



Chapter 3

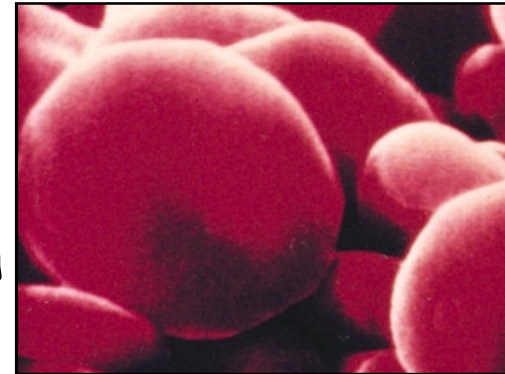
Luciferase
in Firefly

Fig 3-1, p. 71



Amino acids,
peptides,
and proteins

Hemoglobin in
Erythrocytes



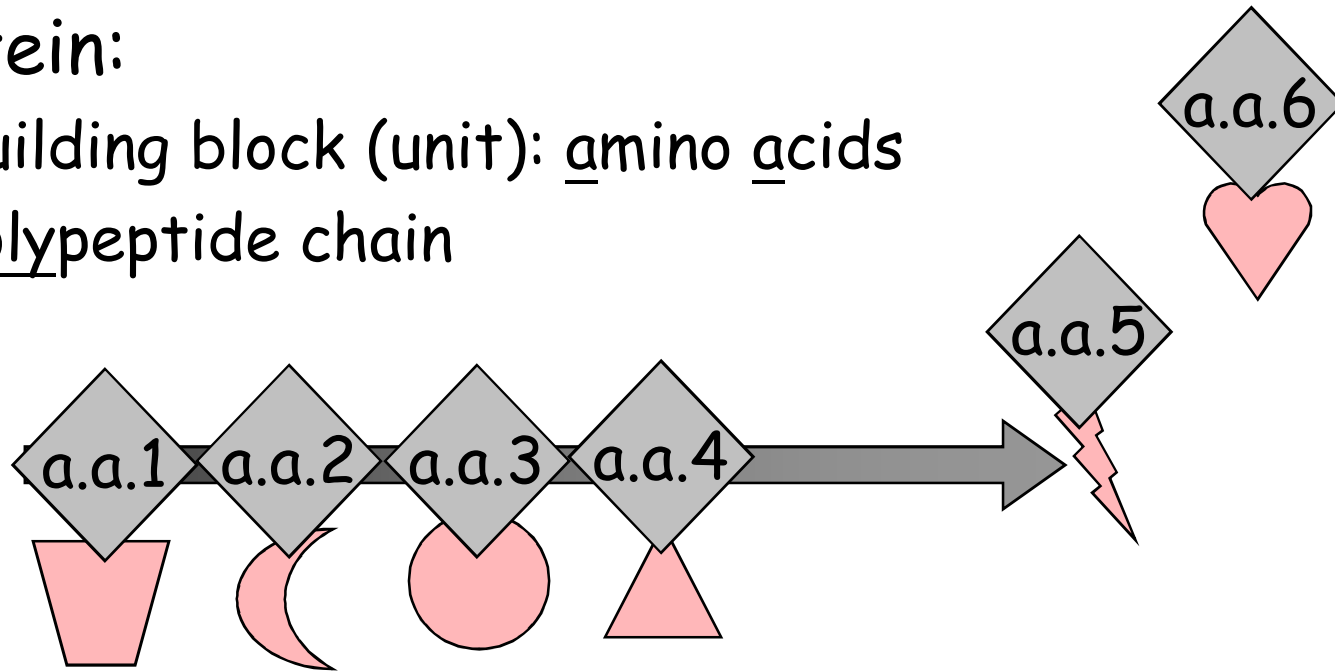
Keratin in
Rhinoceros
horn



Amino acid → Protein

■ Protein:

- Building block (unit): amino acids
- Polypeptide chain



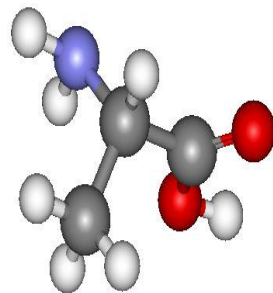
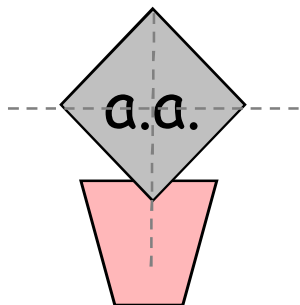
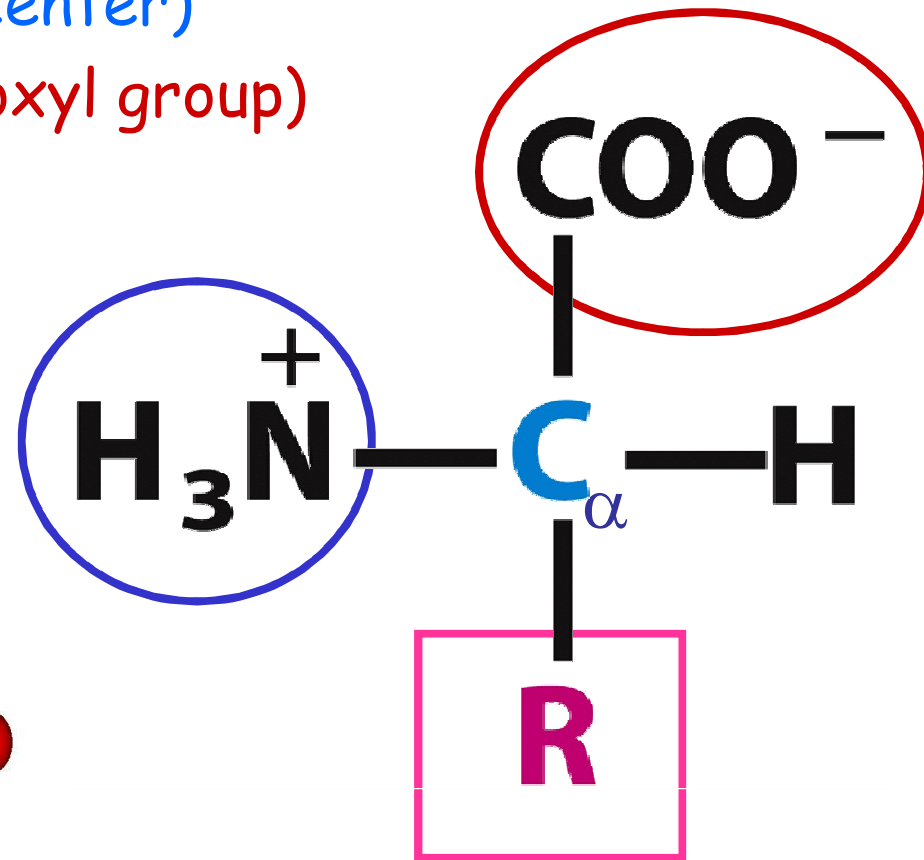
學習目標:(p. 72-78)

