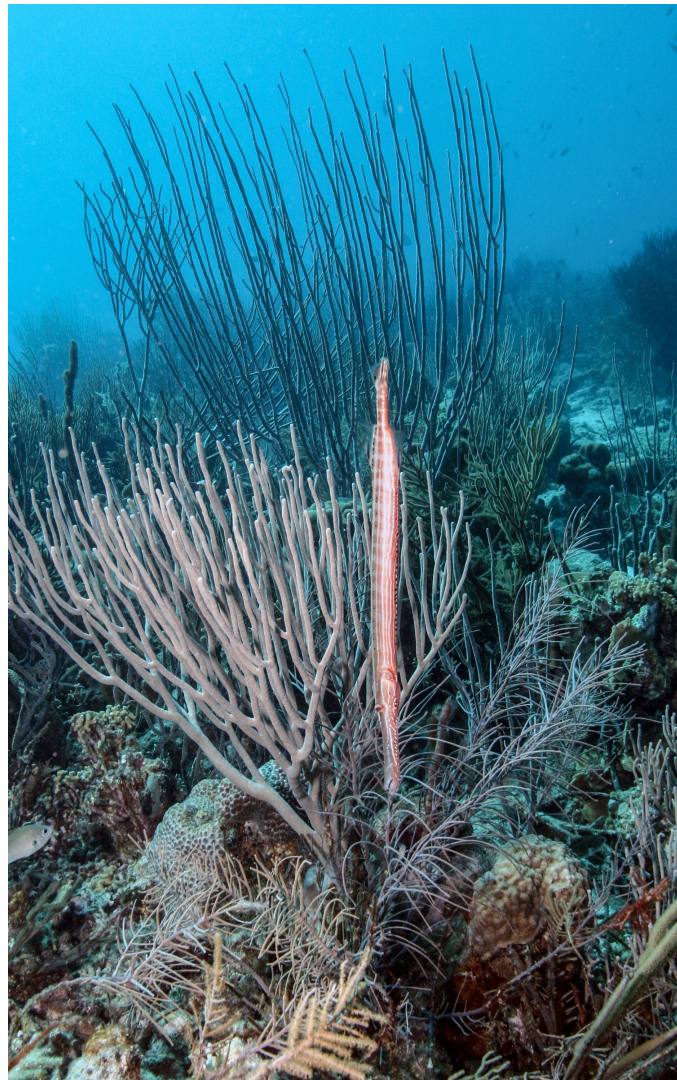
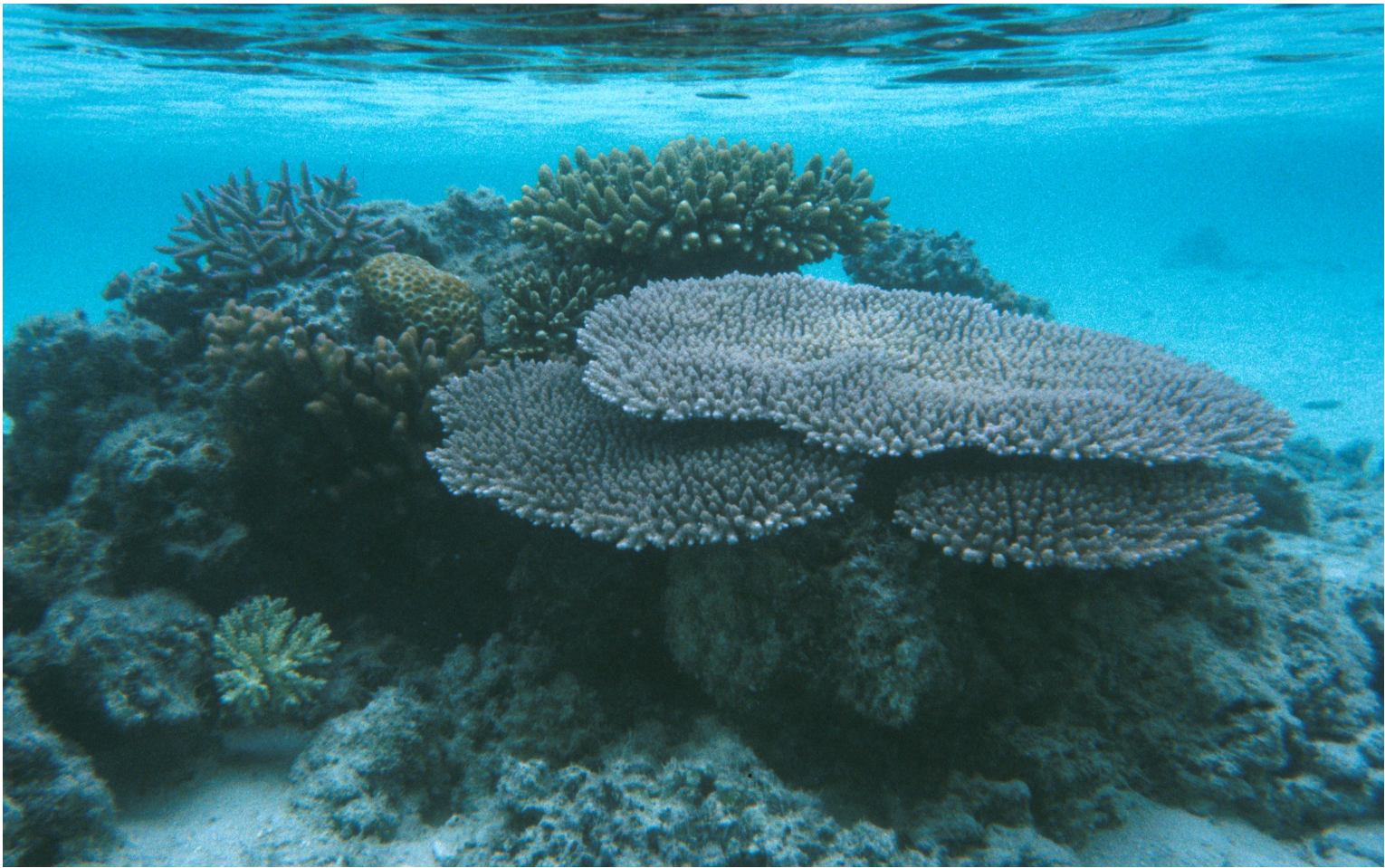






