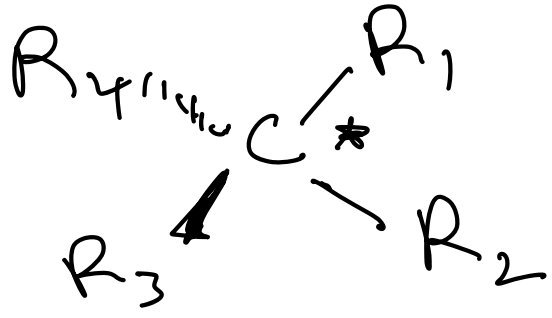
Stereoisomers ⟶ molecules with the same connectivity of atoms, but different orientations of groups in three-dimensional space

enantiomers

Stereoisomers that are mirror images of each other but not identical

diastereomers

stereoisomers that are NOT enantiomers




An $sp^3$ carbon atom that is tetrahedral with four different groups → it is chiral

⇒ Called a chiral center

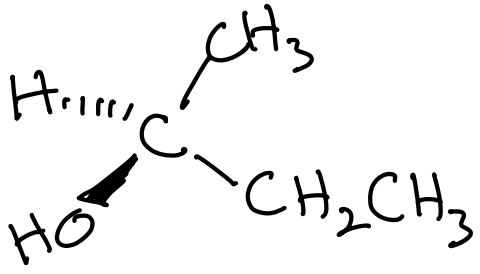
Not superimposable on its mirror images

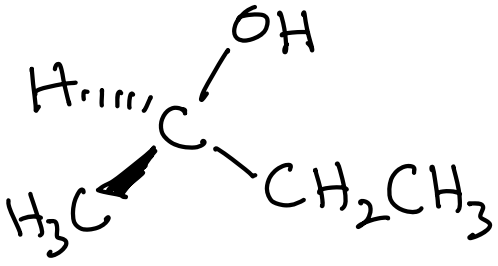
Really hard part → naming the enantiomers

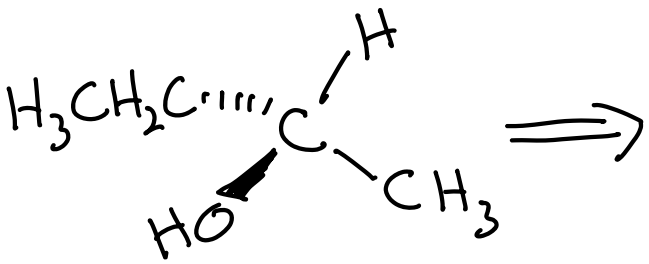
1) Assign atomic number priorities for each group, ranking them 1→4

2) Position the molecule so you are looking down the C→4 bond

3) Count the remaining three groups in order

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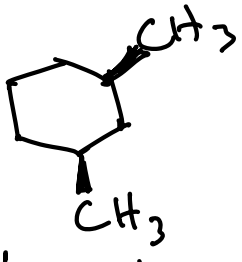
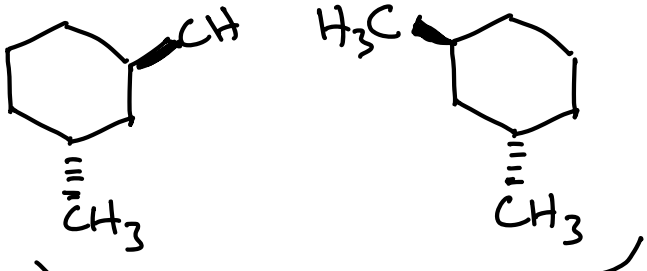
Diastereomer → stereoisomers that are not enantiomers

Pro tip → Use flat cyclohexanes to look for planes of symmetry




Not chiral (meso)



