Amino Acids

By Inga Borchgrevink

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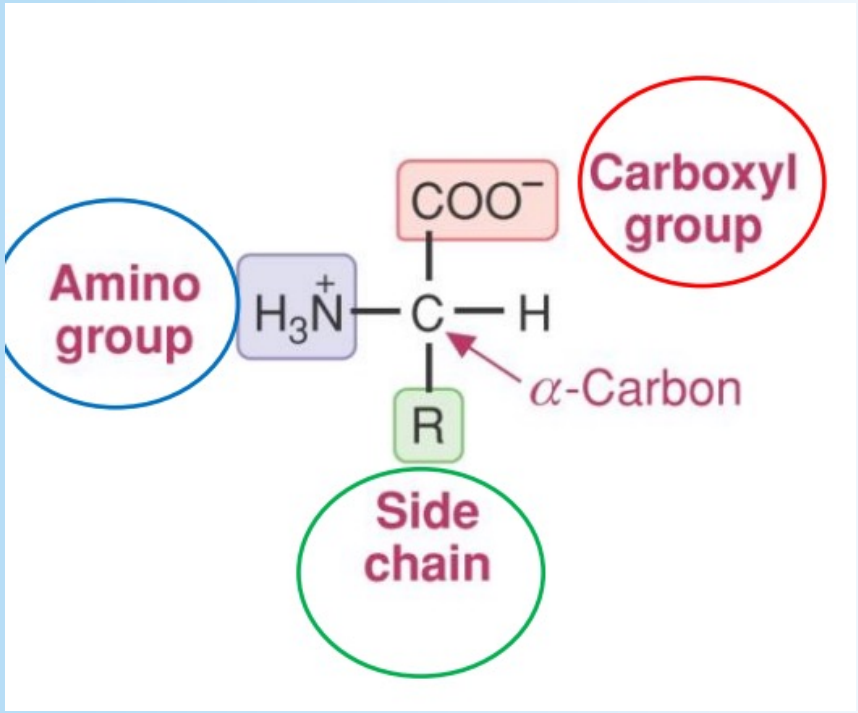
General structure

- Backbone
  - Amino group, α-carbon, carboxyl group, hydrogen
- Unique side chains
- Zwitterions = dipolar ions
  - ion possessing both pos and neg electrical charges
  - All **free** aa are water soluble at physiological pH



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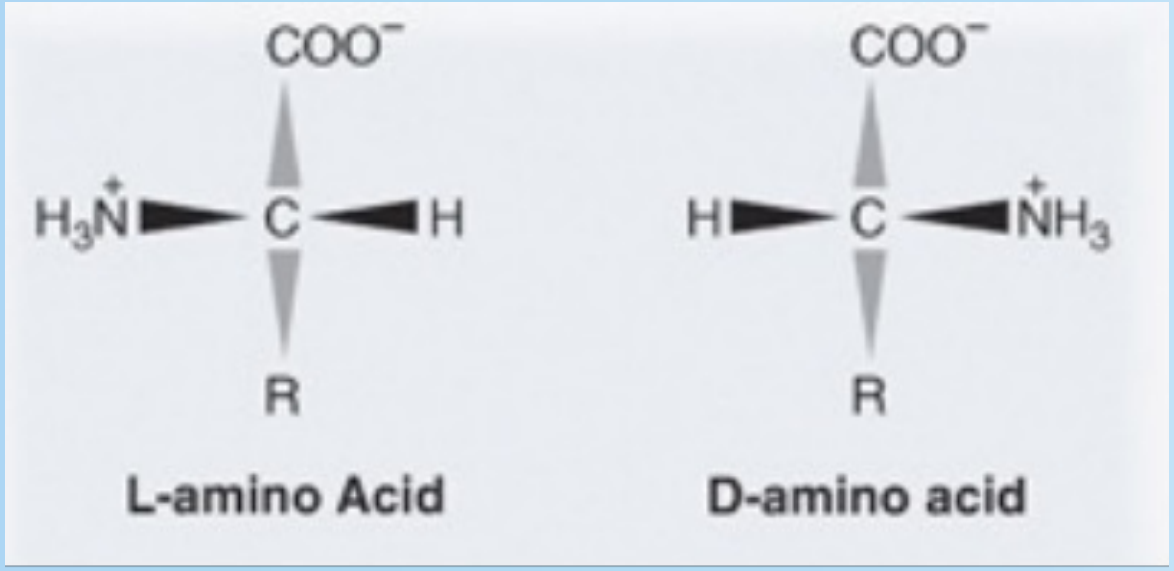
L-α-amino acids

- chiral carbon = 4 single bonds and 4 different groups attached to it
- amino group is attached to the **α-carbon** in the **L-configuration**
- L = left = life (except Glycine)



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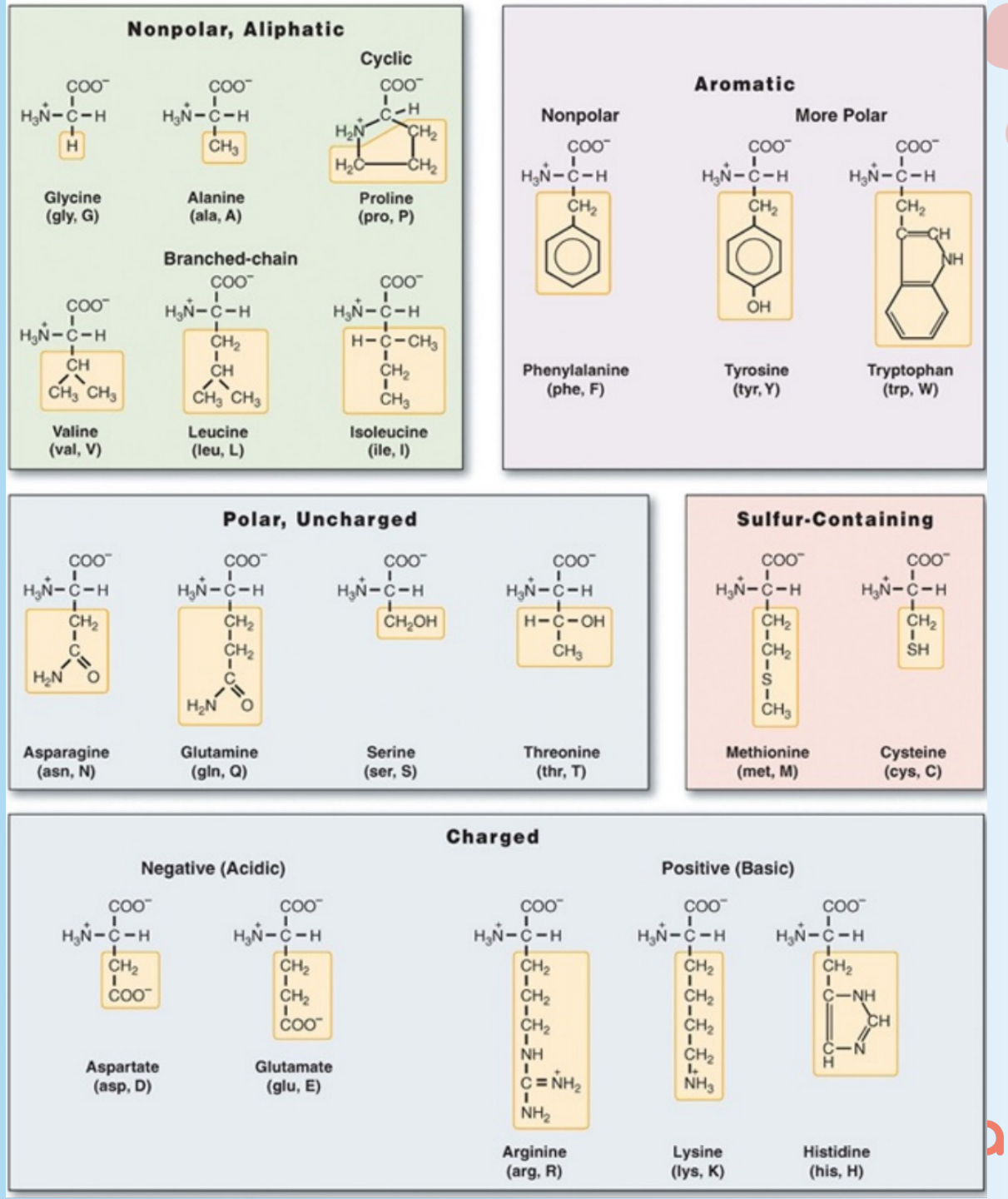
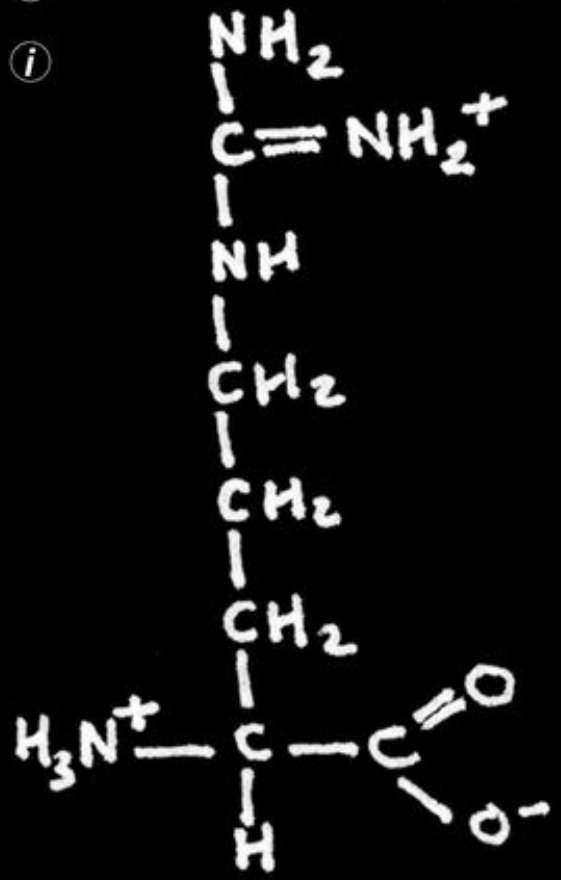
In physiological pH=7.4

