아미노산과 펩타이드

단백질이란?

- 생체물질중에서 가장 중요하다는 의미인 **proteos (Greek, first)**에서 유래

- 아미노산으로 구성
  (peptide bond= amide bond) 로 결합

- 자연계에는 **20**여종의 아미노산 존재
- 아미노산의 결합순서**(sequence)**에 따라 다양한 단백질이 합성된다

Protein and Amino acids

- Amino Acids are the chemical units or "building blocks" of the body that make up proteins.
- Protein substances make up the muscles, tendons, organs, glands, nails, and hair.
- Growth, repair and maintenance of all cells are dependent upon them.
- Next to water, protein makes up the greatest portion of our body weight.

아미노산의 구조

- 아미노기 (amino group): NH2
- 카르복시기 (carboxyl group) : COOH
- 곁사슬 (side chain): R
- 알파탄소 (α-탄소)

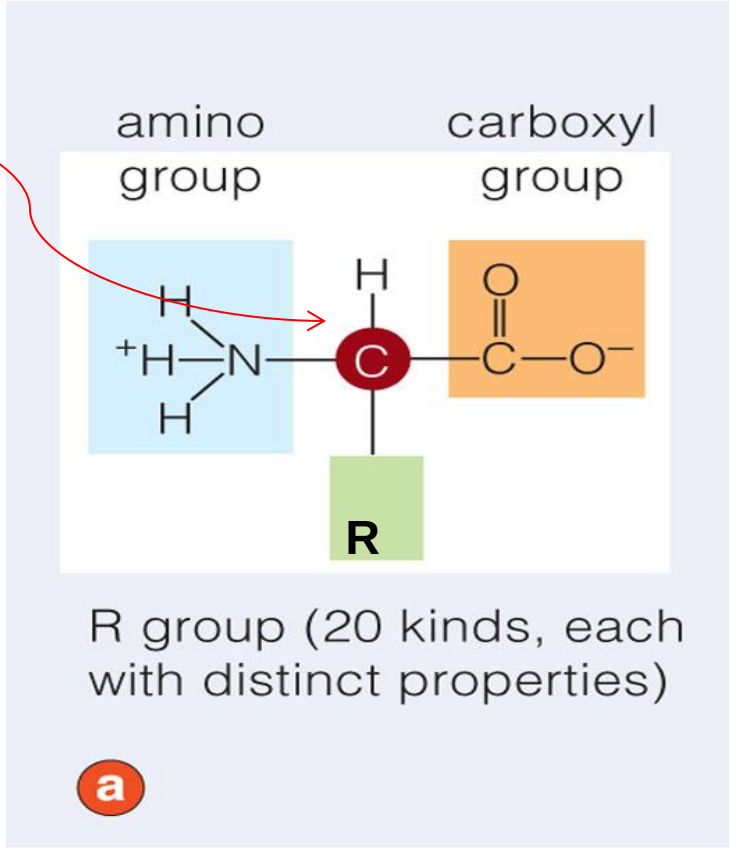
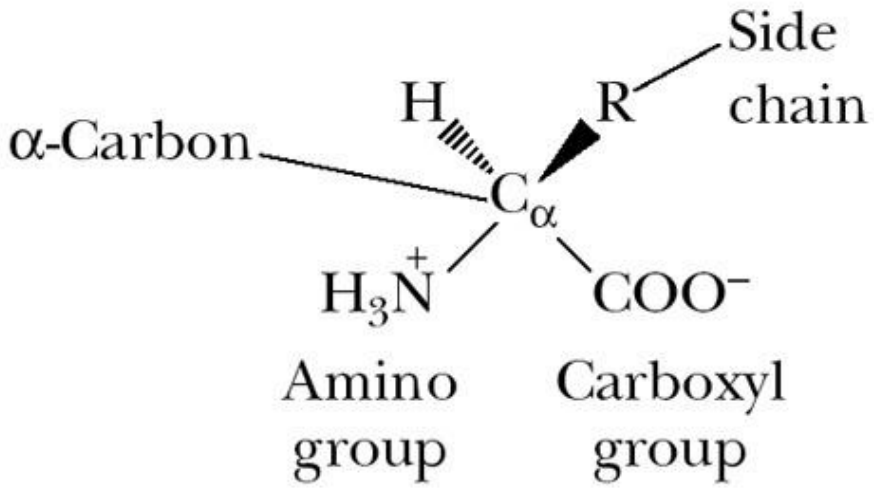
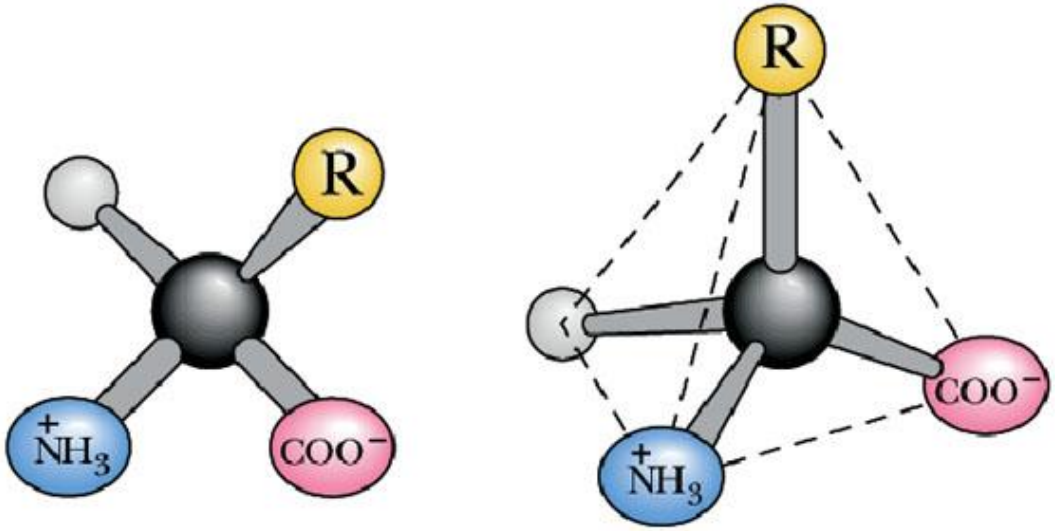


Fig. 3-1b, p.59

(a)





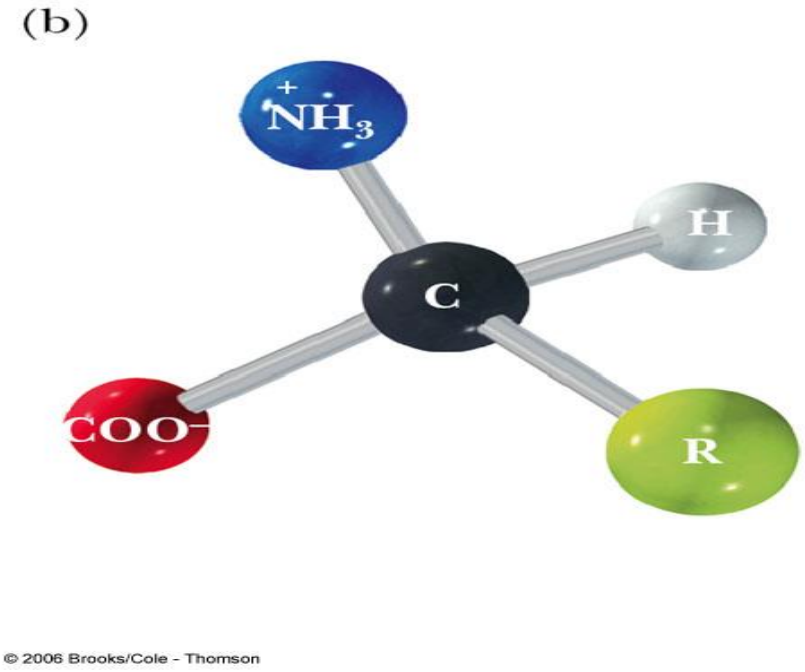
Ball-and-stick model

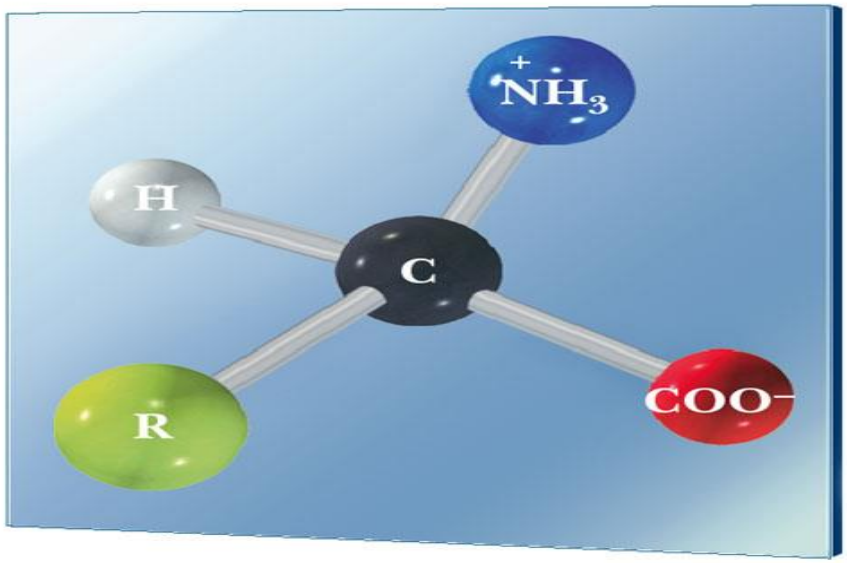
Amino acids are tetrahedral structures

Fig. 3-1a, p.59

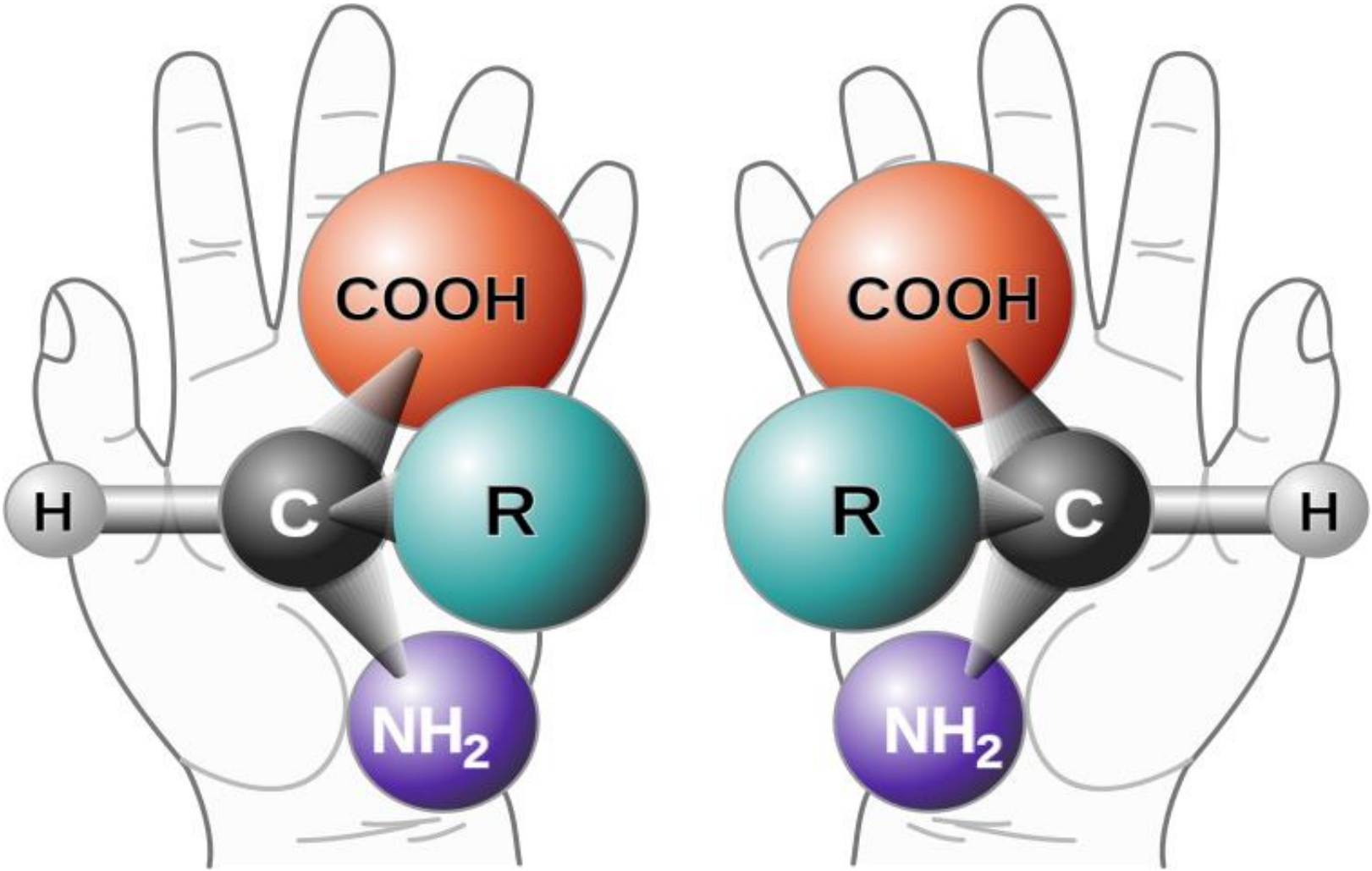
아미노산의 성질 1

- Chiral 분자이다:
- 거울이미지가 겹쳐질 수 없는 화합물





chirality



chirality

- 부제탄소가 있는 화합물에서 생긴다.

- 아미노산은 Glycine을 제외한 모든 아미노산이 chirality를 지닌다.

- 입체이성체가 생긴다. (D, L-이성체)
- D,L개념은 화합물이 편광을 오른쪽 혹은 왼쪽으로 회전시키는 능력에서 유래

- 자연계에는 L-아미노산이 주로 존재한다.