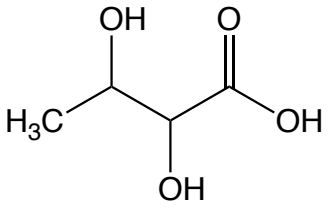

enantiomers → no plane of symmetry

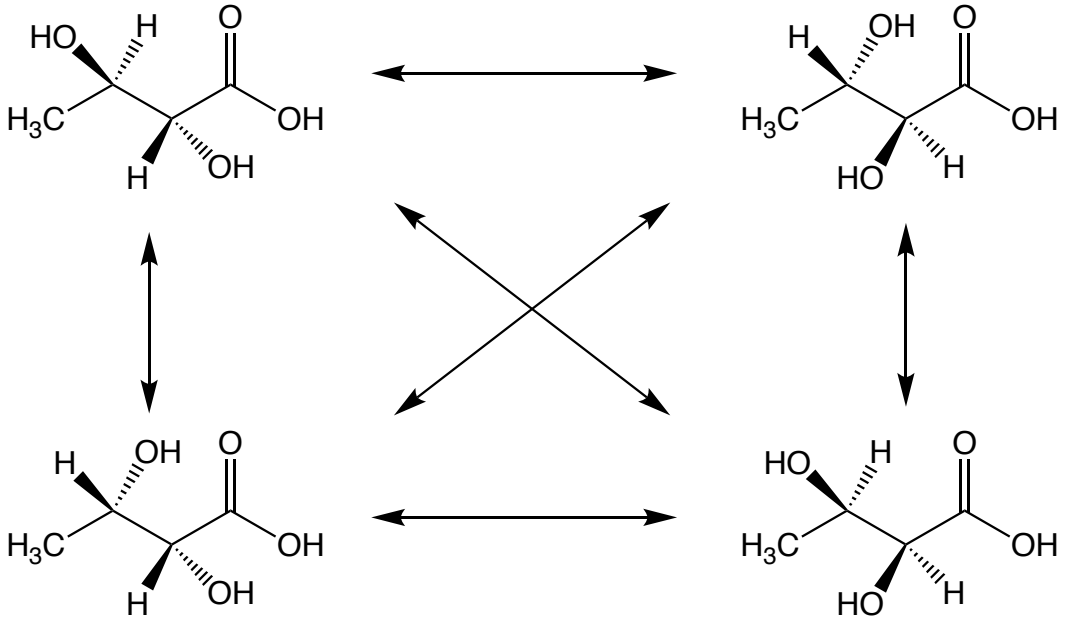
# Molecules With 2 Chiral Centers

1) If a molecule contains n chiral centers there are $2^n$ possible stereoisomers

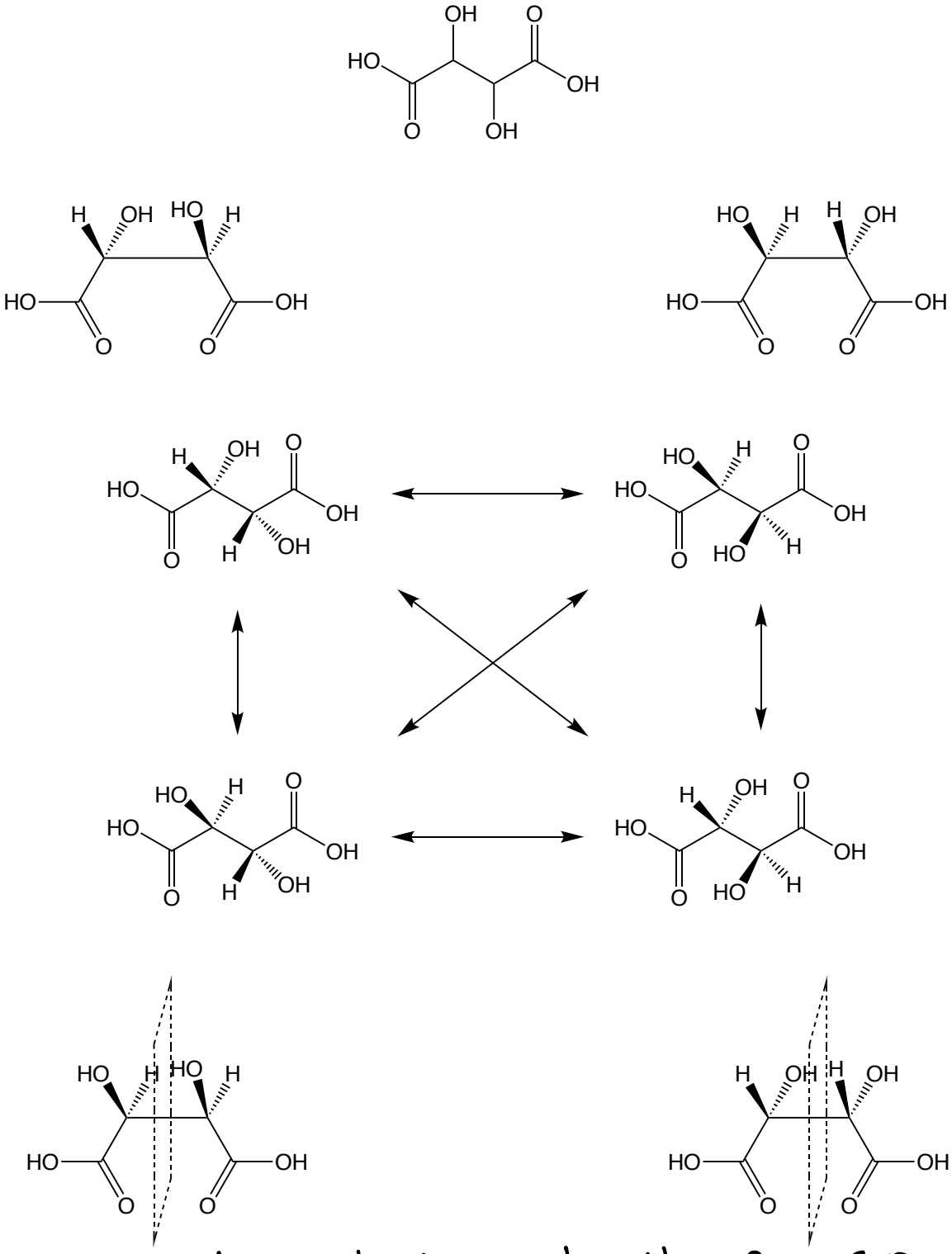
2) R,R and S,S are enantiomers
R,S and S,R are enantiomers
All other pairs are diastereomers (Ex. R,R and R,S)

3) To identify stereoisomer relationships → assign R and S to each chiral center and see Rule 2) above



4) A meso compound has chiral centers but is not chiral due to symmetry (plane of symmetry)