Side Chain Classification



Streak: 11



Glu | Ser | Pro | Arg | Trp

Thr | Ile | Met | Lys | Ala

14:51 4G

Søk

Amino Acid Academy

Andrew McGee

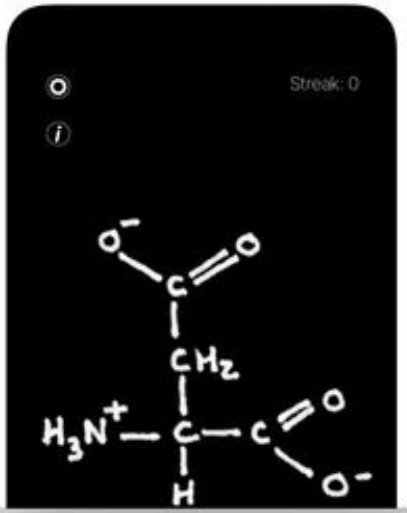
ALDERSGRENSE	KATEGORI	UTVIKLER	SPRÅK
4+ år	Utdannelse	Andrew McGee	EN Engelsk

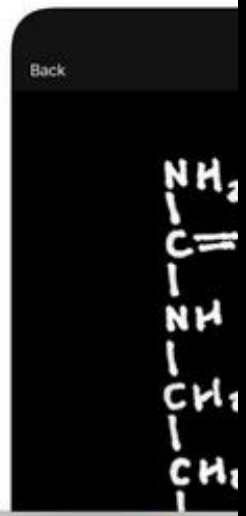
Nytt Versjonslogg

Versjon 1.3.1 — 1 md. siden

Updated for iOS 17!

Forhåndsvisning

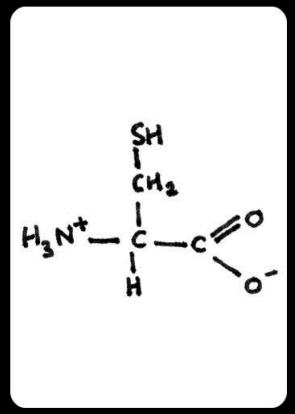


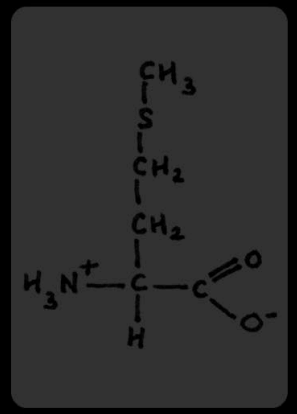


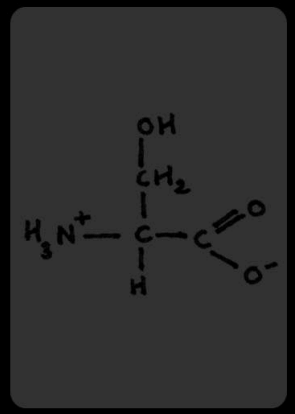
I dag | Spill | Apper | Arcade | Søk

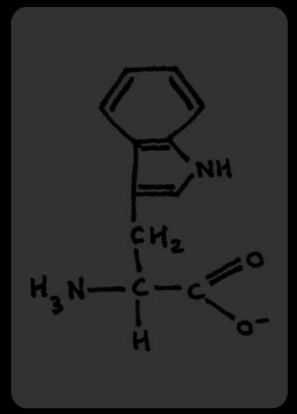
Streak: 100

Correct!
This is Cysteine.
(Cys, C)