- 熟記胺基酸的基本結構；
- 熟記20種標準胺基酸的物理、化學性質與分類。

α -Amino acid (residue)

Fig 3-2, p. 72

- Common structures
 - α -carbon (chiral center)
 - Acid group (Carboxyl group)
 - Amino group
 - Functional group (Side chain) (R group)

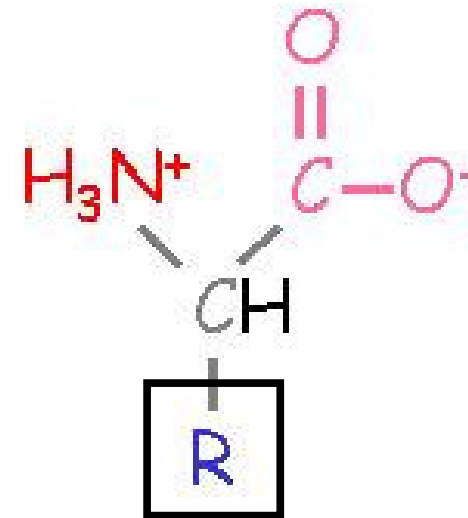


20 standard amino acids

- Chemical properties - by functional group

Table 3-1 (p.73)

- Nonpolar, aliphatic (hydrophobic)
- Aromatic
- Polar, uncharged
- Negatively charged
- Positively charged



Hydrophobic R groups

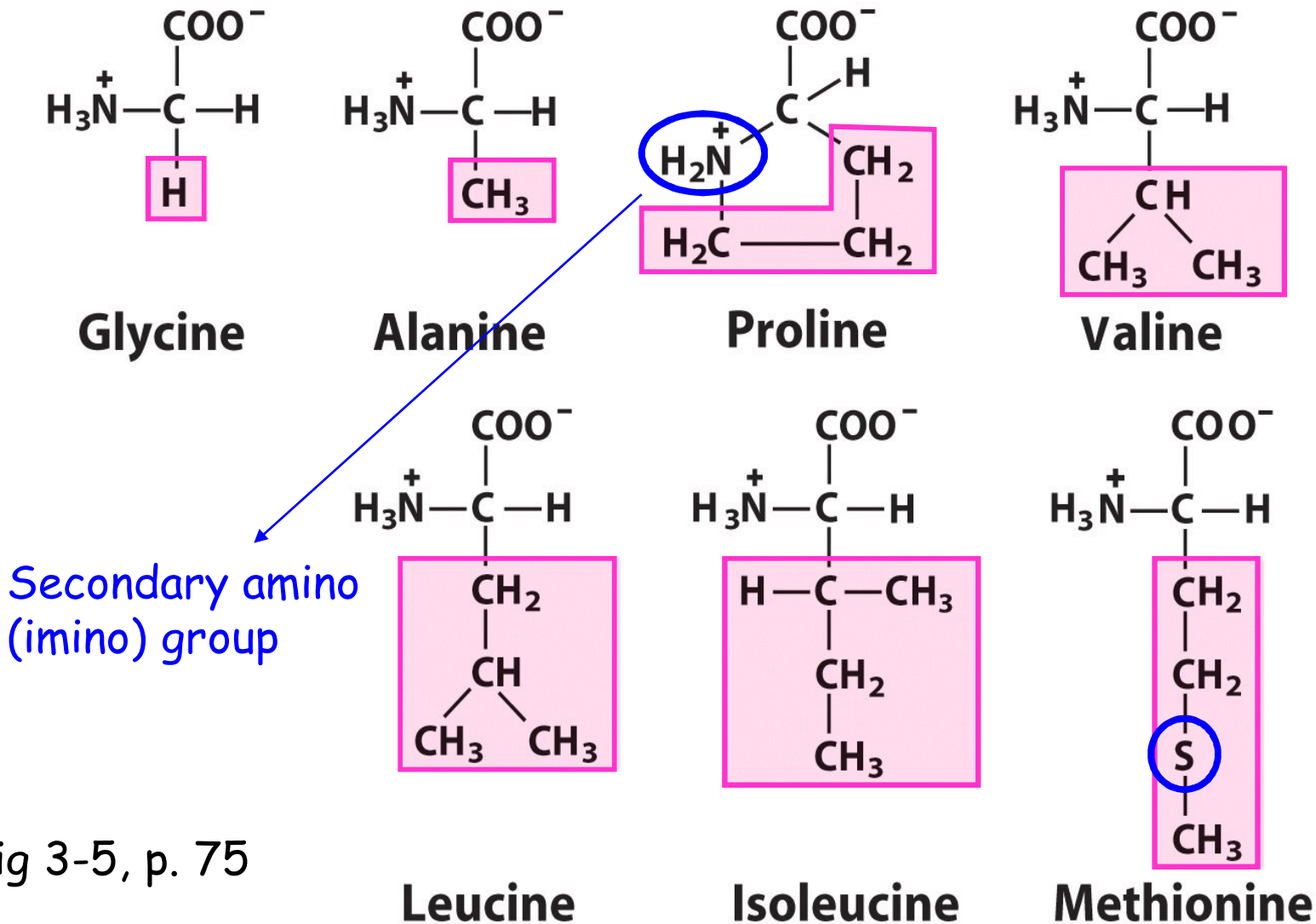
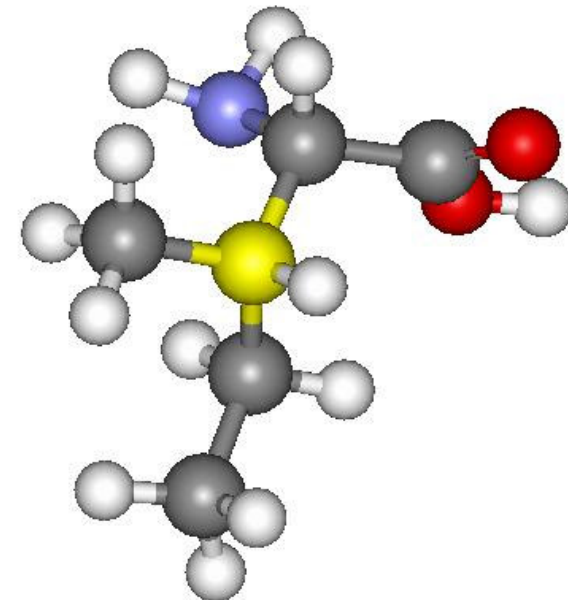
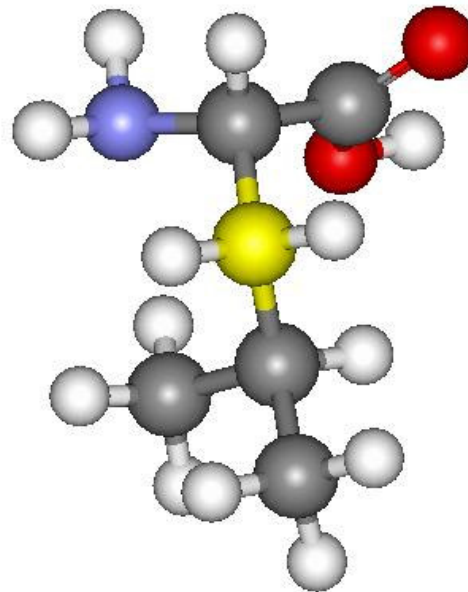
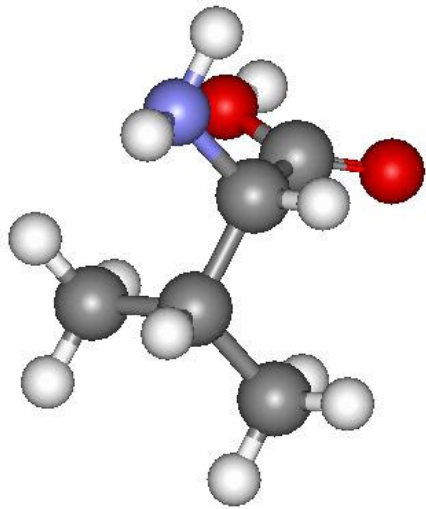


