생유기화학
(Bioorganic Chemistry)

Amino Acids, Peptides, and Proteins-I
(아미노산, 펩타이드, 단백질-1)

Soonchunhyang University

Department of Chemical Engineering

Prof. Jungkyun Im

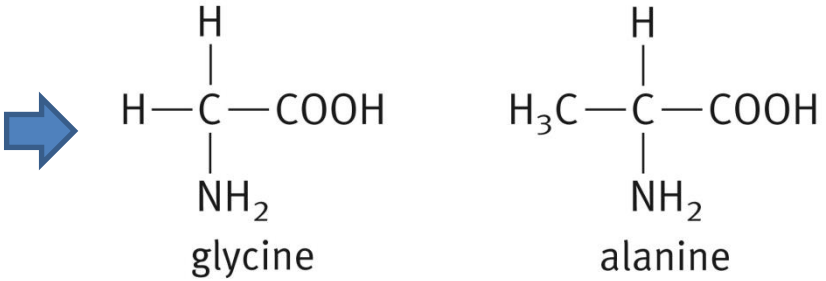
SCH 순천향대학교

순천향대

나노화학공학과

임 정 균 교수

Amino Acids, Peptides, and Proteins



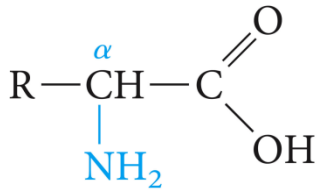
Proteins are naturally occurring polymers composed of amino acid units joined one to another by amide (or peptide) bonds.

Spider webs, animal hair, muscle, egg white, hemoglobin, insulin are all proteins.

amino acids → peptide → polypeptide (oligopeptide) → protein

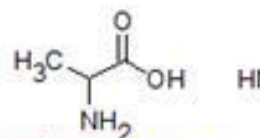
Proteins, peptides, and amino acids are essential to structure, function, and reproduction of living matter.

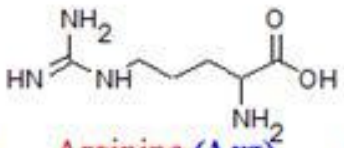
1. Naturally Occurring Amino Acids

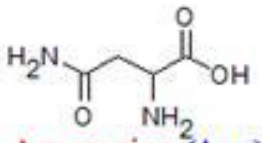


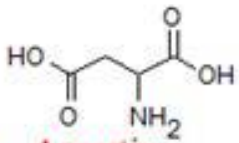
an α-amino acid

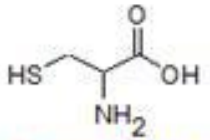
- R의 구조에 따라서 아미노산 종류가 결정된다.
- R이외의 구조는 모든 아미노산에서 동일하다.

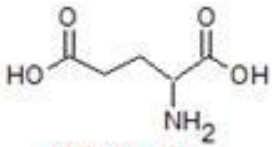

Alanine (Ala)

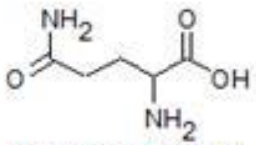

Arginine (Arg)

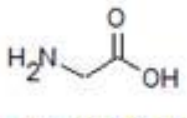

Asparagine (Asn)

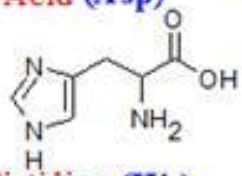

Aspartic Acid (Asp)

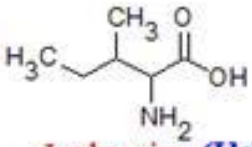

Cysteine (Cys)

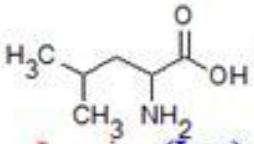

Glutamic Acid (Glu)

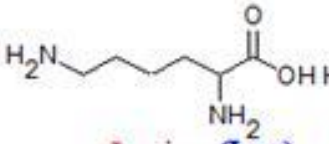

Glutamine (Gln)

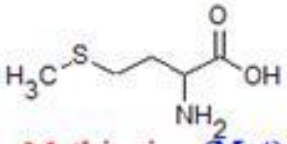

Glycine (Gly)

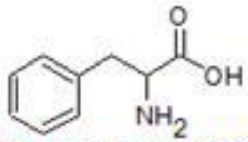

Histidine (His)

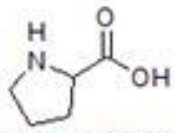

Isoleucine (Ile)

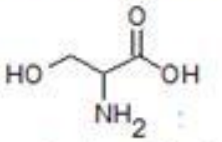

Leucine (Leu)

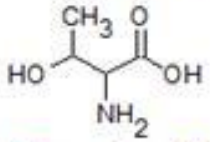

Lysine (Lys)