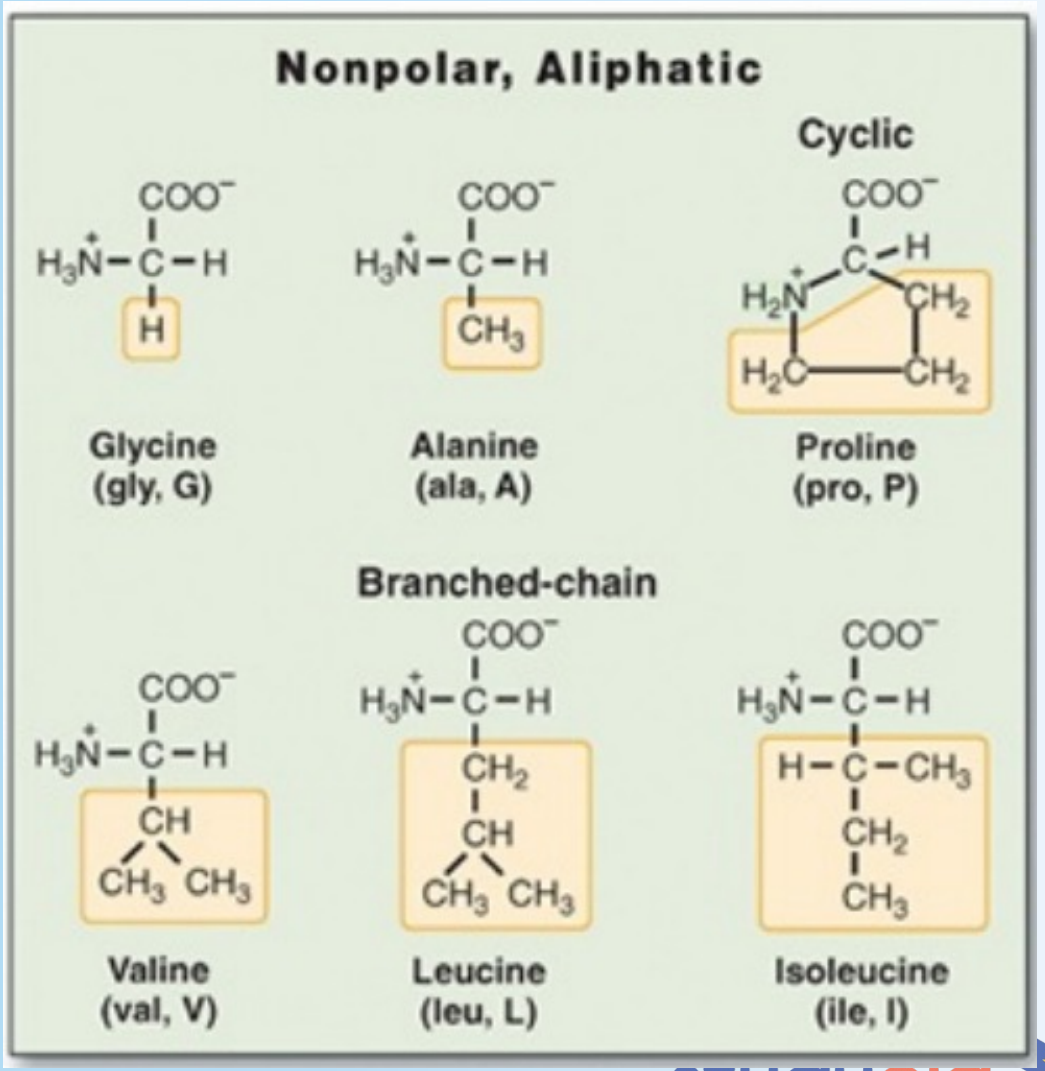






Nonpolar aliphatic

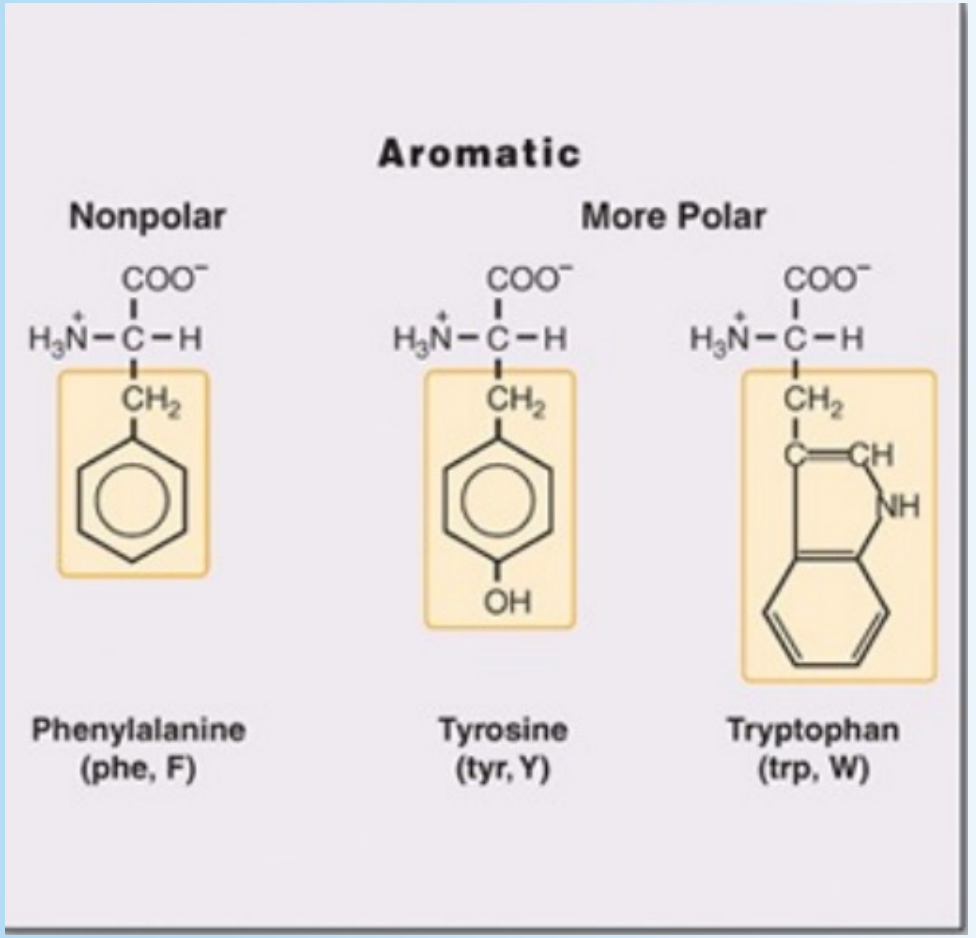
- Hydrophobic = phobia of water
- Van der Waals forces
- Aliphatic = only H and C and single bonds
- Glycine
  - Simplest aa
  - Not asymmetric
- Alanine + BCAA
  - High degree hydrophobicity
- Proline
  - Side chain forms a ring that include its backbone → restrict the conformation of the protein



Aromatic

- Aromatic = sixmembered carbon-hydrogen ring with three conjugated double bonds (benzene or phenyl)
- Absorbe UV-light

- Phenylalanine
  - Nonpolar
- Tyrosine
  - OH- group on phenyl ring → form hydrogen bonds
  - Polar
- Tryptophan
  - N in the ring → form hydrogen bonds
  - Polar



