BIO-ORGANIC CHEMISTRY
(Organic Chemistry for Biology Students)
(SQBS 1603)

Basic Compounds in Biomolecules: Amino Acids in Protein

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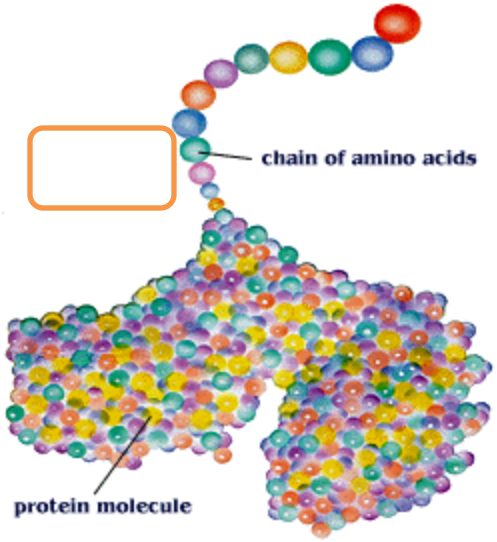
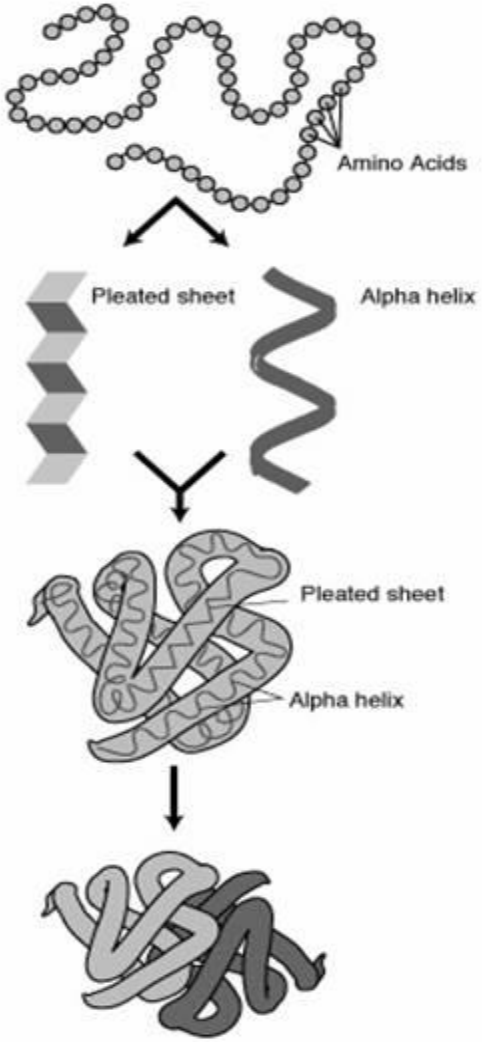
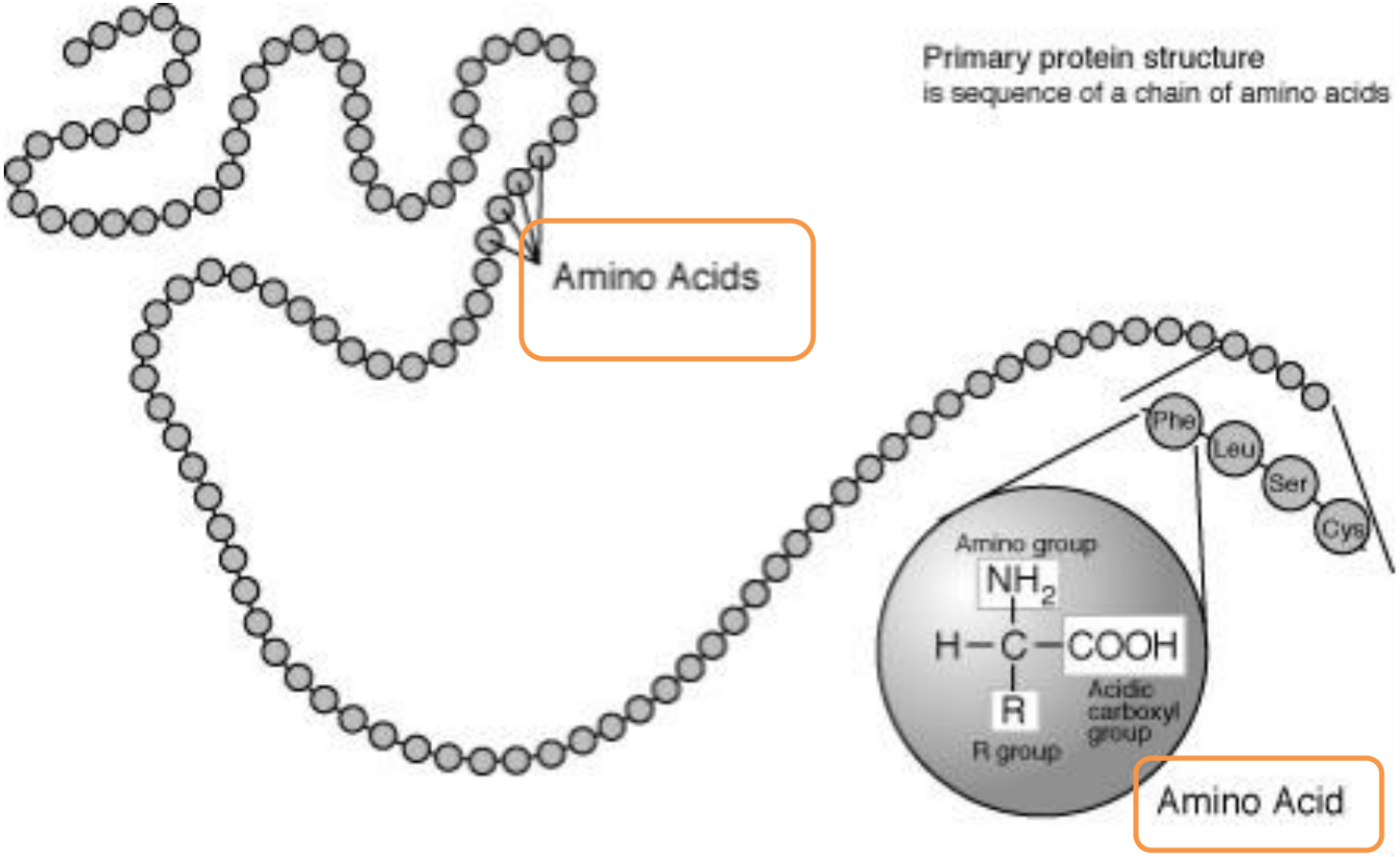
Protein

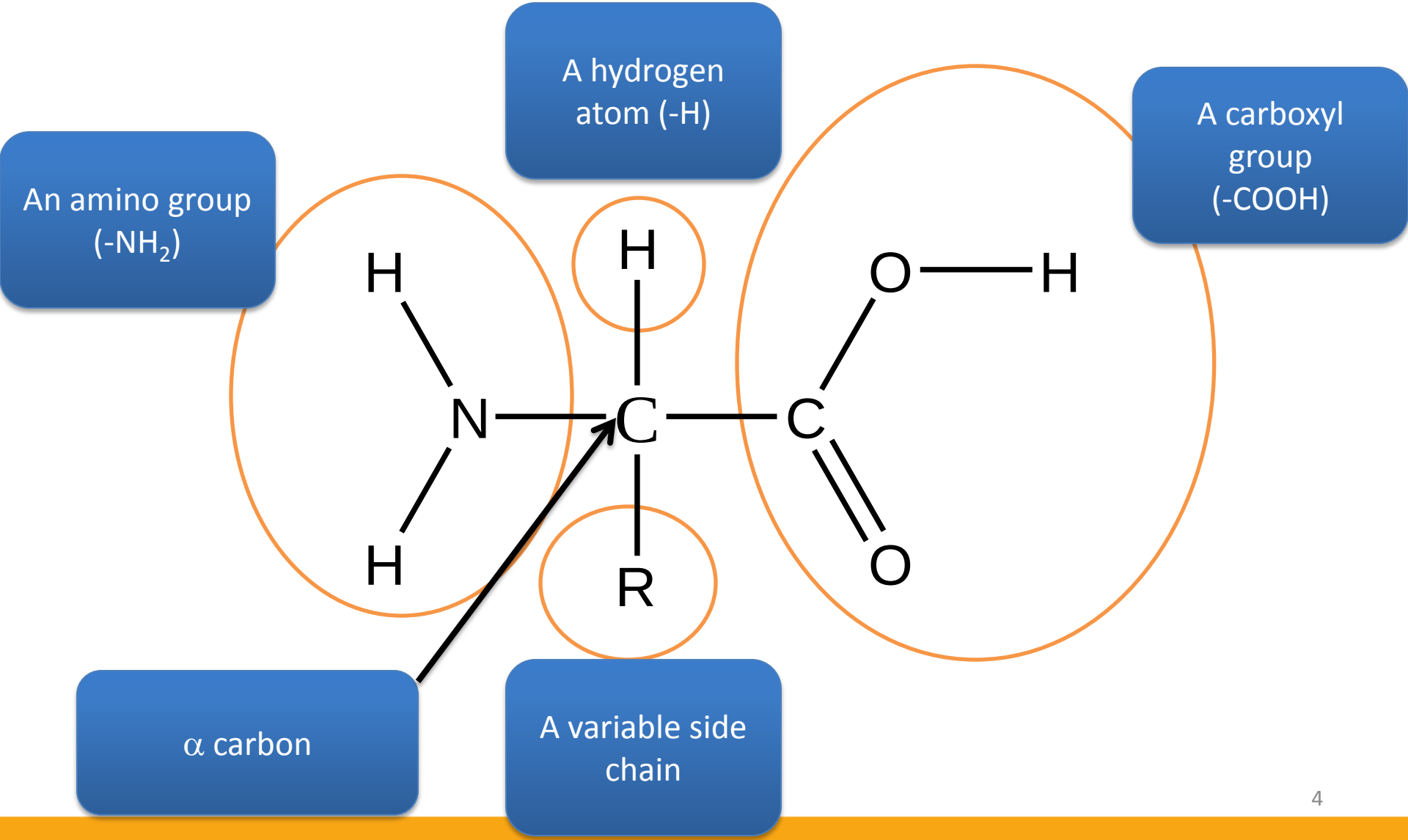

chain of amino acids
protein molecule


Amino Acids
Pleated sheet
Alpha helix
Pleated sheet
Alpha helix

Protein

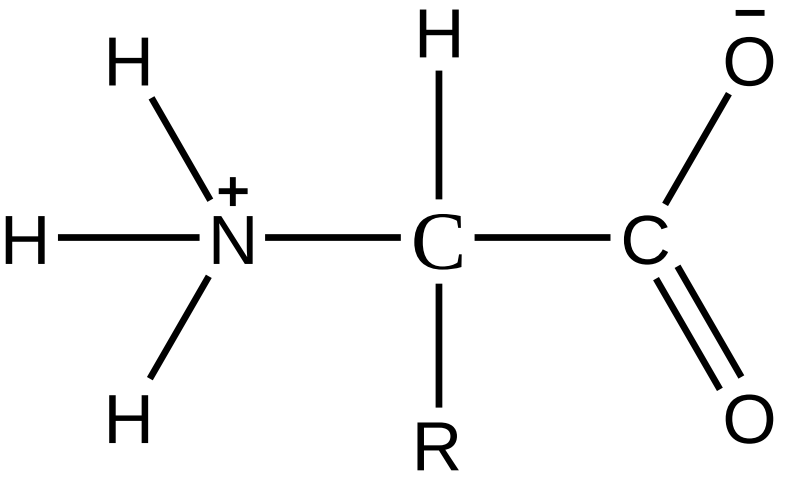

Primary protein structure
is sequence of a chain of amino acids
Amino Acids
Phe
Leu
Ser
Cys
Amino group
NH2
H—C—COOH
R
Acidic carboxyl group
R group
Amino Acid