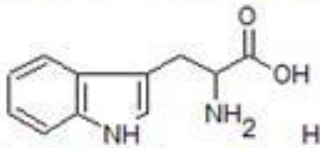

Methionine (Met)

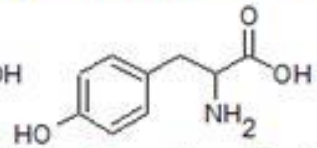

Phenylalanine (Phe)


Proline (Pro)


Serine (Ser)


Threonine (Thr)


Tryptophan (Trp)


Tyrosine (Tyr)

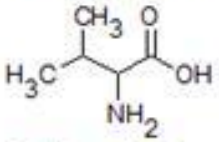

Valine (Val)

Table 17.1 Names and Formulas of the Common Amino Acids

파랑색 글자 아미노산은 필수아미노산(생합성 안됨)

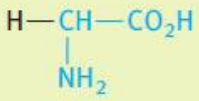
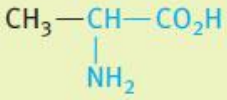
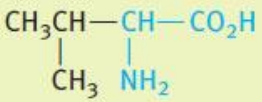
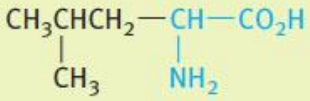
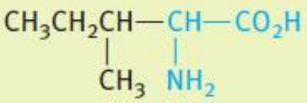
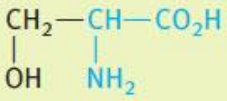
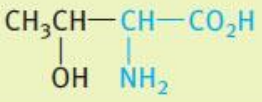
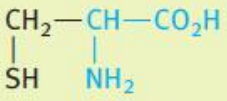
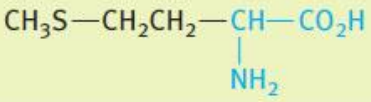
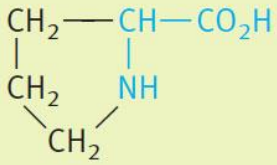
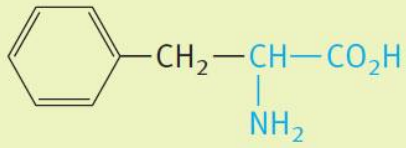
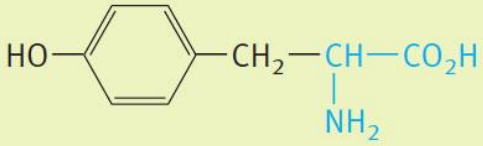
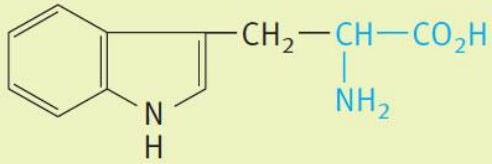
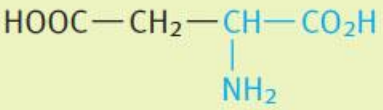
Name	Three-letter abbreviation (isoelectric point) one-letter abbreviation	Formula	R
A. One amino group and one carboxyl group			
1. glycine	Gly (6.0) G		Glycine을 제외한 모든 아미노산은 optically active하다.
2. alanine	Ala (6.0) A		
3. valine	Val (6.0) V		R is hydrogen or an alkyl group.
4. leucine	Leu (6.0) L		
5. isoleucine	Ile (6.0) I		
6. serine	Ser (5.7) S		
7. threonine	Thr (5.6) T		R contains an alcohol function.
8. cysteine	Cys (5.0) C		
9. methionine	Met (5.7) M		R contains sulfur.

Table 17.1 (continued)

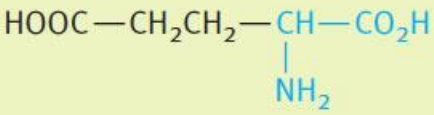
Name	Three-letter abbreviation (isoelectric point) one-letter abbreviation	Formula	R
10. proline	Pro (6.3) P		The amino group is secondary and part of a ring.
11. phenylalanine	Phe (5.5) F		One hydrogen in alanine is replaced by an aromatic or heteroaromatic (indole) ring.
12. tyrosine	Tyr (5.7) Y		
13. tryptophan	Trp (5.9) W		