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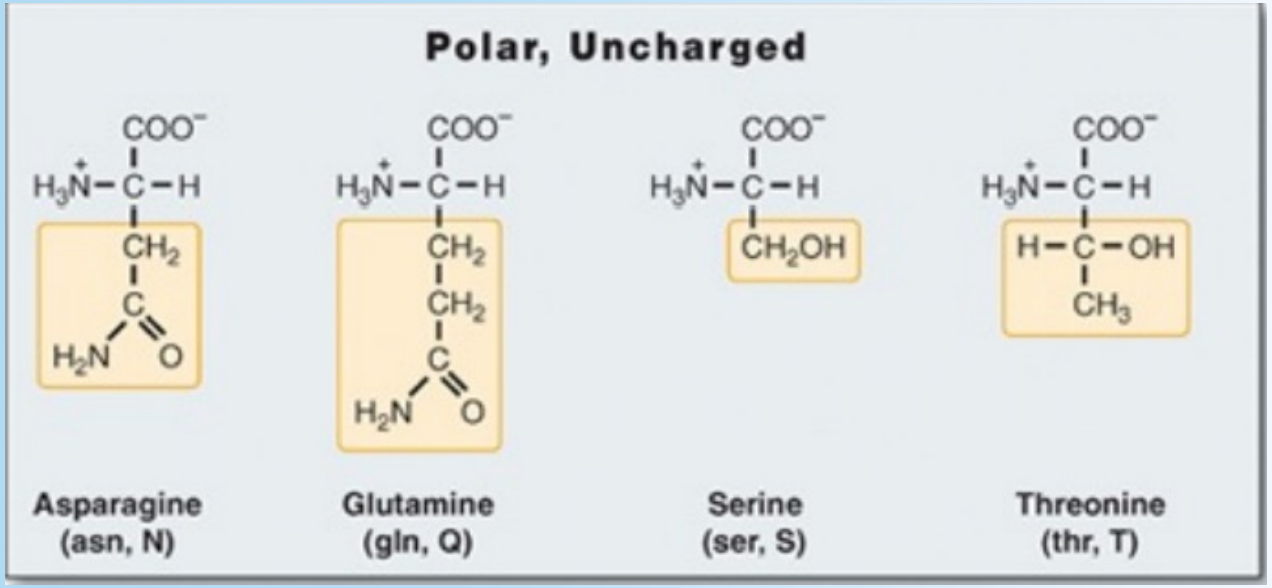
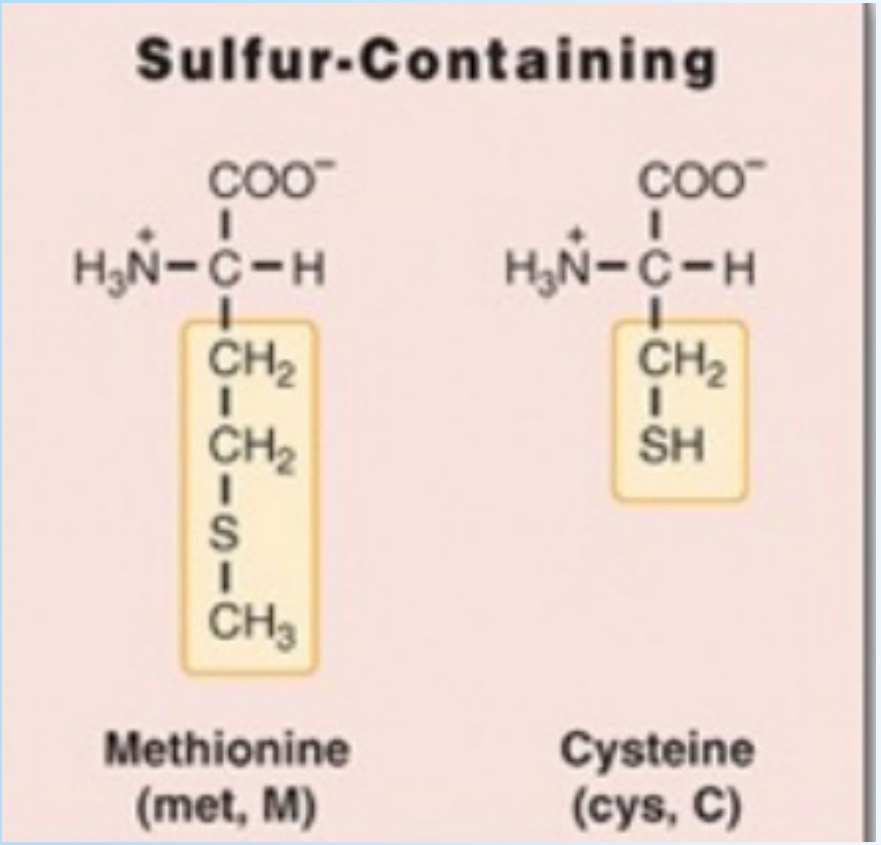
Polar, Uncharged

- Hydrophilic = 💙 water
- Asparagine and Glutamine
  - Amide group → hydrogen bonds
- Serine and Threonine
  - Hydroxyl group → hydrogen bonds



Sulfur containing

- Cysteine
  - Sulfhydryl group → covalent **disulfide bond** with other cysteine
  - Polar
- Methionine
  - does not contain sulfhydryl group → cannot form disulfide bonds!
  - nonpolar



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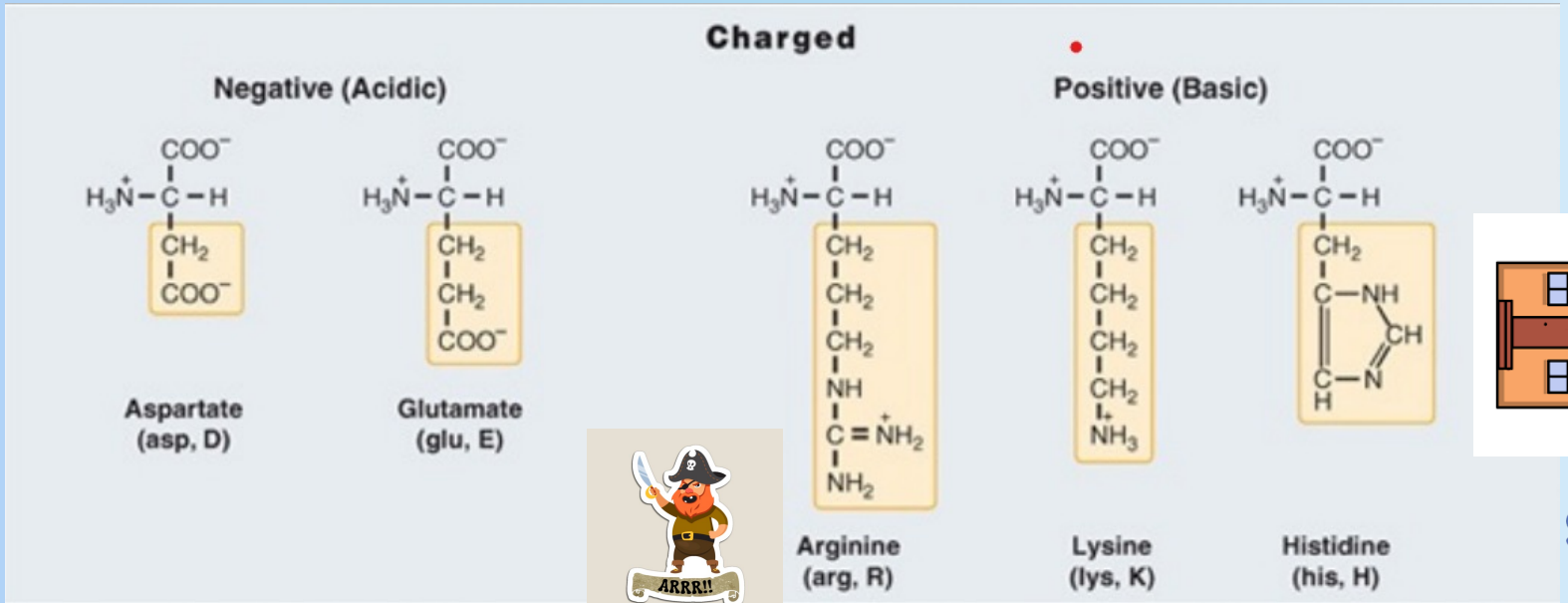
Charged

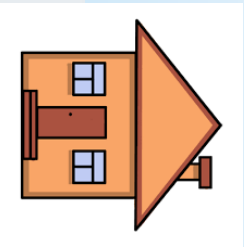
Acidic

- Carboxylic acid group
- **Negative** charge at physiological pH
- Polar
- Ionic and hydrogen bonds, salt bridges

Basic

- Nitrogen that can be pronated
- **Positive** charge at physiological pH
- Polar
- Ionic and hydrogen bonds, salt bridges





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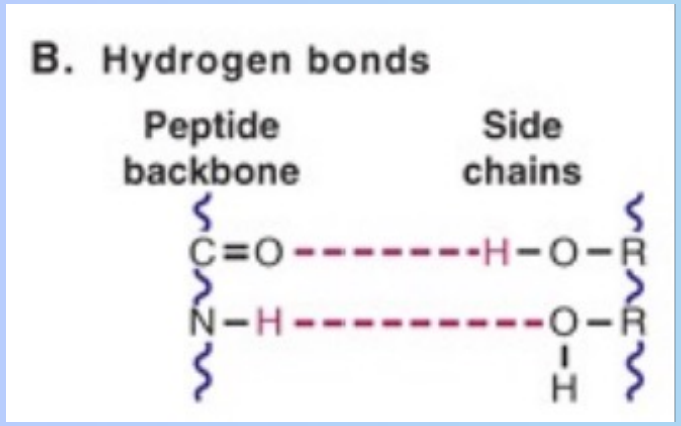
Bonds from side chains