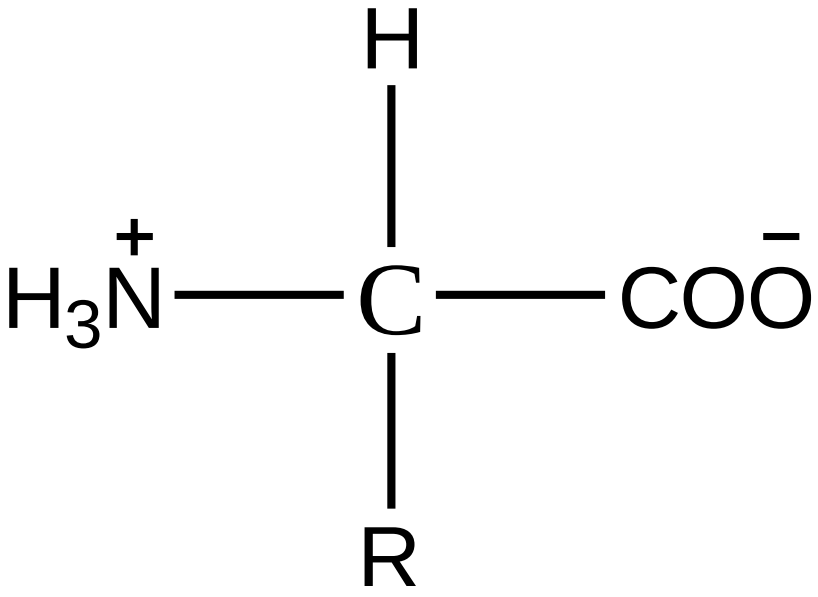
Amino acid


A hydrogen atom (-H)
An amino group (-NH2)
A carboxyl group (-COOH)
H
H
O
H
N
C
C
H
O
H
R
O
α carbon
A variable side chain

Amino acid

Ionized for of amino acid:





Amino acid

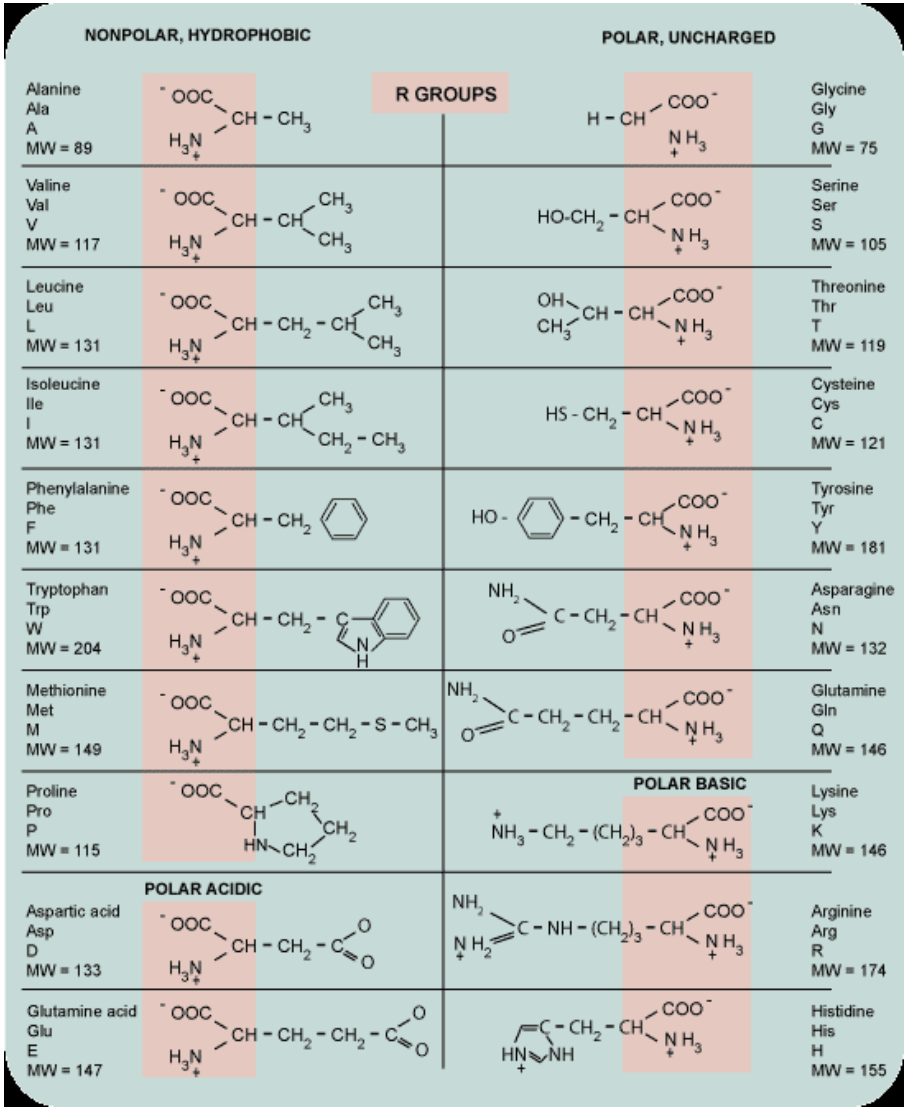
The 20 common naturally occurring amino acids

Name	Abbreviations	symbol
Glycine	Gly	G
Alanine	Ala	A
*Valine	Val	V
*Leucine	Leu	L
*Isoleucine	Ile	I
*phenylalanine	Phe	F
Proline	Pro	P
Serine	Ser	S
*Threonine	Thr	T
tyrosine	Tyr	Y

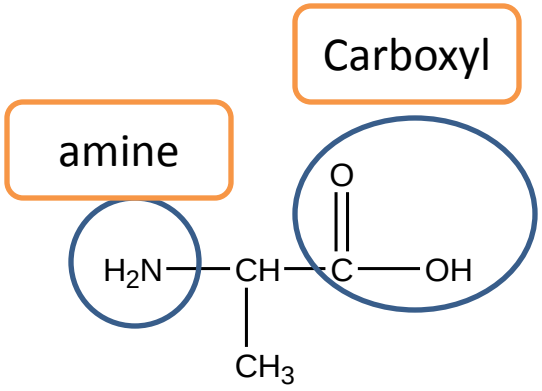
Name	Abbreviations	symbol
Cysteine	Cys	C
*Methionine	Met	M
Asparagine	Asn	N
Glutamine	Gln	Q
*Tryptophan	Trp	W
Aspartic acid	Asp	D
Glutamic acid	Glu	E
*Lysine	Lys	K
*Arginine	Arg	R
PHistidine	His	H

*Essential amino acids

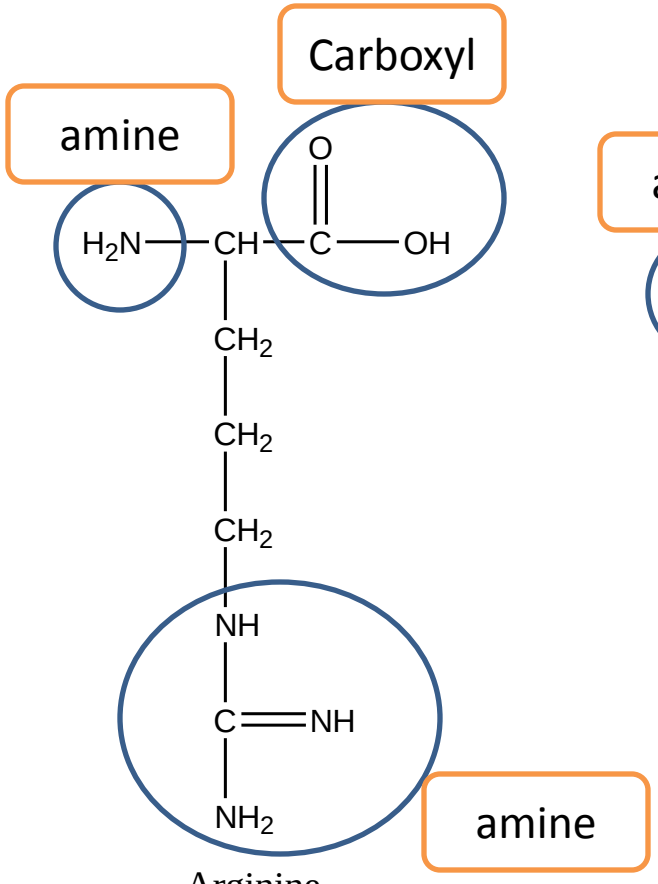
The 20 common naturally occurring amino acids