B. One amino group and two carboxyl groups

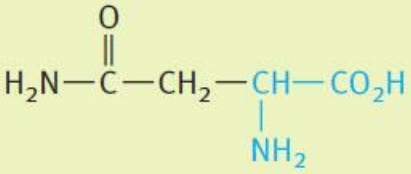
14. aspartic acid — Asp (3.0) D



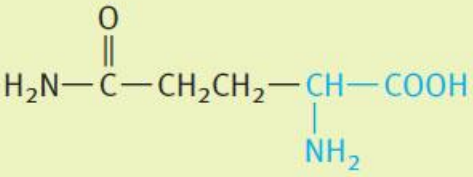
15. glutamic acid — Glu (3.2) E



16. asparagine — Asn (5.4) N

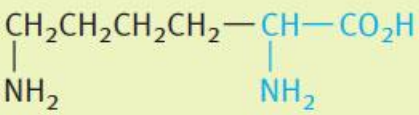


17. glutamine — Gln (5.7) Q

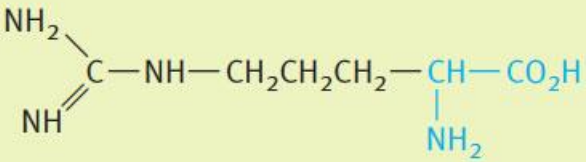


C. One carboxyl group and two basic groups

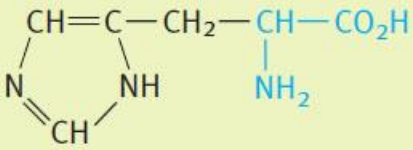
18. lysine — Lys (9.7) K



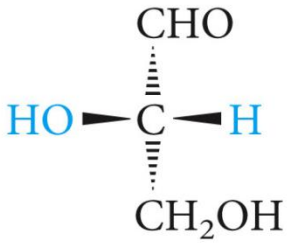
19. arginine — Arg (10.8) R



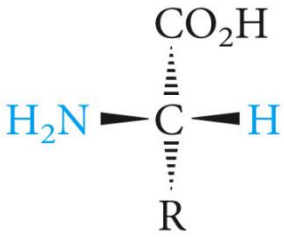
20. histidine — His (7.6) H



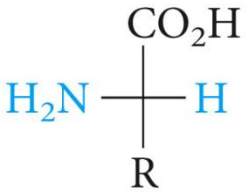
The second basic group is a primary amine, a guanidine, or an imidazole.



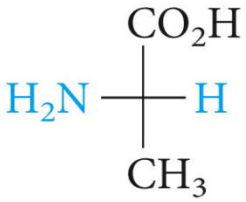
L-(−)-glyceraldehyde



a naturally occurring L-amino acid



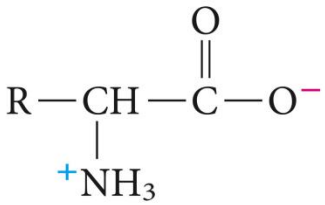
Fischer projection formula
of an L-amino acid



L-(+)-alanine

- 우리몸의 모든 단백질은 L-아미노산으로 이루어있다.
- L-아미노산만 소화가 될 것이다.

2. The Acid-Base Properties of Amino Acids

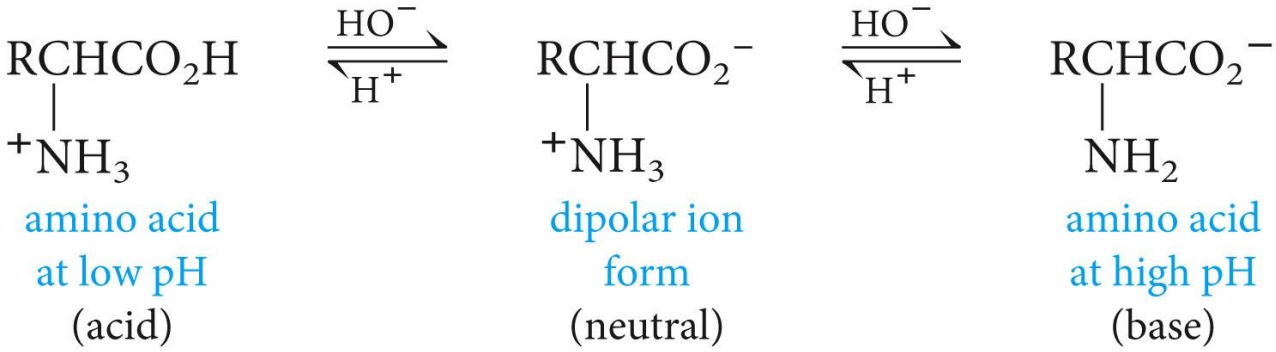


dipolar structure of an α-amino acid

아미노산에 산,염기가 모두 존재한다.→ dipolar structure

높은 b.p.를 갖고 있다.