D-아미노산과 L-아미노산

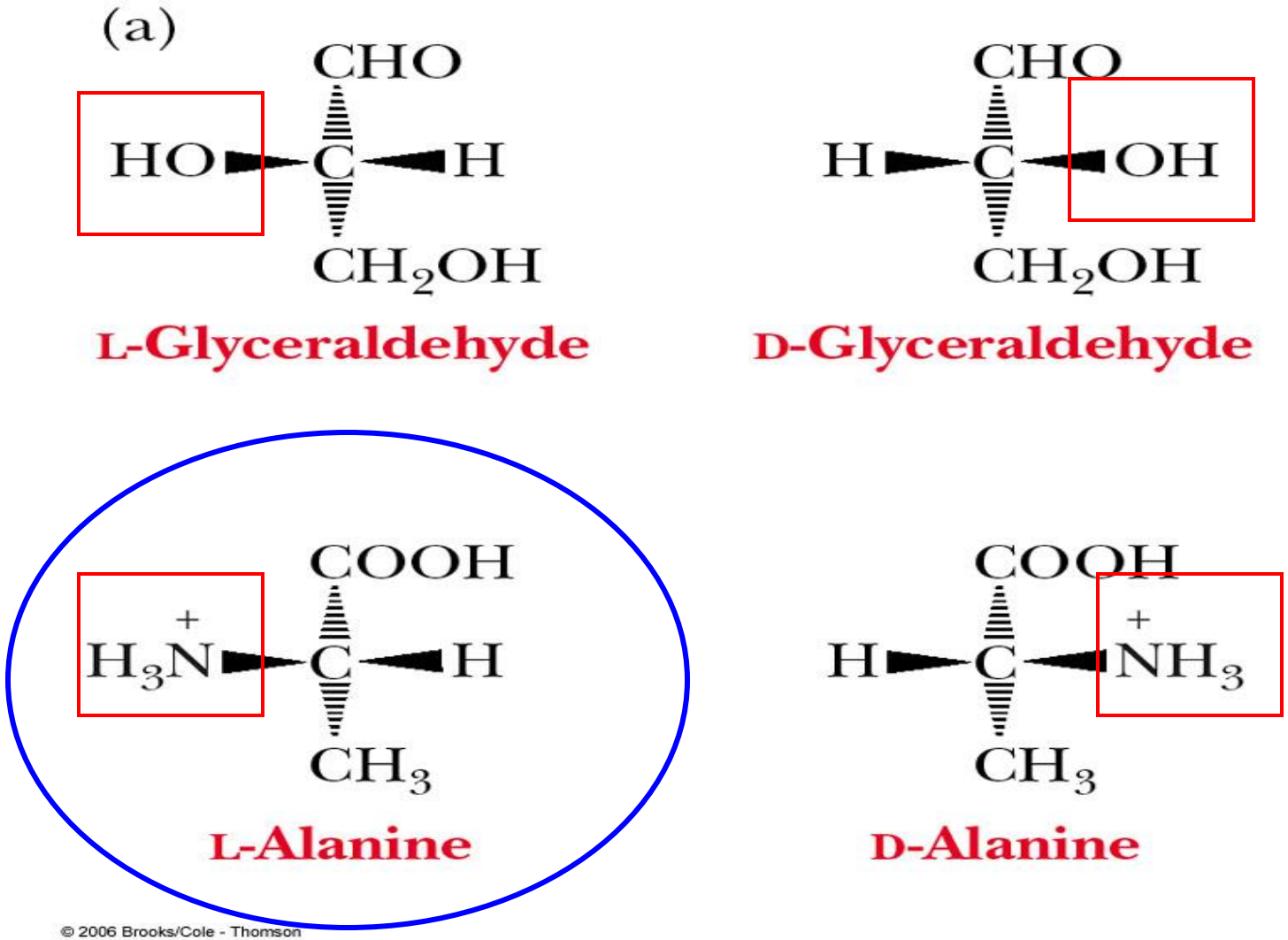


Fig. 3-2a, p.59

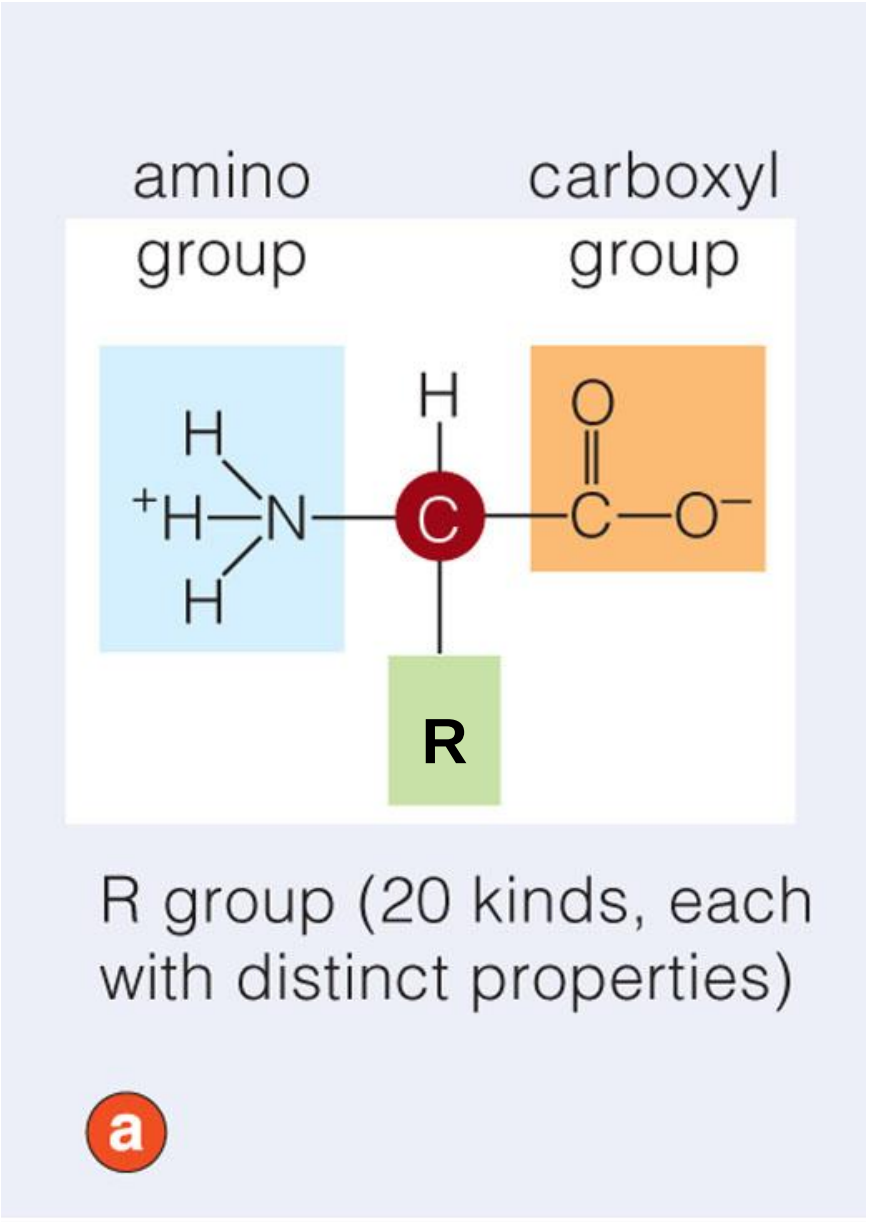
R기의 구조에 따라 다양한 아미노산이 존재한다

1. R기가 극성인가 ? 비극성인가?

2. R기의 산, 염기 작용기 존재 여부

Major Types of AA

- Nonpolar
- Polar
- Acidic
- Basic



아미노산의 분류

가. **Non polar amino acids---Leu, *Pro,* Ala, Val, Ile, Met, Trp, Phe, Gly**

나. **Polar, uncharged A.A.---Ser. Thr. Asn, Gln, Cys, Tyr,**

다. **Acidic A.A.---Asp, Glu**

라. **Basic A.A.---Lys, Arg, His**

마. **Aromatic A.A.---Phe, Tyr, Trp (cyclic compound)**

바. 함황 아미노산--- **Cys, Met**

polar amino acids

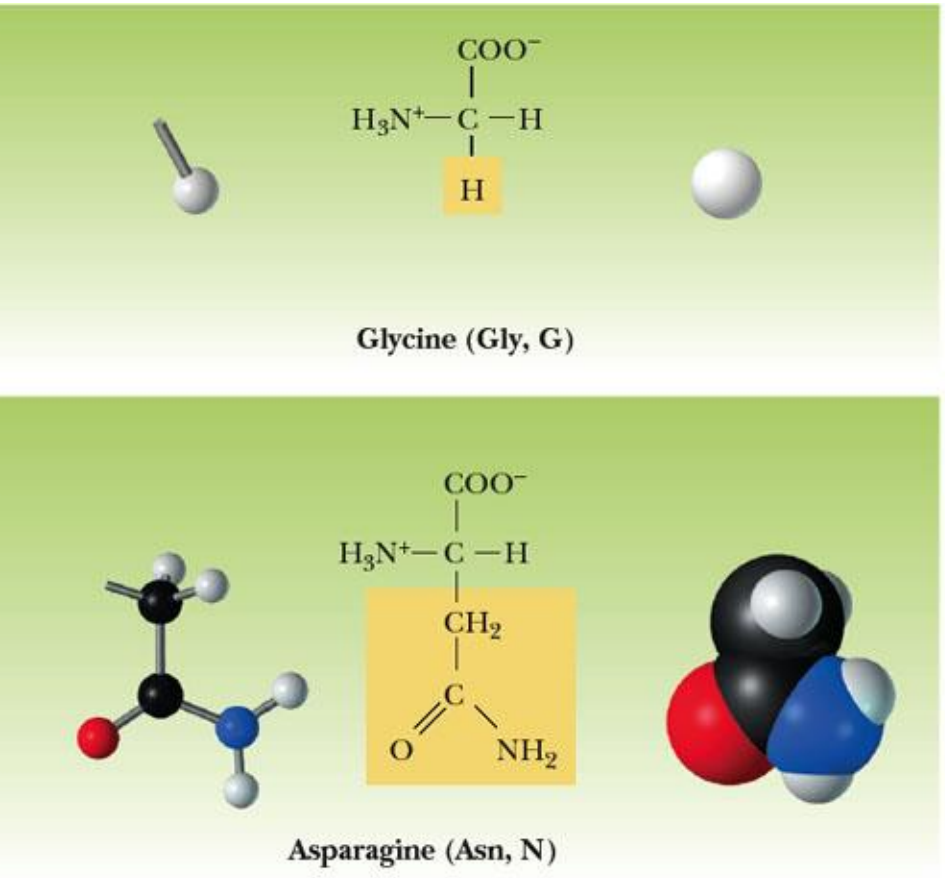
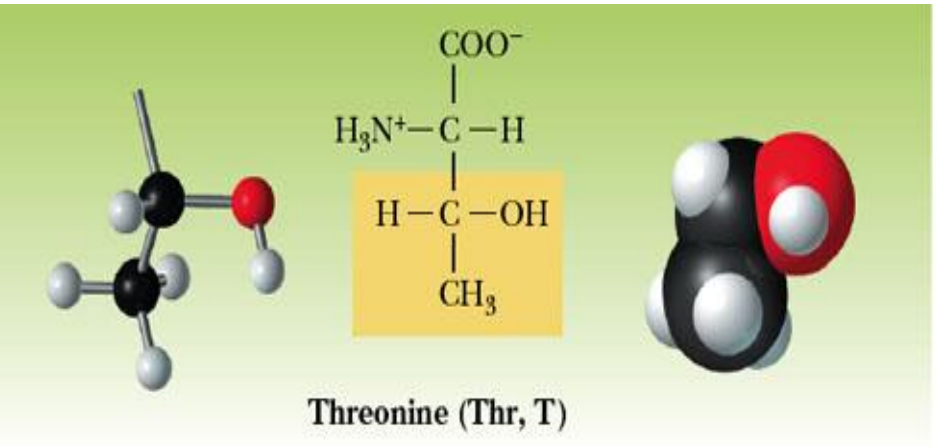
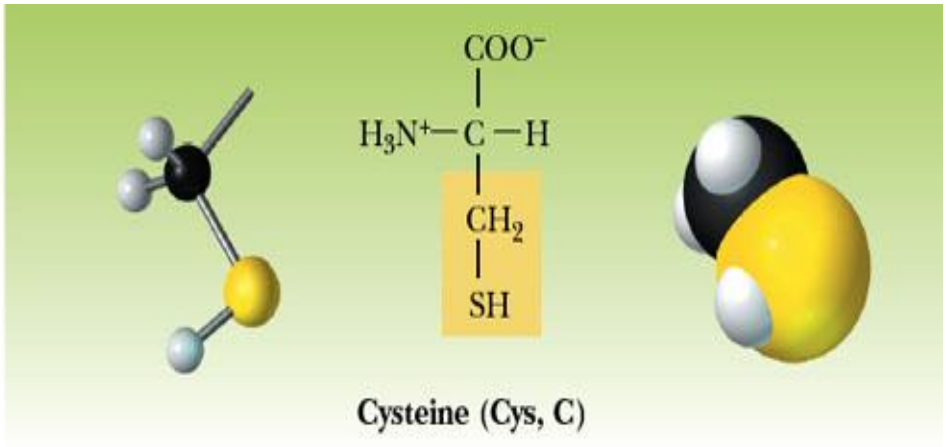


