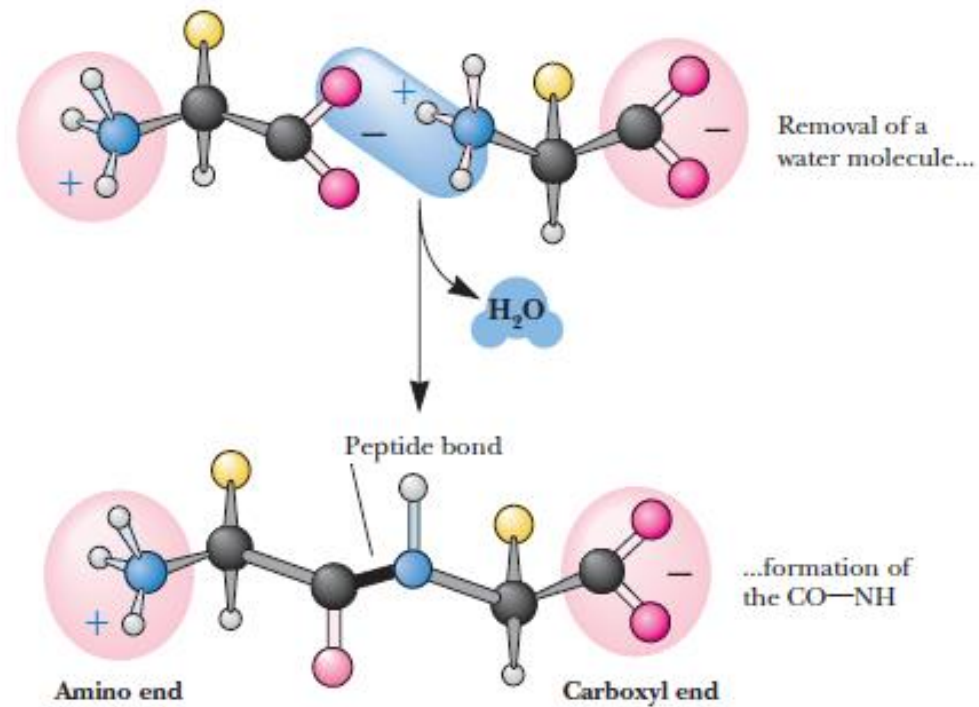
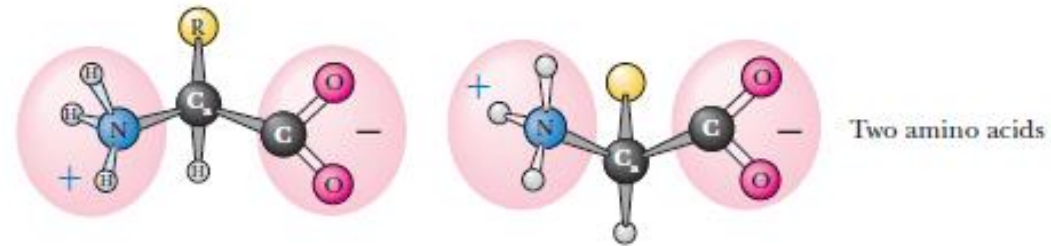