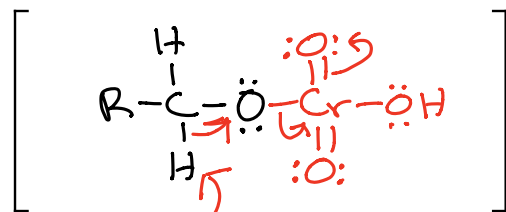
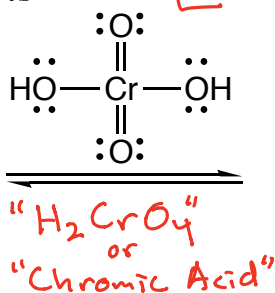
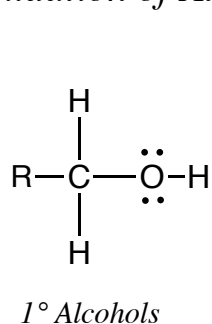


WELCOME TO OUR
REACTION
FESTIVAL

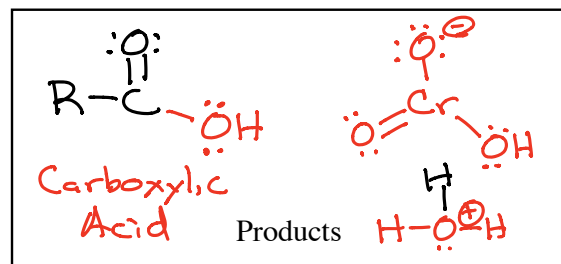
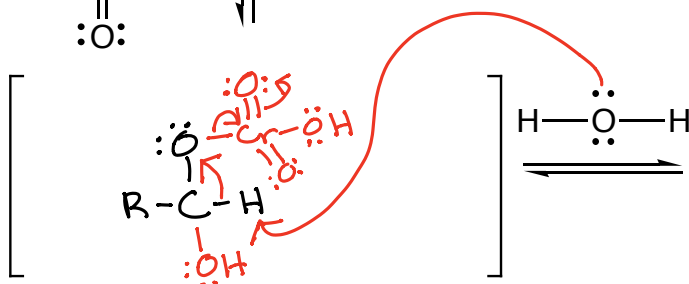
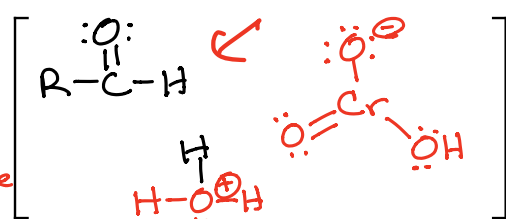
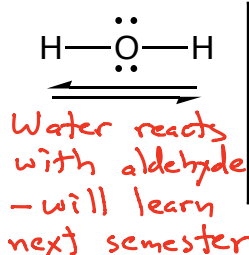
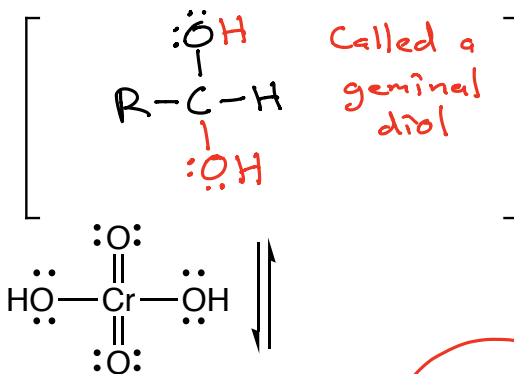
Chromic Acid Oxidation of Alcohols

