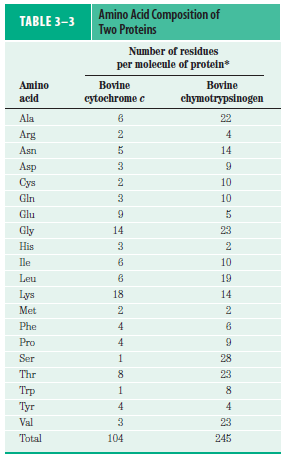
* In a peptide
* the amino acid residue at the end with a free amino group is the **amino-terminal** (or N-terminal) residue
* the residue at the other end, which has a free carboxyl group, is the **carboxyl-terminal** (C-terminal) residue.
* The amino-terminal end is placed on the left, the carboxyl-terminal end on the right.
* The sequence is read left to right, beginning with the amino-terminal end.

**Biologically Active Peptides and Polypeptides Occur in a Vast Range of Sizes and Compositions**

* Naturally occurring peptides range in length from two to many thousands of amino acid residues **(Table 3-2).**

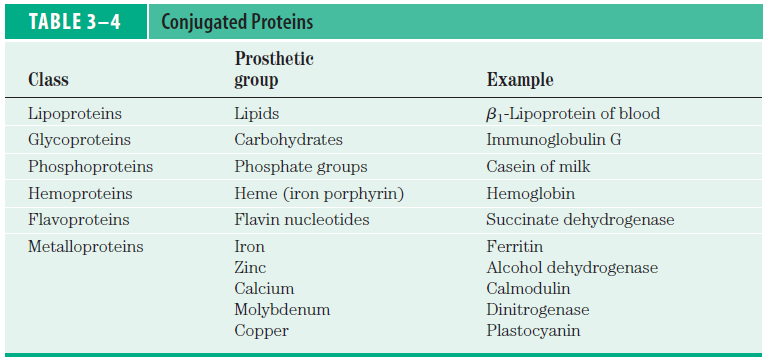


* Even the smallest peptides can have biologically important effects.
* for example, a number of hormones are small peptides (oxytocin -nine amino acid residues).
* Some proteins
* consist of a single polypeptide chain
* have two or more polypeptides (**multisubunit** proteins) **(Table 3-2)**.
* The amino acid composition of proteins is also highly variable **(Table 3-3)**.



**Some Proteins Contain Chemical Groups Other Than Amino Acids**

* These are called **conjugated proteins**.
  + chemical group is called its **prosthetic group**
* Conjugated proteins are classified on the basis of the chemical nature of their prosthetic groups **(Table 3-4)**. For example,
  + lipoproteins contain lipids,
  + glycoproteins contain sugar groups,
  + metalloproteins contain a specific metal.



* Some proteins contain more than one prosthetic group.
* Usually the prosthetic group plays an important role in the protein’s biological function.

**3.4 The Structure of Proteins: Primary Structure**

* There are several levels of protein structure (**Fig. 3-23)**.
* **primary structure** consists of a sequence of amino acids by peptide and disulfide bonds (covalent bonds).
* **secondary structure** refers coiled primary structure by H bonds.
* **tertiary structure** describes three-dimensional folding by noncovalent interactions.
* **quaternary structure** refers noncovalent interactions and disulfide bonds of two or more polypeptide subunits having tertiary structure.