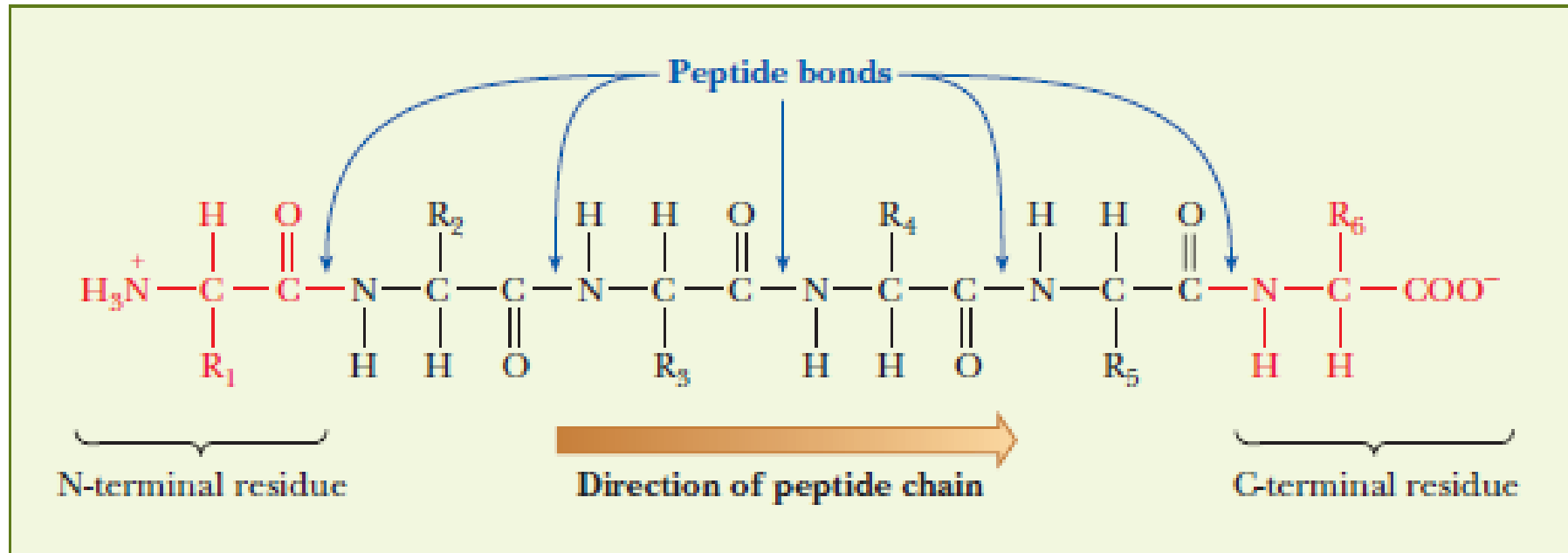