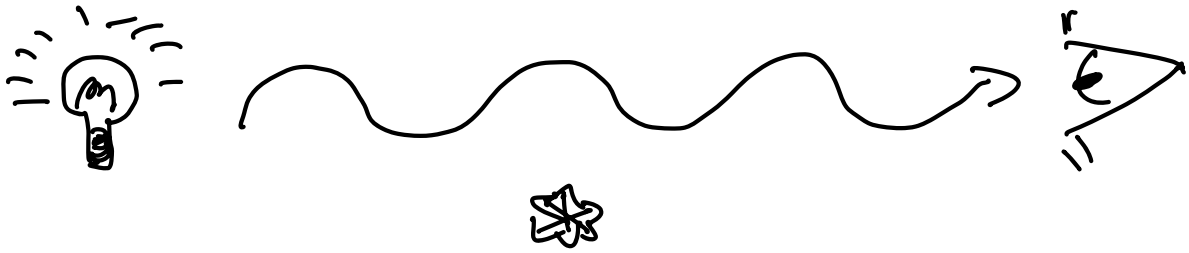
5) Meso compounds will always be the R,S = S,R stereoisomer if both chiral centers have the same four groups

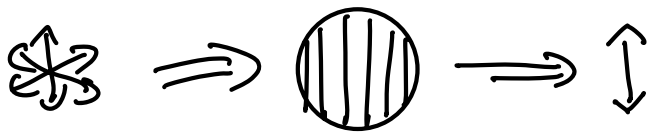
Enantiomers ⟶ identical physical properties

m.p., b.p., density ....

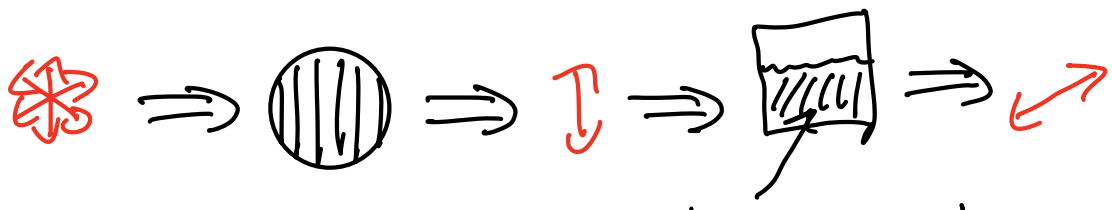
Diastereomers ⟶ DIFFERENT physical properties

m.p., b.p., density ....





A sample of a chiral molecule will rotate the plane of plane polarized light an amount and direction that is characteristic for that molecule

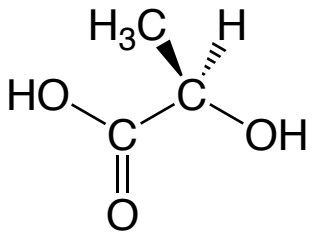


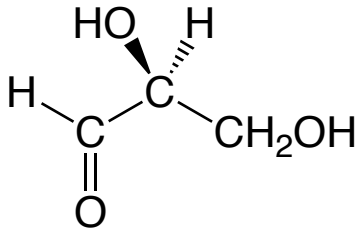
solution containing one enantiomer of a chiral molecule

Clockwise rotation →

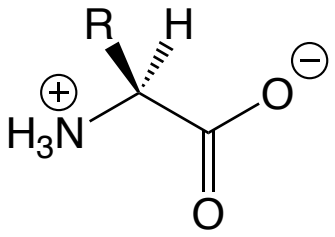
Counterclockwise rotation →

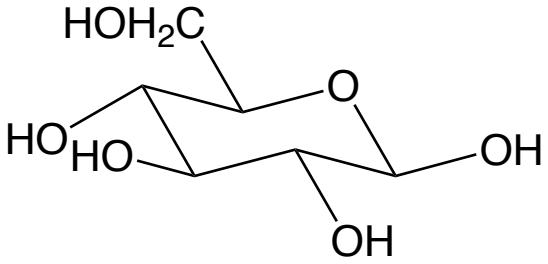
There is no direct connection between R and S and "+" and "−". Sometimes R is "+" and sometimes S is "+". Sometimes R is "−" and sometimes S is "−".