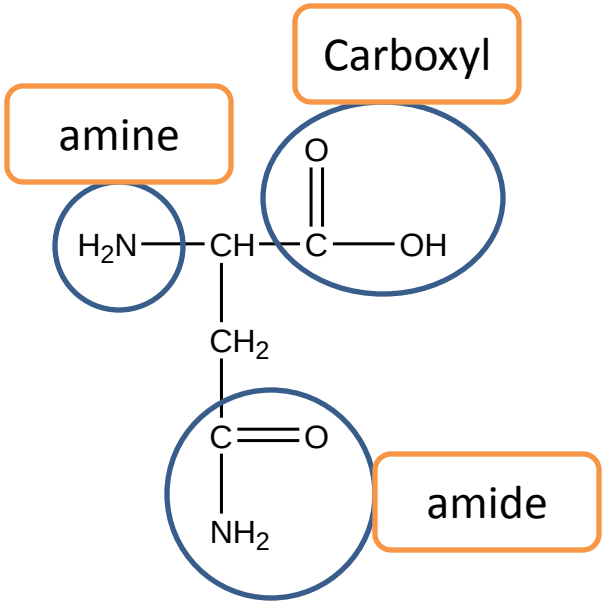
Functional group in Amino Acid



Alanine

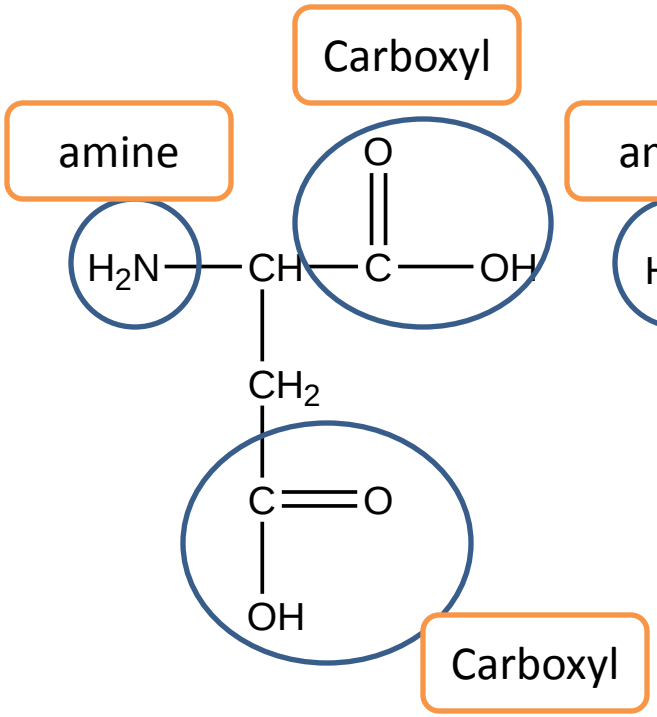


Arginine

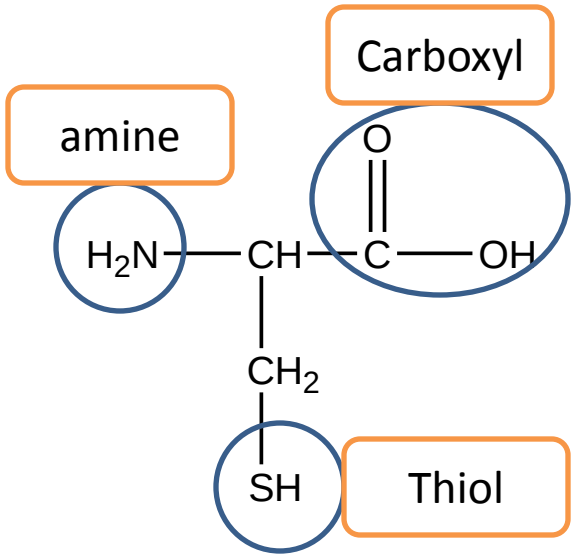


Asparagine

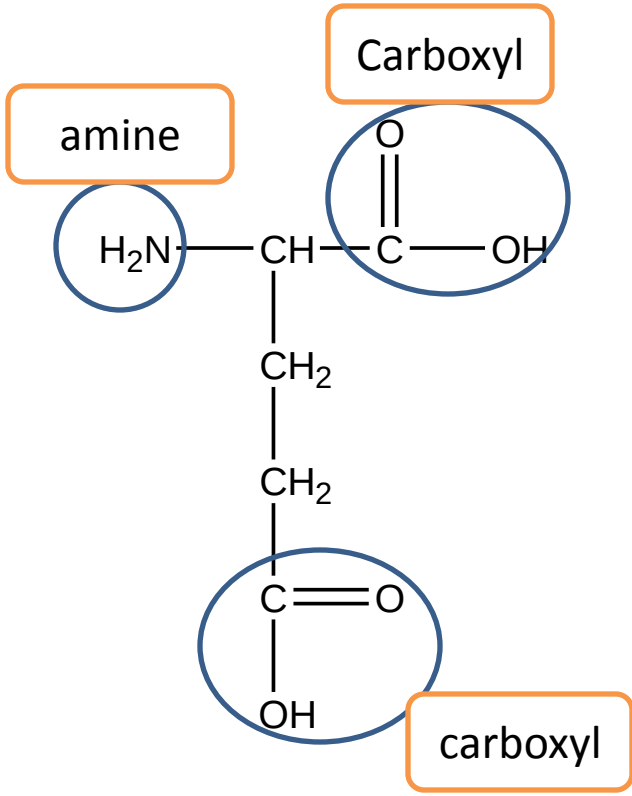
Functional group in Amino Acid



Aspartic acid

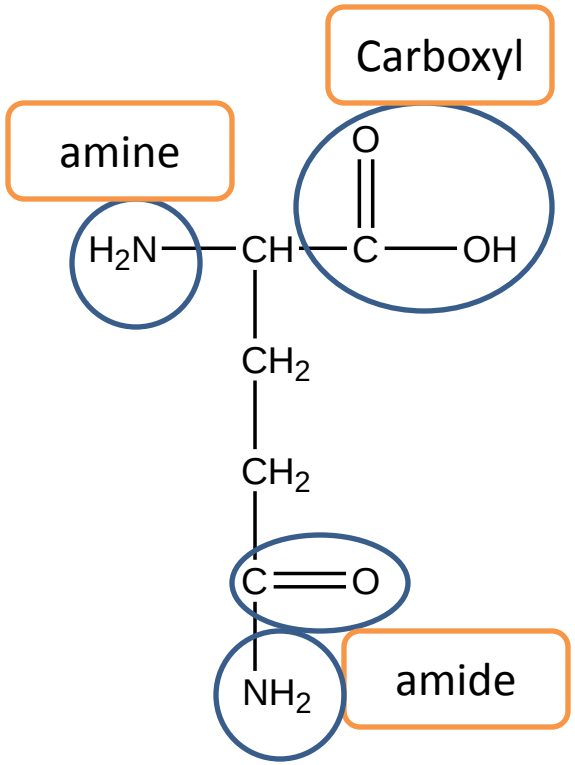


Cysteine

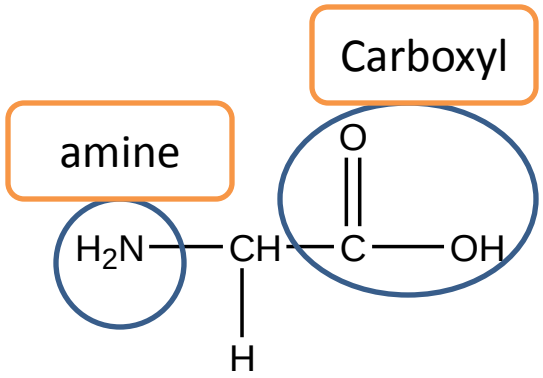


Glutamic acid

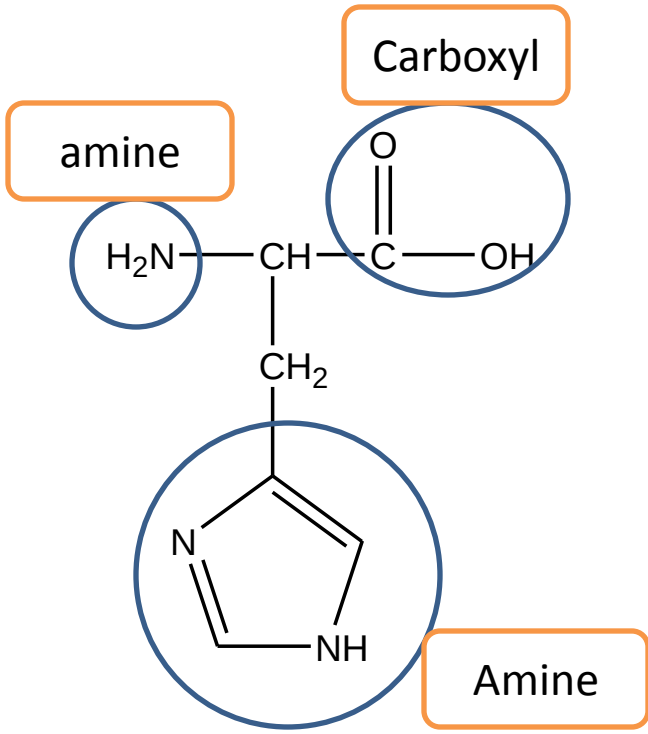
Functional group in Amino Acid



Glutamine

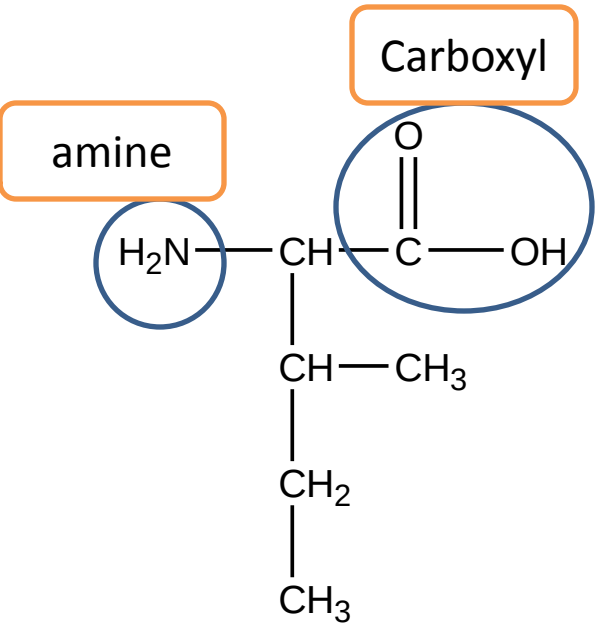


Glycine

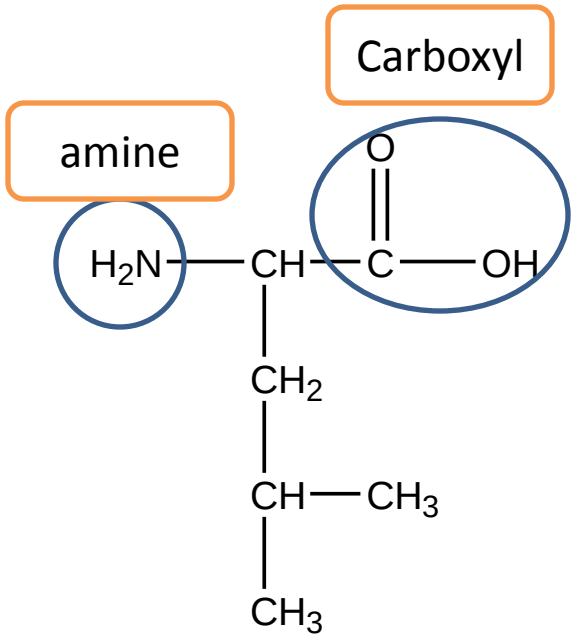


Histidine

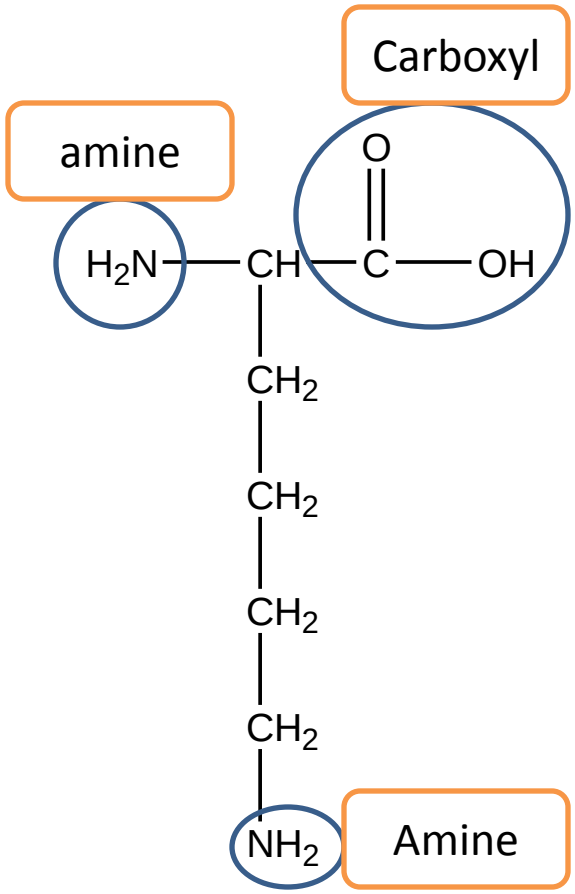
Functional group in Amino Acid



Isoleucine

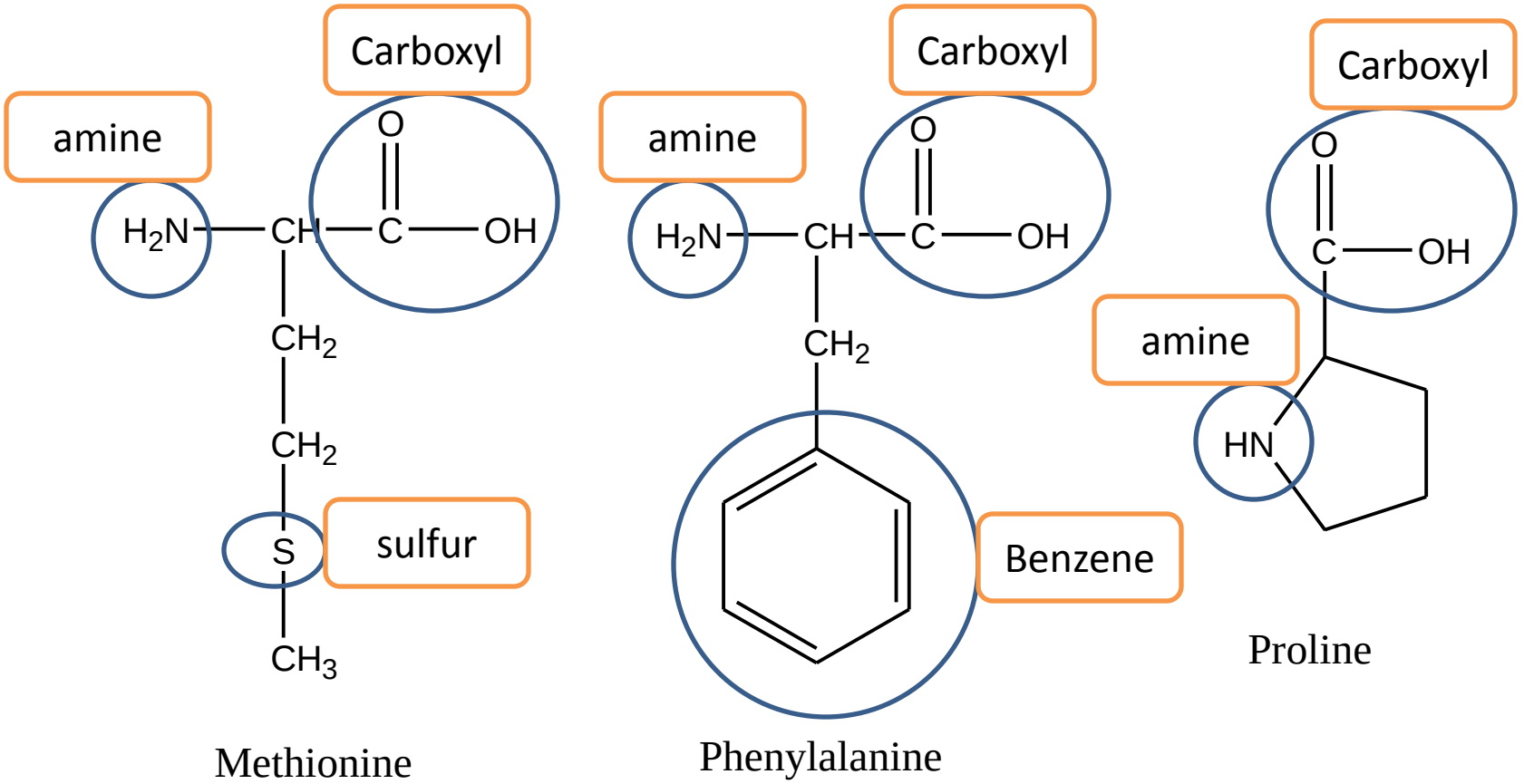