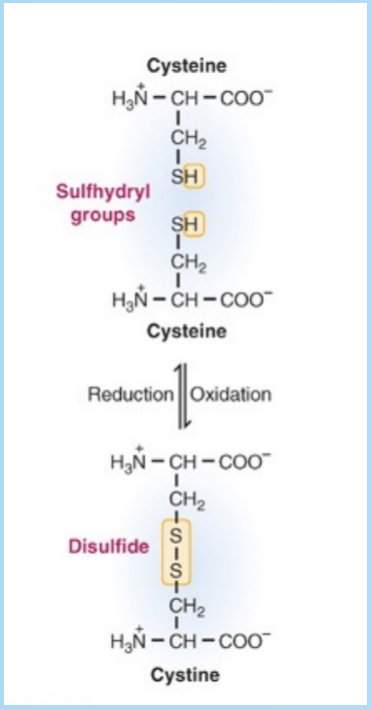
Hydrogen bonds

- Polar
- Hydrogen with NOF



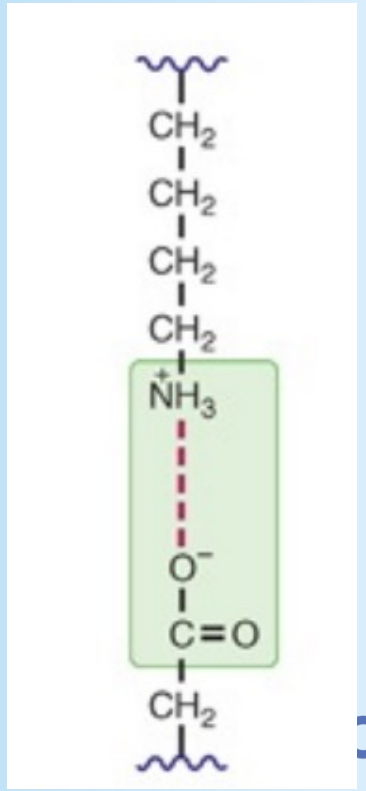
Disulfide bond

- Cys – Cys



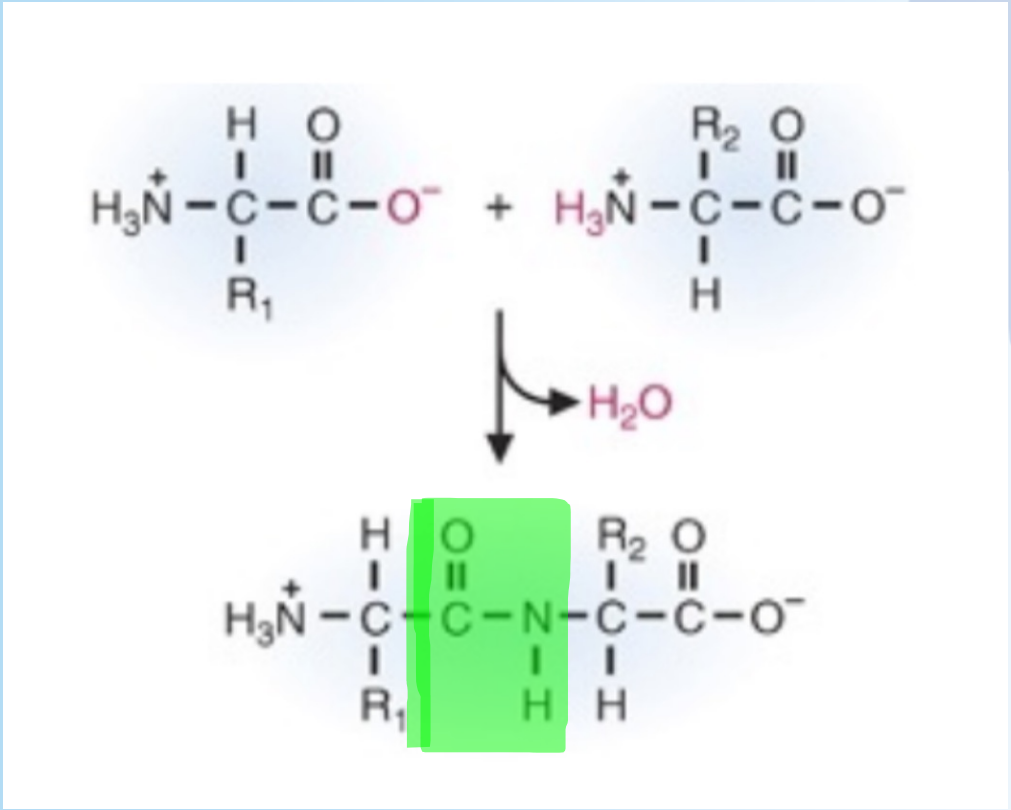
Ionic

- Neg AA - pos AA



Peptide bond

- **CONH**
- Condensation reaction
- → make polypeptides
- Always planar → very little rotation
  - → stabilize protein structure
- Usually trans configuration
- Always read from N → C



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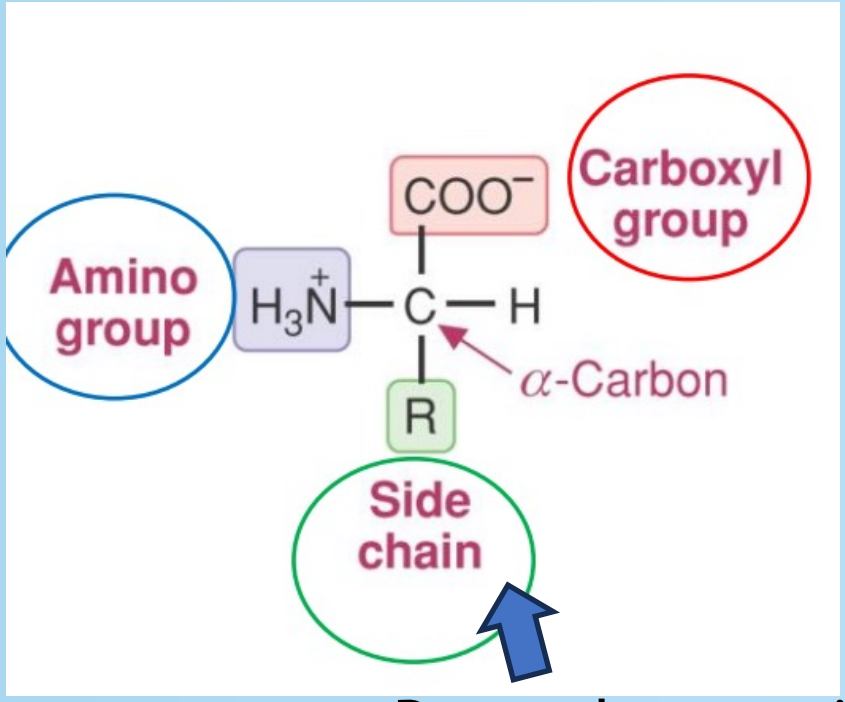
pKa