Called "Jones Reagent" $\left\{ \begin{array}{l} \text{CrO}_3 + \text{H}_2\text{O} \\ \text{or} \\ \text{K}_2\text{CrO}_7 \end{array} \right\} + \text{H}_2\text{SO}_4$

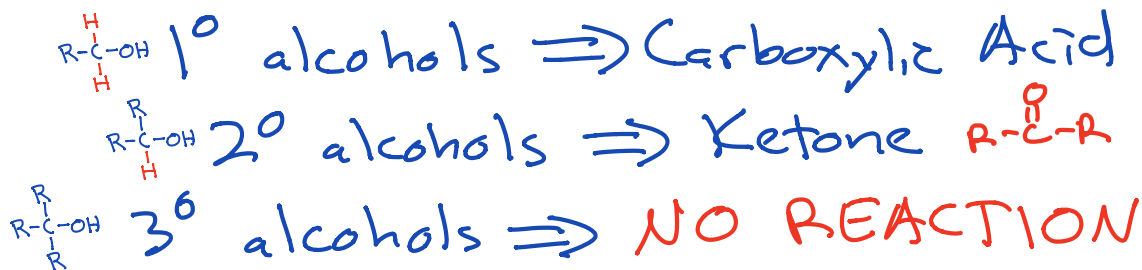
Not responsible for first step



Not responsible for this step



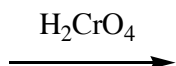
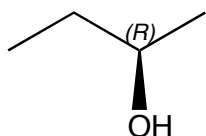
Summary:



Regiochemistry: N/A

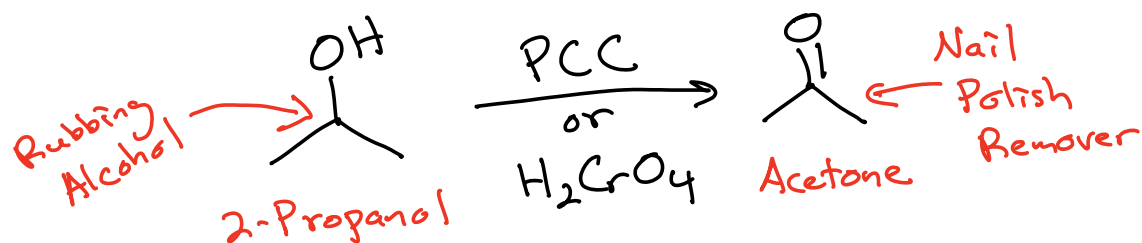
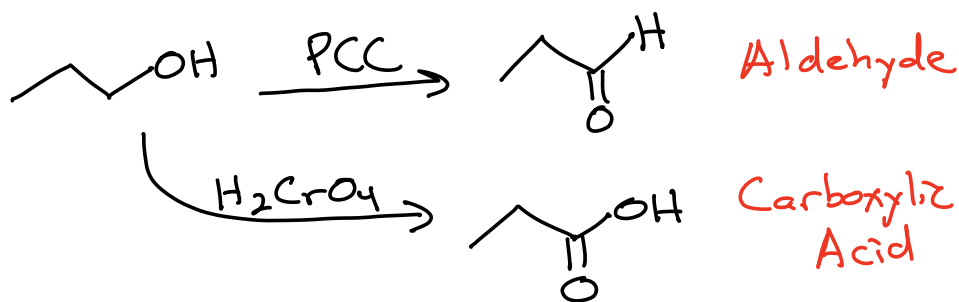
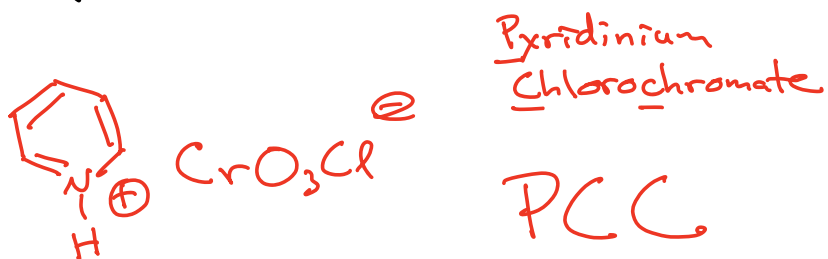
Stereochemistry: N/A