Fig. 3-3a2, p.60

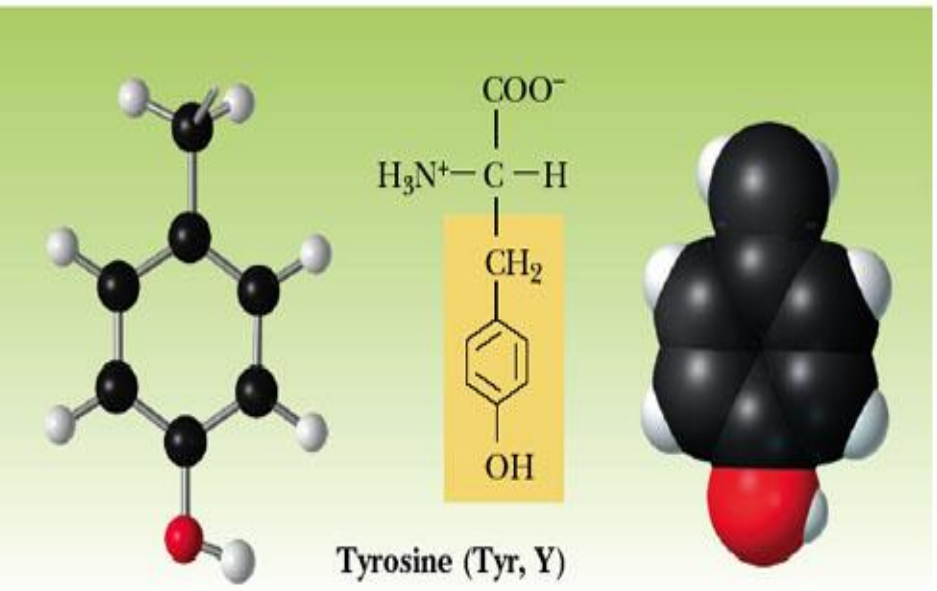
polar amino acids



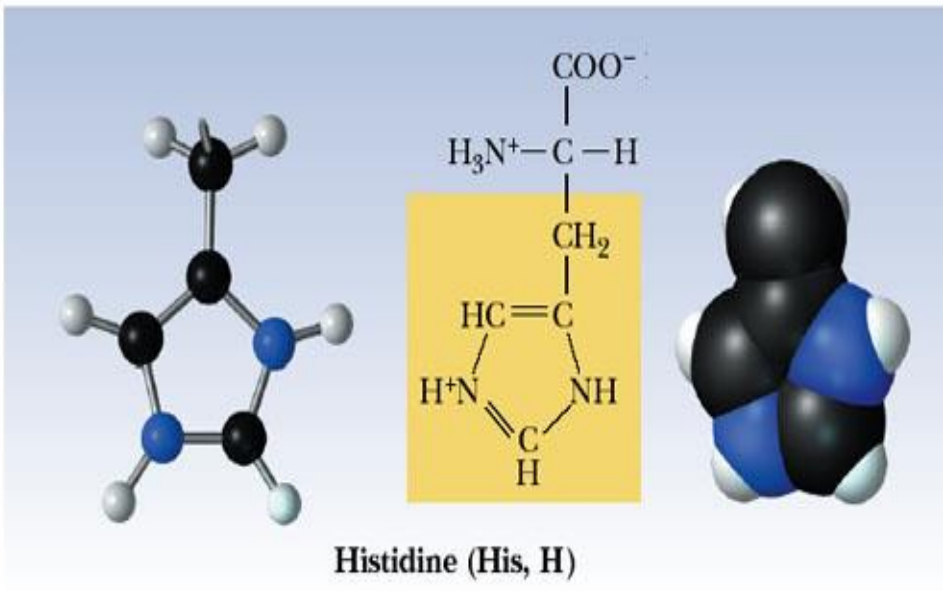
Threonine (Thr, T)



Cysteine (Cys, C)



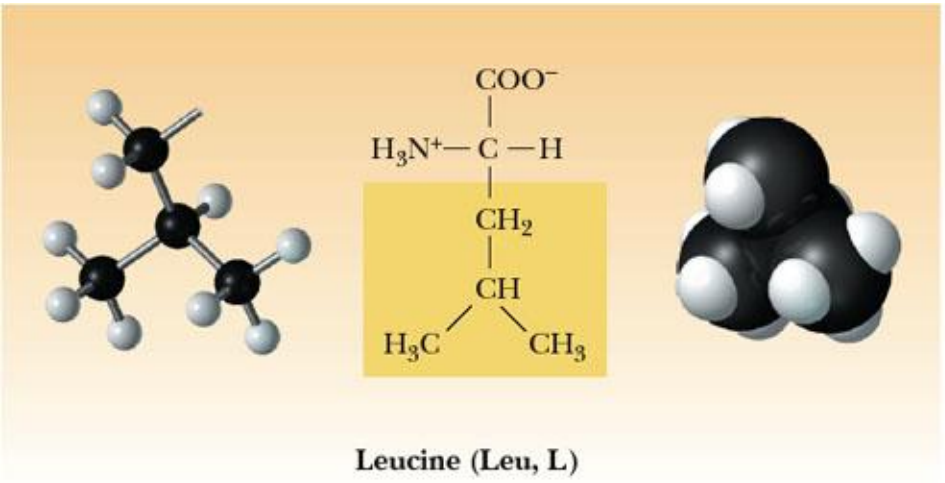
Tyrosine (Tyr, Y)



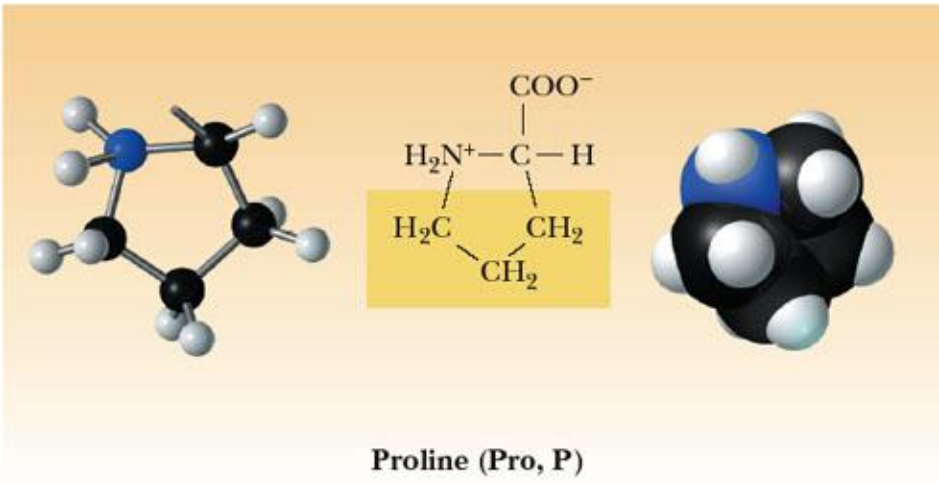
Histidine (His, H)

Fig. 3-3b2, p.60

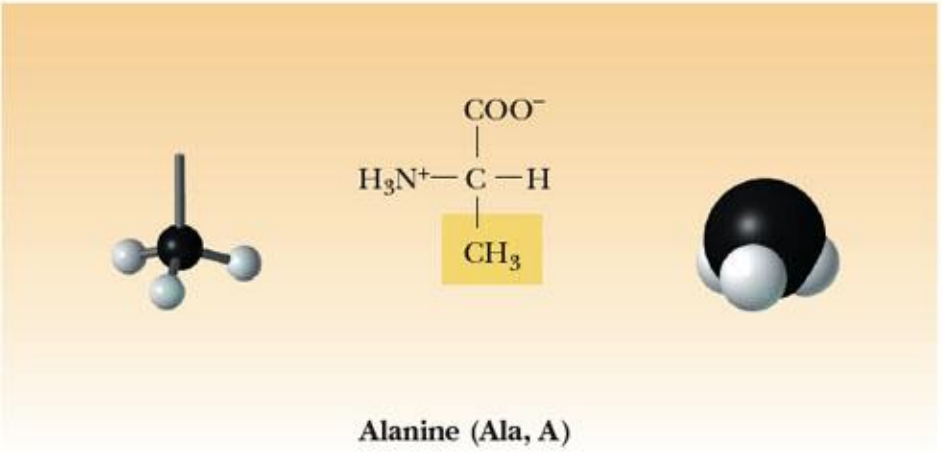
Non polar amino acids



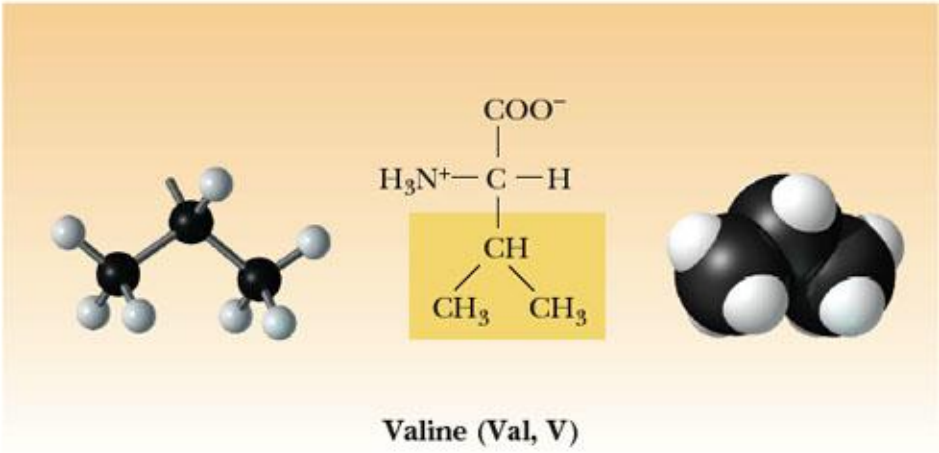
Leucine (Leu, L)



Proline (Pro, P)



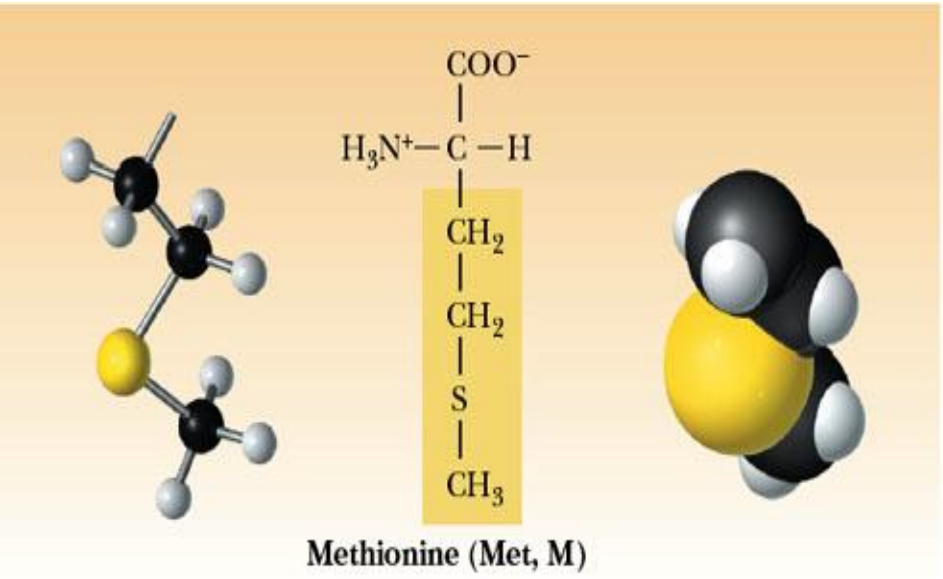
Alanine (Ala, A)



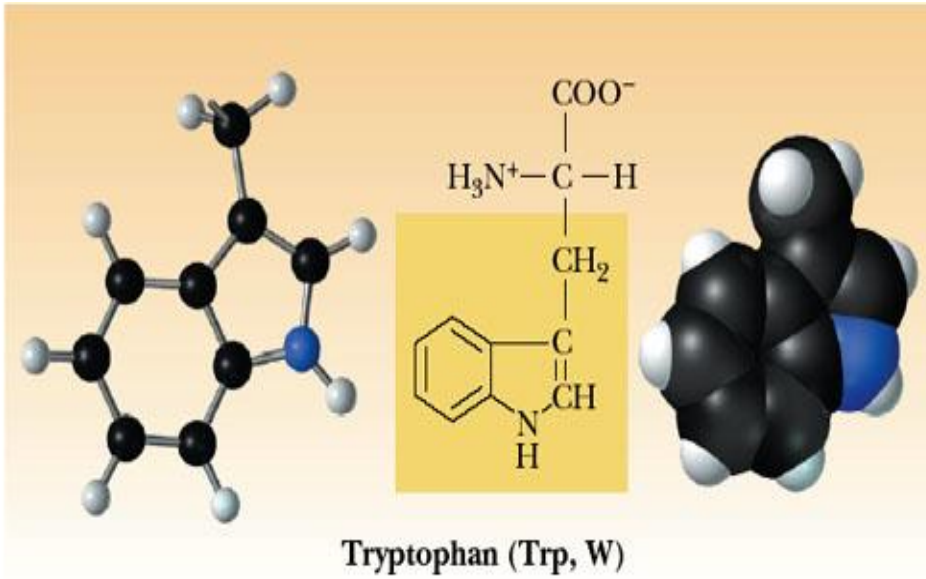
Valine (Val, V)

Fig. 3-3a1, p.60

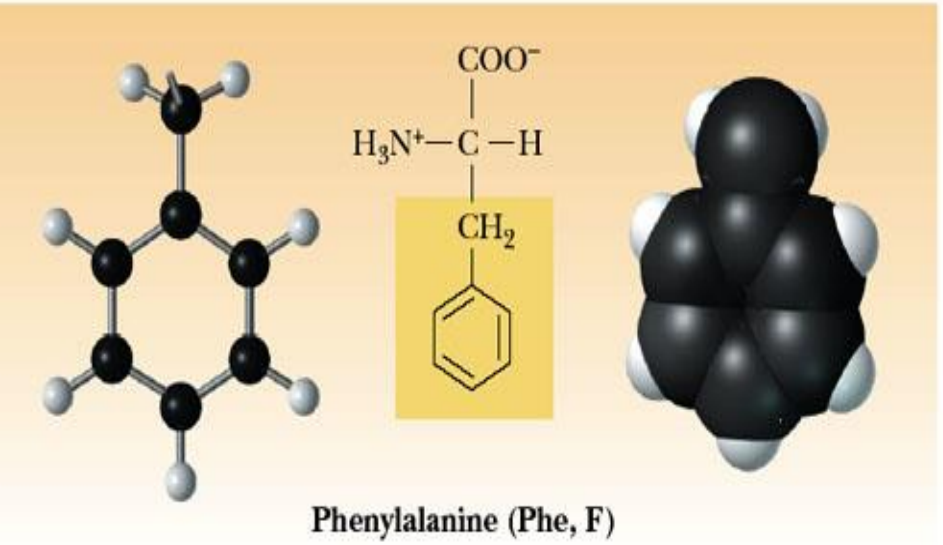
aromatic amino acids (방향족 아미노산)