Fig 3-5, p. 75

BCAA

- Branched-chain amino acid
 - Valine
 - Leucine
 - Isoleucine



Aromatic R groups

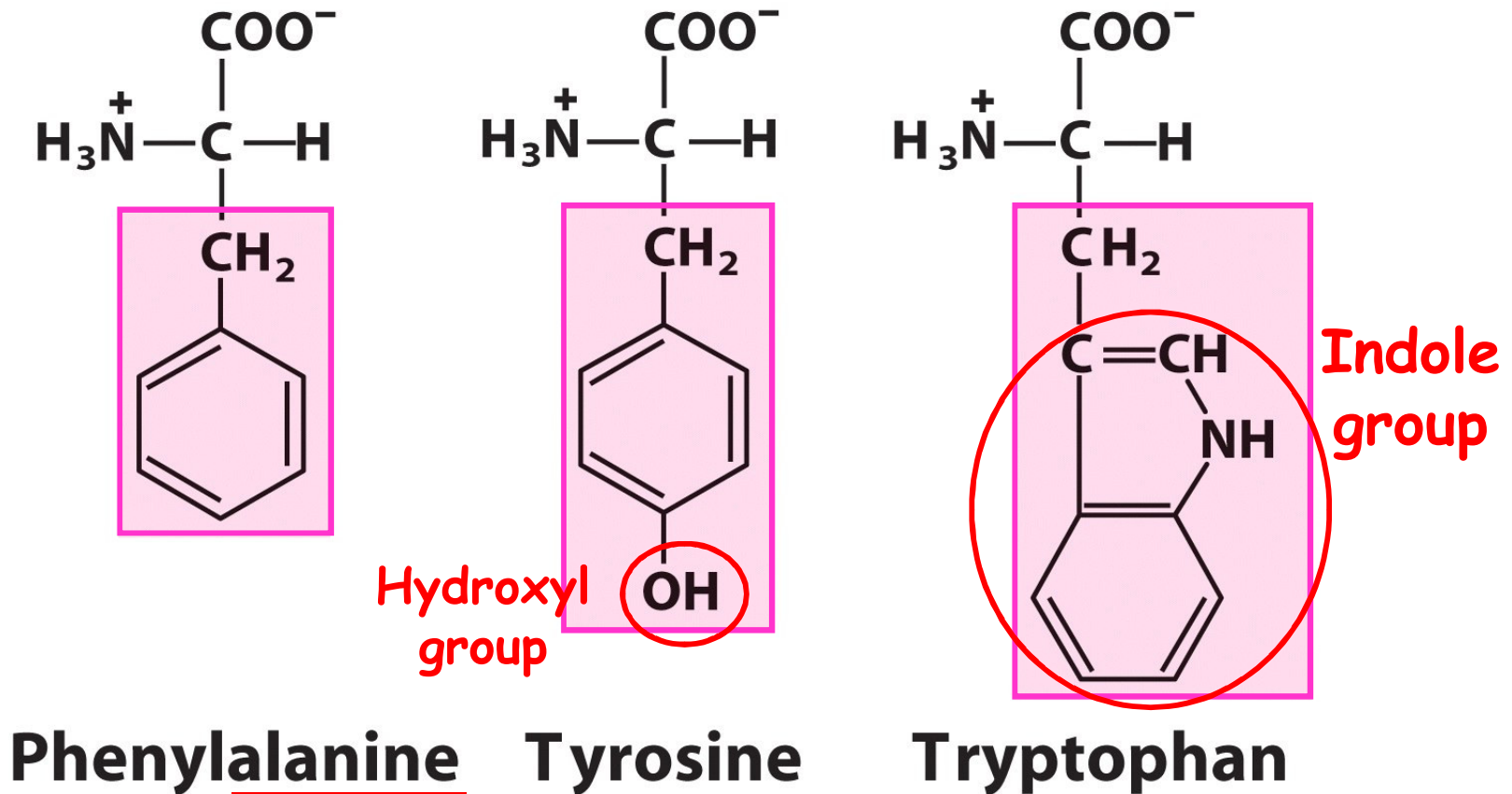


Fig 3-5

Polarity: Tyr \cong Trp \gg Phe

Spectroscopic Properties

- Only Phe, Tyr, and Trp absorb ultraviolet light
 - Absorbance at 280 nm is a good diagnostic device for proteins
- The Lambert-Beer law
 - Box 3-1 (p. 76)