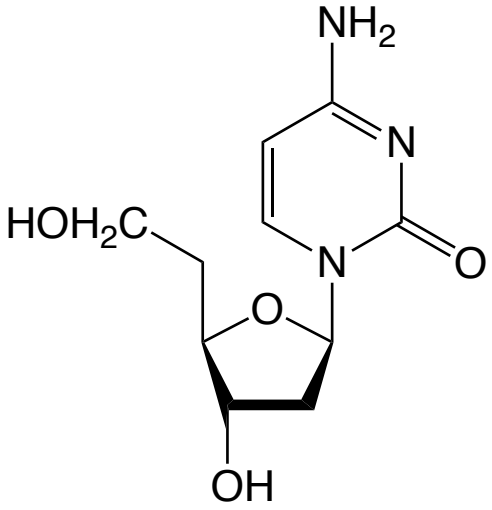
New definition → Racemic Mixture



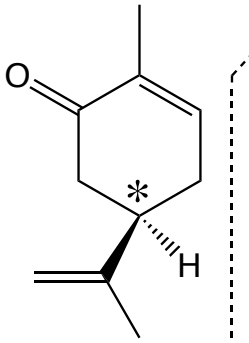

R = 20 different things

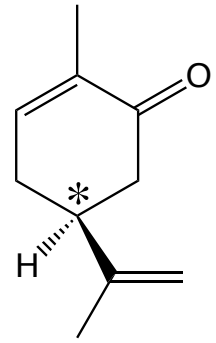
Amino Acids



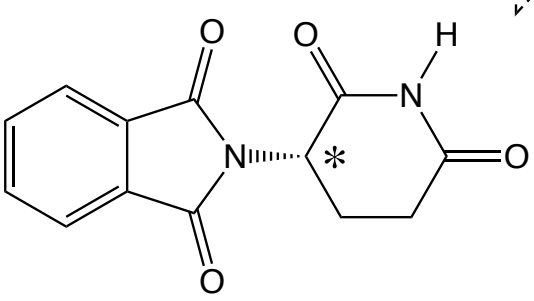

These are our molecular building blocks → they are present as single enantiomers in living things →

*R*-Carvone
Spearmint

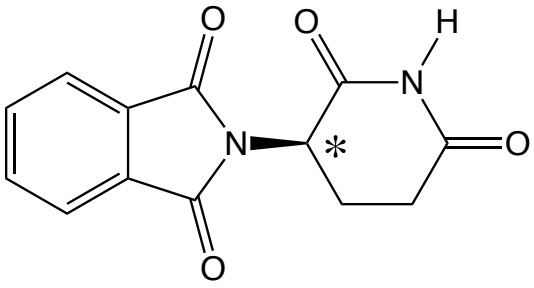




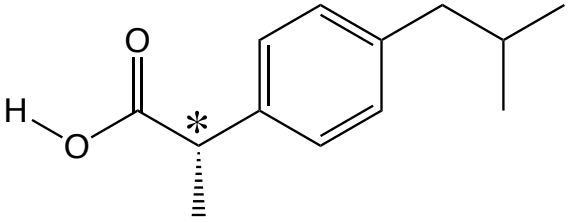
*S*-Carvone
Major component
of caraway seeds



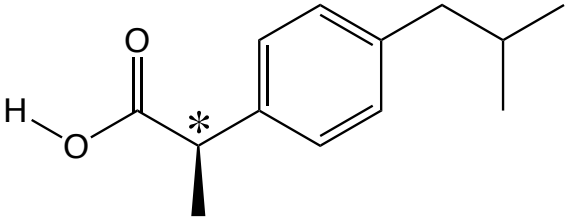
*S*-Thalidomide (Relieves morning sickness)



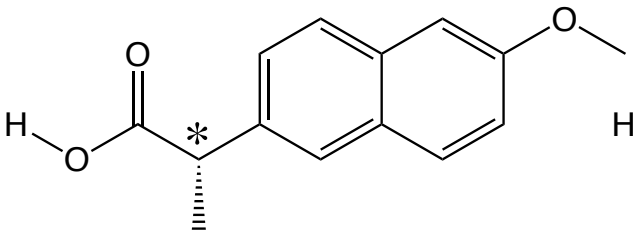
*R*-Thalidomide (Causes birth defects)



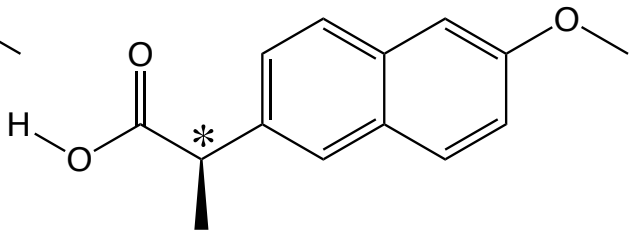
*S*-Ibuprofen (Advil, Motrin)



*R*-Ibuprofen (Inactive and relatively harmless)



*S*-Naproxen (Aleve)



*R*-Naproxen (liver toxin)

**<u>Organic Chemistry</u> is the study of carbon-containing molecules.**

**This class has two points.**

***The first point of the class is to understand the organic chemistry of living systems. We will teach you how to think about and understand the most amazing things on the planet!!***

Water is essential for life, you will learn why water has such special properties. 8/25/26

You will learn the secret structural reason proteins, the most important molecular machines in our bodies, can support the chemistry of life. 9/9/26

You will learn why when you take Advil for pain, exactly half of what you take works, and the other half does nothing.

You will learn how toothpaste works.

You will learn how a single chlorofluorocarbon refrigerant molecule released into the atmosphere can destroy many, many ozone molecules, leading to an enlargement of the ozone hole.

You will learn how medicines like Benadryl, Seldane, and Lipitor work.

You will learn how Naloxone is an antidote for an opioid overdose.

You will learn why Magic Johnson is still alive, decades after contracting HIV.

You will learn how MRI scans work.

***The second point of organic chemistry is the synthesis of complex molecules from simpler ones by making and breaking specific bonds.***

You will learn how to understand movies of reaction mechanisms like alkene hydration.

You will learn reactions that once begun, will continue reacting such that each product molecule created starts a new reaction until all the starting material is used up.