Leucine



Lysine

Functional group in Amino Acid

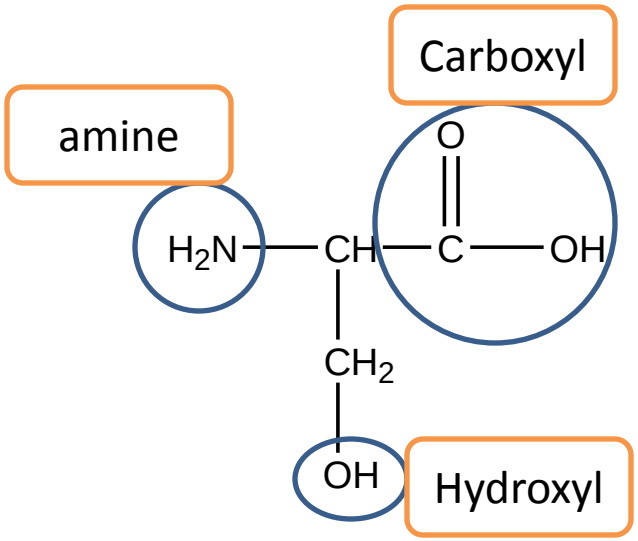


Methionine

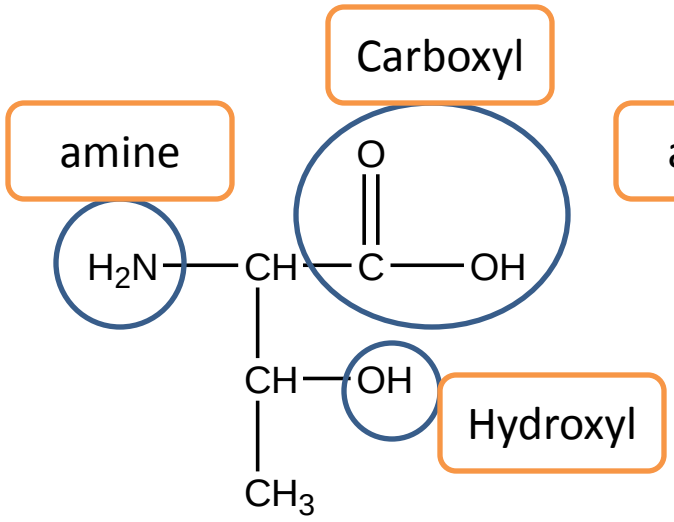
Phenylalanine

Proline

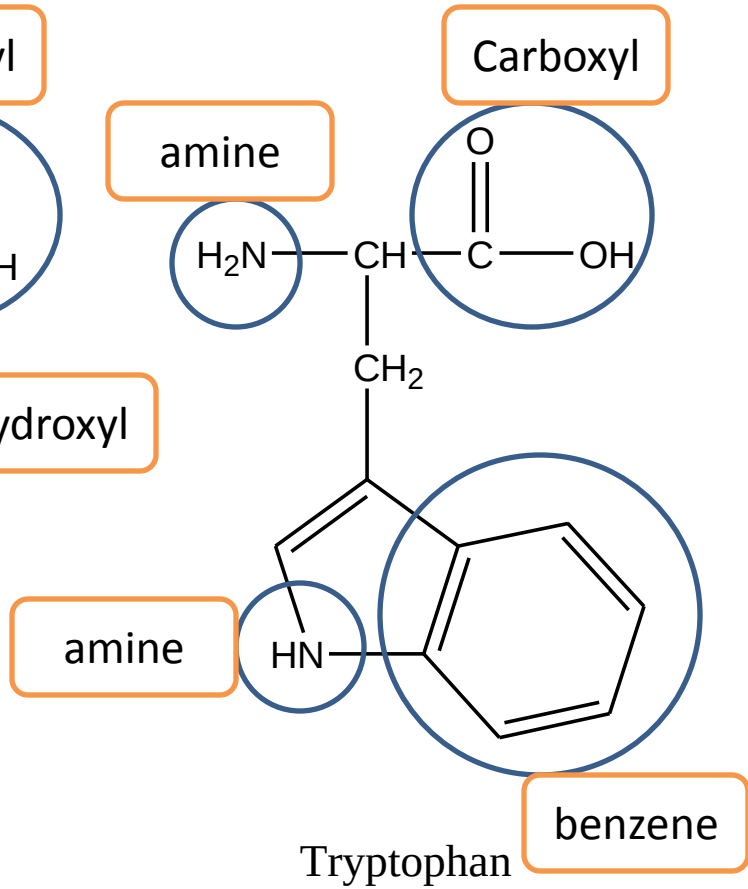
Functional group in Amino Acid



Serine

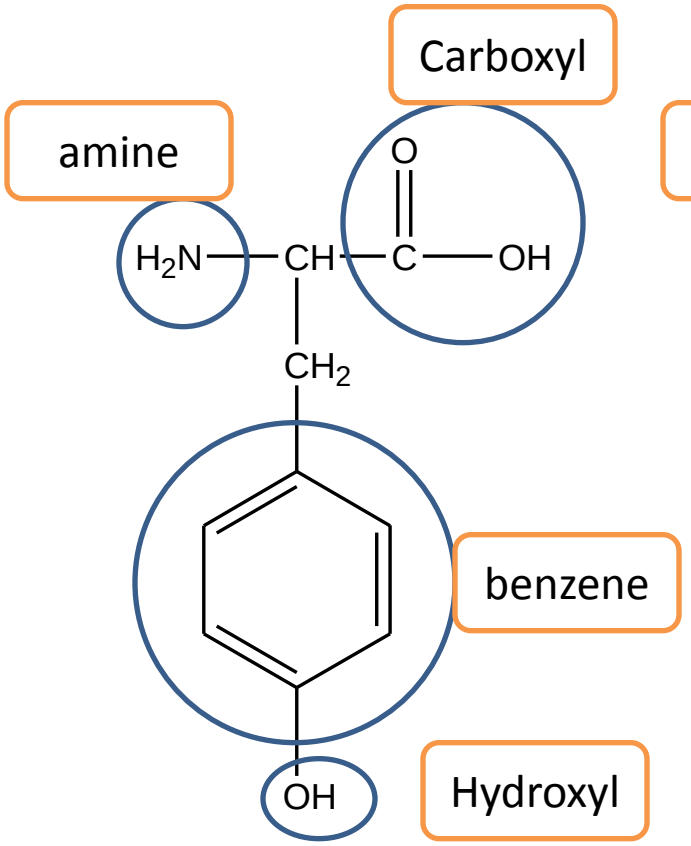


Threonine

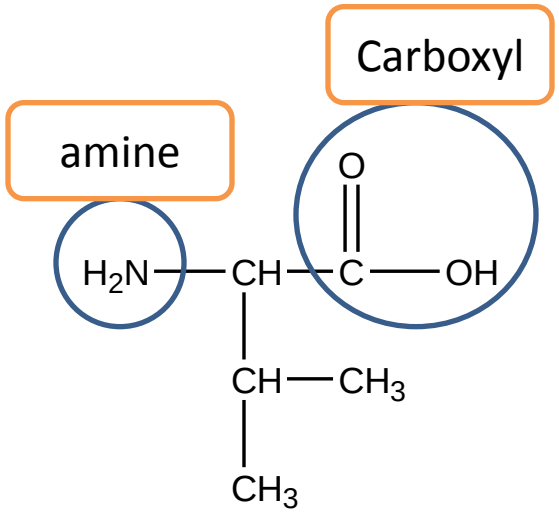


Tryptophan

Functional group in Amino Acid



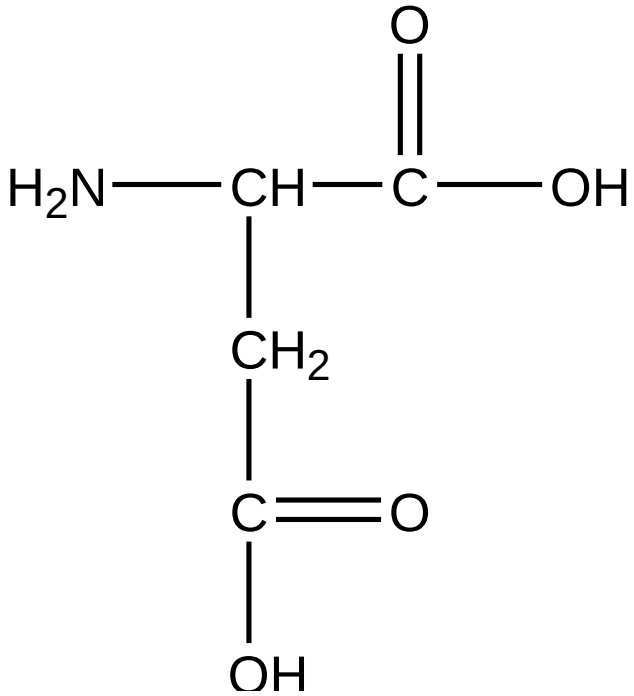
Tyrosine



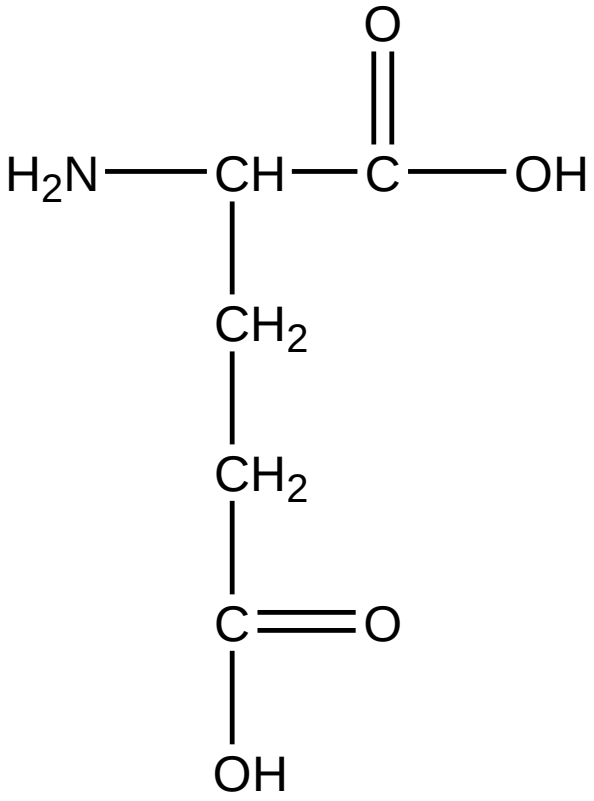
Valine

Amino acid

- Acidic amino acids



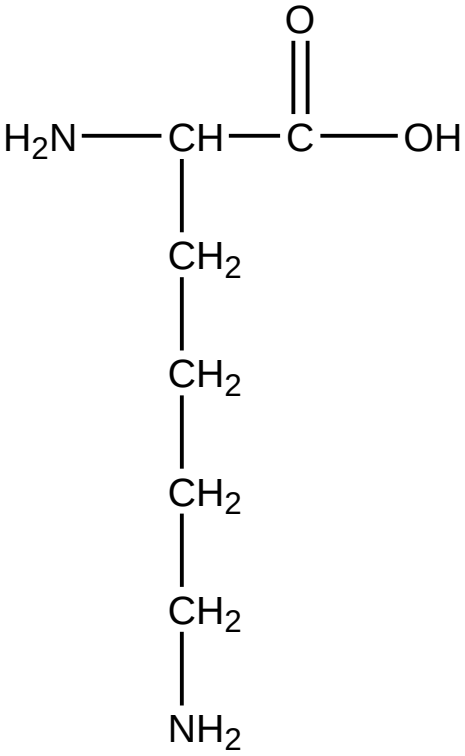
Aspartic acid



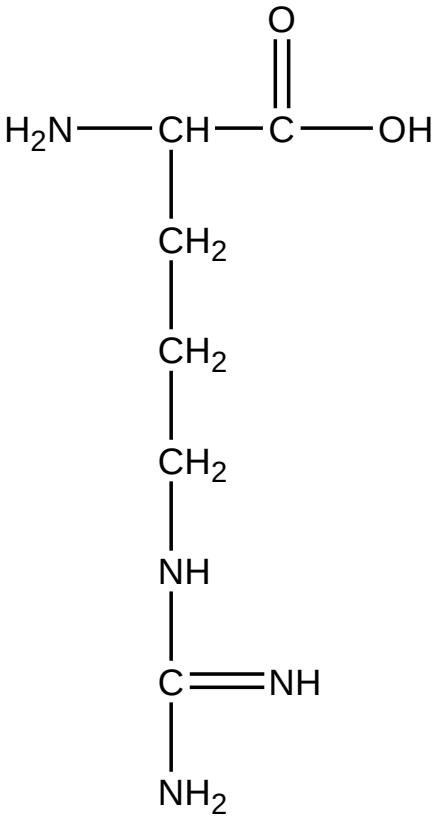
Glutamic acid

Amino acid

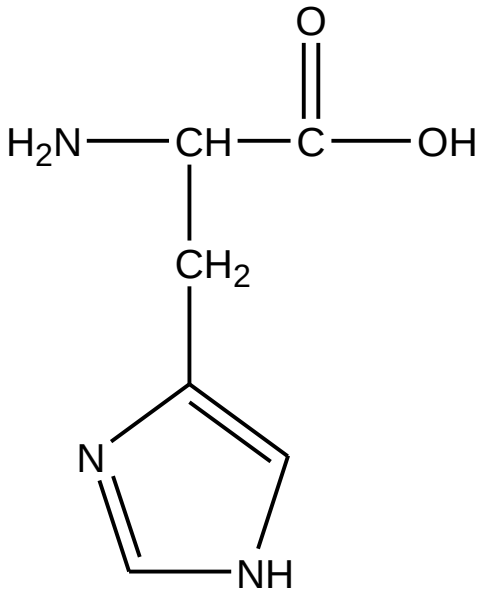
- Basic amino acids



