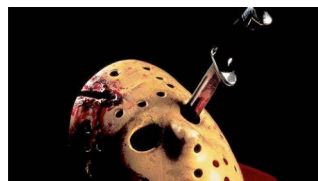


- Reading: Ch3; 70-76
- Homework #1-4 (due this Sunday)

Lecture 4 (9/12/25)



NEXT

- Reading: Ch3; 76-82, 87-89
- Homework #5

OUTLINE

Amino Acids

- Definition, Structure, and Properties
 - The 4 S's
 - Common Properties
 - Five Classes
 - Hydrophobic-aliphatic [6]
 - Hydrophobic-aromatic [3]
 - Special-sulfur [2]
 - Hydrophilic-polar [4]
 - Hydrophilic-charged [5]

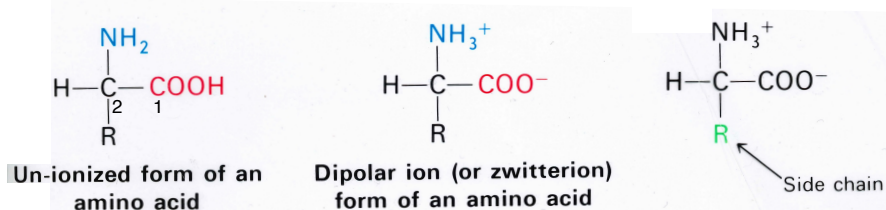
Amino Acids: Building Blocks of Protein

Definition

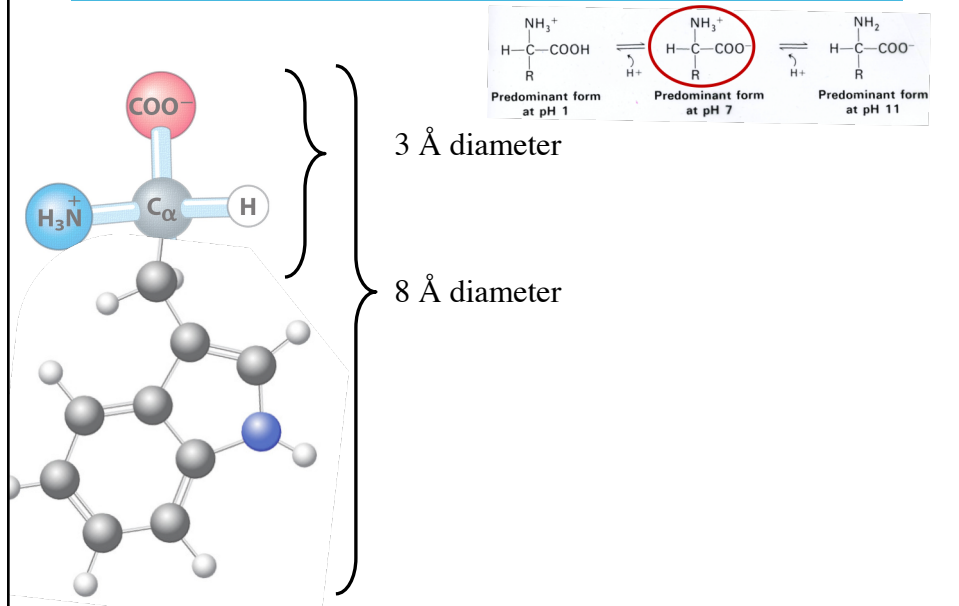
- Proteins are linear heteropolymers of L- α -amino acids.
- These are organic acids with an amino group at the α -position, or the 2-position.

ϵ
6
 δ
5
 γ
4
 β
3
 α
2
1

$C-C-C-C-C$
 Functional Group (COO^-)
- The amino group is basic and the carboxylate group is acidic (of course). The R-groups are different.



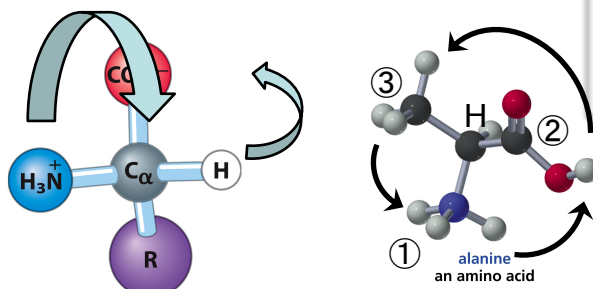
The 4 S's: Size Amino Acids: Building Blocks of Protein



The 4 S's: Shape Amino Acids: Building Blocks of Protein

Here we have to discuss stereochemistry: particularly what is meant by the "L" configuration
The "L" configuration means levorotary, or rotates polarized light counter-clockwise, or left handed

In R/S, this is what?