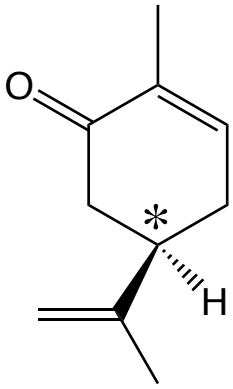
You will learn reactions that can make antifreeze from vodka.

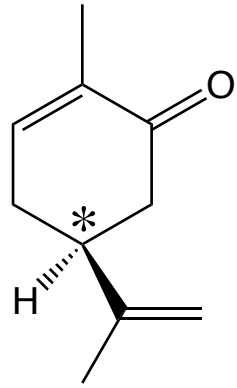
You will learn a reaction that can make nail polish remover from rubbing alcohol.

You will learn how to look at a molecule and accurately predict which atoms will react to make new bonds, and which bonds will break during reactions.

You will learn how to analyze a complex molecule's structure so that you can predict ways to make it via multiple reactions starting with less complex starting molecules.

*R*-Carvone
Spearmint

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Major component
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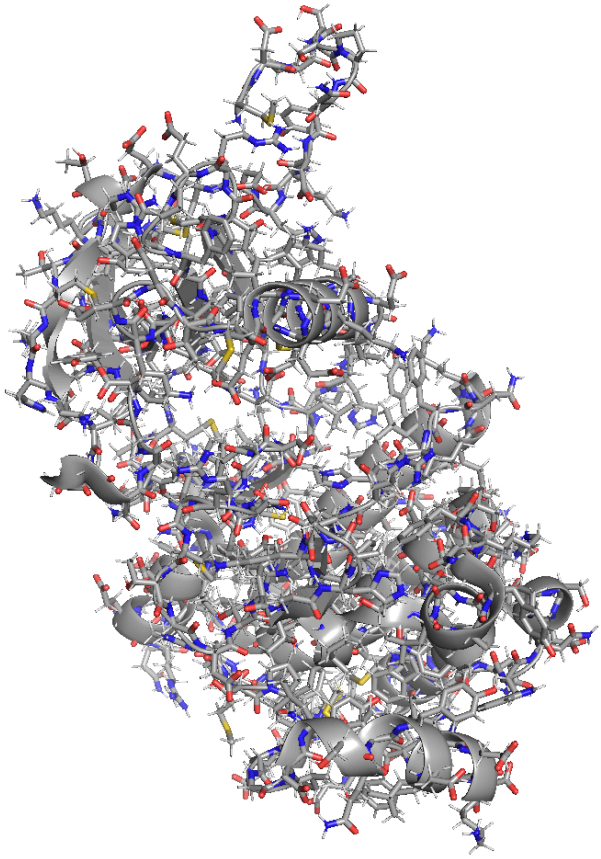
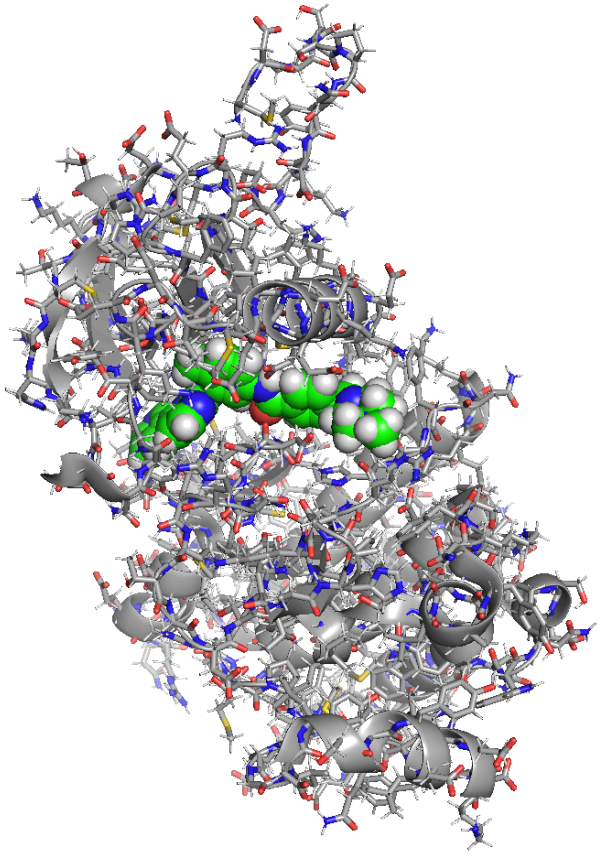
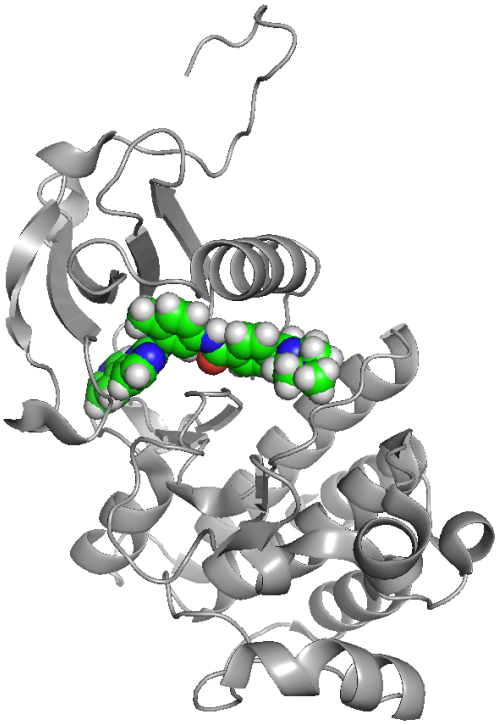
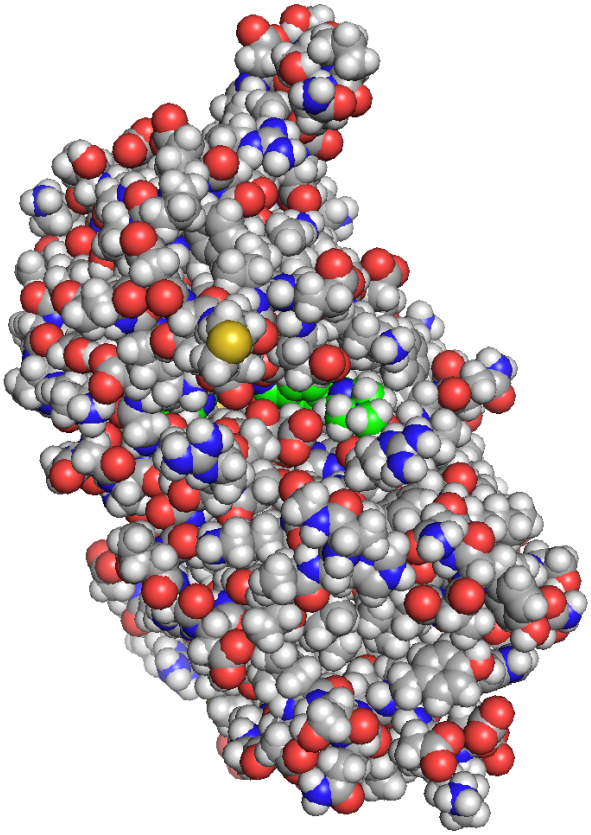