# Peptide bond formation and peptides

# The peptide bond



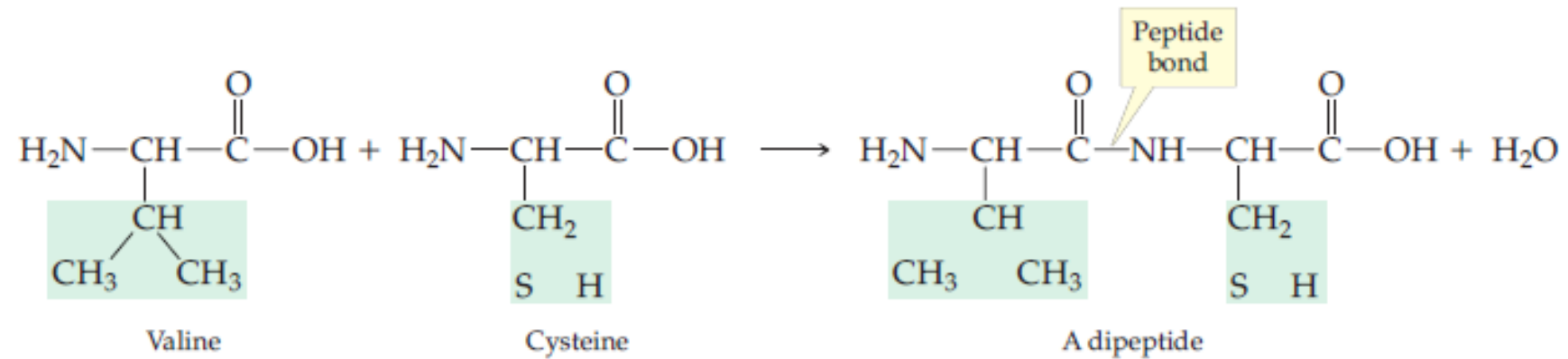
# Peptide and polypeptide chains



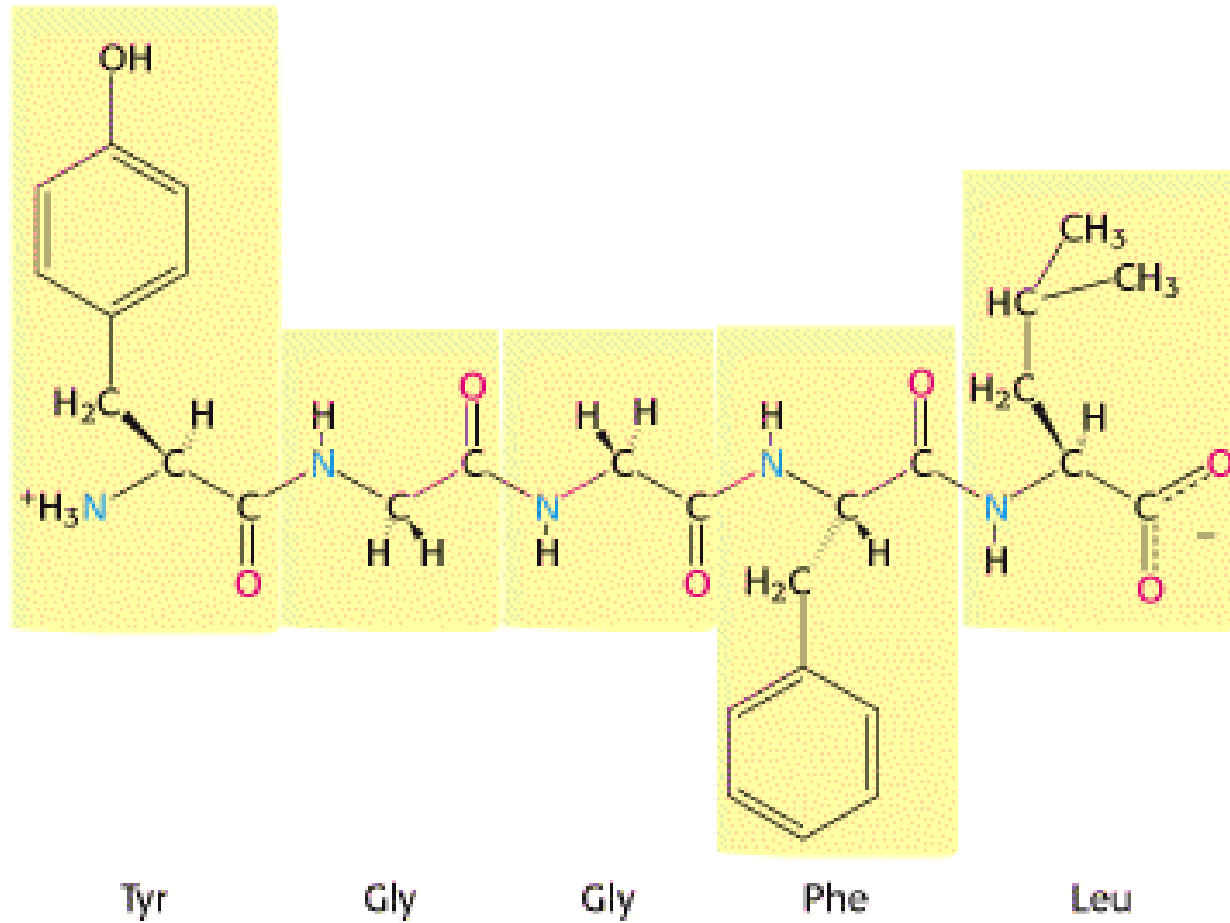
**Peptides:** two to several dozens AA.