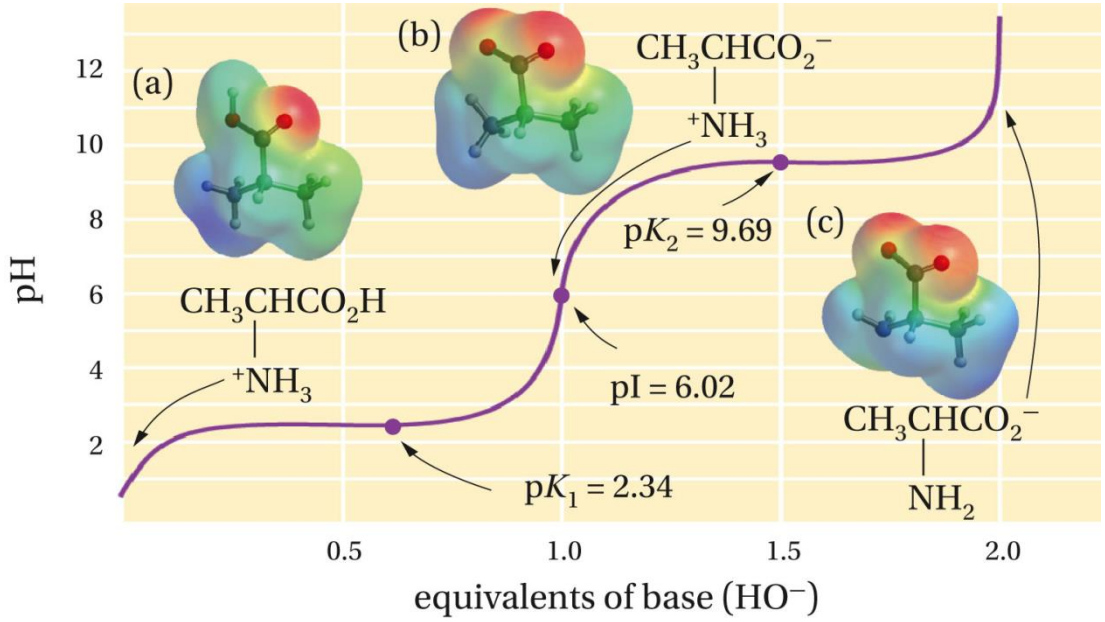
유기용매에 잘 안녹는다.



amphoteric, zwitterion, hybrid ion, amphiprotic

(양쪽성; 한 분자 내에서 proton을 주거나 받을 수 있는 형태)

Alanine의 적정 곡선



If the pH of the solution is less than the pKa, the proton is on.

If the pH of the solution is greater than the pKa, the proton is off.

$$CH_3CHCO_2H \;(+NH_3\ Cl^-) + Na^+\ HO^- \longrightarrow CH_3CHCO_2^- \;(+NH_3) + Na^+\ Cl^- + H_2O$$

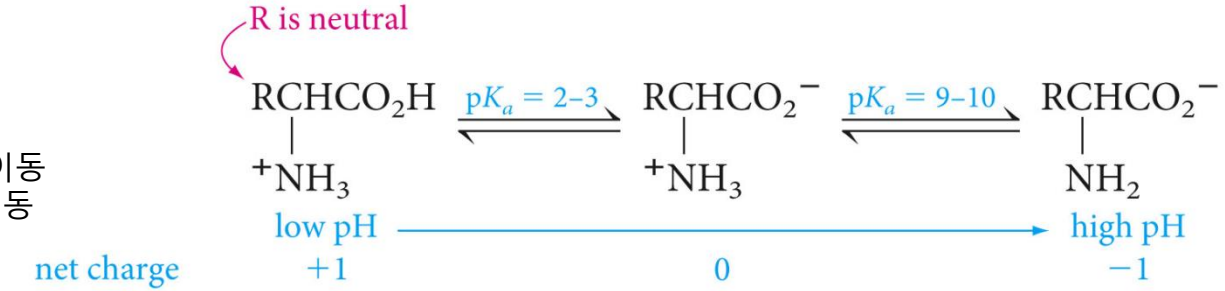
ammonium salt → dipolar ion

$$CH_3CHCO_2^- \;(+NH_3) + Na^+\ HO^- \longrightarrow CH_3CHCO_2^-Na^+ \;(NH_2) + H_2O$$

dipolar ion → carboxylate salt

At low pH: alanine는 양전하를 갖고 있음
At high pH: alanine는 음전하를 띠고 있음

Alanine을 전기장(electric field)에 놓으면
At low pH: alanine은 음극(cathode)쪽으로 이동
At high pH: alanine은 양극(anode)쪽으로 이동



어떤 중간 pH (isoelectric point, pI, 등전점)에서 alanine은 양쪽성을 띠고 이 때 실전하는 0이라서 중성이고 전기장에서 어떠한 이동도하지 않을 것이다.

pI는 보통 두개의 pKa의 중간값에 가깝다.