Lysine



Arginine



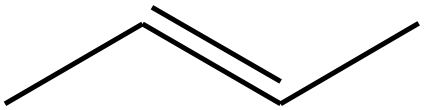
Histidine

Isomers

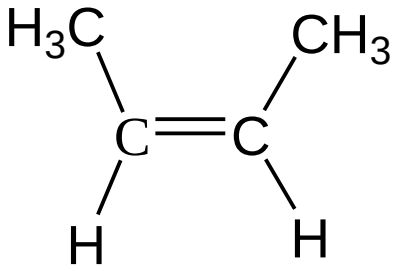
- Groups of compounds that comprise exactly the same atoms (same chemical composition) but which have different structure, and often different physical and chemical properties too.
- Two types
  1. Structural Isomers
  2. Stereoisomers

Stereoisomers

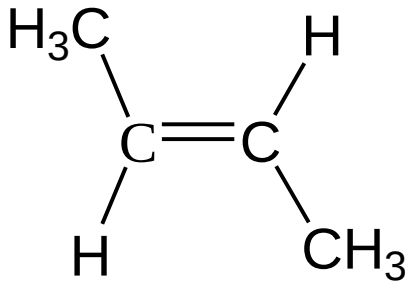
- Stereoisomers posses the same atoms, which exhibits the same connectivity but the composite atoms are oriented differently in space.
  - Different configuration.
  - Differ only in the 3-dimensional arrangement of atoms.
- Two classes
  1. Geometric (cis-trans) isomers.
  2. Enantiomers.