**Polypeptide chain:** many amino acids (usually more than a hundred)

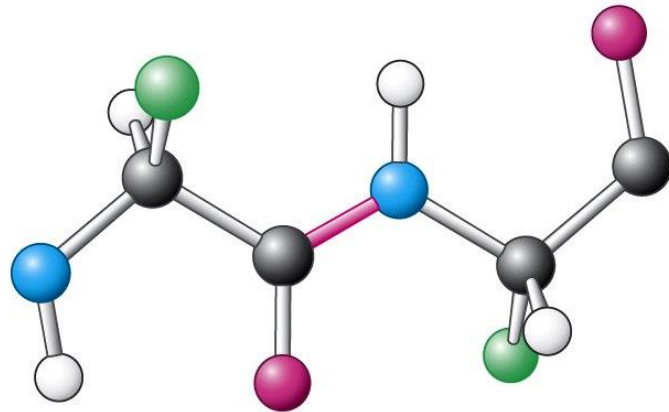
# Proteins are polymers of amino acids



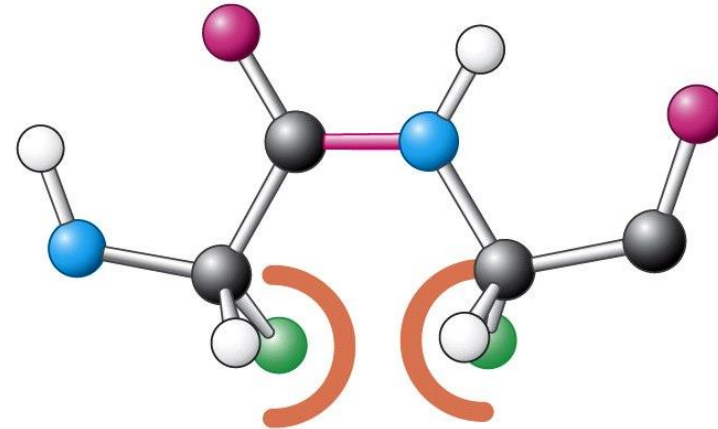
# Cis vs. trans configurations



# Why is it all trans?



**Trans**

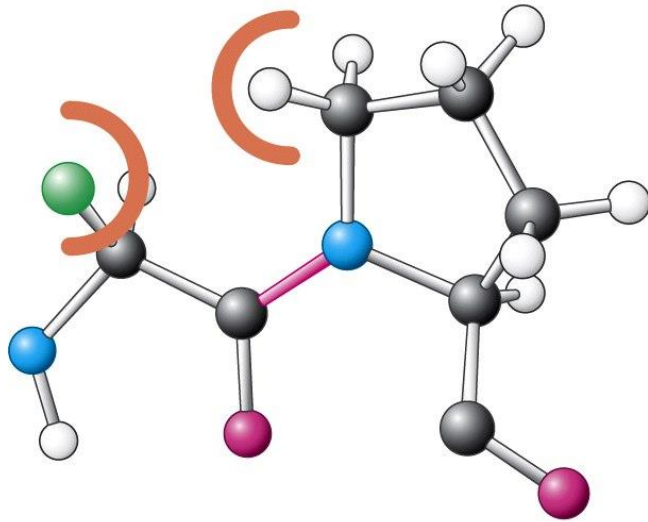


**Cis**

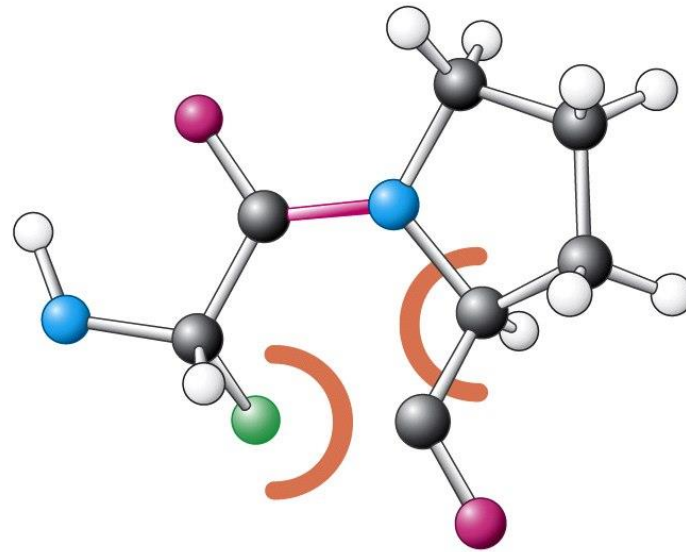
Figure 2-25  
*Biochemistry, Sixth Edition*  
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# Except for proline

- In proline, both *cis* and *trans* conformations have about equivalent energies
- Proline is thus found in the *cis* configuration more frequently than other amino acid residues

