



Exam Preview

20 questions

Lewis structures/
Contributing structures

52 pts.

Molecular dipoles

18 pts.

Bonding theory

69 pts.

Nomenclature

34 pts.

Chirality

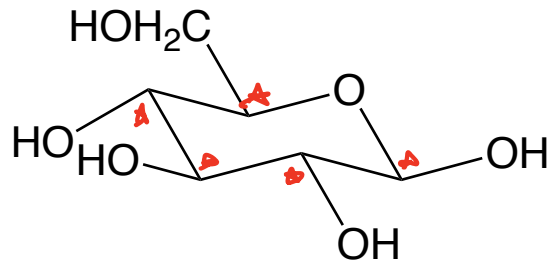
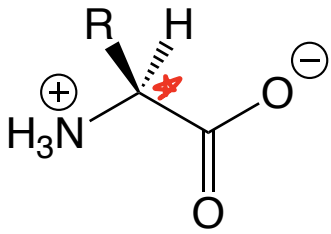
98 pts.

Conformations/Strain

44 pts.

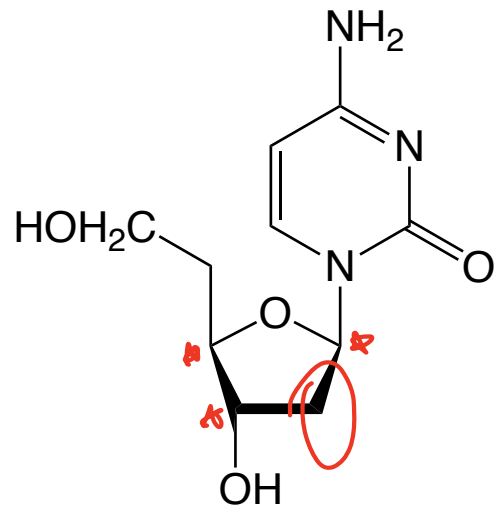
MCAT question

20 pts.



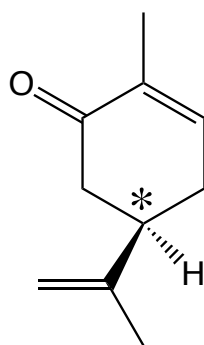
R = 20 different things

Amino Acids

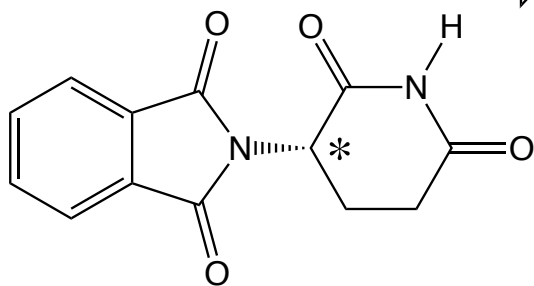
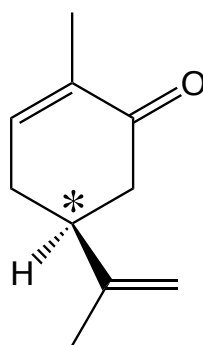


These are our molecular building blocks → they are present as single enantiomers in living things → WE ARE CHIRAL!!!

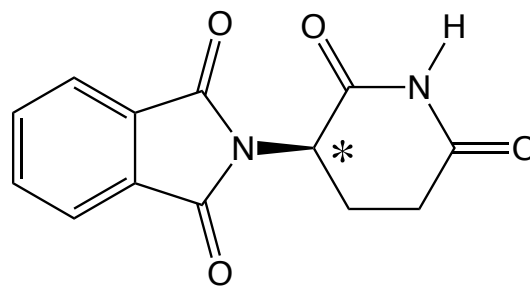
R-Carvone
Spearmint



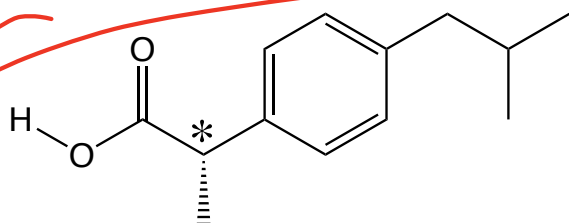
S-Carvone
Major component
of caraway seeds