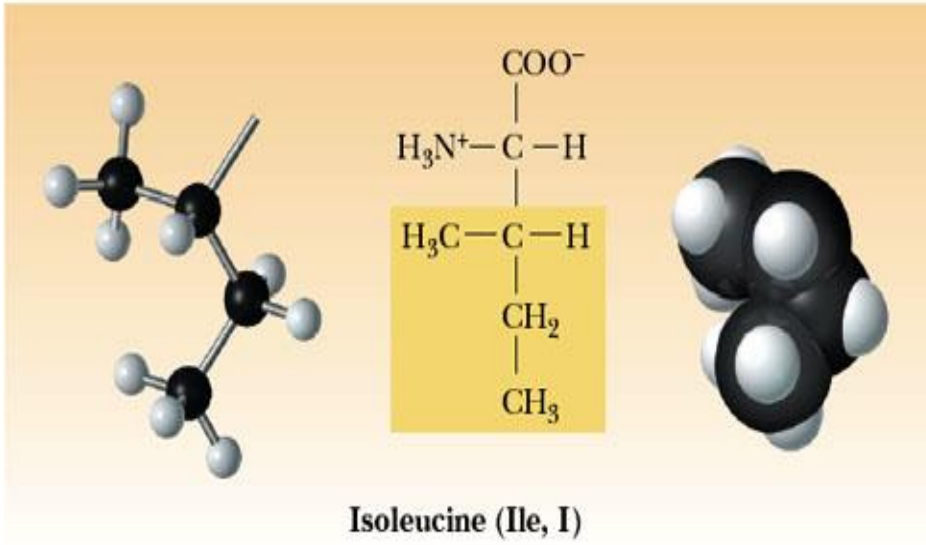
Methionine (Met, M)



Tryptophan (Trp, W)



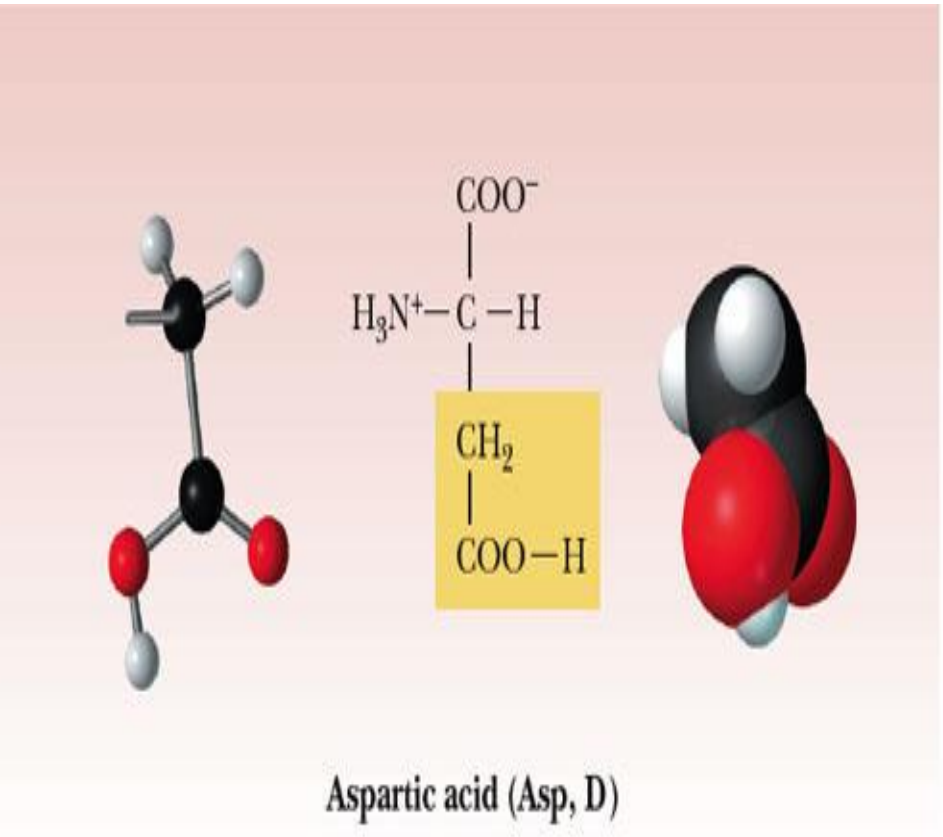
Phenylalanine (Phe, F)



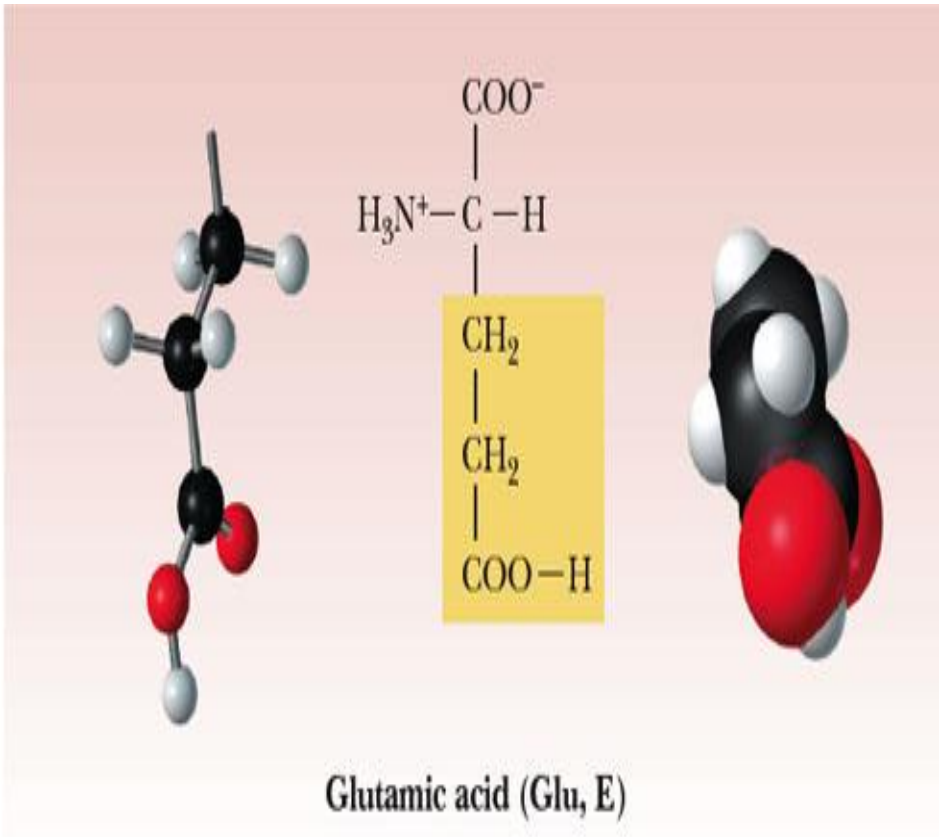
Isoleucine (Ile, I)

Fig. 3-3b1, p.60

Acidic A.A (산성 아미노산)



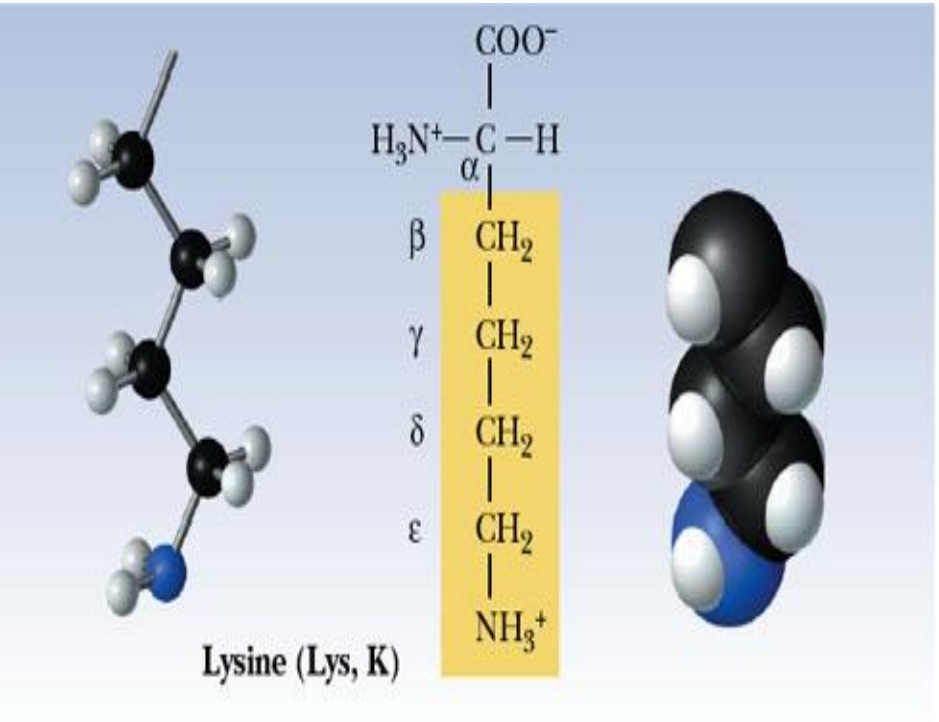
Aspartic acid (Asp, D)



Glutamic acid (Glu, E)

Fig. 3-3a3, p.60

Basic A.A (염기성 아미노산)



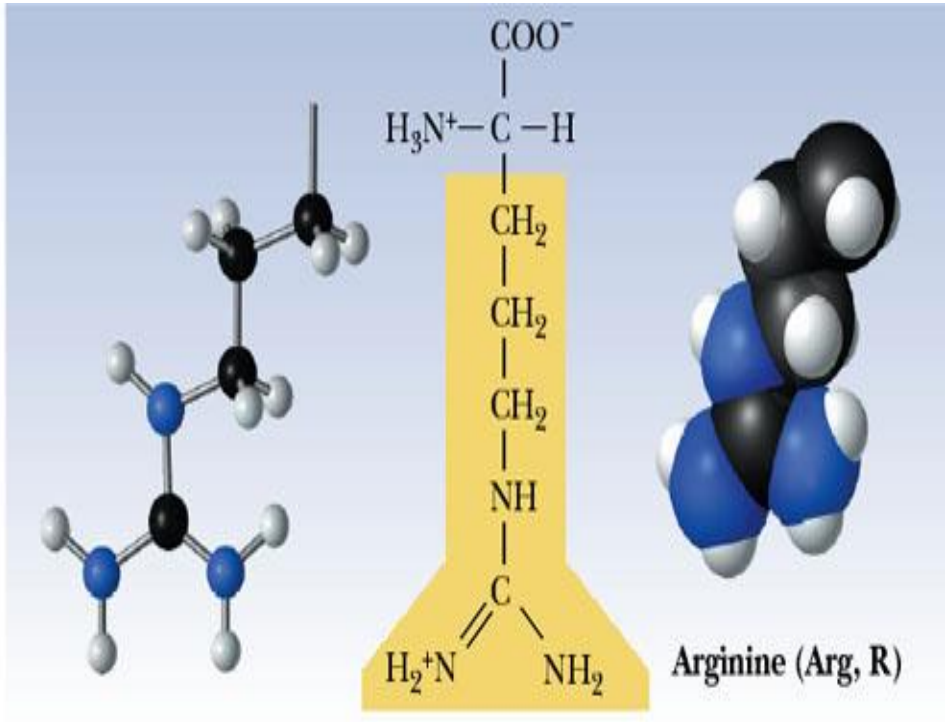


Fig. 3-3b3, p.60

아미노산 이름과 기호

Table 3.1

Names and Abbreviations of the Common Amino Acids

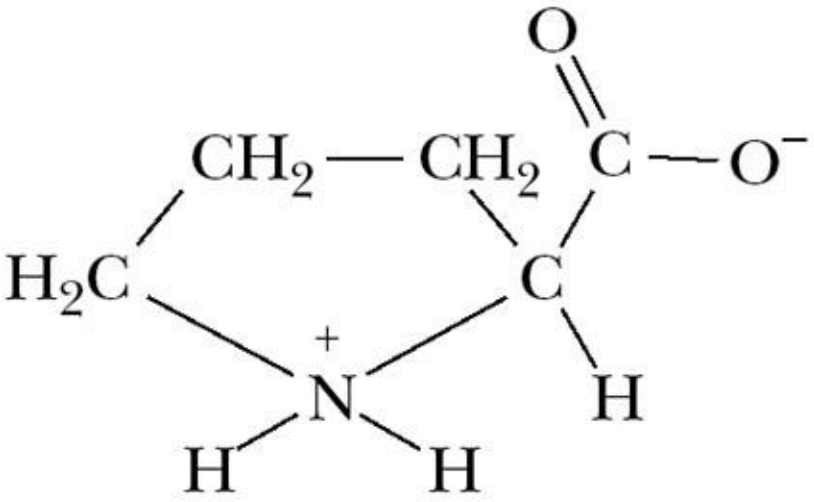
Amino Acid	Three-Letter Abbreviation	One-Letter Abbreviation
Alanine	Ala	A
Arginine	Arg	R
Asparagine	Asn	N
Aspartic acid	Asp	D
Cysteine	Cys	C
Glutamic acid	Glu	E
Glutamine	Gln	Q
Glycine	Gly	G
Histidine	His	H
Isoleucine	Ile	I
Leucine	Leu	L
Lysine	Lys	K
Methionine	Met	M
Phenylalanine	Phe	F
Proline	Pro	P
Serine	Ser	S
Threonine	Thr	T
Tryptophan	Trp	W
Tyrosine	Tyr	Y
Valine	Val	V