- pKa = pH at which 50% of the protons have dissociated
- Each group that has a dissociable proton, have a pKa
  - In polypeptides only the first amino group and the last carboxyl group + side chains have pKas

pKa ≈ 9.5



pKa ≈ 2

Depends on amino acid

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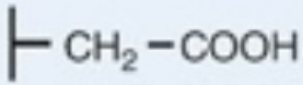
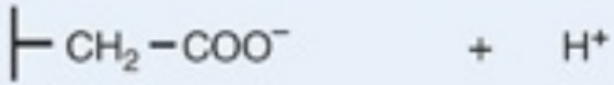
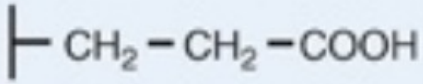
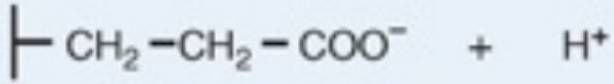
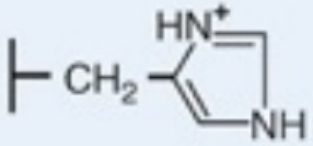
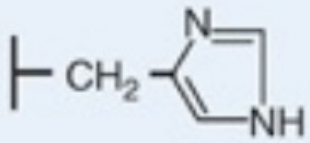
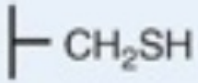
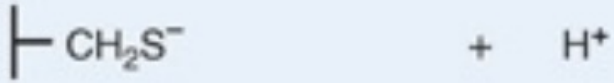
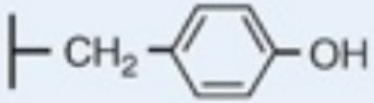
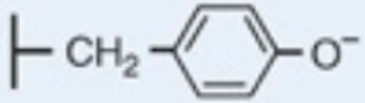
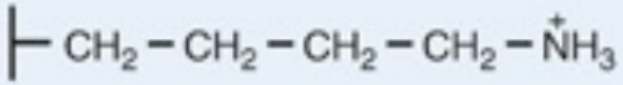
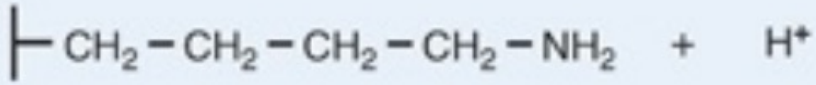
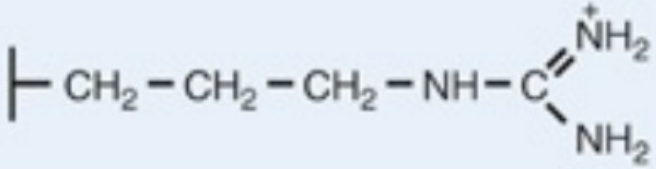
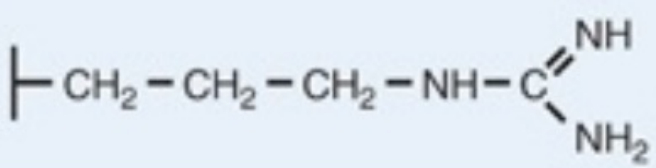
	Form that predominates below the pK_a	pK_a	Form that predominates above the pK_a
Aspartate		3.9	
Glutamate		4.1	
Histidine		6.0	
Cysteine		8.4	
Tyrosine		10.5	
Lysine		10.5	
Arginine		12.5	

Isoelectric point=pl/IEP

- **= the pH at which the NET charge is 0**
- If 3 pKa → use the ones on each side of net charge 0

$$pl = \frac{pKa_1 + pKa_2}{2}$$

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⇧Free H+

Molecules wants to
KEEP H for themself

⇩Free H+

Molecules wants
to GIVE H away

pH

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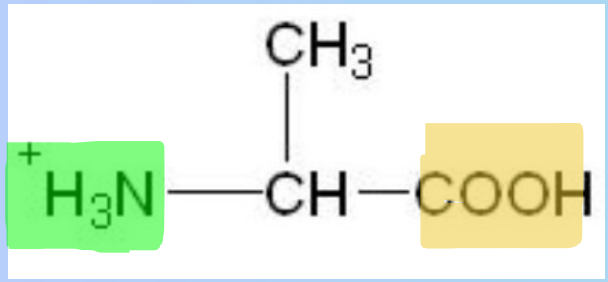
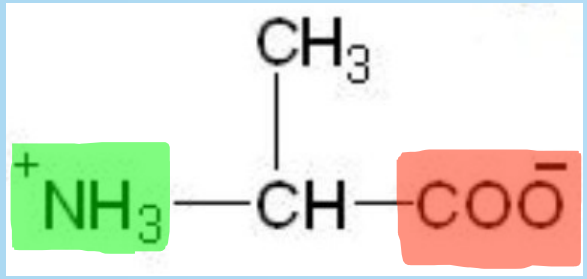
⬆Free H+

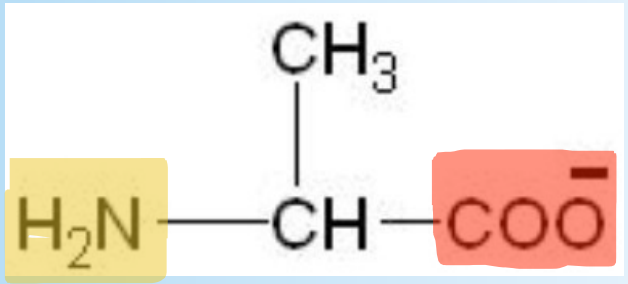
Alanine in different pH

$pKa_1 = 2,3, \qquad pKa_2 = 9,7$

⬇Free H+







+1 0 -1

2,3 9,7

$$pI = \frac{2,3 + 9,7}{2} = 6$$

pH

Physiological pH: Charge = 0

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Arginine shows 3 pKas at 1.8, 9.0 and 12.5. What is the charge at physiological pH (7.4) and the pI value?

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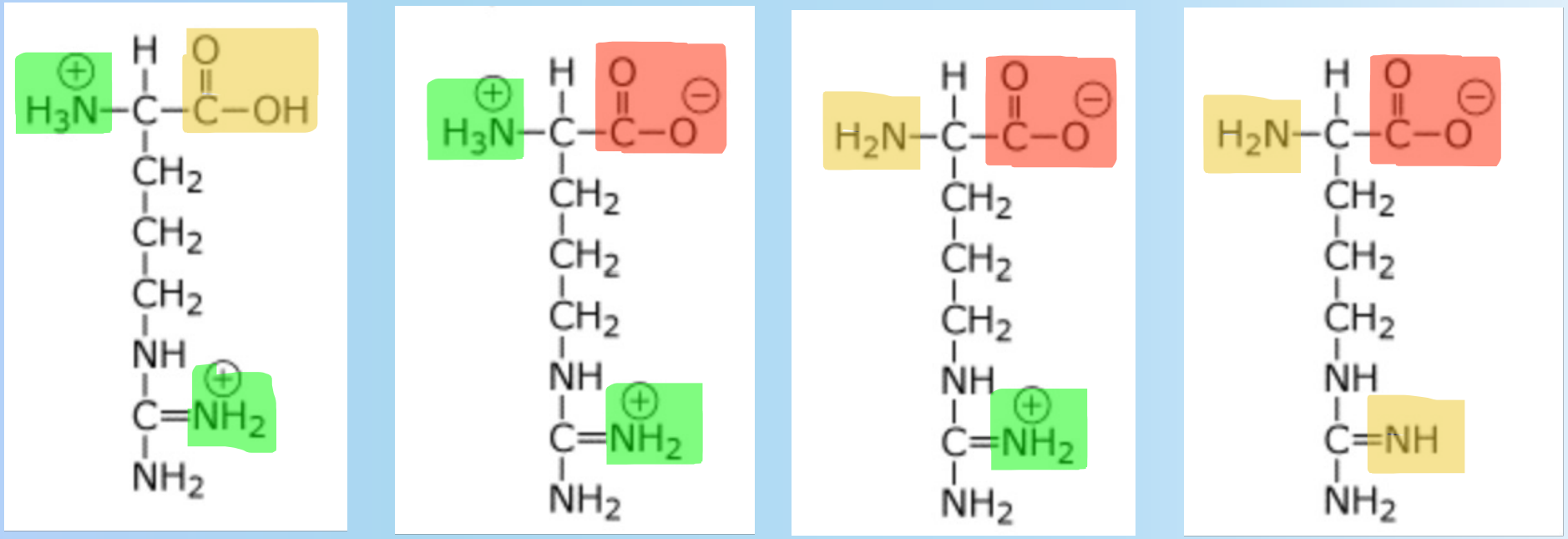
Arginine in different pH