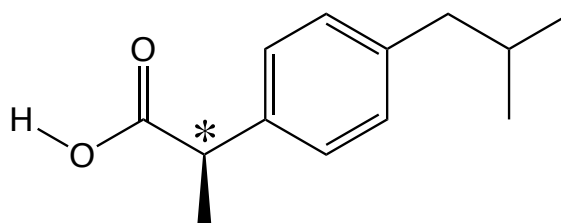
S-Thalidomide (Relieves morning sickness)



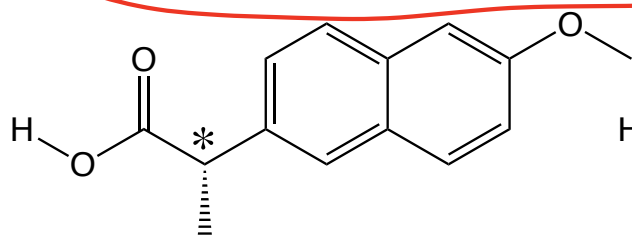
R-Thalidomide (Causes birth defects)



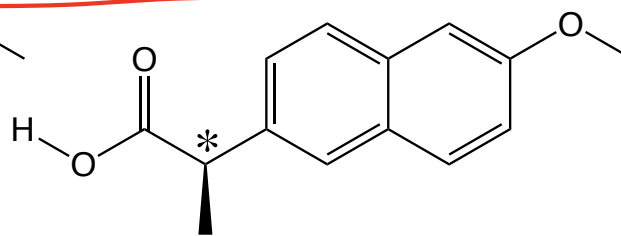
S-Ibuprofen (Advil, Motrin)



R-Ibuprofen (Inactive and relatively harmless)



S-Naproxen (Aleve)



R-Naproxen (liver toxin)

Organic Chemistry 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. 8/24/26

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. 9/21/26

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.

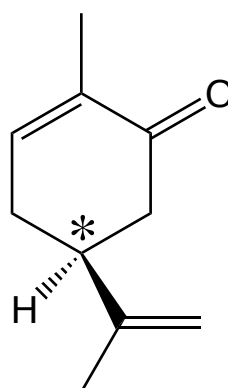
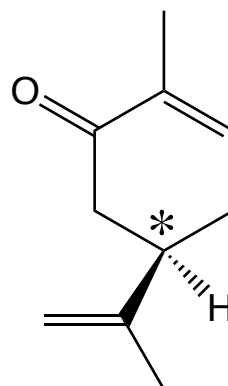
You will learn a reaction that can make nail polish remover from rubbing alcohol.

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.