Recall:

Clockwise is R

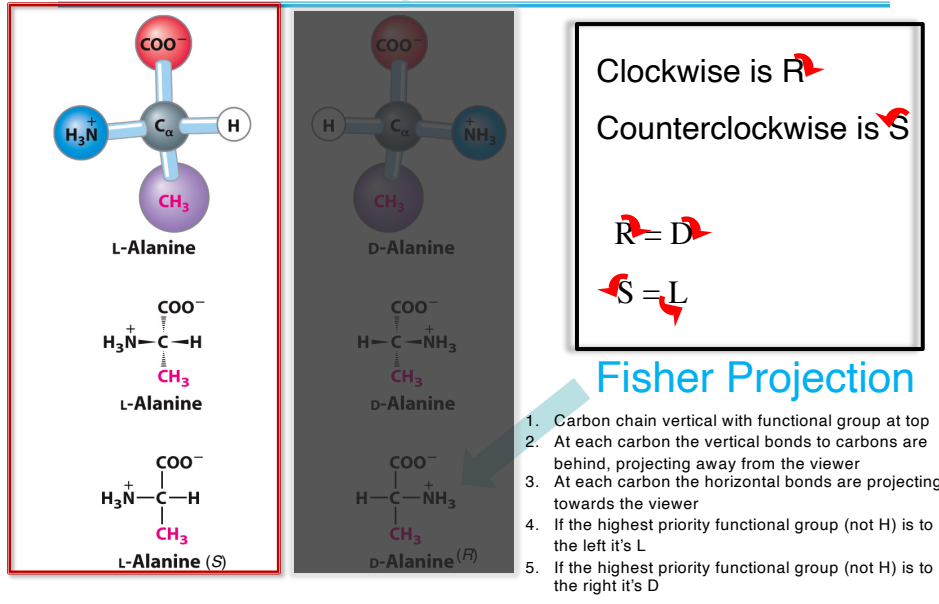
Counterclockwise is S

What is the relationship between R/S and D/L?

R = D

S = L

The 4 S's: Shape Amino Acids: Building Blocks of Protein



The 4 S's: Stability Amino Acids: Building Blocks of Protein

Most amino acids are stable to acid, base, and heat

Exceptions are:

1. Tryptophan (oxidation) → N-formyl-kynurenine
2. Cysteine (oxidation) → Disulfides (R'-S-S-R'')
3. Asparagine (deamination) → Hydrolysis of amide: Asp
4. Glutamine (deamination) → Hydrolysis of amide: Glu

The 4 S's: Solubility Amino Acids: Building Blocks of Protein

- As zwitterions, most amino acids are soluble to some degree. But, depending on the R group they are less soluble or more soluble
- The general grouping puts 10 as less soluble:

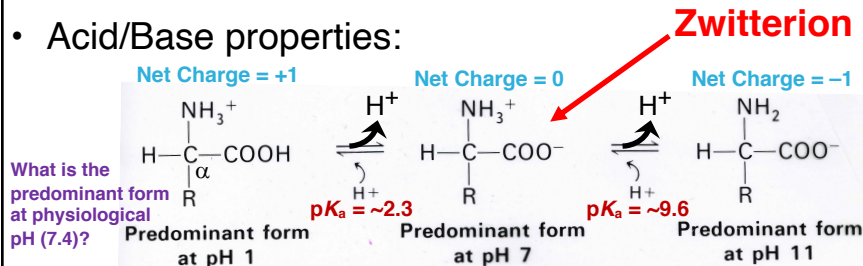
A, V, L, I, P, W, Y, F, M, C

- and 10 as more soluble:

G, S, T, N, Q, D, E, H, K, R

Amino Acids Have Three Common Properties

- Groups Attached to the α Carbon. The α carbon always has four substituents and is tetrahedral.
 - an **acidic** carboxyl group connected to the α carbon
 - a **basic amino** group (1° or 2°) connected to the α carbon
 - an α hydrogen connected to the α carbon
 - A fourth substituent called an “R group.”
- All Amino Acids are chiral with the L configuration (except glycine where the R-group is a hydrogen).
- Acid/Base properties:



Amino Acids: Classification

- The 20 amino acids found in proteins can be placed in five families based on the physical and chemical properties of their R groups:

Must KNOW:

Name
3-letter abbrev.
1-letter abbrev.
recognize and
draw the structure,
including the charge