⇧Free H+ $pKa_1 = 1,8,$ $pKa_2 = 9,3,$ $pKa_3 = 12,5$ ⇩Free H+



+2 +1 0 -1

1,8 9,0 12,5

Physiological pH: Charge = +1

pH

$$pI = \frac{9,0+12,5}{2} = 10,75$$

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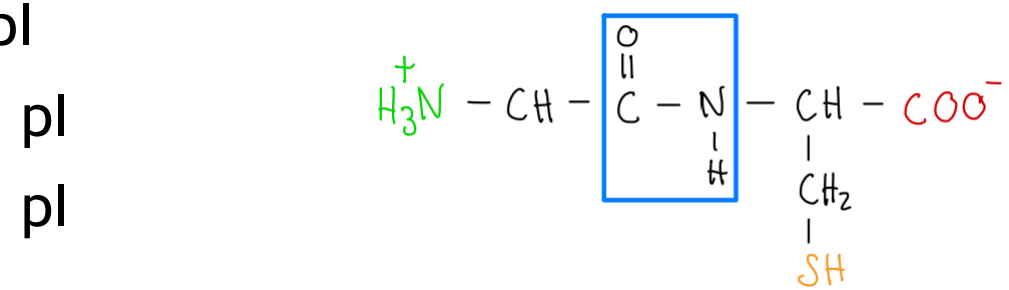
Draw all possible ionic forms of dipeptide Ala-Cys and choose which form is predominant at:

a) pH=pI

b) pH > pI

c) pH < pI



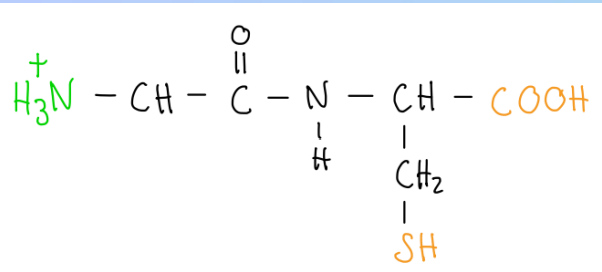
Ala: pKa(COOH)= 2,34, pKa(NH3+)= 9,69;

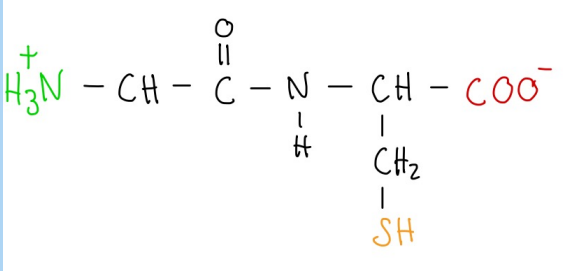
Cys: pKa(COOH)= 2,0, pKa(NH3+)= 8,2, pKa(SH)= 10,3

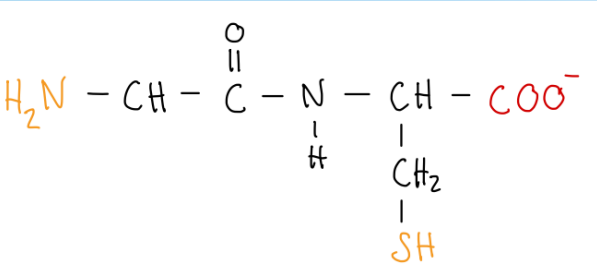
⬆Free H+

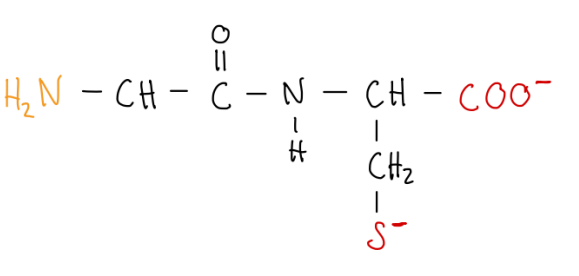
⬇Free H+

Ala: pKa(NH3+)= 9,69;
Cys: pKa(COOH)= 2,0, pKa(SH)= 10,3









+1 **0** **-1** **-2**

pH<pI **2** **pH=pI** **9,69** **pH>pI** **10,3** **pH>>pI**

Physiological pH:
Charge = 0

pH

$$pI = \frac{2+9,69}{2} = 5,845$$

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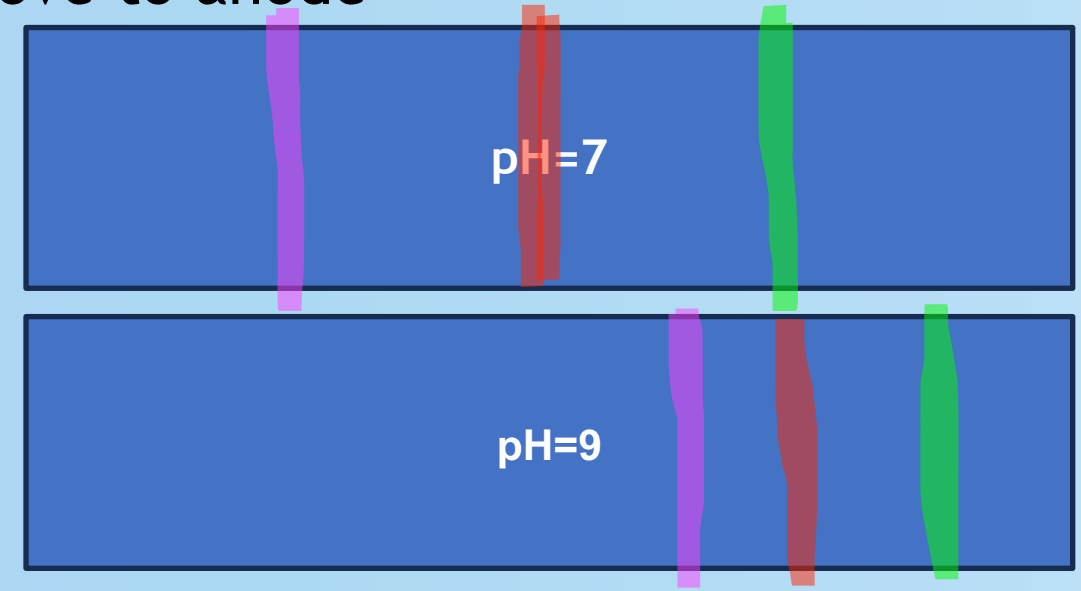
Electrophoretic separation

- Use electrical charge to separate AA and proteins
- If pH = pI the protein will stand still
- If pH < pI → move to cathode
- If pH > pI → move to anode

pI = the pH where net charge is 0!!!