But-2-ene



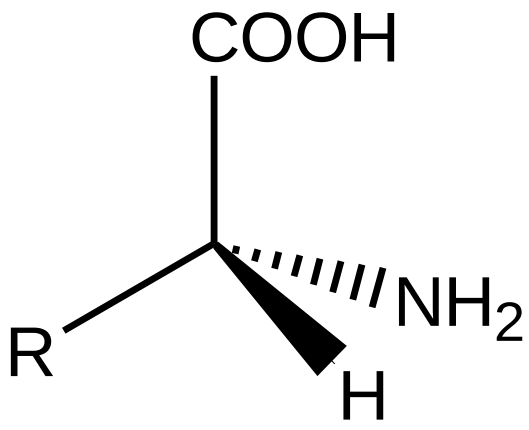
But-2-ene

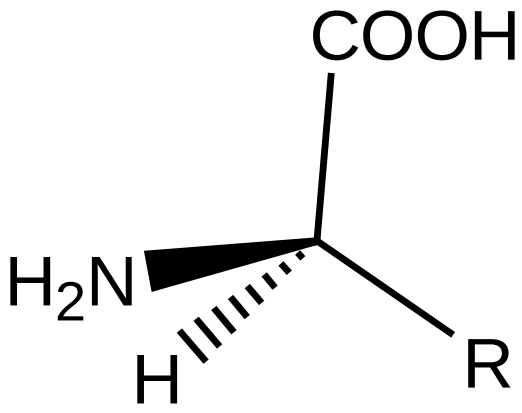


But-2-ene

Enantiomers

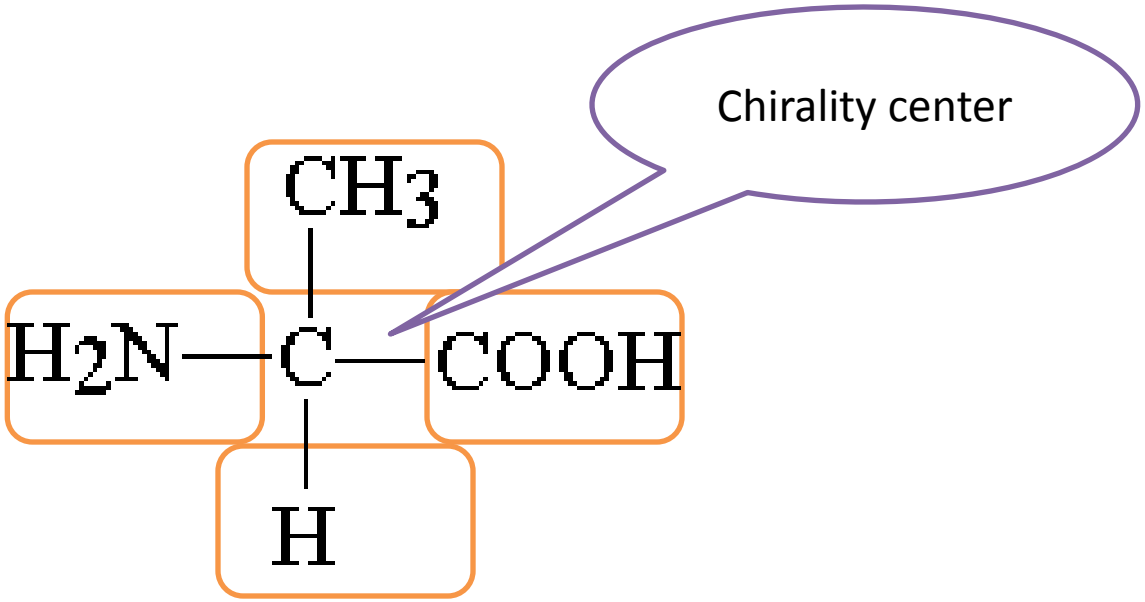
- Enantiomers
  - Mirror images that are not superimposable





Enantiomers

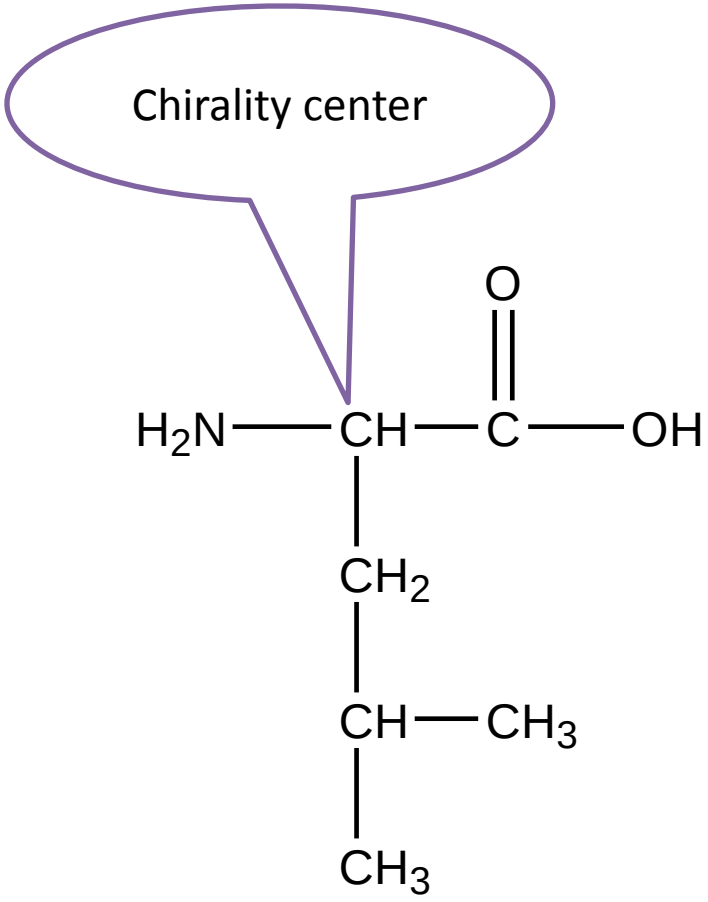
- Chirality center
  - A carbon surrounded by four (4) different groups



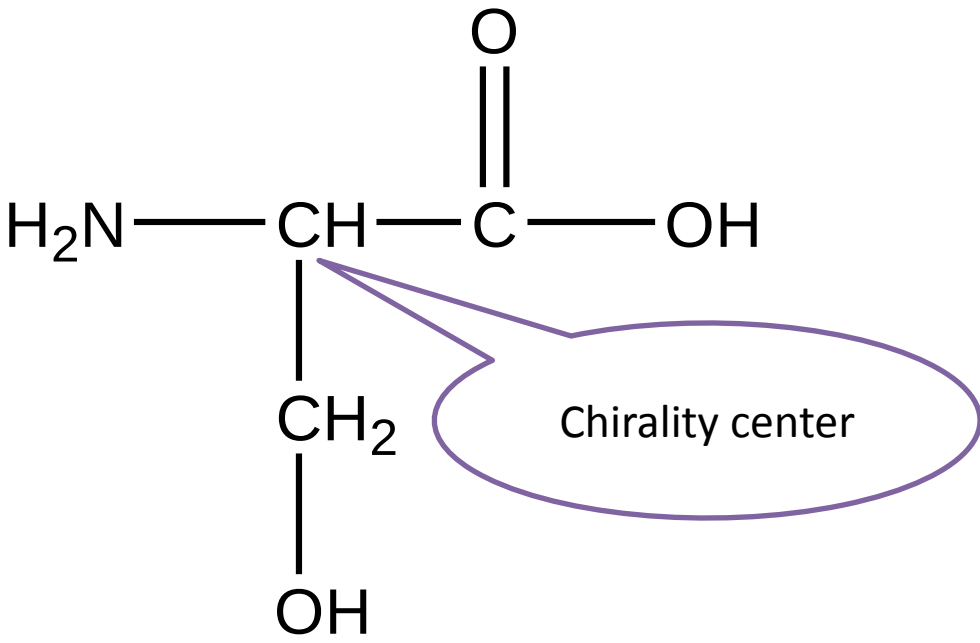
alanine

Enantiomers

- Locate the chirality center for:



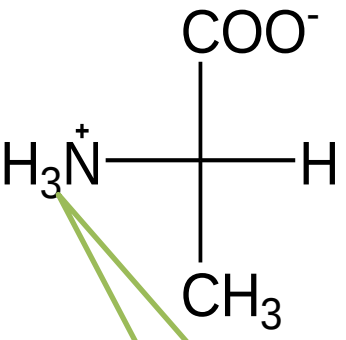
Leucine



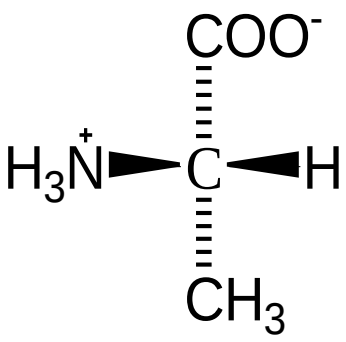
Serine

Enantiomers

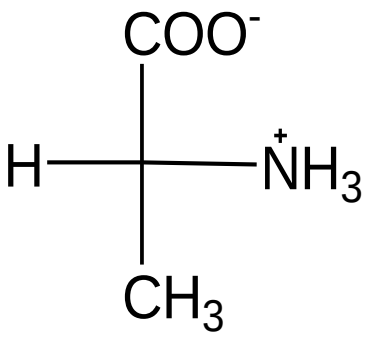
Fischer projection



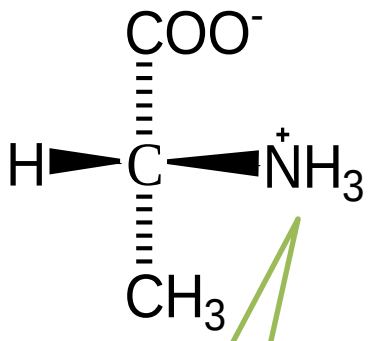
L isomer



L -alanine



D -alanine

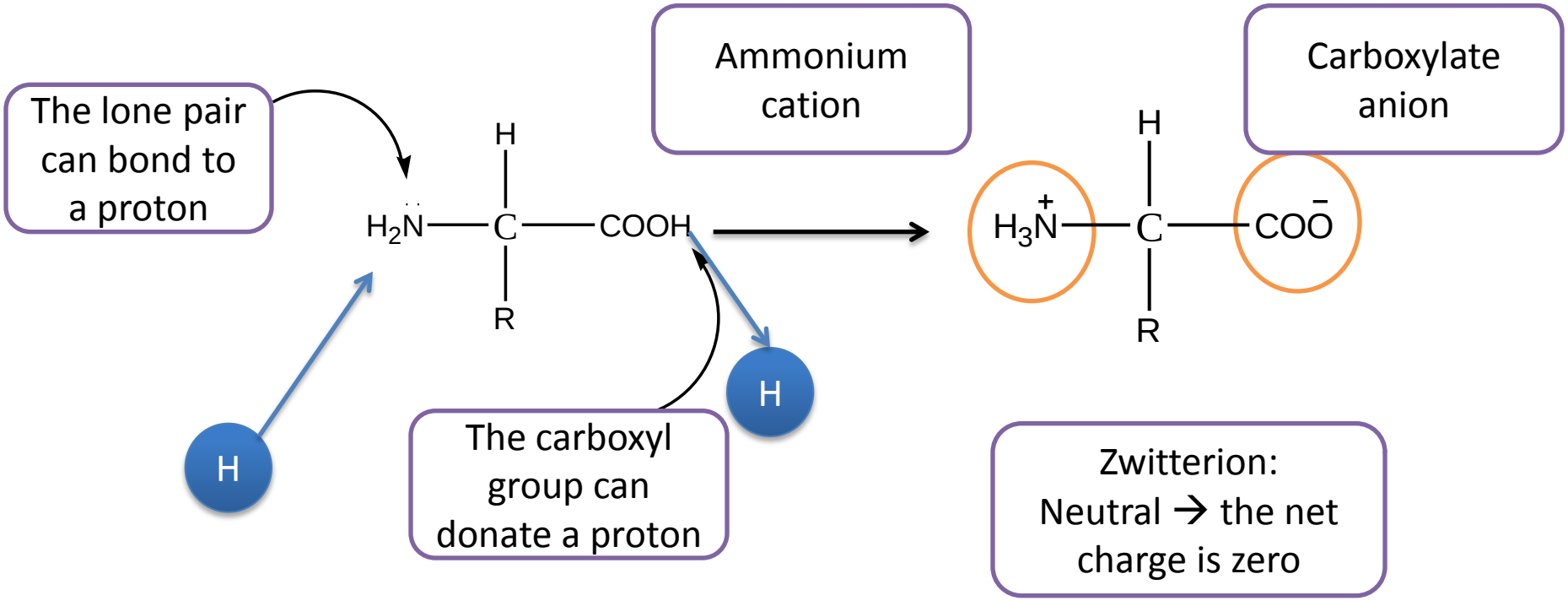


D isomer

Common naturally occuring amino acids

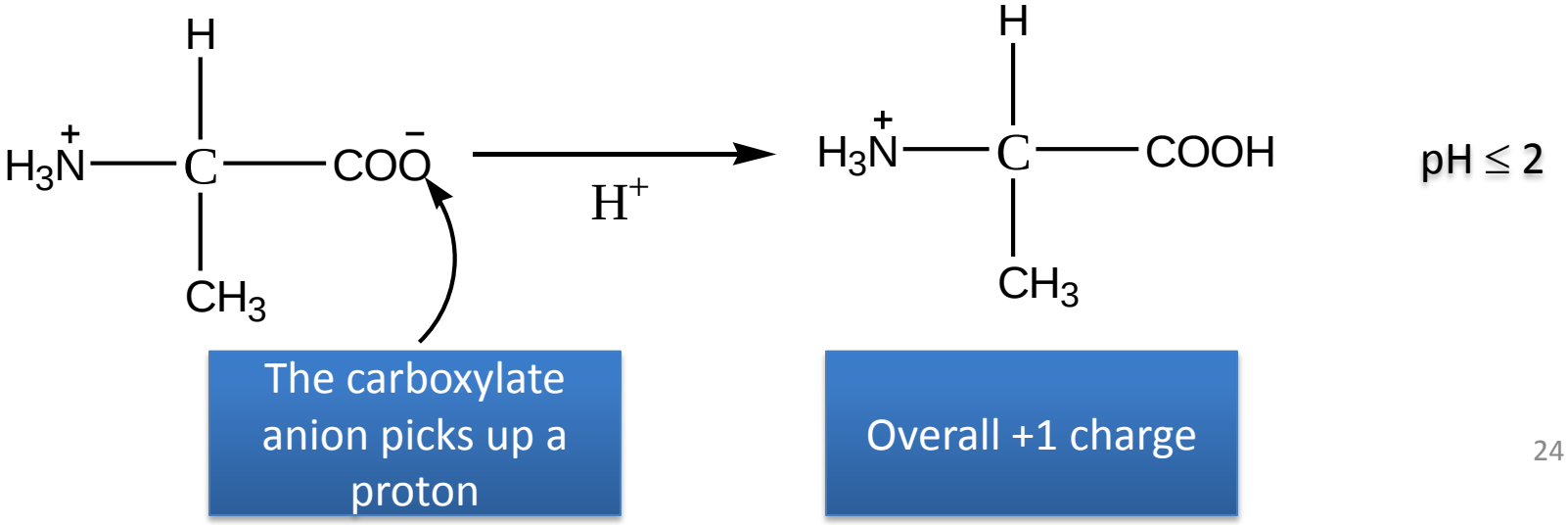
Acid-base behavior of amino acid

- Basic amino group (NH_2)
- Acidic Carboxyl group (COOH)



Acid-base behavior of amino acid

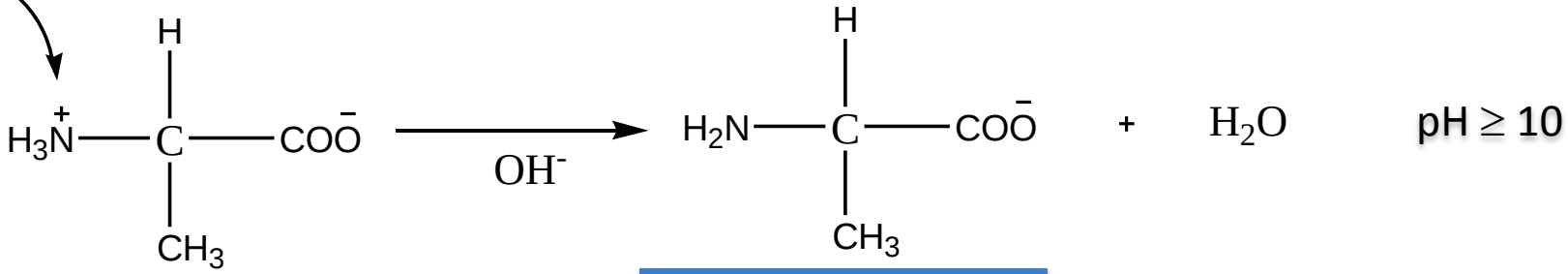
- An amino acid can exist in different forms: depending on the pH of the aqueous solution in which it is dissolved.
- When strong acid (pH 2 or less) is added
  - The carboxylate anion gains a proton
  - The amino acid has a net positive charge



Acid-base behavior of amino acid

- When strong base (pH 10 to higher) is added
  - The ammonium cation loses a proton
  - The amino acid has a net negative charge

The ammonium cation loses a proton



Overall -1 charge

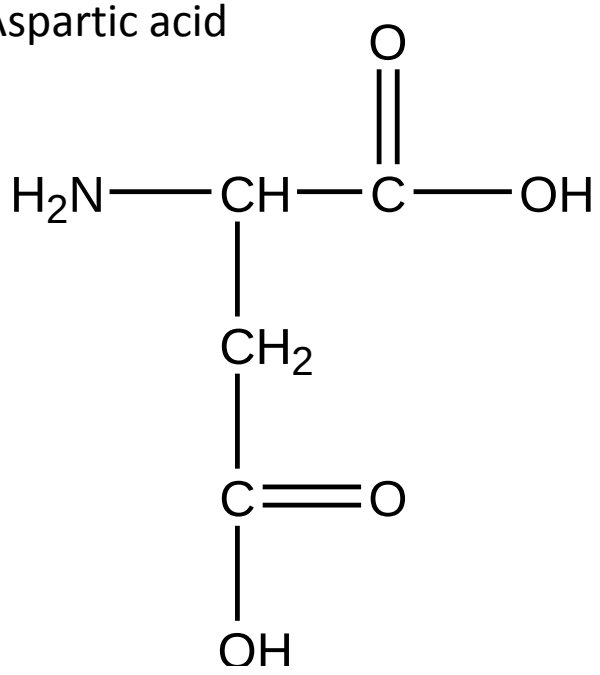
Acid-base behavior of amino acid

- The pH at which the amino acid exists primarily in its neutral form → *isoelectric point* (p*I*)
- The p*I* of neutral amino acids are generally around 6.
- Acidic amino acids (Asp and Glu)
  - Additional carboxylic group → Can lose additional proton.
  - Have lower p*I* values (around 3)
- Basic amino acids (Arg, His and Lys)
  - Additional basic N → can accept additional proton.
  - Have higher p*I* values (7.6 to 10.8)