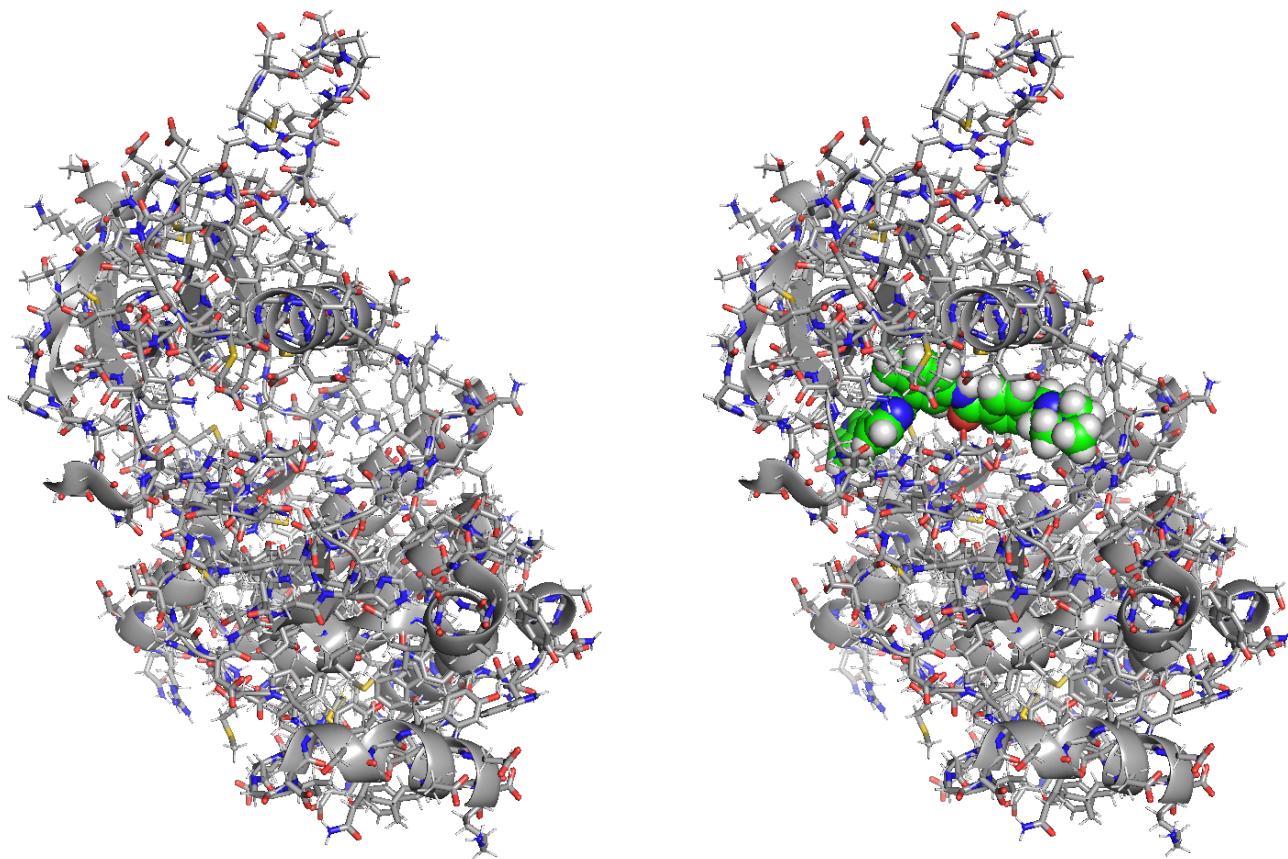


R-Carvone
Spearmint

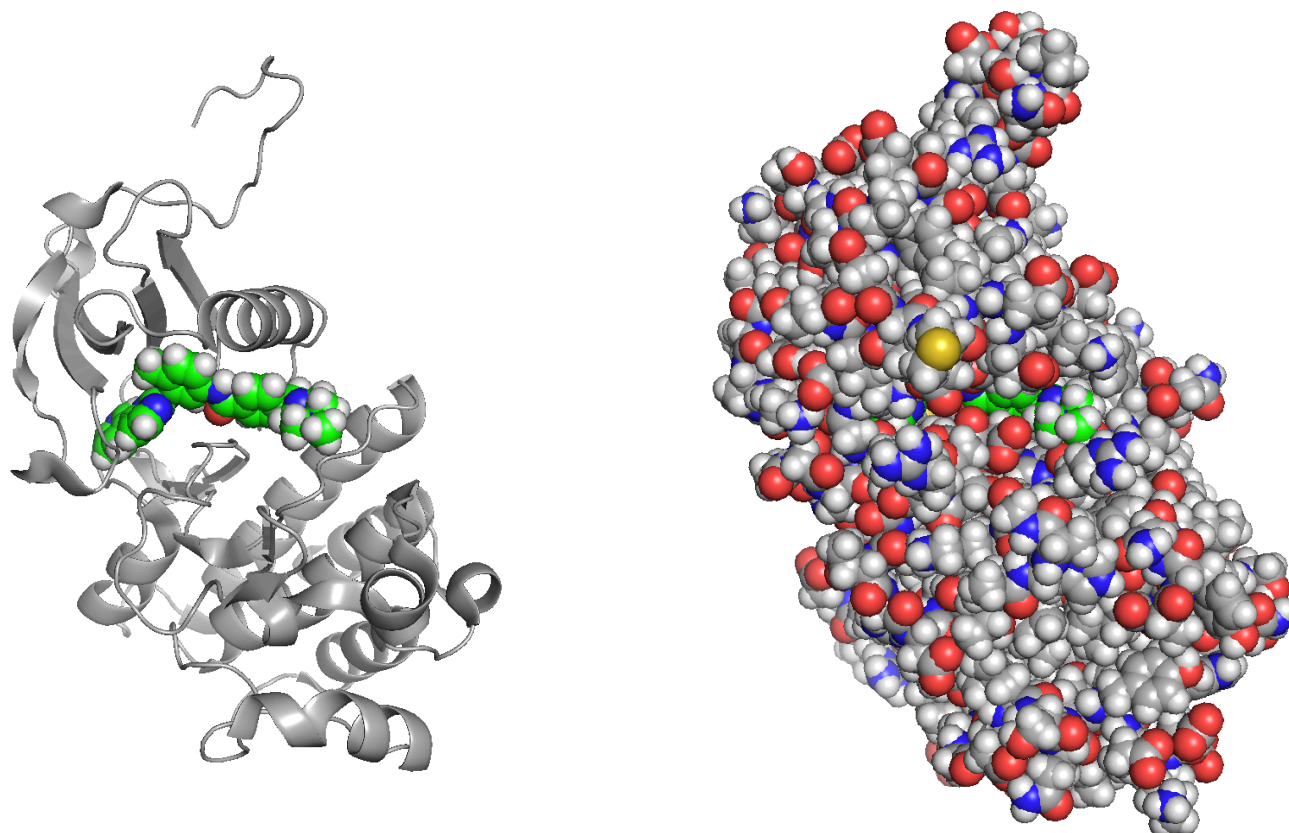


S-Carvone
Major component
of caraway seeds





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

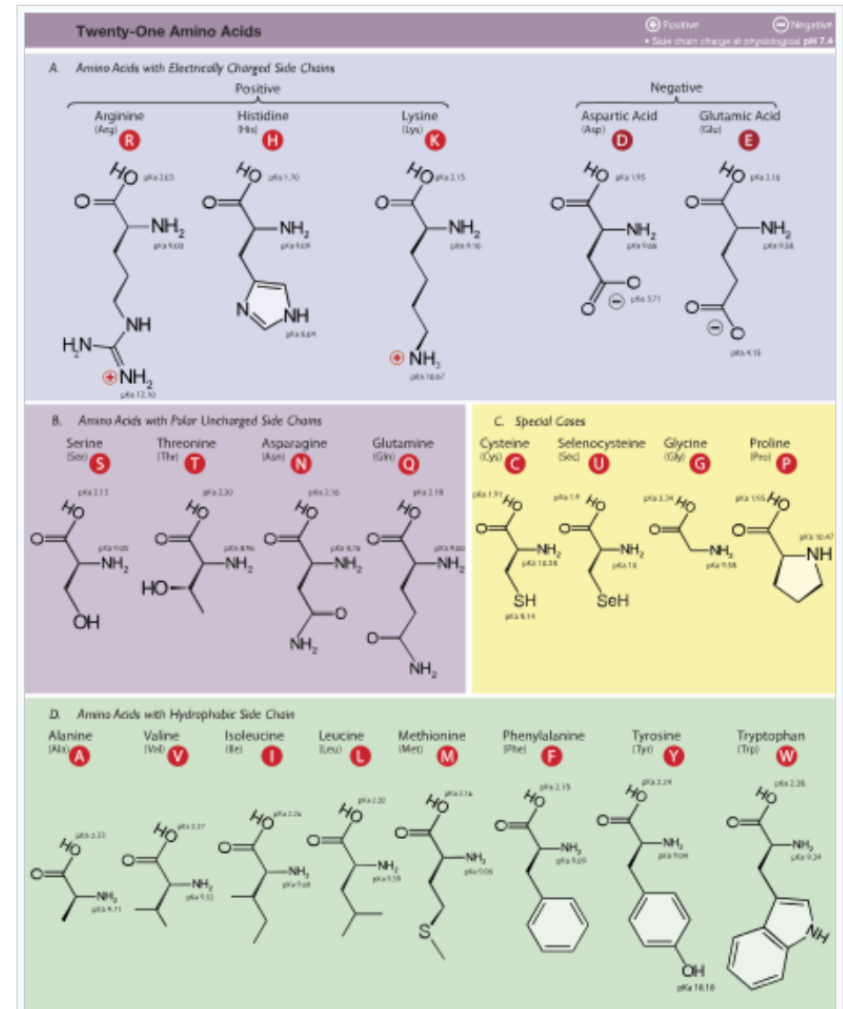


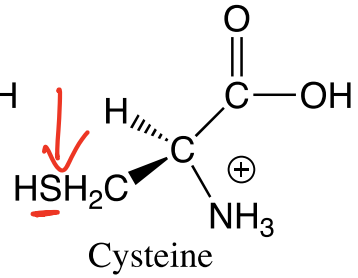