Example:



Ketone

A chromic acid-like reagent WITHOUT WATER will stop at the **aldehyde** when using a **primary alcohol** as starting material



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. 8/27/25

You will learn the secret structural reason proteins, the most important molecular machines in our bodies, can support the chemistry of life. 9/10/25

You will learn why when you take Advil for pain, exactly half of what you take works, and the other half does nothing. 9/24/25

You will learn how toothpaste works. 10/6/25

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. 10/29/25

You will learn how medicines like Benadryl, Seldane, and Lipitor work. 11/12/25

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. 10/8/25

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. 10/29/25

You will learn reactions that can make antifreeze from vodka. 11/12/25

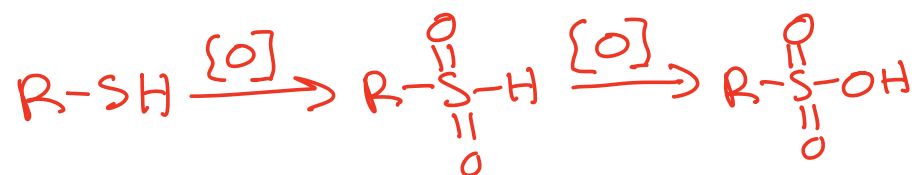
You will learn a reaction that can make nail polish remover from rubbing alcohol. 11/17/25

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.

Thiols $\rightarrow R-\ddot{S}-H$

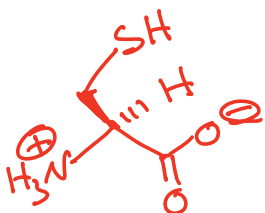
The sulfur atom can be oxidized!



In the presence of O_2 :



This is a slow but spontaneous reaction!

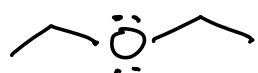


The amino acid
cysteine (Cys)

Disulfide bonds between cysteine residues that are far apart in the sequence, but overlap in three-dimensions, provide covalent links that stabilize folded protein structures — especially common in proteins that are outside of cells
ex. antibodies $\leftarrow$ In bloodstream

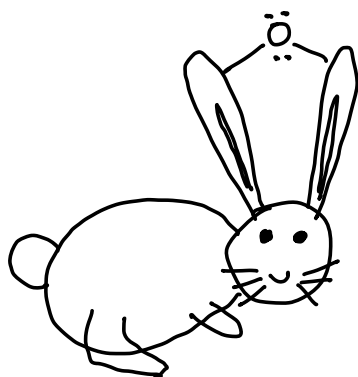


$\hookrightarrow$ Unreactive under most conditions



Diethyl ether

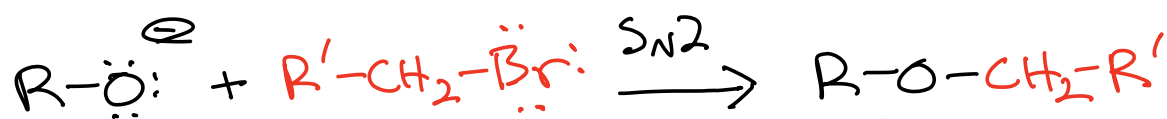
} Good solvent - polar but not protic - can interact with cations but not anions



Ether Bunny!