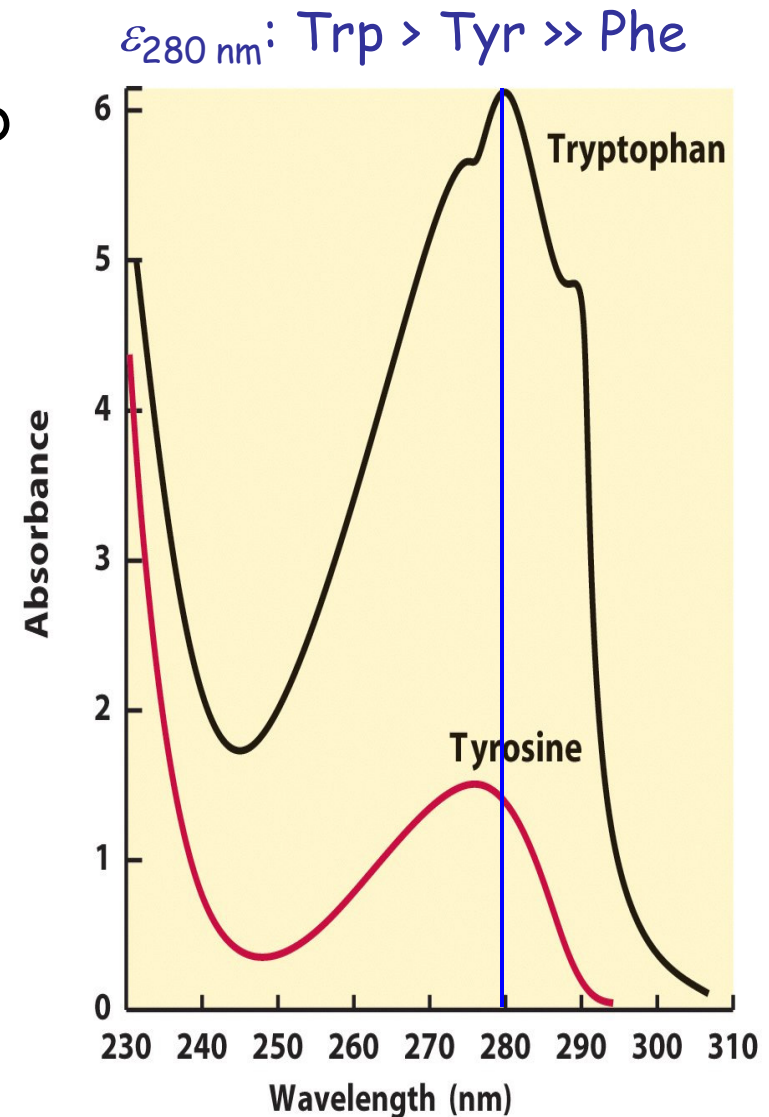
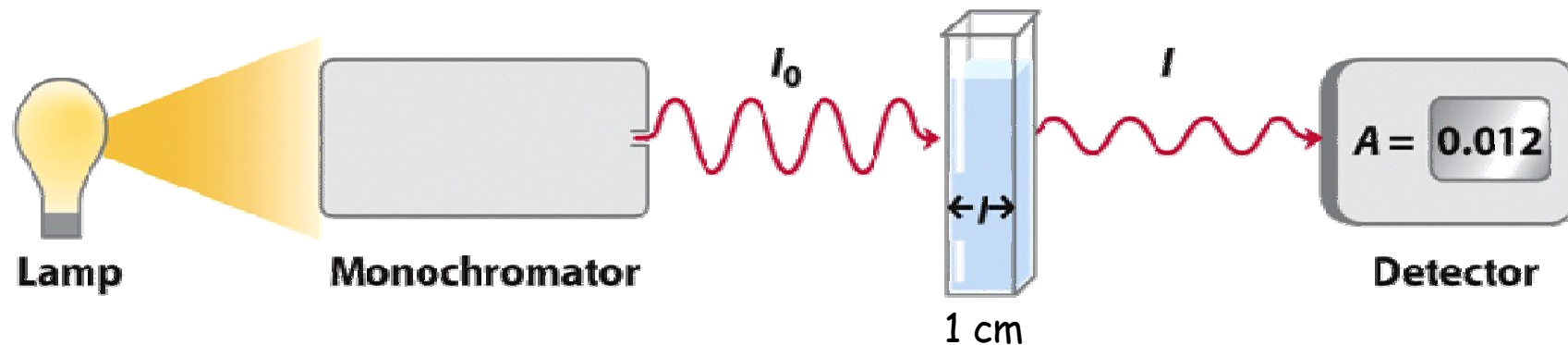