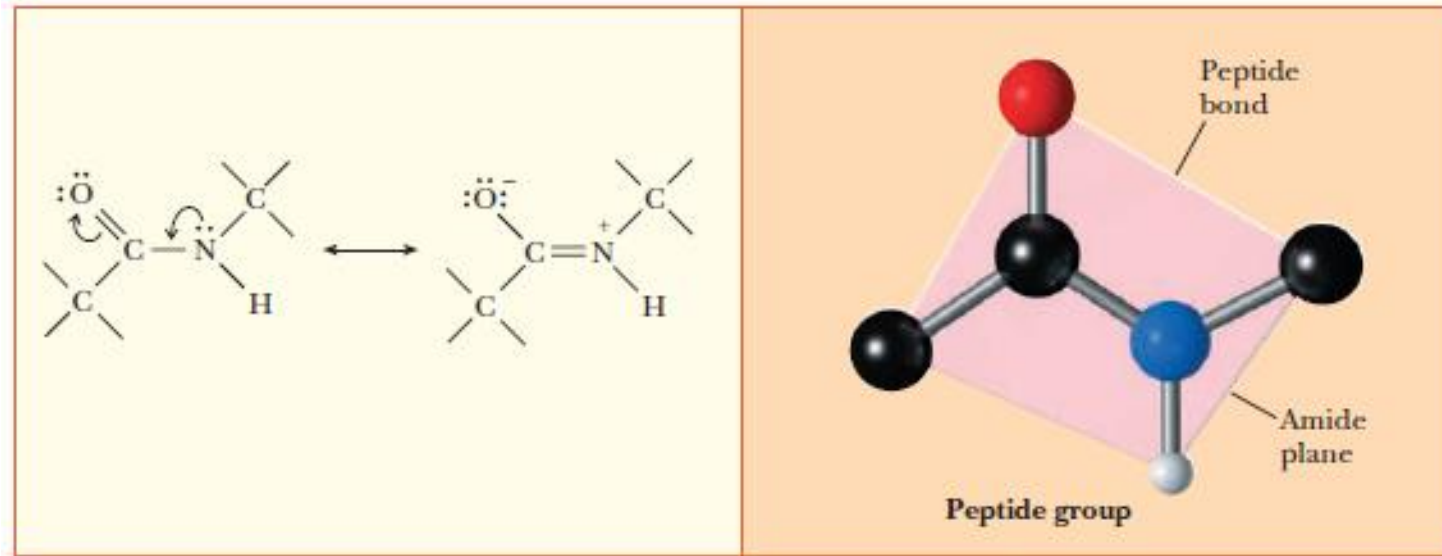


**Trans**



**Cis**

# Resonance structures



**A** Resonance structures of the peptide group.

**B** The planar peptide group.

The peptide bond group is planar because it has partial double bond character.

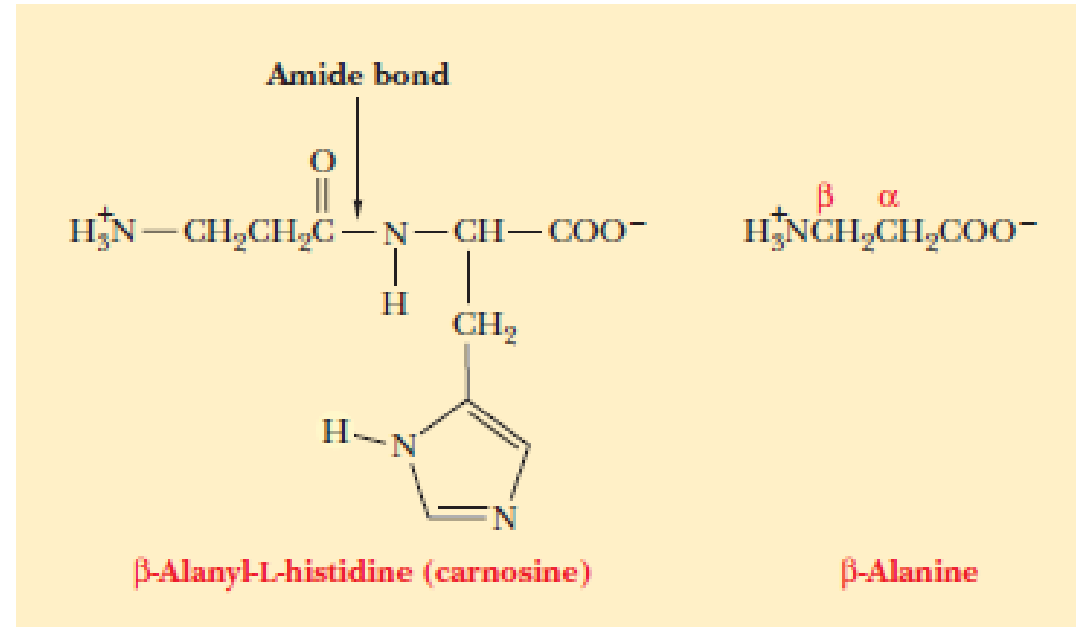
The peptide bond is stronger than an ordinary single bond because of the resonance stabilization.