Table 3-1, p.62

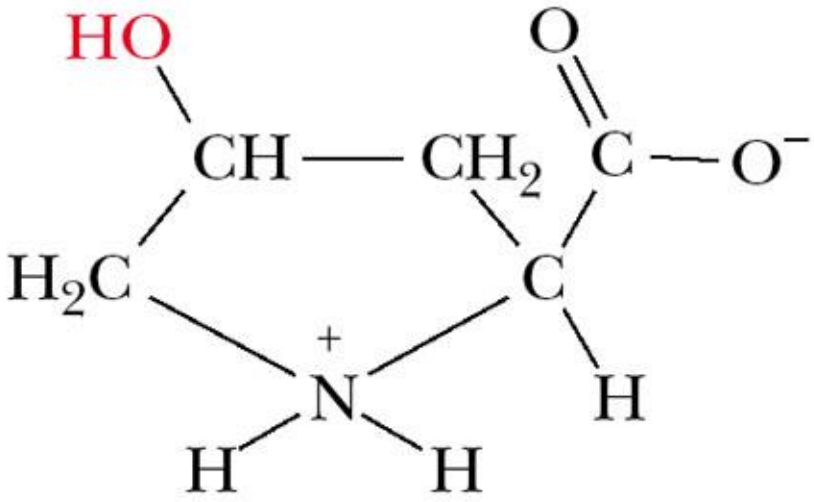
아미노산의 유도체

- Hydroxyproline) 콜라겐 구성 아미노산
- Hydroxylysine
- Thyroxine 갑상선호르몬
- Serotonin 신경전달물질
- Epinephrine (Adrenalin) 호르몬
- nor-epinephrine
- Dopamine

Hydroxyproline



Proline



Hydroxyproline

Fig. 3-4a, p.65

Hydroxylysine과 thyroxine

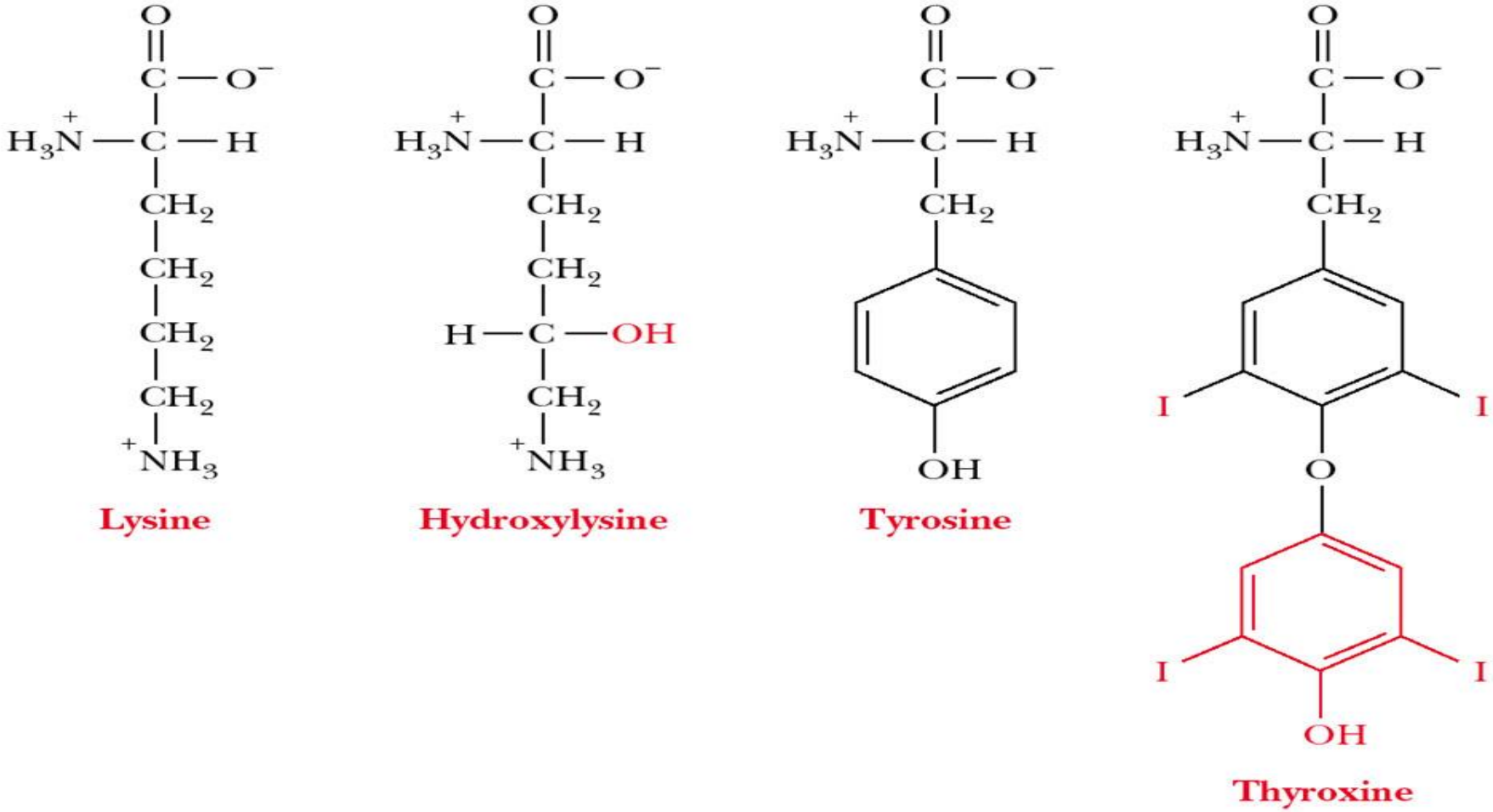
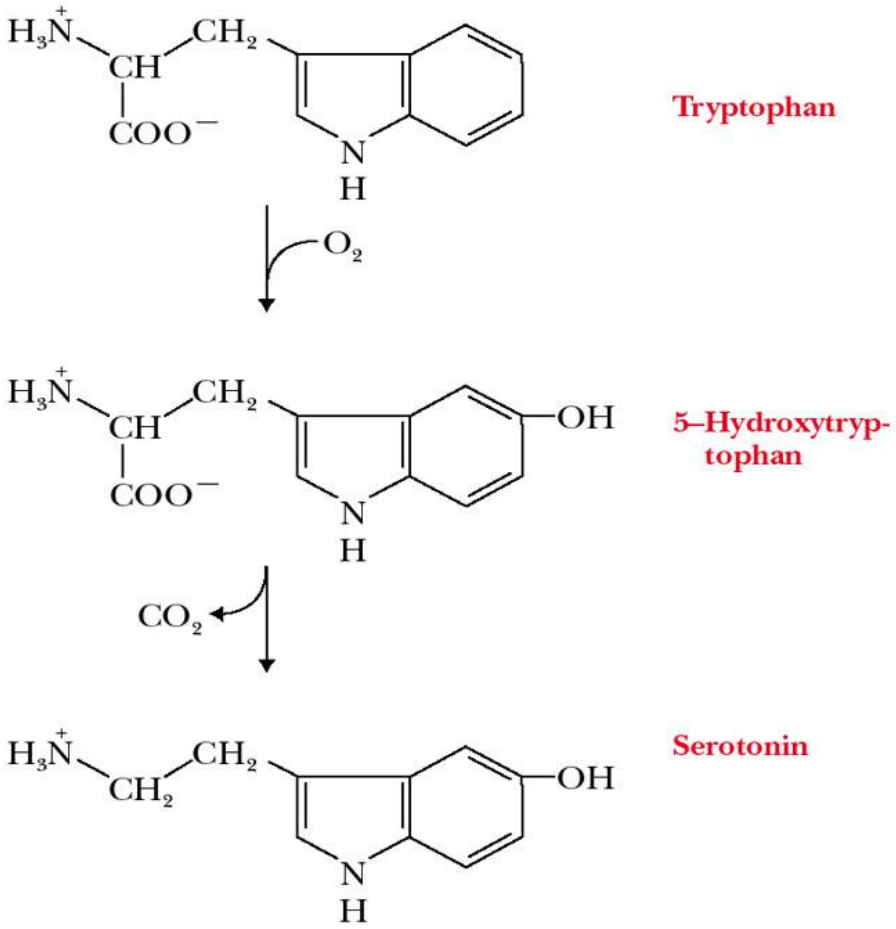
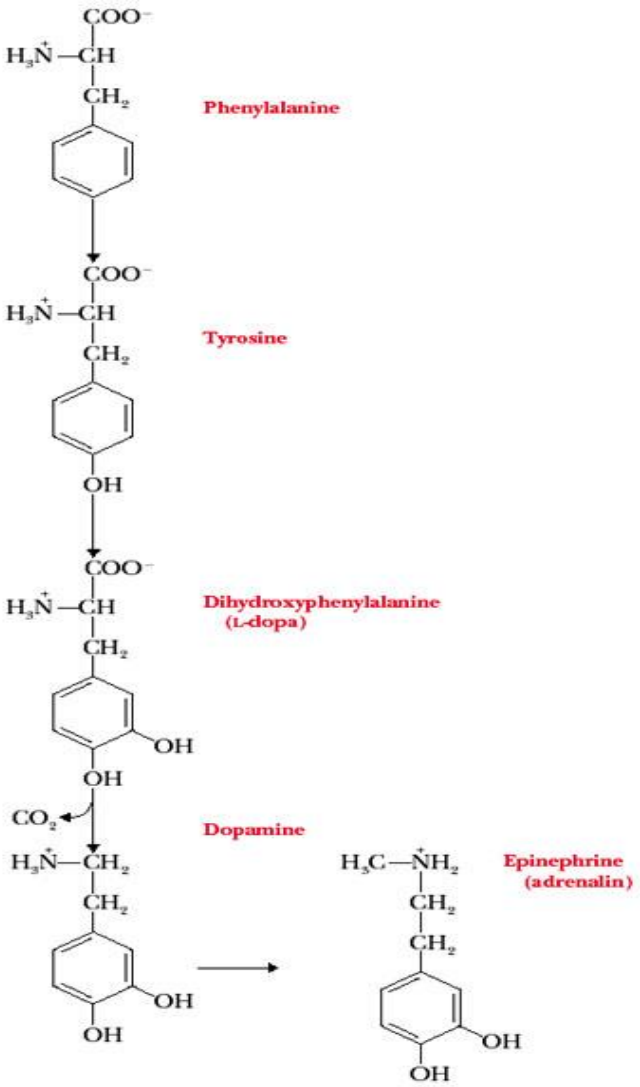


Fig. 3-4b, p.65

Serotonin



에피네프린 (아드레날린)



분자사슬 아미노산 (78쪽)

아미노산의 성질 2

- 약한 산이다
- Acid-base (산-염기)성질을 지닌다
- 완충능을 지닌다

아미노산은 약산 (weak acid)이다.

- 용액에서 수소이온이나 전자를 발생하는 화합물

- $COOH \rightarrow COO^- + H+$
  (산) (염기)
- $NH^{3+} \rightarrow \mathbf{NH_2} + H+$
  (산) (염기)

용액의 **pH**에 따라 산 혹은 염기의 형태로 존재한다

생체 내에서 아미노산의 존재 형태

- 존재하는 용액의 pH에 따라 형태가 변화한다.
- pH에서 아미노산의 존재형태는 Henderson-Hasselbach방정식으로 결정한다.
- 산과 염기의 비율을 결정한다.

(예) pH 7에서 alanine의 존재형태는?

아미노산의 존재 형태를 알기 위해서는

- 각 아미노산의 pKa값을 알아야 한다.

- Henderson-Hasselbach 방정식에 pH와 pKa값을 넣고 산과 염기의 존재비율을 결정하면 된다.

아미노산의 **pKa** 값

Table 3.2

pK_a Values of Common Amino Acids

Acid	α-COOH	α-NH_3^+	RH or RH^+
Gly	2.34	9.60	
Ala	2.34	9.69	
Val	2.32	9.62	
Leu	2.36	9.68	
Ile	2.36	9.68	
Ser	2.21	9.15	
Thr	2.63	10.43	
Met	2.28	9.21	
Phe	1.83	9.13	
Trp	2.38	9.39	
Asn	2.02	8.80	
Gln	2.17	9.13	
Pro	1.99	10.6	
Asp	2.09	9.82	3.86*
Glu	2.19	9.67	4.25*
His	1.82	9.17	6.0*
Cys	1.71	10.78	8.33*
Tyr	2.20	9.11	10.07
Lys	2.18	8.95	10.53
Arg	2.17	9.04	12.48

Table 3-2, p.67

pH 7인 우리 몸에서 Alanine의 존재형태 결정하기

- COOH의 pKa 2.34

- pH = pKa + log [공역염기]/[공역산]에 대입

  7 = 2.34 + log [COO-]/[COOH]

  4.64 = log [COO-]/[COOH]