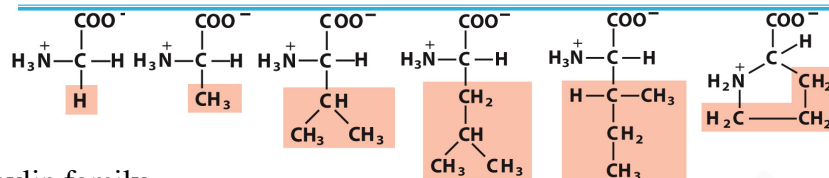
- Hydrophobic, aliphatic (6)
- Hydrophobic, aromatic (3)
- Special (hydrophobic/hydrophilic) (2)
- Hydrophilic, polar (4)
- Hydrophilic, charged (5)

Essential

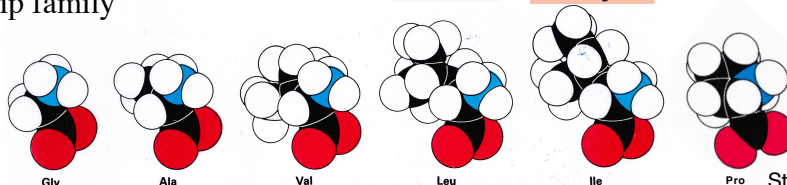
Table:

Name	3-letter	1-letter	Year discovered	% abundance in proteins	NOTES	Structure mnemonic device
✓						

Hydrophobic, aliphatic Amino Acids: Classification



Gavlip family



Name	3-letter	1-letter	Year discovered	% abundance in proteins	NOTES	Structure mnemonic device
Glycine	Gly	G	1820	7	Smallest, not chiral	H
Alanine	Ala	A	1888	8	Foundational for ~10 other AA	Methyl
Valine ✓	Val	V	1856	7	isopropyl	V-shaped
Leucine ✓	Leu	L	1819	10		Ala + Val
Isoleucine ✓	Ile	I	1904	6	Two chiral centers (L & D)	Val + Me
Proline	Pro	P	1901	5	Only imino acid (2° amine); special bonds in proteins; is modified by hydroxyl	5-membered ring; same # as Val; 3C

Amino Acids: Classification

- The 20 amino acids found in proteins can be placed in five families based on the physical and chemical properties of their R groups:
 - Hydrophobic, aliphatic (6) Gavlip family
 - Hydrophobic, aromatic (3)
 - Special (hydrophobic/hydrophilic)(2)
 - Hydrophilic, polar (4)
 - Hydrophilic, charged (5)

Hydrophobic, aromatic **Amino Acids: Classification**

PTT family (push-to-talk)

Absorbance

Wavelength (nm)

Phe Tyr Trp

Recall:

Fluorescent

360 nm

Phe Tyr Trp

Absorb UV light

λ_{max}	Extinction coefficient ($\times 10^{-3}$)
259	0.7
278	1.1
279	5.2

Name	3-letter	1-letter	Year discovered	% abundance in proteins	NOTES	pK_a	Structure mnemonic device
Phenylalanine	✓Phe	F	1879	4	aromatic		Phenyl+Ala
Tyrosine	Tyr	Y	1846	3	aromatic, can ionize; $pK_a \approx 10.1$ amphipathic		p-phenol+Ala
Tryptophan	✓Trp	W	1901	1	aromatic & fluorescent; least abundant		Indole+Ala

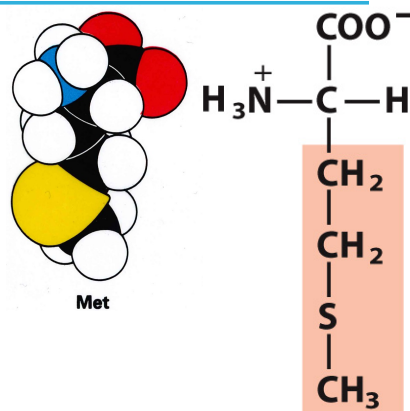
Amino Acids: Classification

- The 20 amino acids found in proteins can be placed in five families based on the physical and chemical properties of their R groups:
 - Hydrophobic, aliphatic (6) Gavlip family
 - Hydrophobic, aromatic (3) PTT family
 - Special (hydrophobic/hydrophilic)(2)
 - Hydrophilic, polar (4)
 - Hydrophilic, charged (5)

Special (Sulfur)

Hydrophobic

Amino Acids: Classification



Name	3-letter	1-letter	Year discovered	% abundance in proteins	NOTES	pK _a	Structure mnemonic device
Methionine ✓	Met	M	1922	2	Most like straight-chain aliphatic		Ala+Me/ether