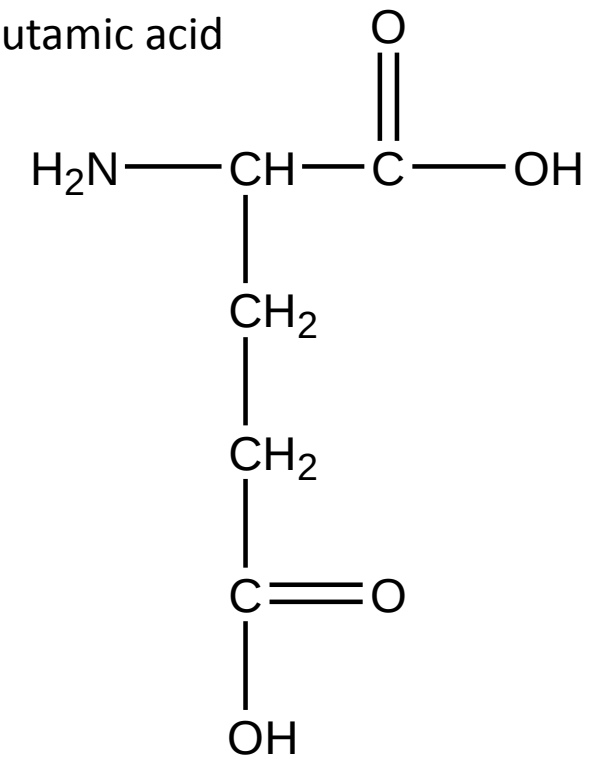
Acid-base behavior of amino acid

- Acidic amino acids (Asp and Glu)
  - Additional carboxylic group → Can lose additional proton.
  - Have lower p*I* values (around 3)

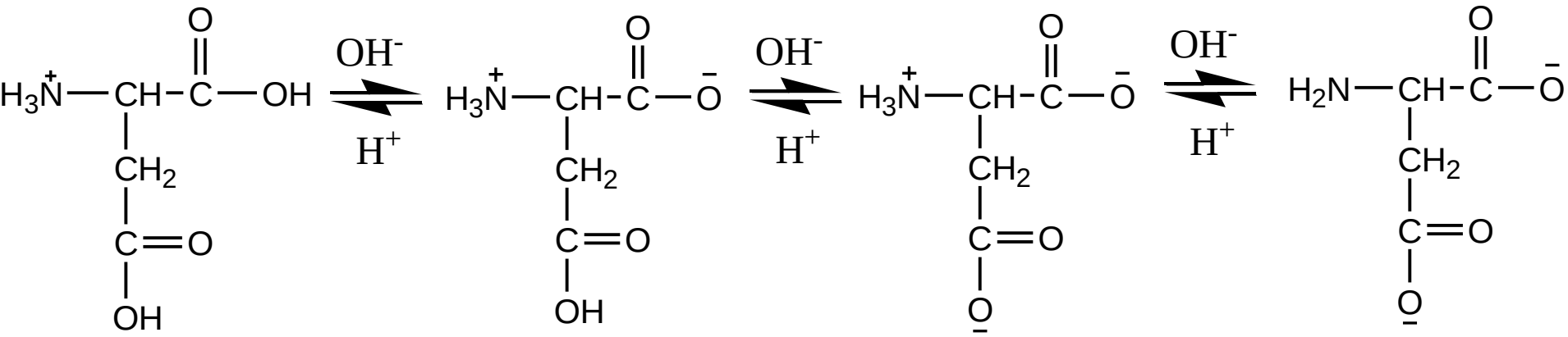
Aspartic acid



Glutamic acid



Acid-base behavior of amino acid



pH < 2
(Charge = 1+)

pH = 2.8
(Charge = 0)

pH 7
(Charge = 1-)

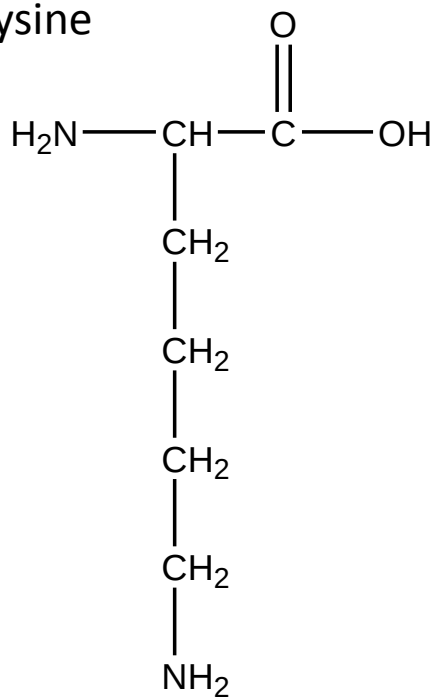
> 10
(Charge = 2-)

pI of aspartic acid

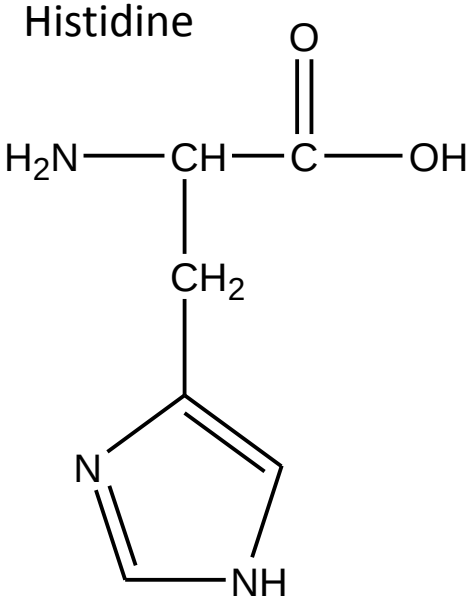
Acid-base behavior of amino acid

- Basic amino acids (Arg, His and Lys)
  - Additional basic N → can accept additional proton.
  - Have higher p*I* values (7.6 to 10.8)

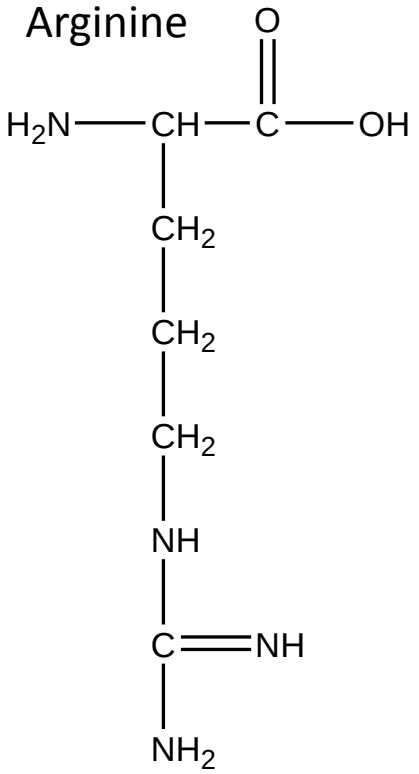
Lysine



Histidine

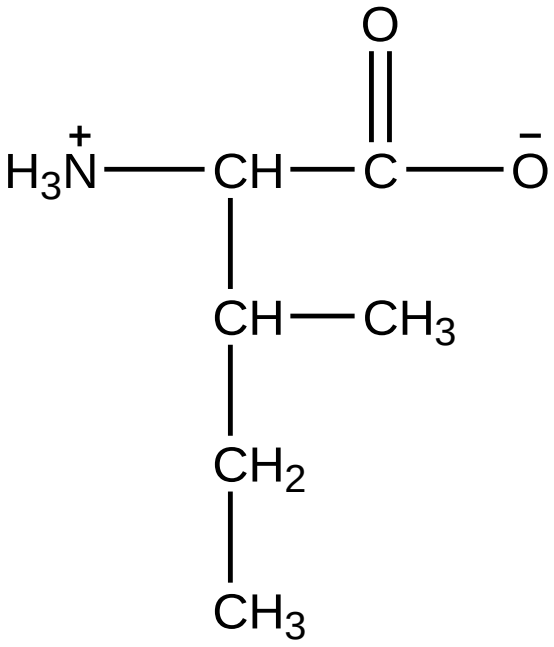


Arginine



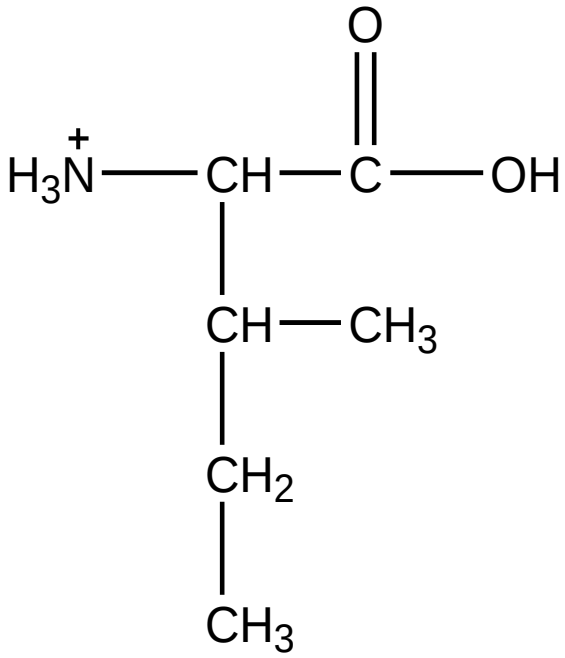
Acid-base behavior of amino acid

- Structure of the amino acid isoleucine at each pH:
  - pH 6



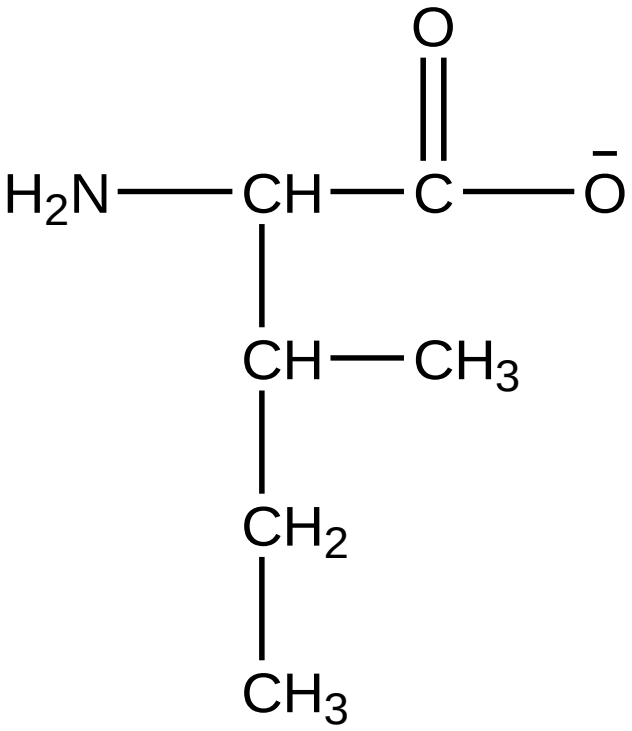
Acid-base behavior of amino acid

- Structure of the amino acid isoleucine at each pH:
  - pH 2



Acid-base behavior of amino acid

- Structure of the amino acid isoleucine at each pH:
  - pH 11



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