  [COO-]/[COOH] = $10^{4.64}$ = 43,600

  pH 7의 용액에서는 COO- 이 우세

pH 7인 우리 몸에서 Alanine의 존재형태 결정하기

- NH_3의 pKa 9.69

- pH = pKa + log [공역염기]/[공역산]에 대입

  $7 = 9.69 + \log [NH_2]/[NH_3^+]$

  $-2.69 = \log [NH_2]/[NH_3^+]$

  $[NH_2]/[NH_3^+] = 10^{-2.69} = 1 / 490$

  pH 7의 용액에서는 NH_3^+ 이 우세

아미노산 (Alanine)의 형태와 전하

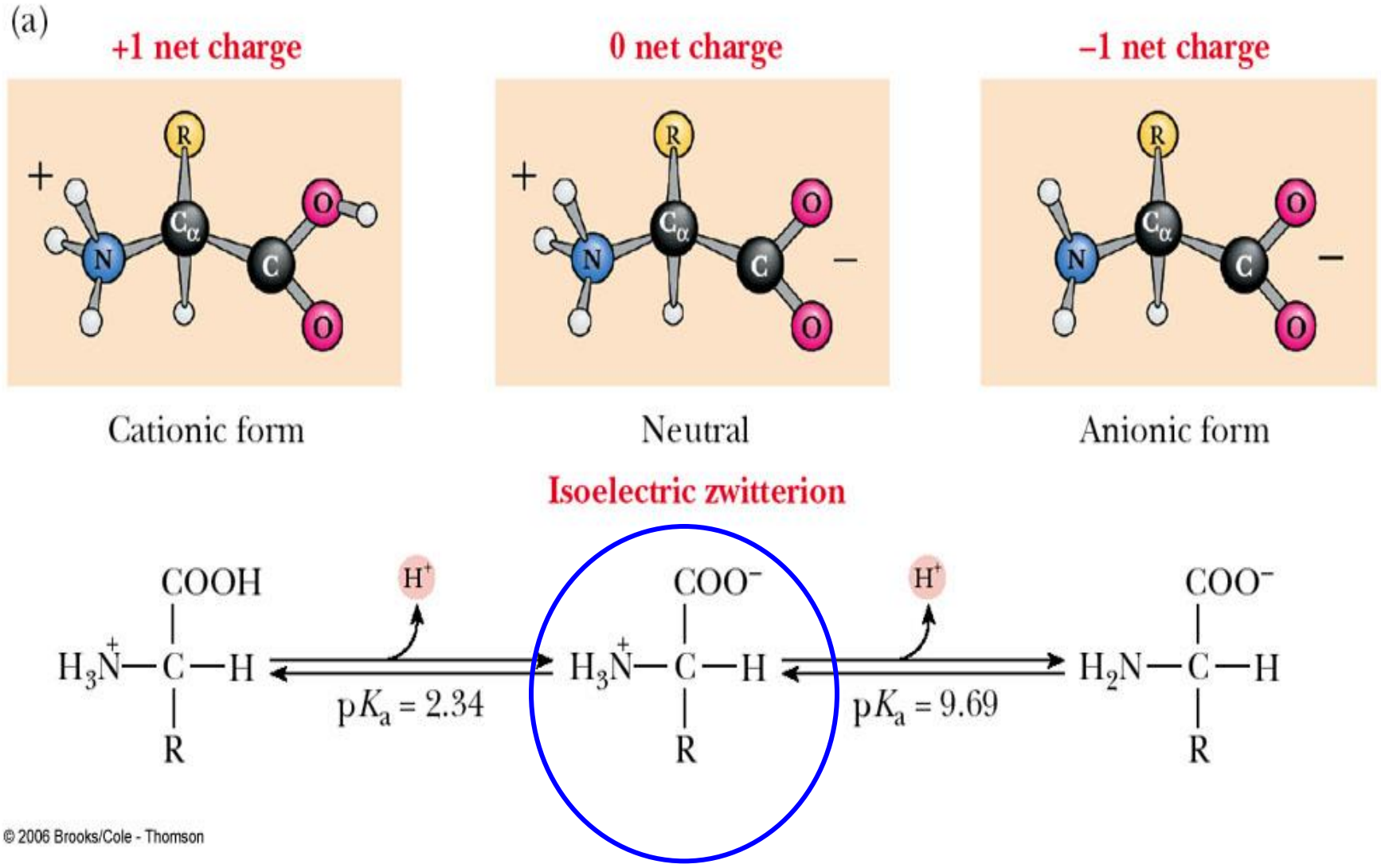


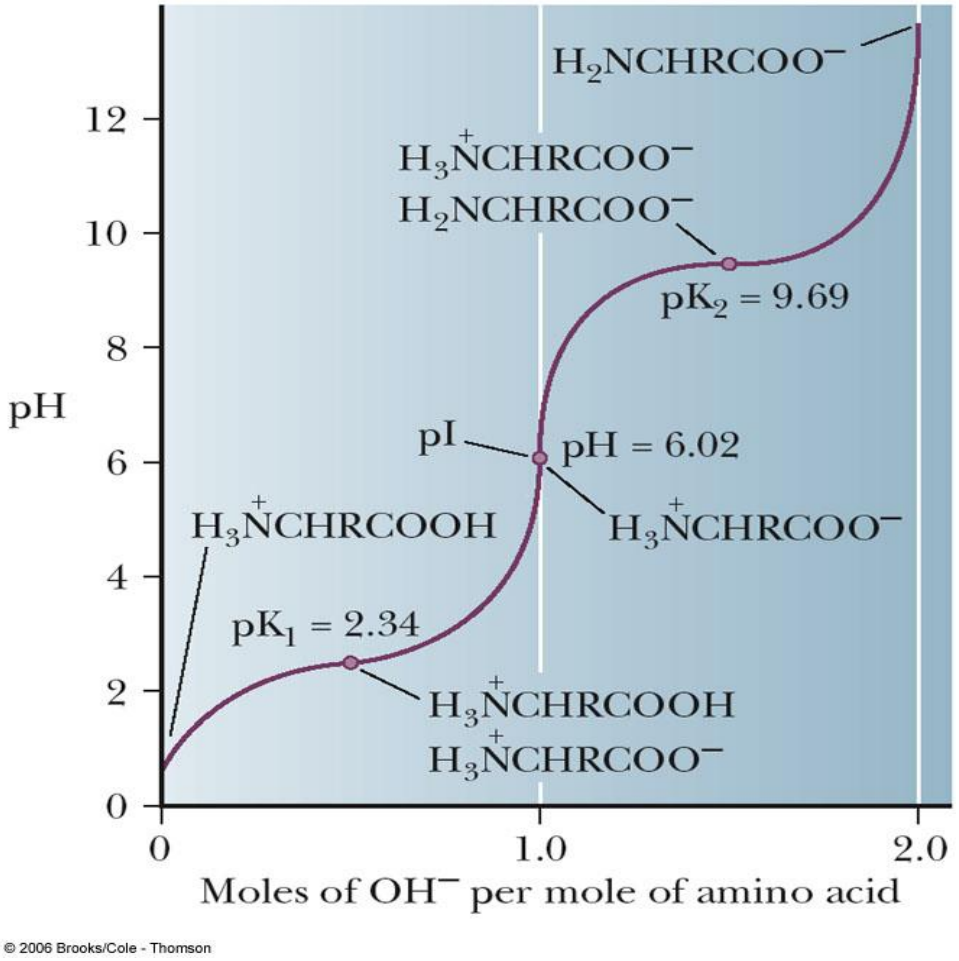
Fig. 3-5a, p.66

등전점 이란? (pI: Isoelectric point)

- Net charge (알짜전하)가 0 이 되는 pH

- 등전 pH에서 아미노산은 전기장에서 움직이지 않는다.

The titration curve of alanine



Alanine의 등전점

$$pI = \frac{pKa1 + pKa2}{2}$$

$$pI = \frac{2.34 + 9.69}{2}$$

$$= 6.02$$

Fig. 3-6, p.66

pH가 pKa와 동일한 값일 때

- pH = pKa + log [공역염기]/[공역산]

  2.34 = 2.34 + log [COO-]/[COOH]

  log [COO-]/[COOH] = 0

  [COO-]/[COOH] = 1

용액에 존재하는 공역산과 염기의 비율은 1:1이다.

용액에 존재하는 공역산과 염기의 비율은 1:1이다.

실전응용 (74쪽)

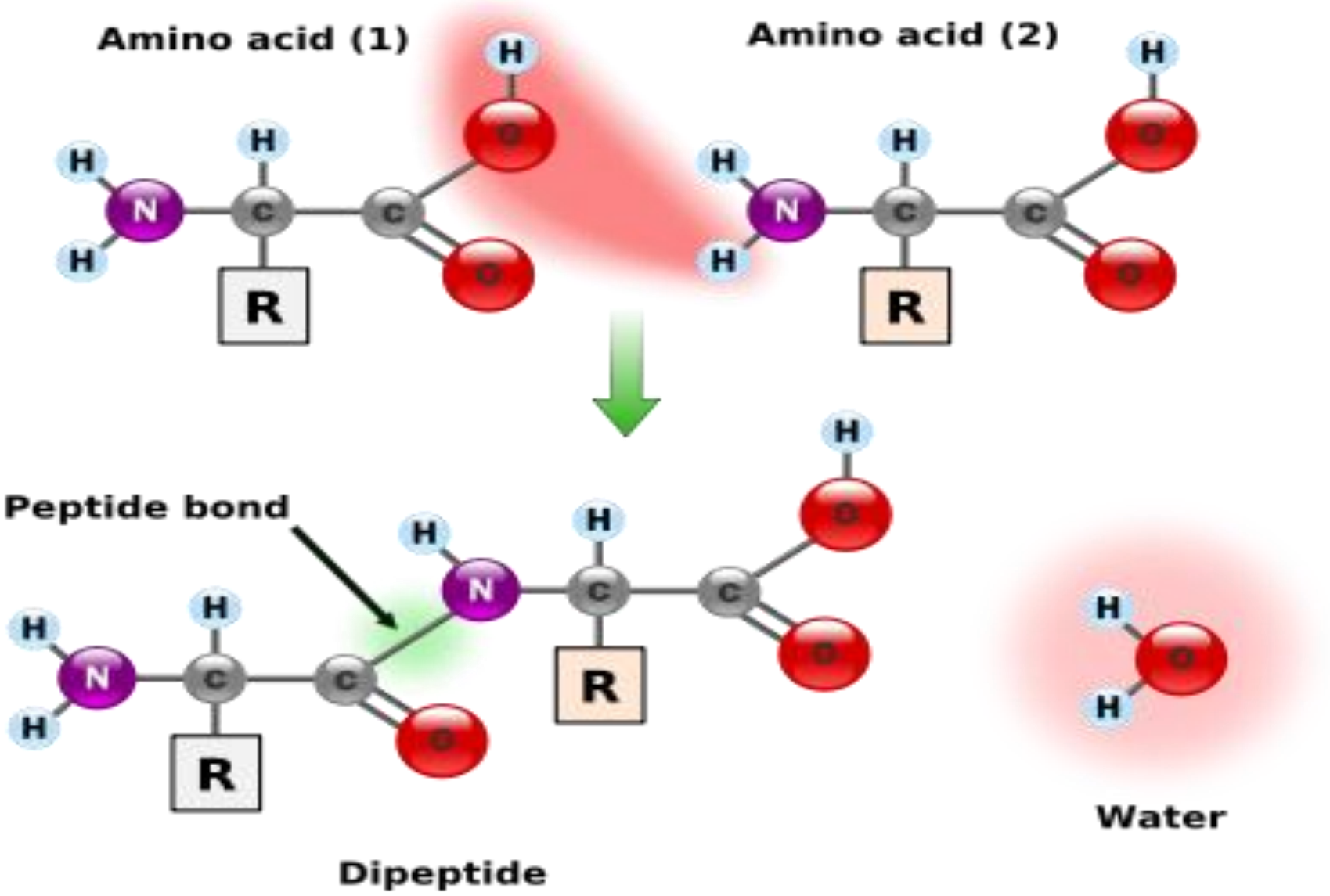
- pH 1에서 Aspartic acid의 알짜전하는 얼마인가?

Peptides 란?