Fig 3-6, p.76

Lambert-Beer Law

Box 3-1, p.76

■ Absorption Spectrophotometry



$$\text{Absorbance (A)} = \log(I_0/I) = \epsilon c l$$

ϵ : molar extinction coefficient

→ $A \propto \text{concentration (c)}$

Polar, uncharged R groups

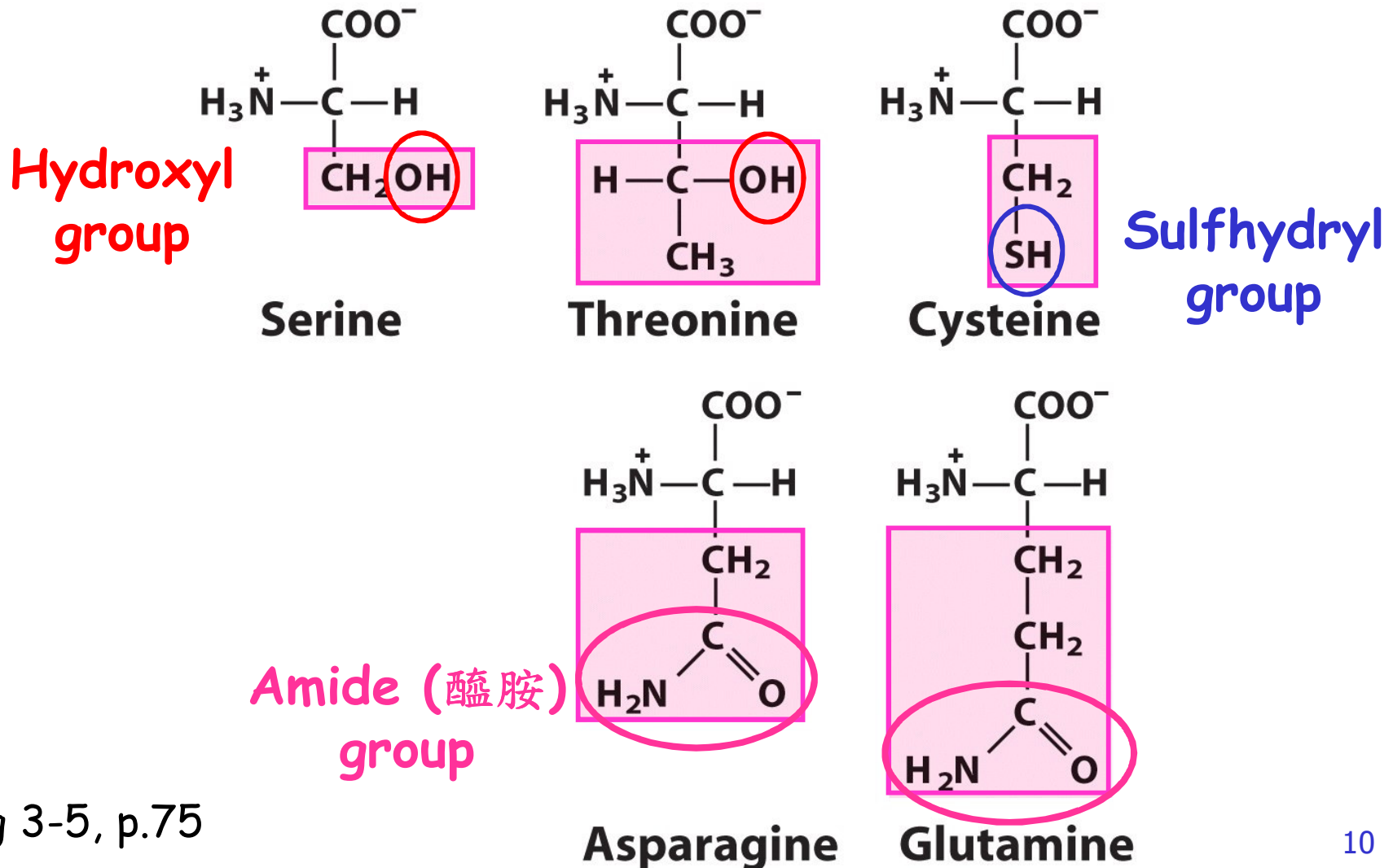


Fig 3-5, p.75

Disulfide bond

- 2 Cys residues can be oxidized to form a disulfide bond

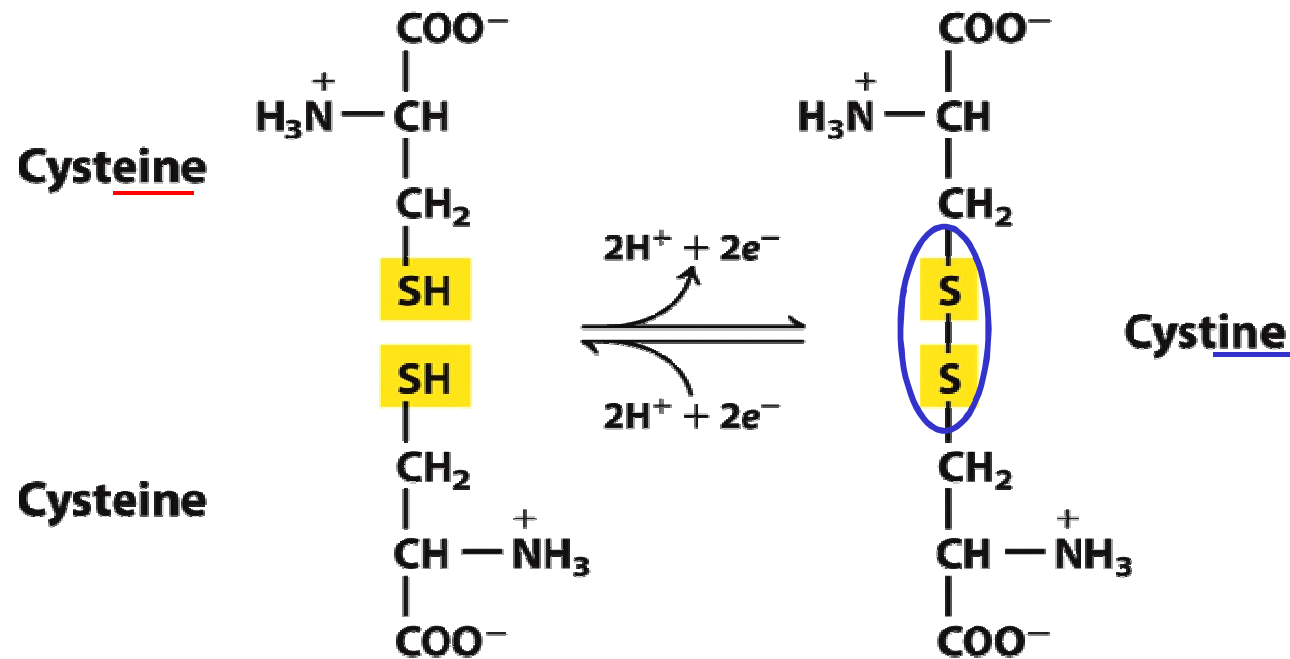
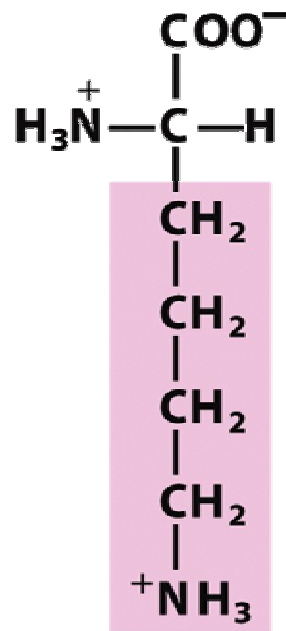