No significant rotation around the peptide bond acts as a stereochemical constraint that affects protein folding.



# Small peptides with physiological functions

## Carnosine

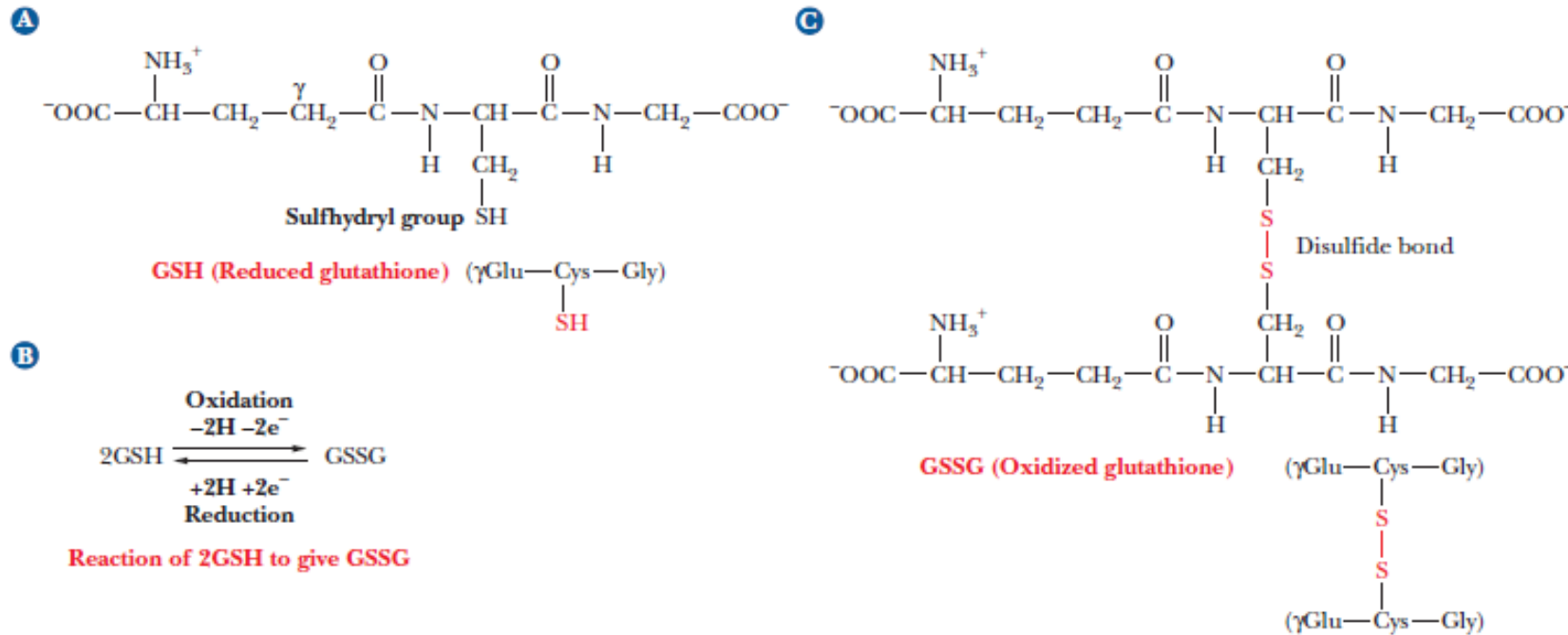


■ **FIGURE 3.11** Structures of carnosine and its component amino acid β-alanine.