- 아미노산과 아미노산이 Peptide bond로 연결되어있다

- 카르복시기와 아미노기 사이에서 결합

Peptide Bond



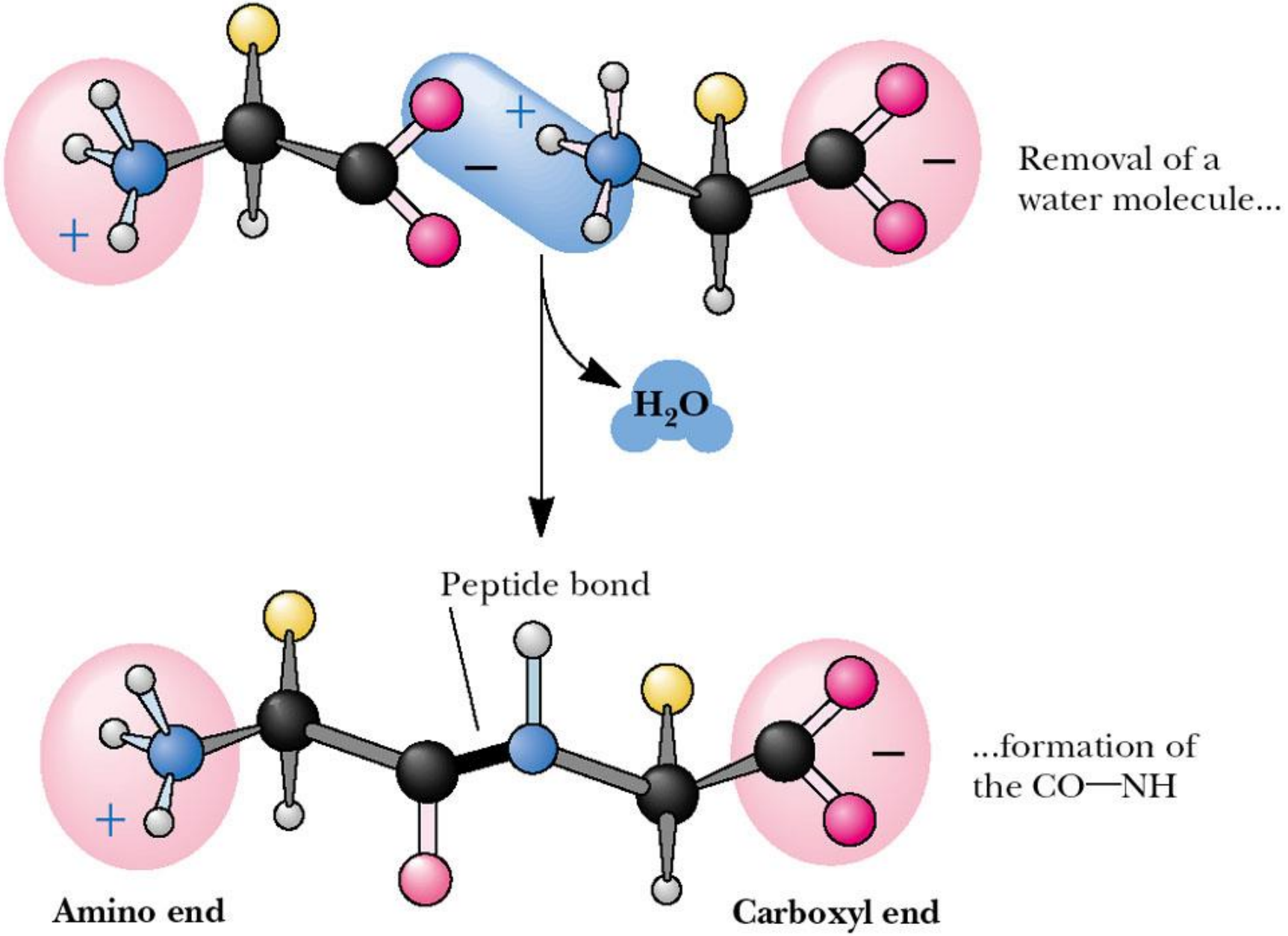


Fig. 3-8b, p.69

펩타이드의 공명구조

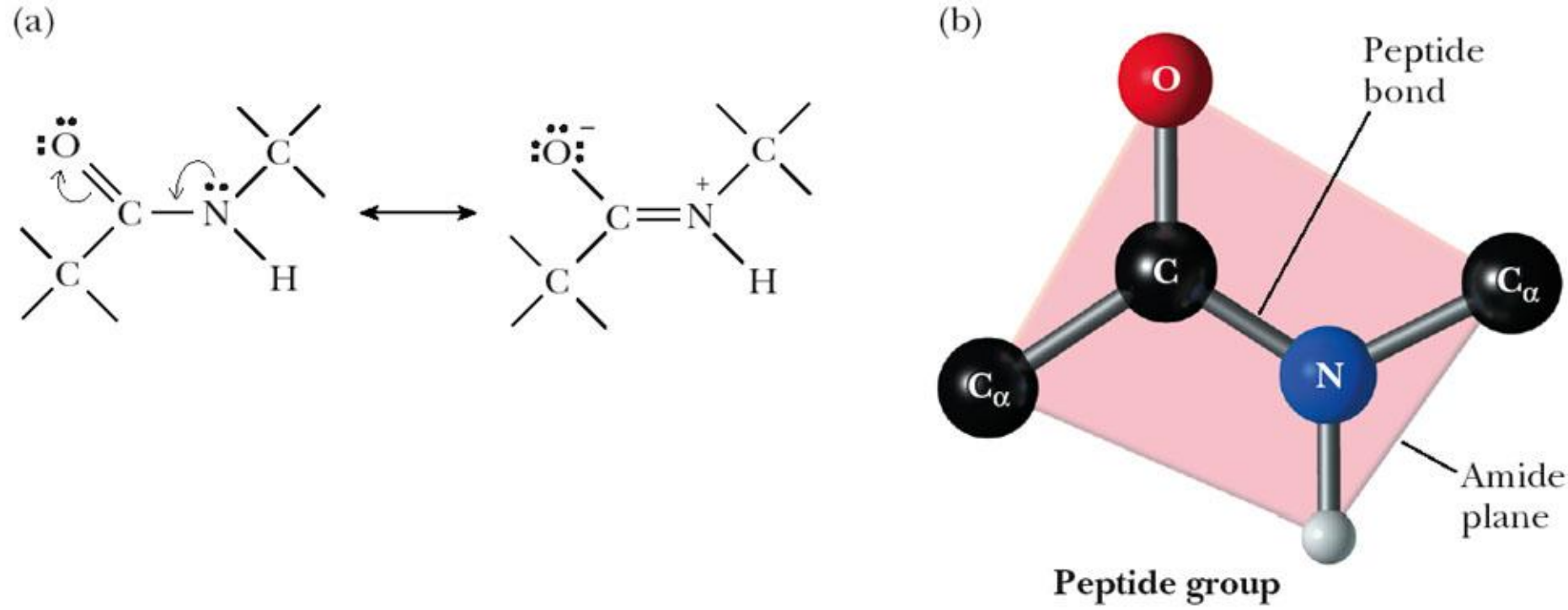


Fig. 3-10, p.72

펩타이드사슬의 방향성 (N→ C)

N 말단에서 C 발단으로 읽는다

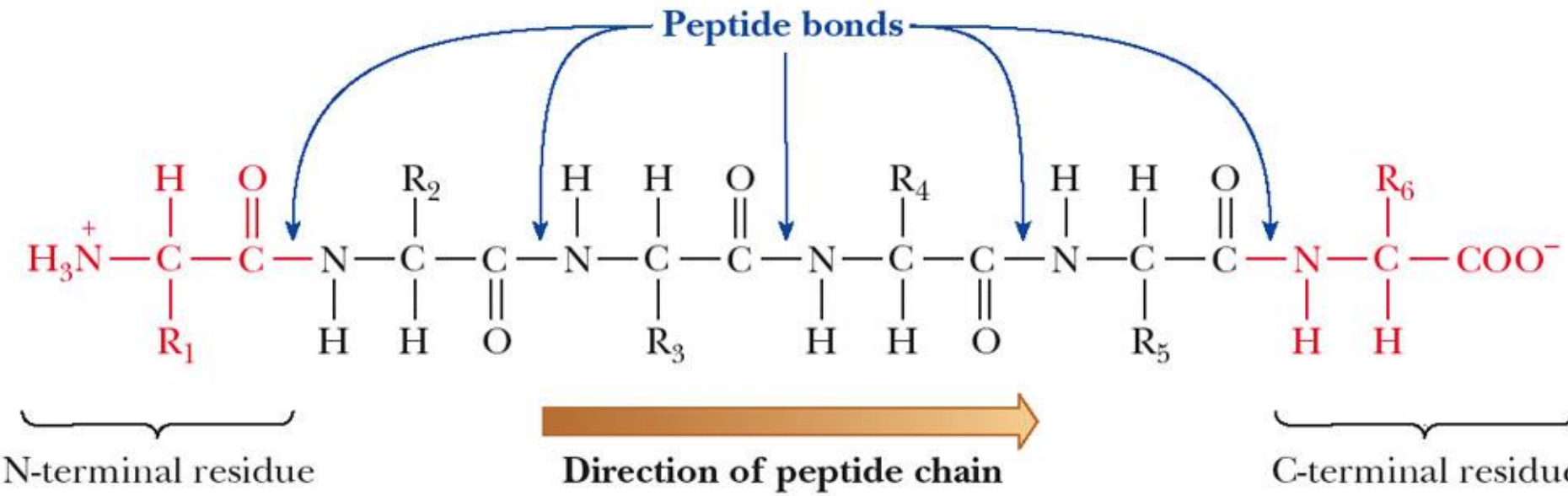
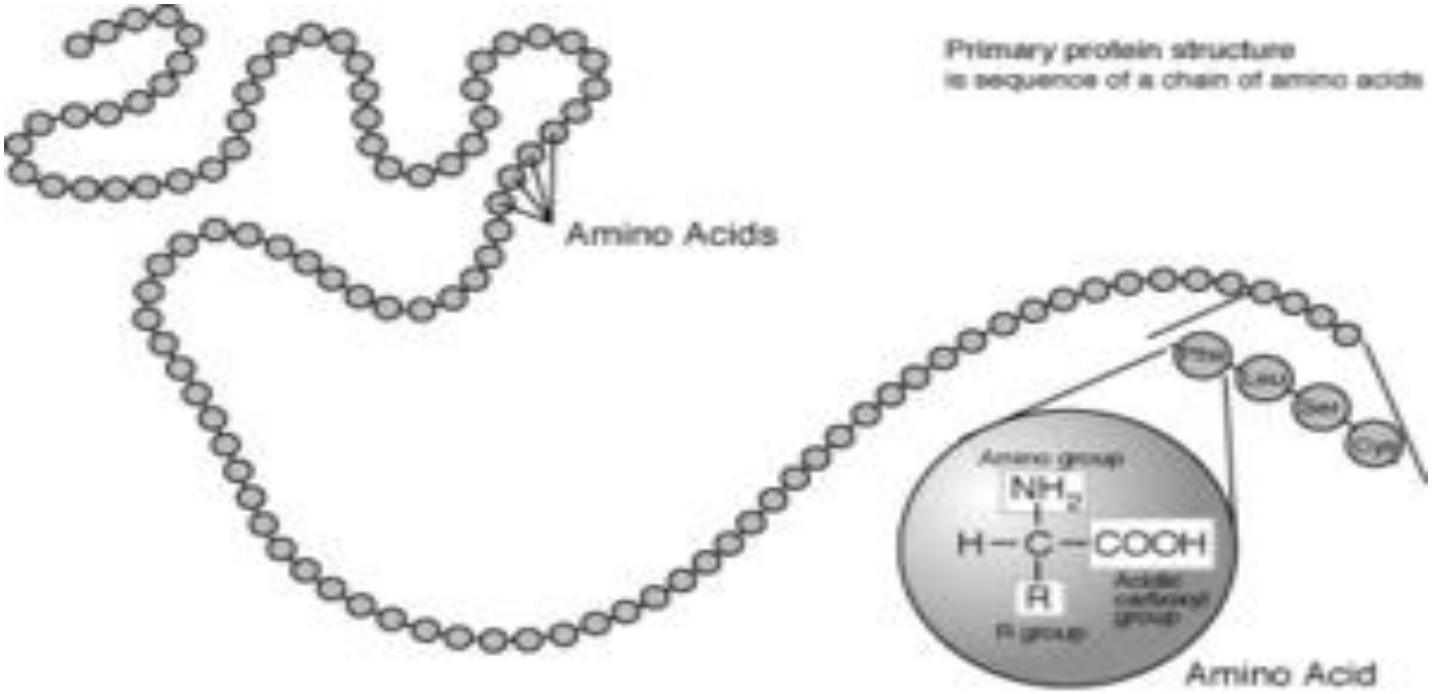


Fig. 3-9, p.69

Polypeptide Bond



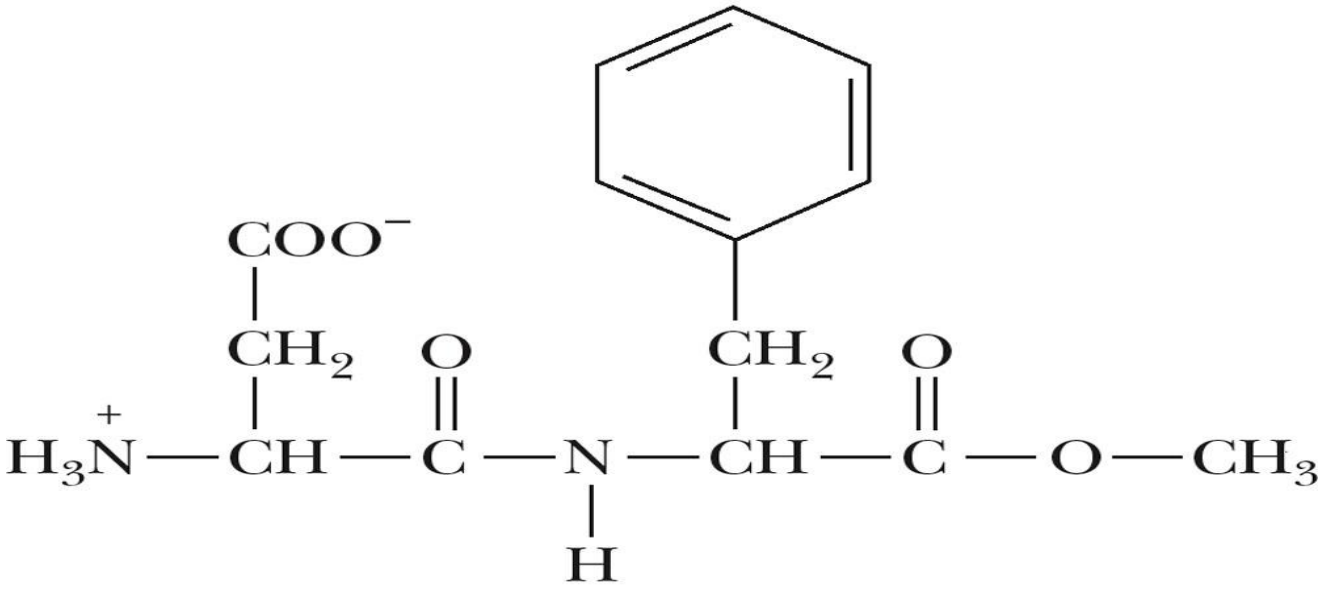
펩타이드의 종류

- Dipeptide
- Tripeptide
- Oligopeptide
- Polypeptide - 단백질

생리활성(기능)을 지닌 **Peptides**

- Aspartame
- Glutathione (GSH)
- oxytocin
- Vasopressin

감미료 아스파탐

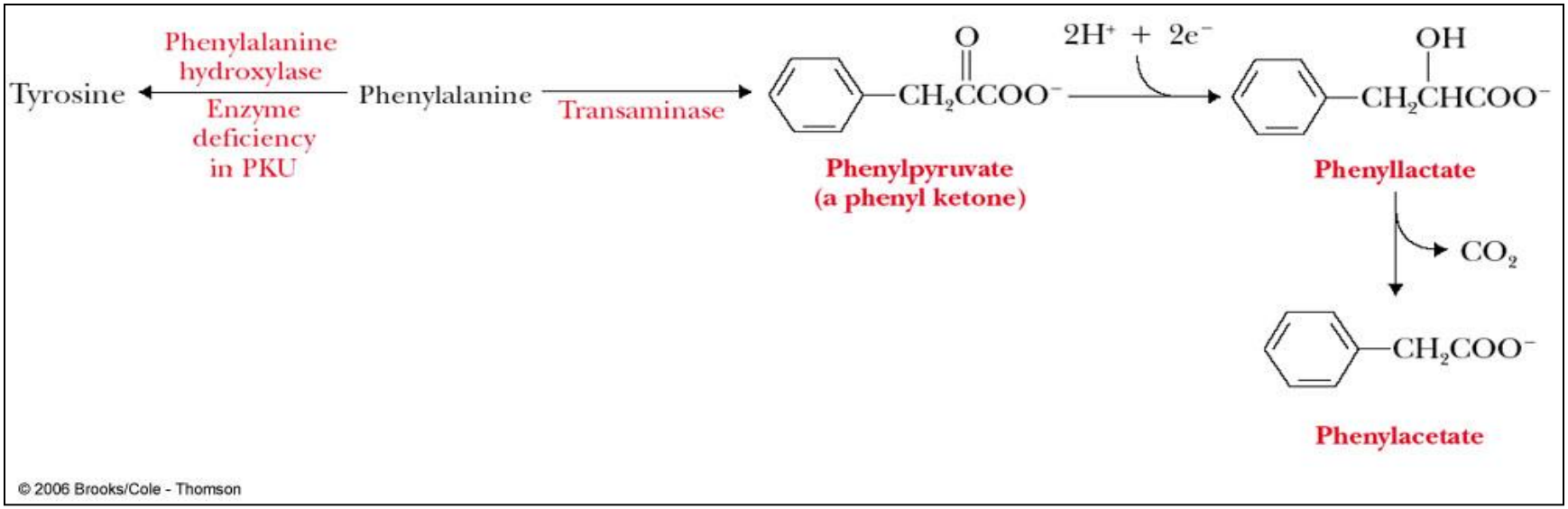


L-Aspartyl-L-phenylalanine (methyl ester)