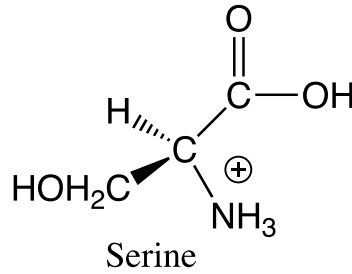
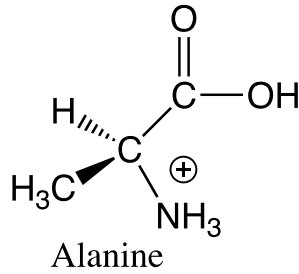
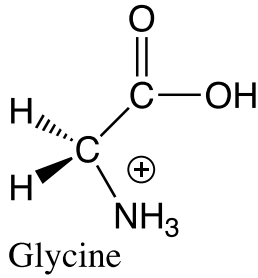
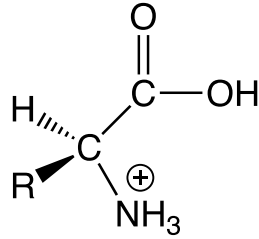
General structure [edit]

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]





X

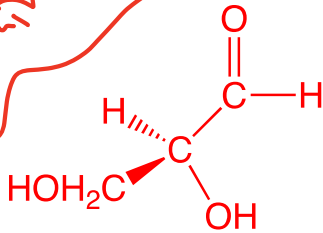
S

S

R

IUPAC

Can be used to
synthesize all 19
chiral amino acids



(L)-(-)-Glyceraldehyde

Levorotary

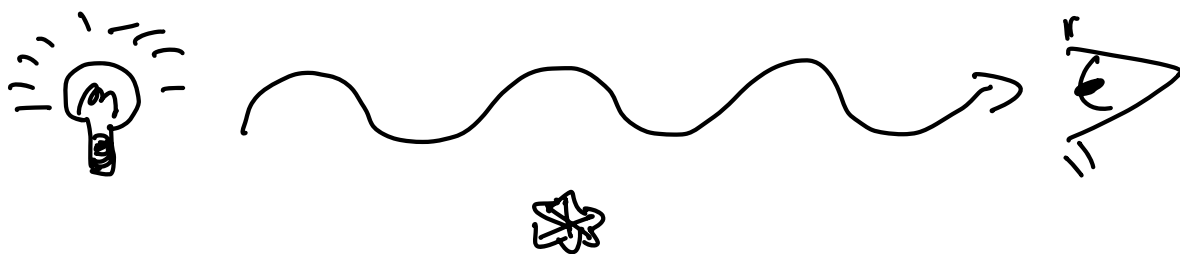
Another word for "-"
Rotates the plane of plane
polarized light counter-
clockwise