- A naturally occurring dipeptide
- It is highly concentrated in muscle and brain tissues
  - Protection of cells from ROS (radical oxygen species) and peroxides
  - Muscle contraction

# Small peptides with physiological functions

## Glutathione: $\gamma$ -glutamyl-L-cysteinylglycine



■ **FIGURE 3.12** The oxidation and reduction of glutathione. (a) The structure of reduced glutathione. (b) A schematic representation of the oxidation–reduction reaction. (c) The structure of oxidized glutathione.

- A tripeptide that acts as a scavenger for oxidizing agents by reacting with them.
- Some oxidizing agents are harmful and play a role in the development of cancer
- Oxidized form is generated by the interaction of two reduced molecules by forming a disulfide bond between the —SH groups of the two cysteine residues

# Small peptides with physiological functions

## Enkephalins

Tyr—Gly—Gly—Phe—Leu (three-letter abbreviations)

Y—G—G—F—L (one-letter abbreviations)

Leucine enkephalin

Tyr—Gly—Gly—Phe—Met

Y—G—G—F—M

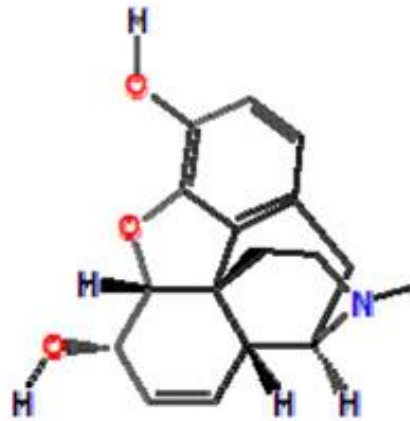
Methionine enkephalin

Two pentapeptides found in the brain

Naturally occurring analgesics (pain relievers).

The aromatic side chains of Tyr and Phe in these peptides play a role in their activities.

# Morphine and enkephalins



**Morphine**



**Enkephalins**

3D structures of opiates, such as morphine, and enkephalins are similar, hence, opiates bind to encephalin receptors in the brain to produce their physiological activities.

# Small peptides with physiological functions

## Oxytocin and vasopressin

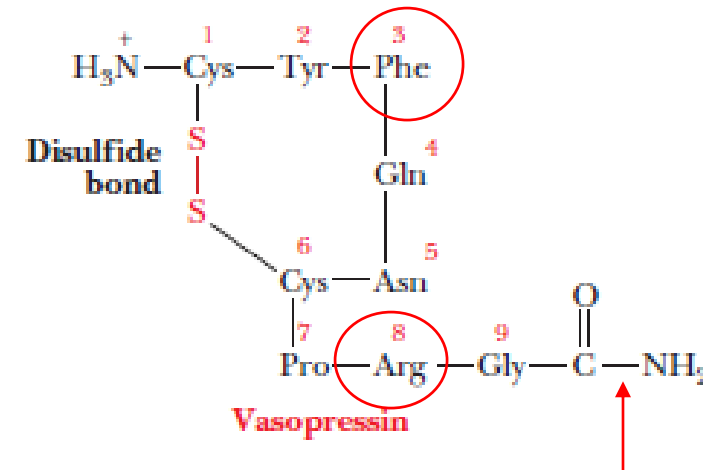
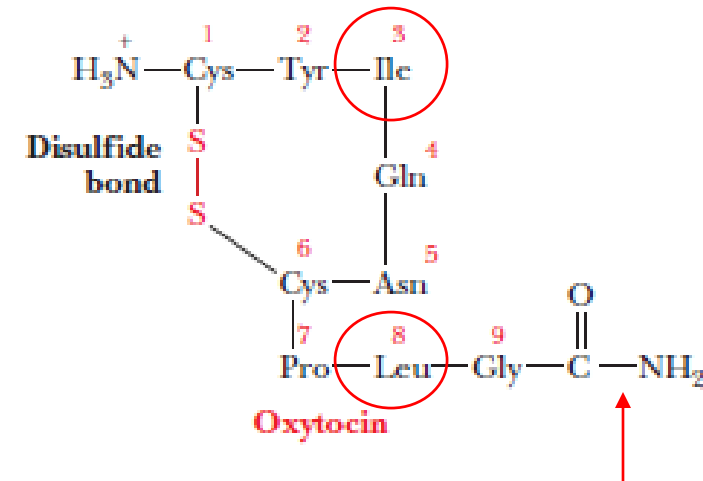
Cyclic structures due to an —S—S— bond

Each contains nine amino acid residues

Each has an amide group (rather than a free carboxyl group) at the C-terminal end

Each has a disulfide link between Cys residues at positions 1 and 6.