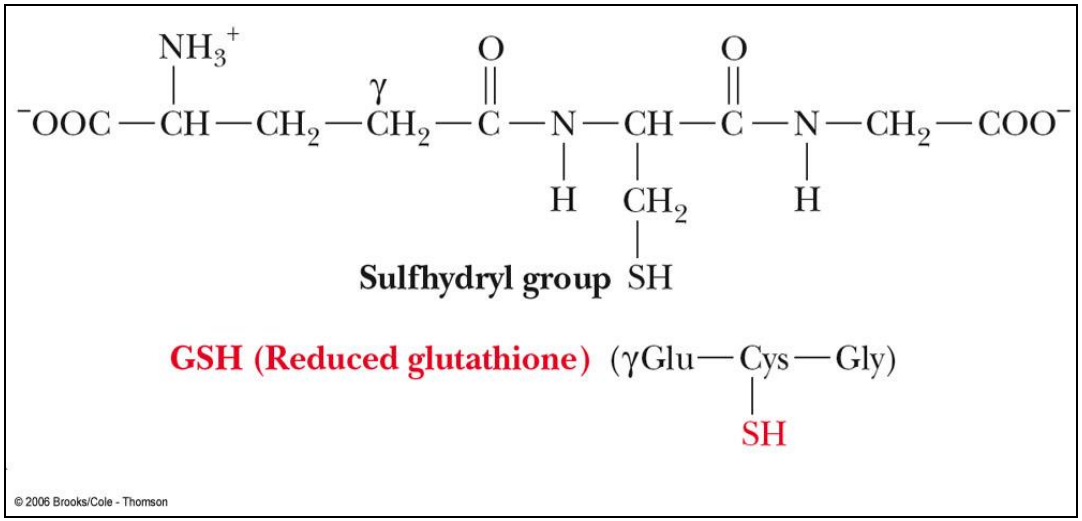
저칼로리 청량음료에 이용
페닐케톤뇨증을 앓고 있는 사람은 피해야 한다

페닐케톤뇨증 (PKU)

- 유전적 결함에 의한 질환
- Phenylalanine hydroxylase의 결여에 의한 대사적 장애
- Phenylpyruvate 의 축적으로 mental retardation 유발
- 요법: phenylalanine의 섭취 제한



글루타치온: 항산화제



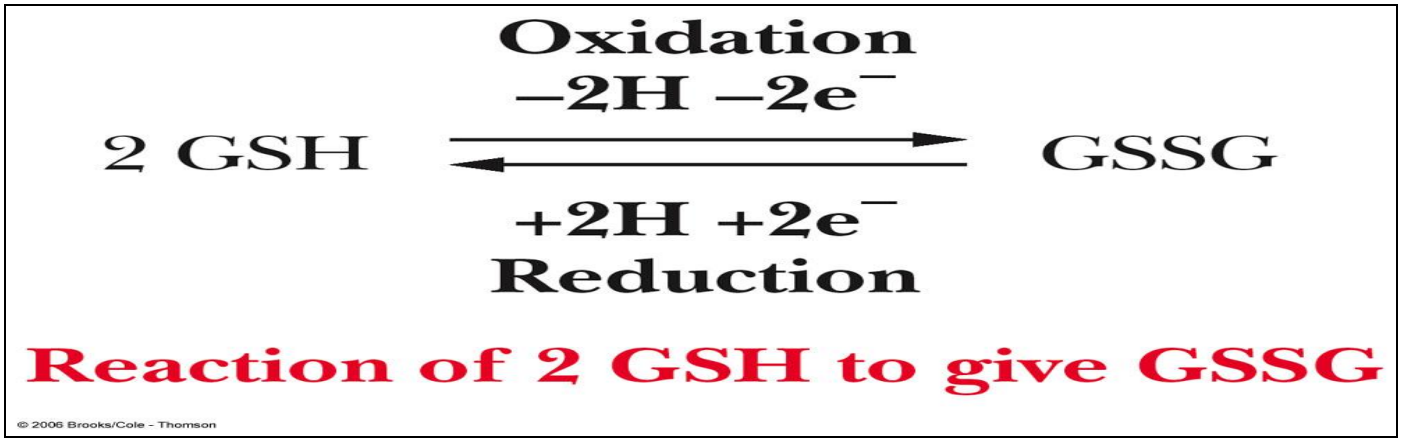
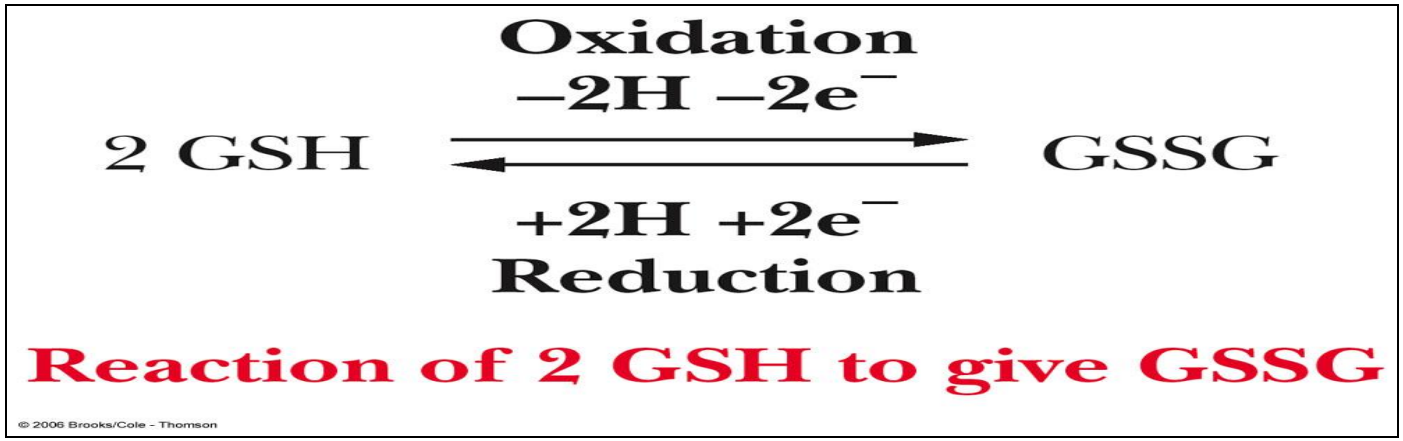
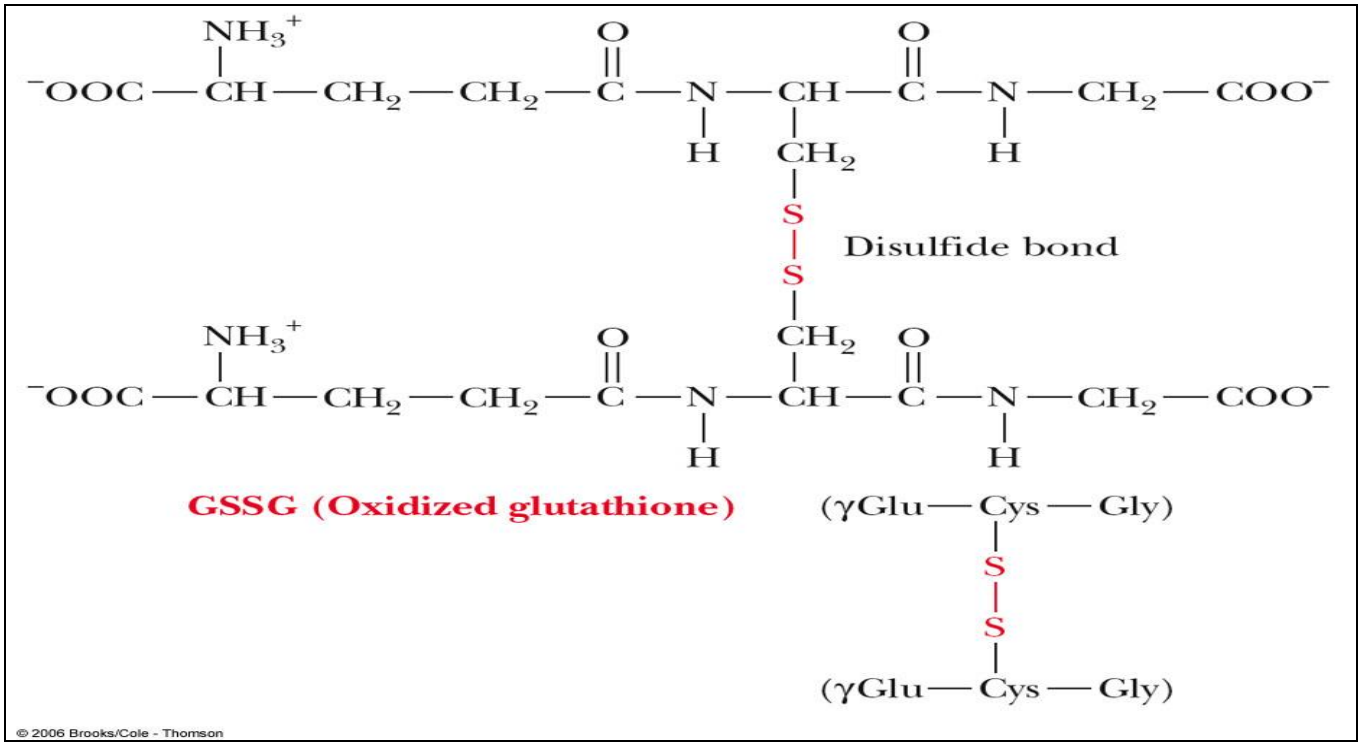


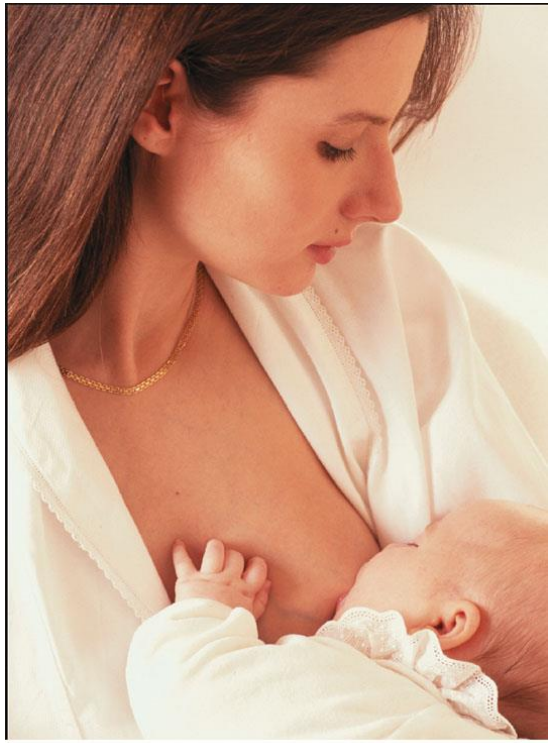
Fig. 3-12a, p.74



Reaction of 2 GSH to give GSSG



Peptide
호르몬



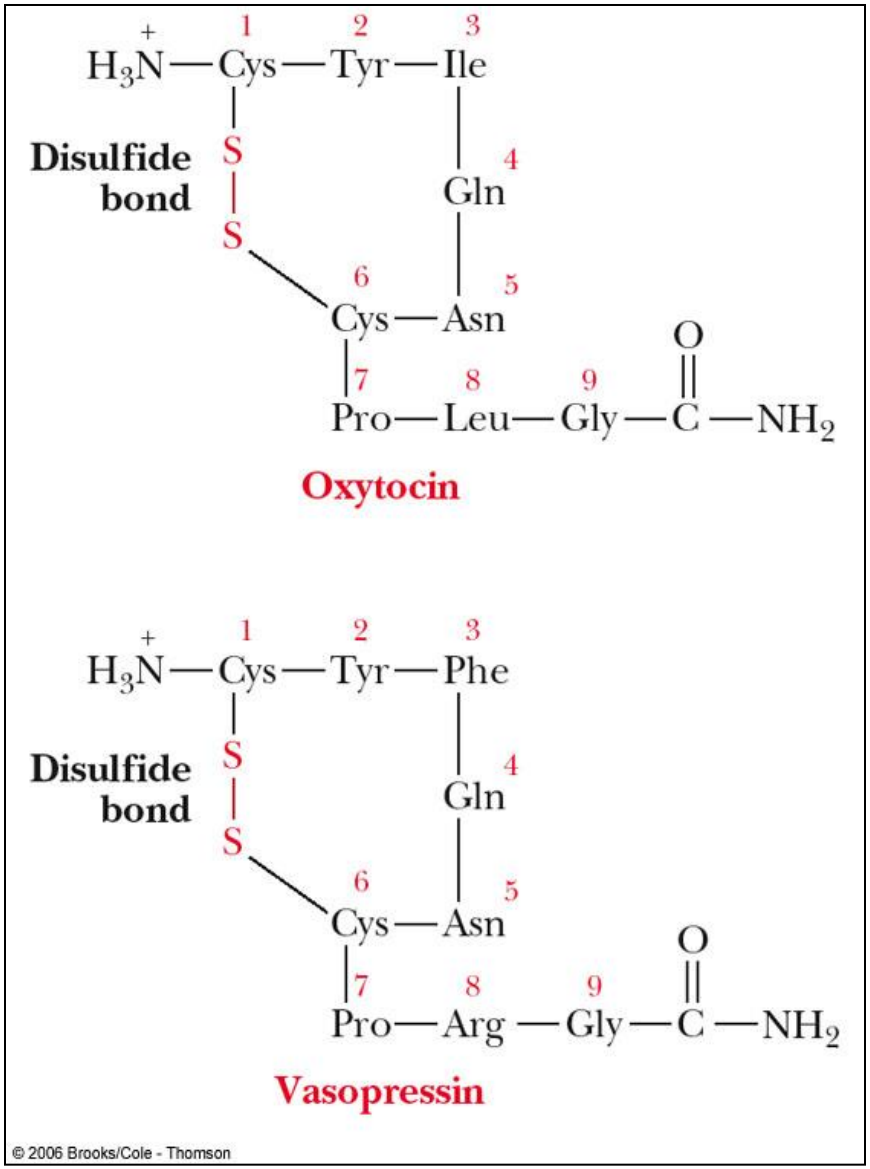


Fig. 3-13, p.75