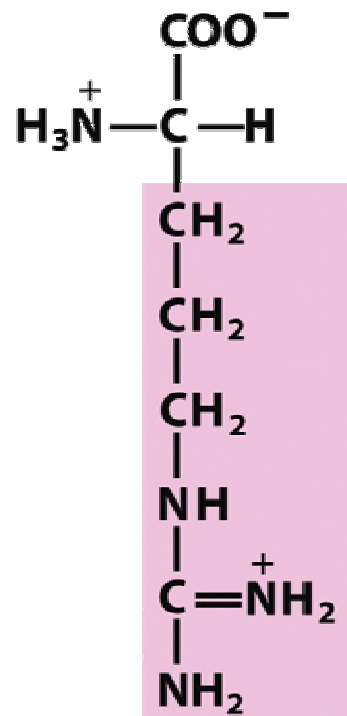
Fig 3-7, p. 77

Positively charged R groups

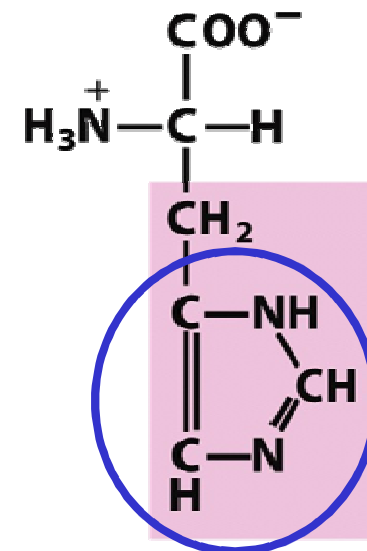
At pH = 7.0



Lysine



Arginine



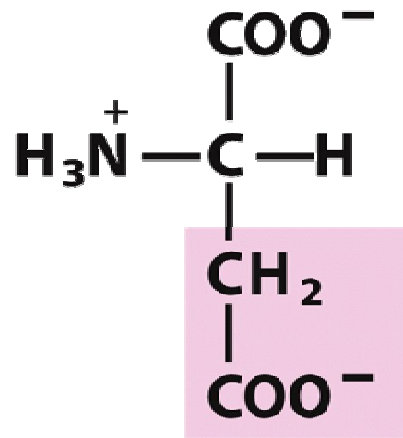
**Imidazole
group**

Histidine

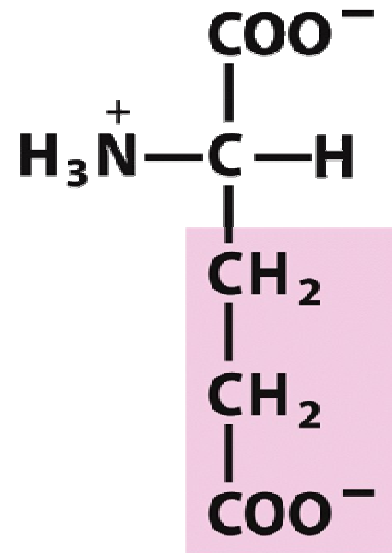
Fig 3-5, p.75

Negatively charged R groups

At pH = 7.0



Aspartate
= Aspartic acid



Glutamate
= Glutamic acid

Fig 3-5, p.75

Common structures of a.a.

- C_{α} - chiral center
 - Mirror images
 - Stereoisomer (stereoisomerism, Fig 3-3)
 - Enantiomers (p. 72)
 - Non-super-imposable mirror images of each other.
 - L-amino acid and D-amino acid (p.74)
 - Proteins are made exclusively from L-form a.a. !!
 - D-form a.a. only in few small peptides
 - Some peptides in bacterial cell walls
 - Certain peptide antibiotics

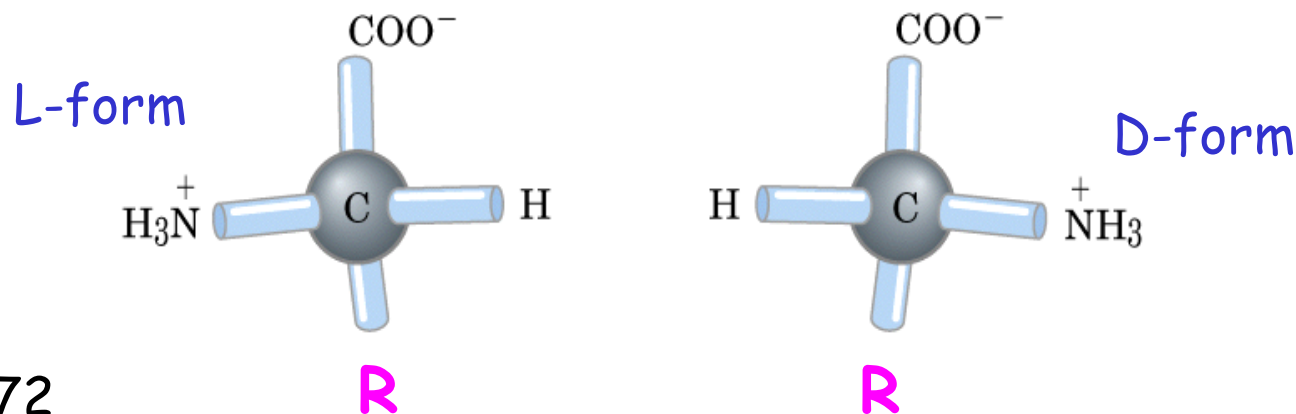
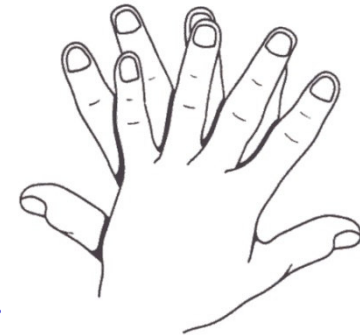
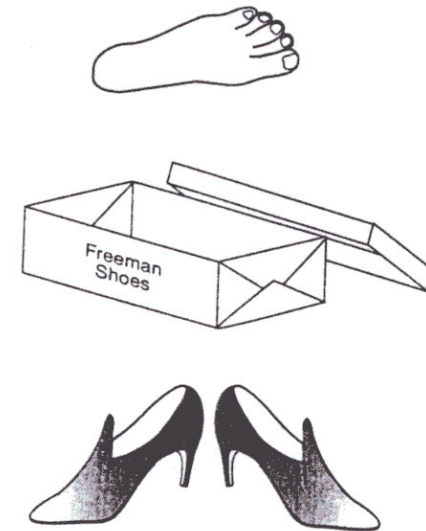