The drug Gleevec (green) bound to its target protein, the ABL kinase.

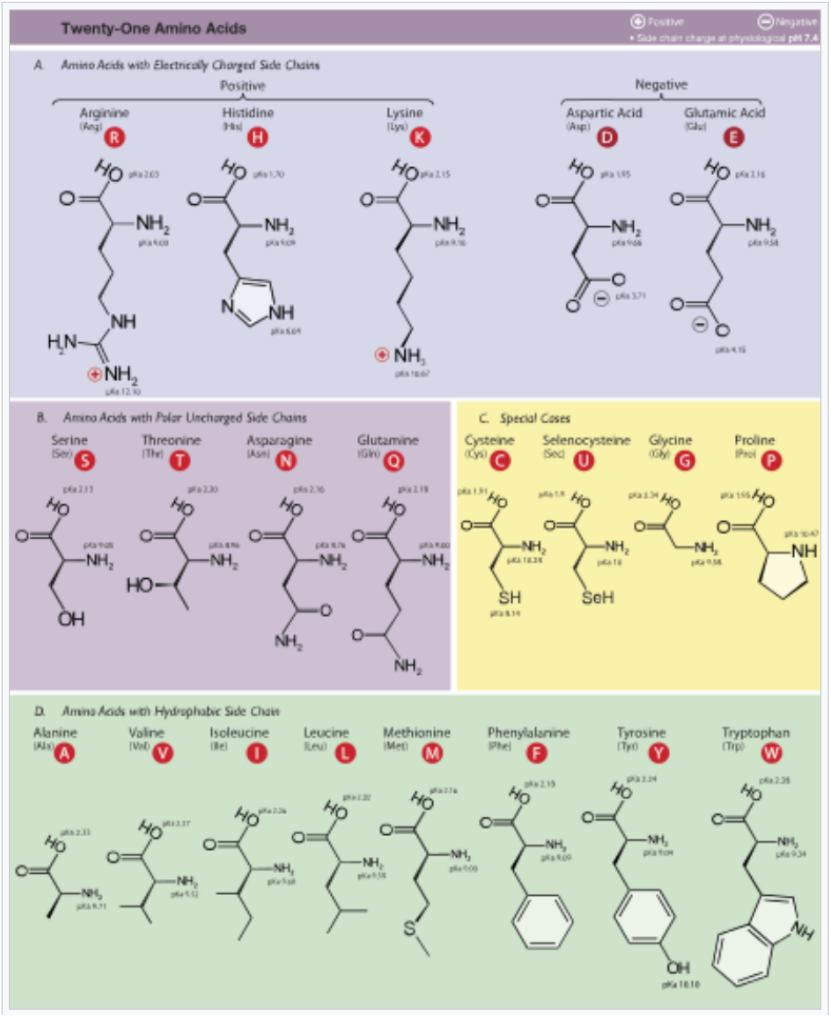




From Wikipedia “Amino Acids” 9-28-2018

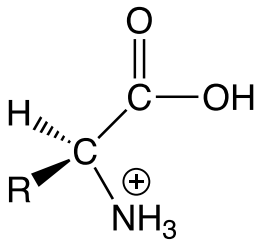
## General structure [ edit ]