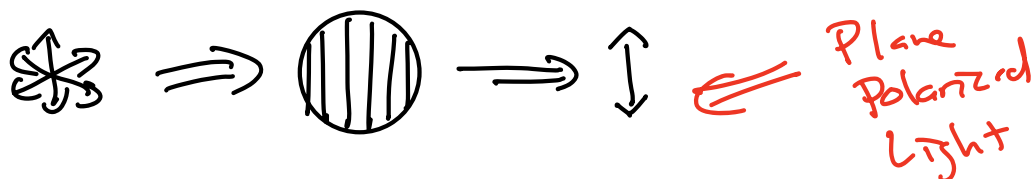
(D)-(+)-Glyceraldehyde

Dextrorotary

Another word for "+"
Rotates the plane of plane
polarized light clockwise

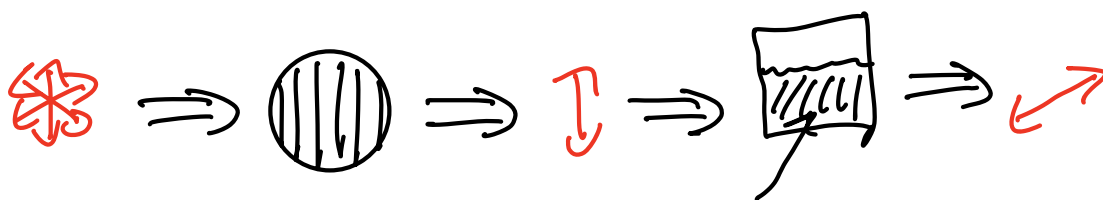


Polarizing filter $\Rightarrow$ makes it so only light in a single plane passes through



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

enantiomer will rotate the plane of plane polarized light the same amount but in the opposite direction



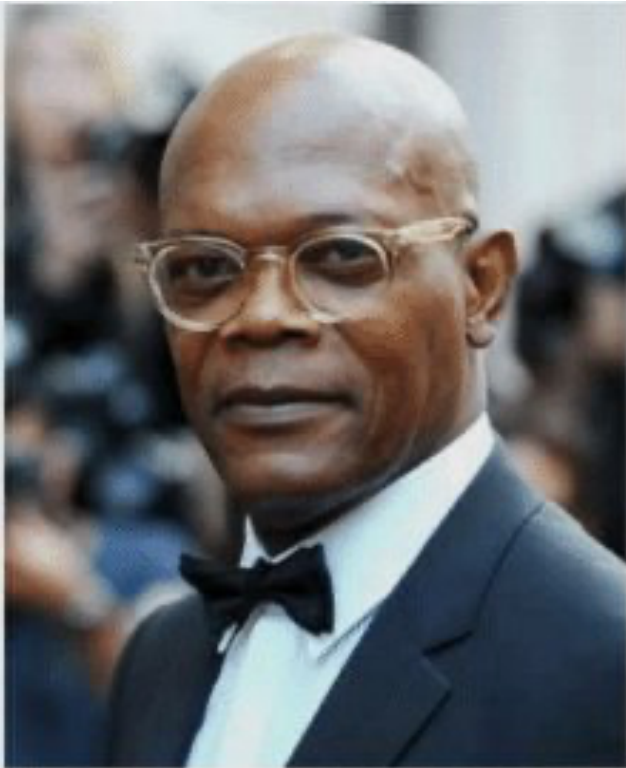
solution containing one enantiomer of a chiral molecule