Fig 3-3a, p. 72

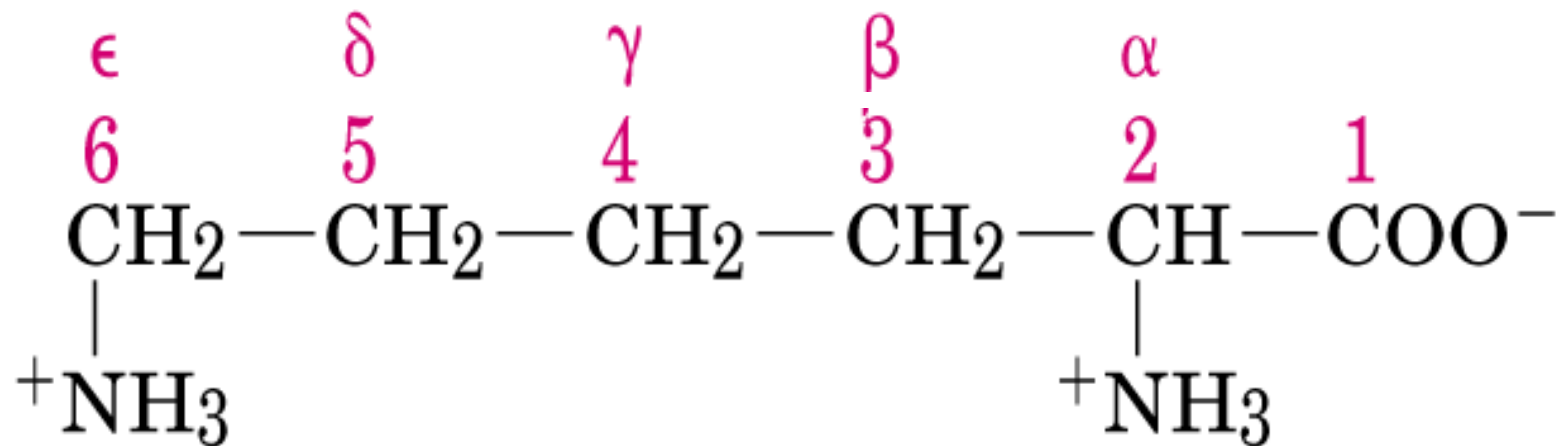
Single-handed cooperation

- When is chiral important ?
 - ✓ Left foot
 - ✓ Shoe box
 - ✓ Shoes
- L-amino acids and D-sugars
 - ✓ *Our bodies use only "left-handed" amino acids and "right-handed" sugars...*
- Biomolecular interactions are stereospecific
 - ✓ Complement between interacting partners (p. 18)
 - ✓ Because the enzymes that synthesize them are also chiral molecules (p.18 and 77).



Identifying C

- By number (from atomic number)
- By Greek letter (from side chain)

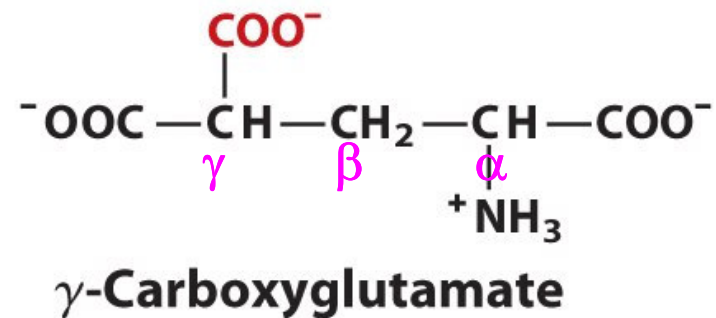
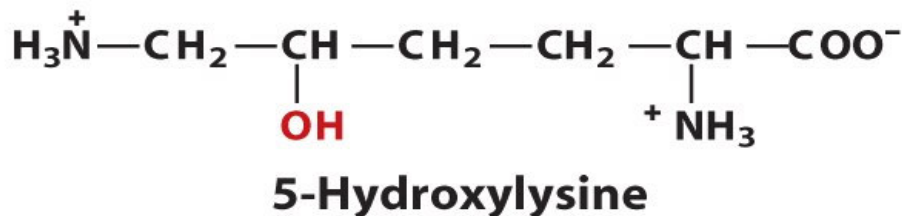
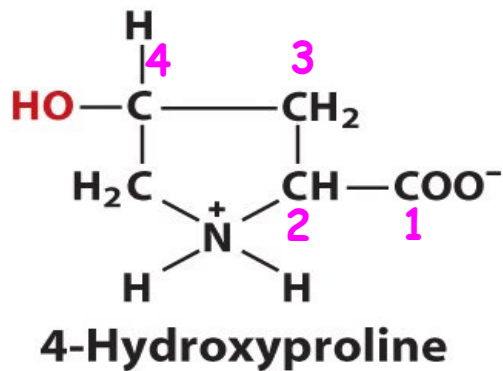


Lysine

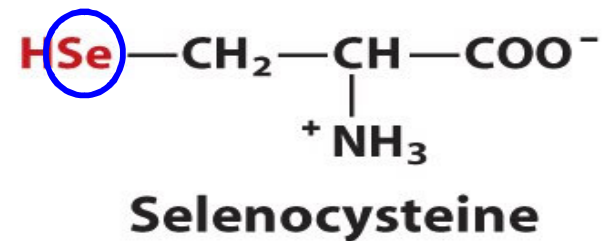
p. 74

Nonstandard amino acids

- Derived from standard amino acid (p. 77-78)
 - 4-hydroxyproline
 - 5-hydroxylysine
 - γ -carboxyglutamate
 - Selenocysteine



selenium (硒)