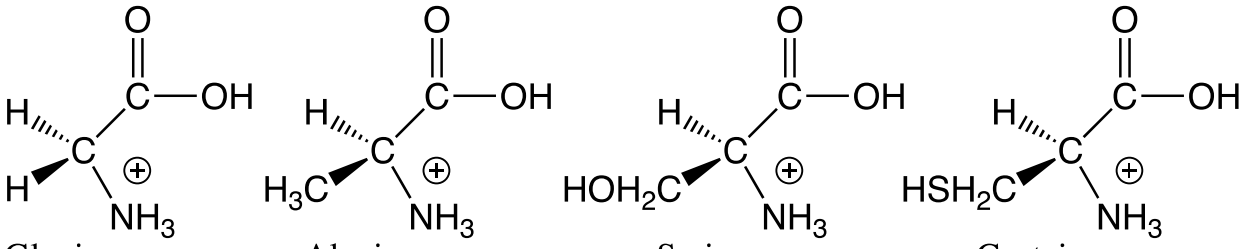
In the structure shown at the top of the page, **R** represents a side chain specific to each amino acid. The carbon atom next to the carboxyl group (which is therefore numbered 2 in the carbon chain starting from that functional group) is called the α–carbon. Amino acids containing an amino group bonded directly to the alpha carbon are referred to as *alpha amino acids*.[34] These include amino acids such as proline which contain secondary amines, which used to be often referred to as "imino acids".[35][36][37]




### Isomerism [ edit ]

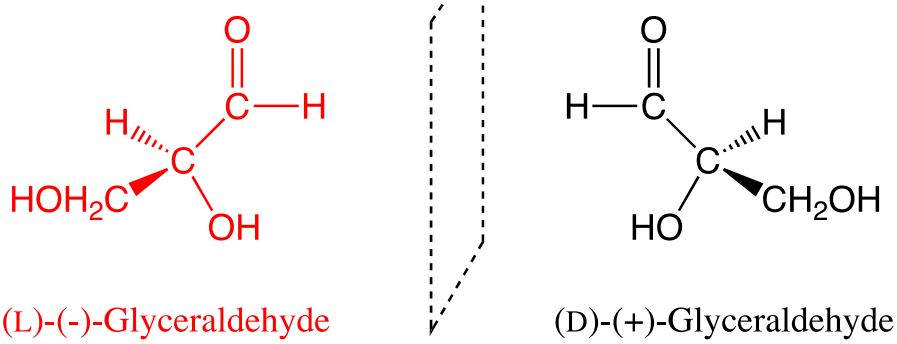
The alpha amino acids are the most common form found in nature, but only when occurring in the L-isomer. The alpha carbon is a chiral carbon atom, with the exception of glycine which has two indistinguishable hydrogen atoms on the alpha carbon.[38] Therefore, all alpha amino acids but glycine can exist in either of two enantiomers, called L or D amino acids, which are mirror images of each other (*see also Chirality*). While L-amino acids represent all of the amino acids found in proteins during translation in the ribosome, D-amino acids are found in some proteins produced by enzyme posttranslational modifications after translation and translocation to the endoplasmic reticulum, as in exotic sea-dwelling organisms such as cone snails.[39] They are also abundant components of the peptidoglycan cell walls of bacteria,[40] and D-serine may act as a neurotransmitter in the brain.[41] D-amino acids are used in racemic crystallography to create centrosymmetric crystals, which (depending on the protein) may allow for easier and more robust protein structure determination.[42]