- pI = 6, pI = 7, pI = 8

Cathode

-

Anode

+

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Protein and enzymes

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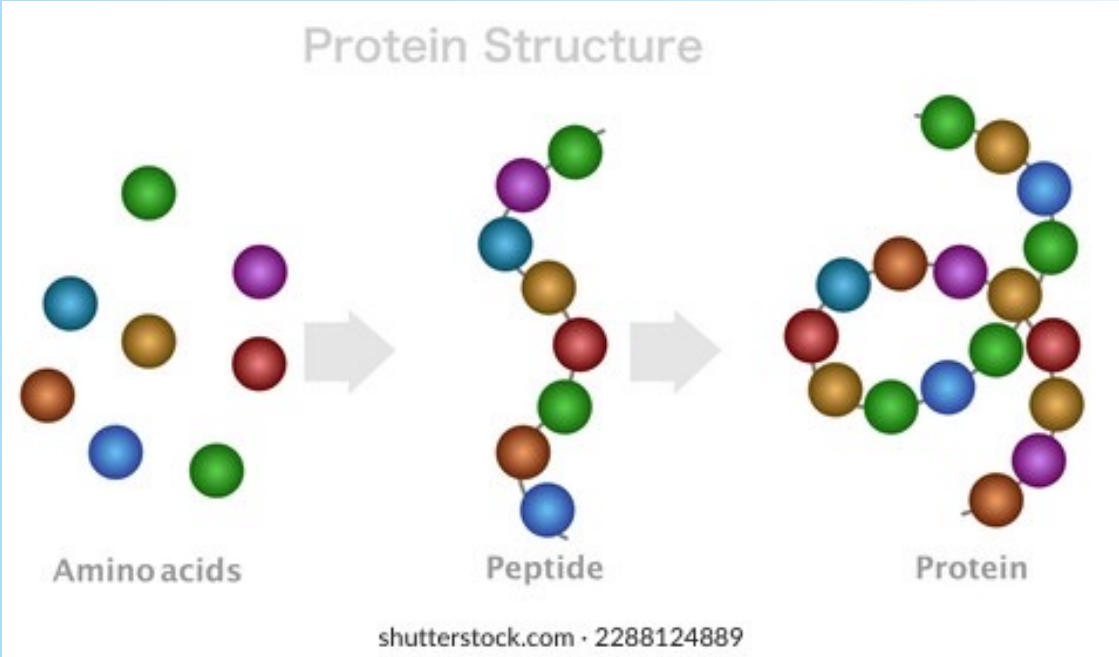
Peptides → Proteins

- Peptides = short polymers of amino acids
  - Each unit (aa) is called a residue
  - **2** residues – **di**peptide
  - **3** residues – **tri**peptide
  - **12-20** residues – **oligo**peptide
  - < 51 – polypeptide
  - **> 51 - protein**
- Always N → C



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Levels of protein structure

- Primary –
  - sequence of aa
- Secondary –
  - a- helix, b-sheets and turns
  - stabilized by hydrogen bonds
- Tertiary –
  - 3D configuration
  - Domains and folds
  - Makes binding site for ligands
- Quaternary –
  - two or more subunits
  - Binding site for ligands

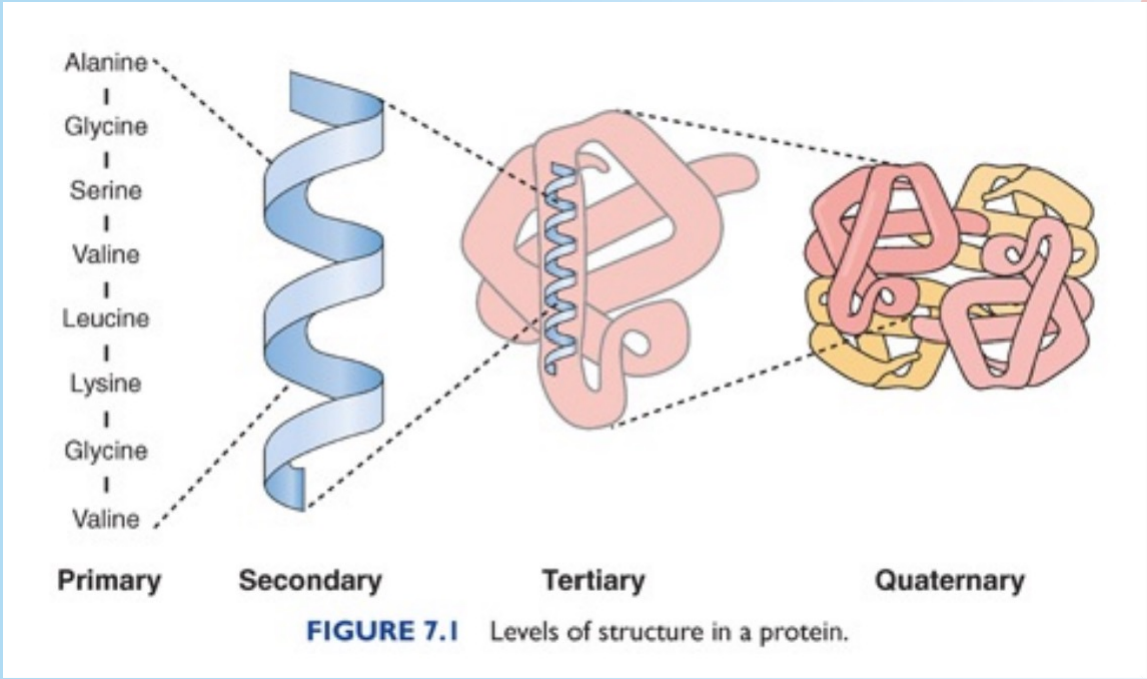
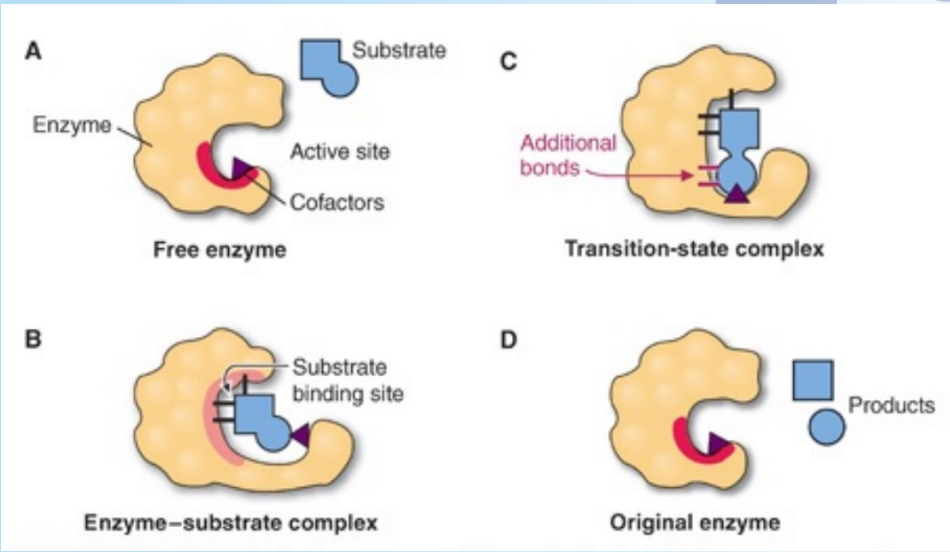


FIGURE 7.1 Levels of structure in a protein.

Enzymes



- = proteins that act as catalysts
  - → increase the rate of chemical reactions
- Bind reactants (substrates)
  - → convert them to products
  - → release the products
- May be modified during their participation, but return to their original form
- Regulate the rate of metabolic pathways in the body ++

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