If only one amino acid (a.a.) begins with a certain letter, that letter is used (p.72)

Cysteine = Cys = C

Histidine = His = H

Isoleucine = **Ile** = I

Methionine = Met = M

Serine = Ser = S

Valine = Val = V

If more than one a.a. begins with a certain letter, that letter is assigned to the most commonly occurring one

Alanine = Ala = A

Glycine = Gly = G

Leucine = Leu = L

Proline = Pro = P

Threonine = Thr = T

Phonetically suggestive

Aspartic acid ("aspar**D**ic acid") = Asp = D

Phenylalanine ("**F**enylalanine") = Phe = F

Arginine ("a**R**ginine") = Arg = R

Tyrosine ("t**Y**rosine") = Tyr = Y

Tryptophan (**double** ring in the molecule)
= **Trp** = W

A letter close to the initial
is used

Asparagine (contains N) = Asn = N

Glutamic acid (near D) = Glu = E

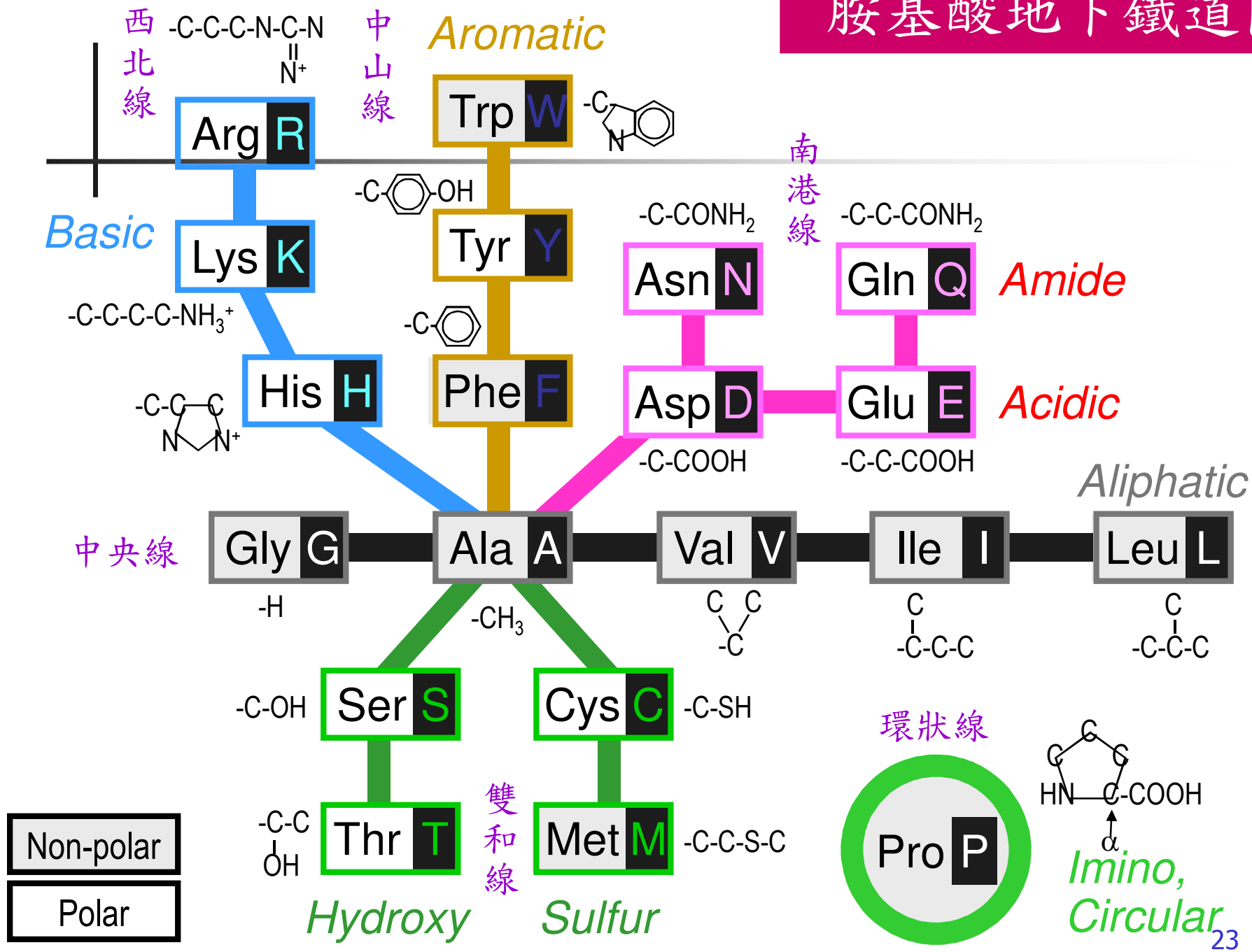
Glutamine ("Q-tamine") = Gln = Q

Lysine (near L) = Lys = K

Amino acids

- Alanine (丙胺酸)
- Arginine (精胺酸)
- Asparagine (天門冬醯胺)
- Aspartate (天門冬酸)
- Cysteine (半胱胺酸)
- Glutamate (麩胺酸)
- Glutamine (麩胺醯胺)
- Glycine (甘胺酸)
- Histidine (組織胺酸)
- Isoleucine (異白胺酸)
- Leucine (白胺酸)
- Lysine (離胺酸)
- Methionine (甲硫胺酸)
- Phenylalanine (苯丙胺酸)
- Proline (脯胺酸)
- Serine (絲胺酸)
- Threonine (蘇胺酸)
- Tryptophan (色胺酸)
- Tyrosine (酪胺酸)
- Valine (纈胺酸)

胺基酸地下鐵道圖



Interesting websites

- Lehniger 5th ed. website:
www.whfreeman.com/lehniger
- www.huichun.tcu.edu.tw
- [台大莊榮輝老師教學網站](#)
- [Quiz on Amino acids](#)
- [Chime](#) plugin is required to run
 - Self-guided tour of the [amino acids](#)
 - [Amino Acid ID Quiz](#)
 - [Biochemistry Quiz on Amino Acids](#)