Glycine Alanine Serine Cysteine

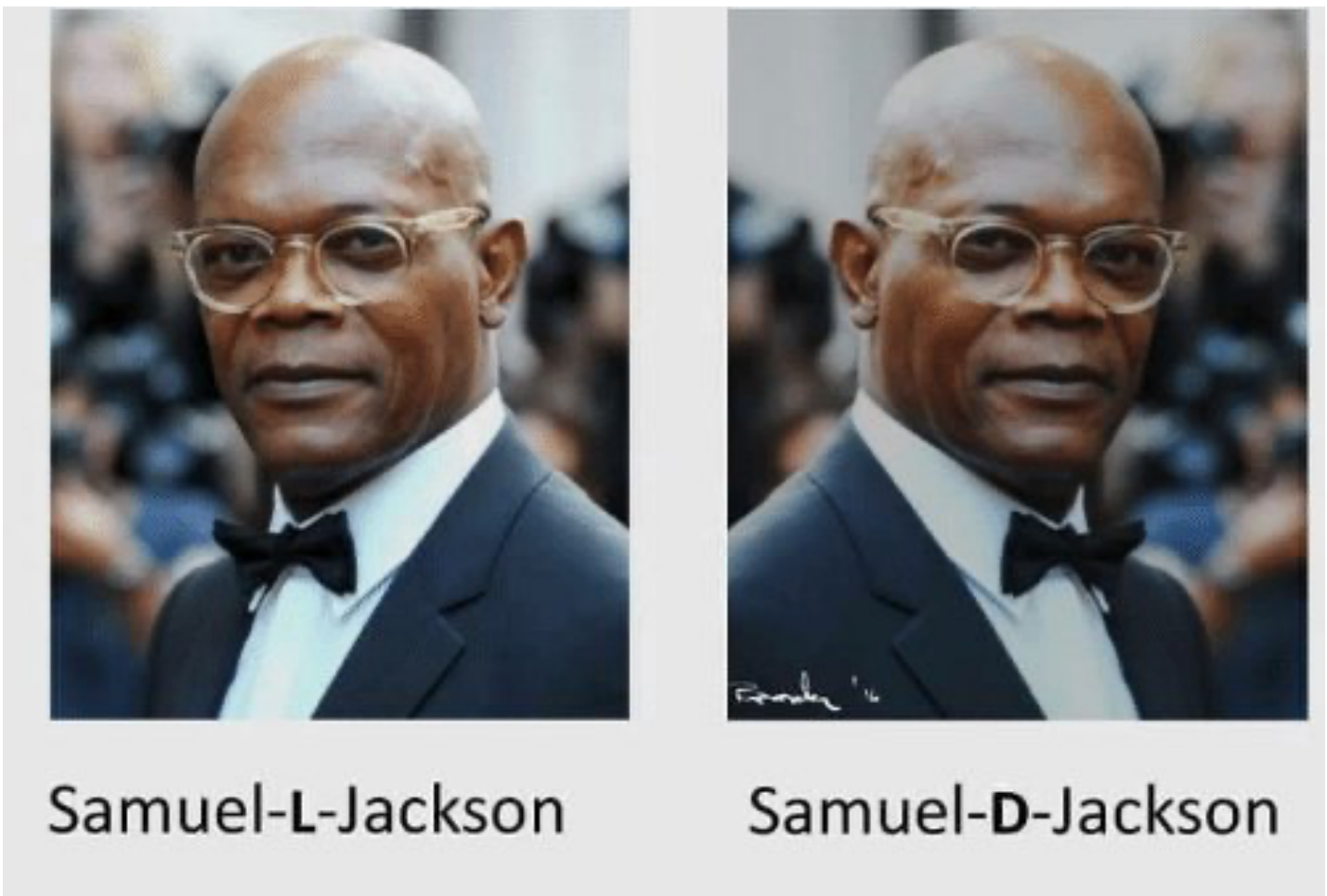
☐ ☐ ☐ ☐



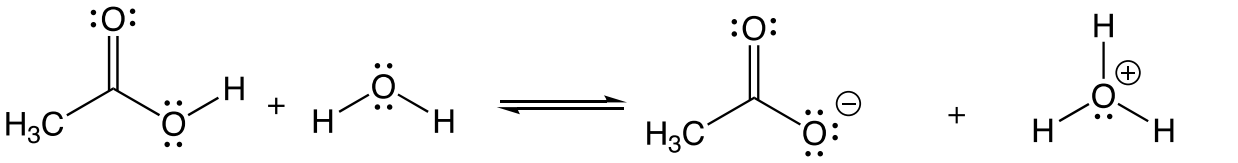
(L)-(-)-Glyceraldehyde (D)-(+)-Glyceraldehyde

Levorotary Dextrorotary

The 19 chiral common amino acids are all "L" amino acids (even cysteine!)




I hope this goes chiral



Acid (H-A) Base (B:) Conjugate Base ($A^{\ominus}$) Conjugate Acid (B-$H^{\oplus}$)

At equilibrium: $K_{equilibrium} = \dfrac{[Products]}{[Reactants]} = \dfrac{[CH_3CO_2^{\ominus}]\,[H_3O^{\oplus}]}{[CH_3CO_2H]\,[H_2O]}$

Assume: $[H_2O] = 55$ M and does not change

$$K_a = K_{equilibrium}\,[H_2O] = K_{equilibrium}\,[55\ M]$$

$$K_a = \frac{[CH_3CO_2^{\ominus}]\,[H_3O^{\oplus}]}{[CH_3CO_2H]} \qquad pK_a = -\log K_a$$

A stronger acid has a _____ value of $pK_a$

A weaker acid has a _____ value of $pK_a$

General Rule

All acid-base reactions favor formation of the weaker acid

H-Cl + NaOH ⇌ $H_2O$ + NaCl

How to estimate relative acid strengths

$H\text{-}A_1 + H_2O \rightleftharpoons A_1^{\ominus} + H_3O^{\oplus}$

$H\text{-}A_2 + H_2O \rightleftharpoons A_2^{\ominus} + H_3O^{\oplus}$

→ Compare the relative stabilities of the anions produced upon deprotonation

2 important principles for predicting anion stability

1) Negative charge (⊖) is neutralized by nuclear ⊕ charge.

2) Delocalizing negative charge (⊖) over a larger area is better.

## Rules for anion stability —

The anion is more stable when the negative charge (⊖) is:

a) On a more electronegative element (Principle 1)

b) On a larger atom (Principle 2)

c) On an atom with more "s" character to its hybridization

"s" orbitals are closer to the nucleus (Principle 1)

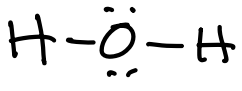
d) stabilized by resonance delocalization. (Principle 2)

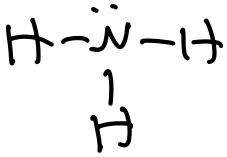
e) Stabilized by the (Principles 1 and 2)

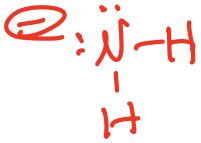
# Examples

Rule a)

Ex.







Rule b)