Clockwise rotation $\rightarrow$ "+" plus

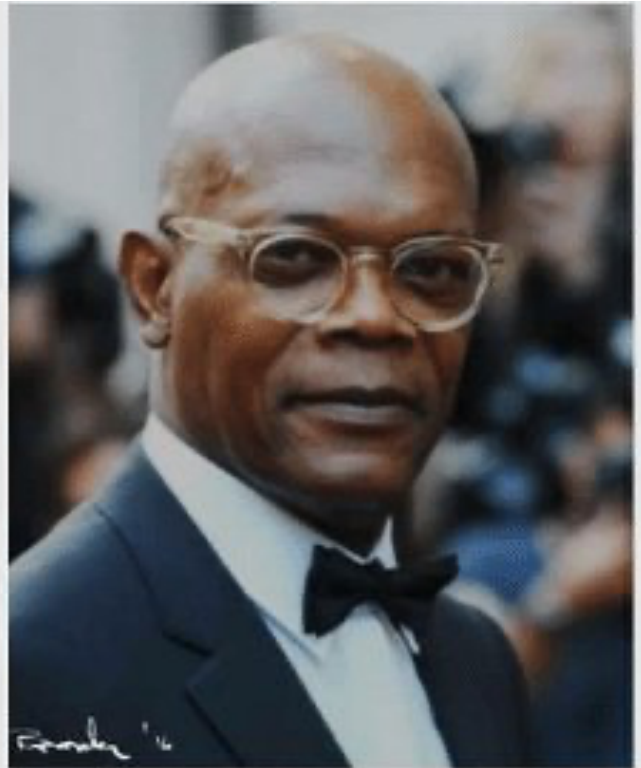
Counterclockwise rotation $\rightarrow$ "-" minus

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

The "L" designation of amino acids
is based on the structural relationship
to (L)-(-)-glyceraldehyde

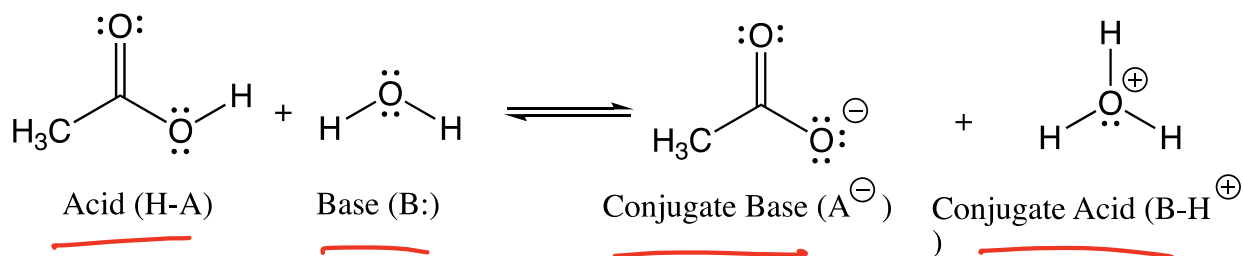


Samuel-L-Jackson



Samuel-D-Jackson

I hope this goes chiral



At equilibrium: $K_{\text{equilibrium}} = \frac{[\text{Products}]}{[\text{Reactants}]} = \frac{[\text{CH}_3\text{CO}_2^-][\text{H}_3\text{O}^+]}{[\text{CH}_3\text{CO}_2\text{H}][\text{H}_2\text{O}]}$

Equilibrium Constant $\uparrow$

Assume: $[\text{H}_2\text{O}] = 55 \text{ M}$ and does not change

Acid Constant $\rightarrow$

$$K_a = K_{\text{equilibrium}} [\text{H}_2\text{O}] = K_{\text{equilibrium}} [55 \text{ M}]$$

$$K_a = \frac{[\text{CH}_3\text{CO}_2^-][\text{H}_3\text{O}^+]}{[\text{CH}_3\text{CO}_2\text{H}]}$$

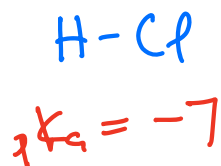
$$pK_a = -\log K_a$$

A stronger acid has a lower value of pK_a

A weaker acid has a higher value of pK_a

General Rule

All acid-base reactions favor formation of the weaker acid



$pK_a = 15.7$
weaker acid

Favored
at
equilibrium

How to estimate relative acid strengths



How do you
predict anion
stability?