Both are hormones



■ **FIGURE 3.13** Structures of oxytocin and vasopressin.

# Peptide hormones: oxytocin and vasopressin

Oxytocin induces labor in pregnant women by controlling contraction of uterine muscle and stimulates the flow of milk in a nursing mother

During pregnancy, the number of receptors for oxytocin in the uterine wall increases.

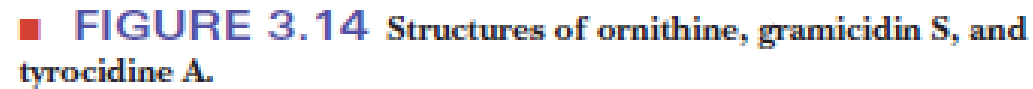
As the cervix stretches, sending nerve impulses to the hypothalamus as a positive feedback to release more oxytocin by the posterior pituitary gland.

Vasopressin controls of blood pressure by regulating smooth muscle contraction.

Vasopressin is released by the action of the hypothalamus on the posterior pituitary.

Vasopressin stimulates water reabsorption by the kidney (an antidiuretic effect) resulting in water retention and blood pressure increase.

## Gramicidin S and Tyrocidine A



Both contain the amino acid ornithine (Orn), a metabolic intermediate



# Biochemical applications: Aspartame

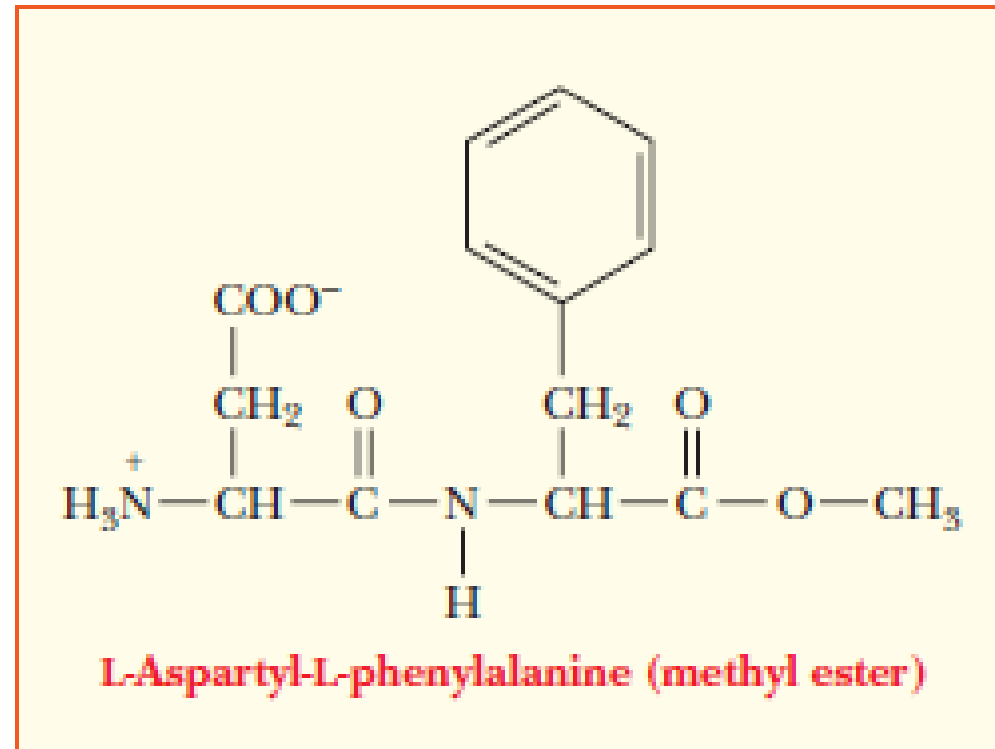
## L-Aspartyl-L-phenylalanine (methyl ester)

~200 times sweeter than sugar

Controversial safety

Diet soft drinks

If both Asp and Phe or one is D-isomer, it tastes bitter.



**A** Structure of aspartame.