Compare the relative stabilities of the anions produced upon deprotonation → the more stable anion comes from the stronger acid

2 important principles for predicting anion stability

- 1) Negative charge ($\ominus$) is neutralized by nuclear $\oplus$ charge.
- 2) Delocalizing negative charge ($\ominus$) over a larger area is better. → Golden Rule #5

Rules for anion stability -

The anion is more stable when the negative charge ($\ominus$) is:

a) On a more electronegative element (Principle 1)
→ Periodic Table (across a single row)

b) On a larger atom (Principle 2)
↓ Periodic Table (down a single column)

c) On an atom with more "s" character to its hybridization
($sp > sp^2 > sp^3$)
← anion stability

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

d) stabilized by resonance delocalization.
(Principle 2)

e) Stabilized by the inductive effect
(Principles 1 and 2)

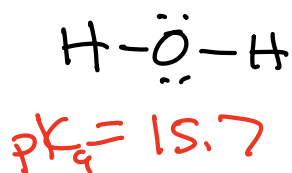
Operates
through sigma
bonds

nearby electronegative atoms attract $\ominus$ charge and therefore spread the $\ominus$ charge onto more atoms

Examples

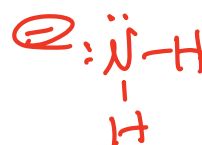
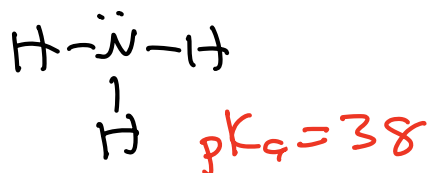
Rule a)

Ex.



more stable
anion

O is more electronegative



Rule b)



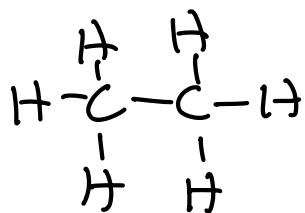
(Only compare atoms
in same column of
the Periodic Table)

$\text{p}K_a$	3.5	-7	-8	-9
	H-F	H-Cl	H-Br	H-I
	$\text{F}^\ominus$	$\text{Cl}^\ominus$	$\text{Br}^\ominus$	$\text{I}^\ominus$

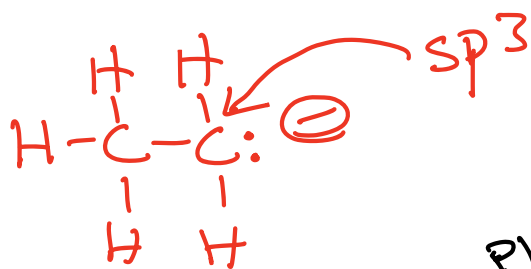
larger ion

acid strength

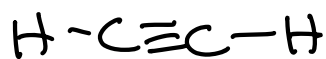
Rule c)



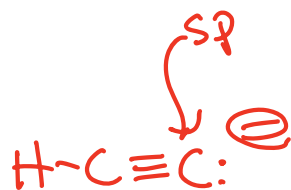
$$\text{p}K_{\text{a}} \cong 50$$



$$\text{sp}^3 \rightarrow 25\% \text{ s} \\ 75\% \text{ p}$$



$$\text{p}K_{\text{a}} = 25$$



Places more
 $\ominus$ closer
to nucleus

More "s" $\rightarrow$

$$\text{sp} \rightarrow 50\% \text{ s} \\ 50\% \text{ p}$$

max stable anion