How to make ethers

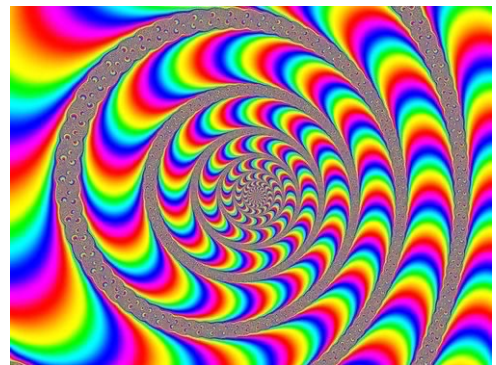
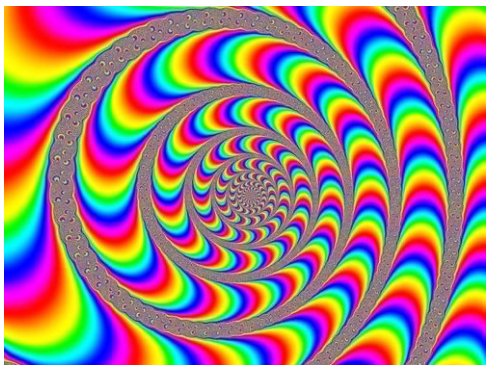
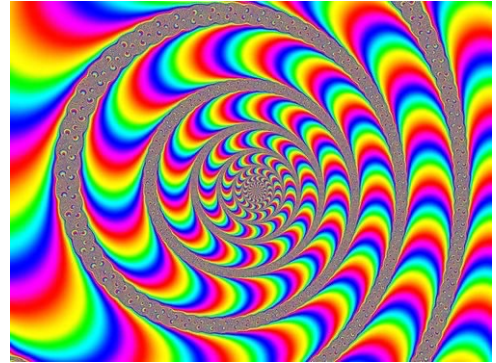
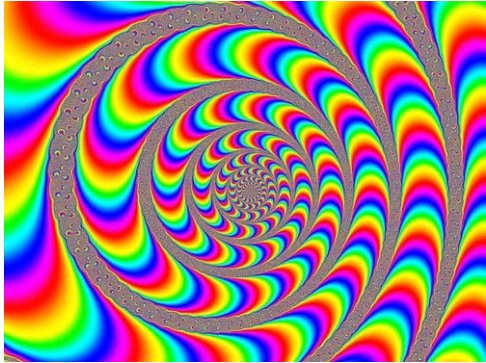
Williamson Ether Synthesis



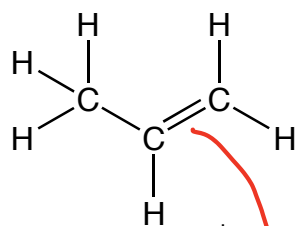
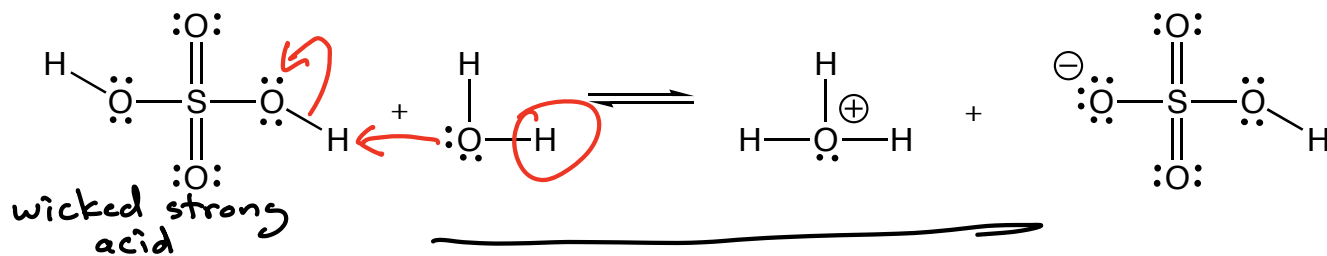
Must be a
primary
alcohol to
avoid E2

You can also react alkenes with
alcohols in the presence of catalytic
amounts of H_2SO_4 to make ethers:

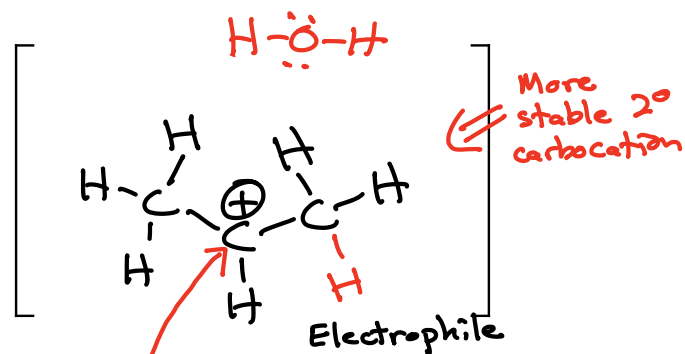
Flashback!



Acid-catalyzed Hydration of an Alkene

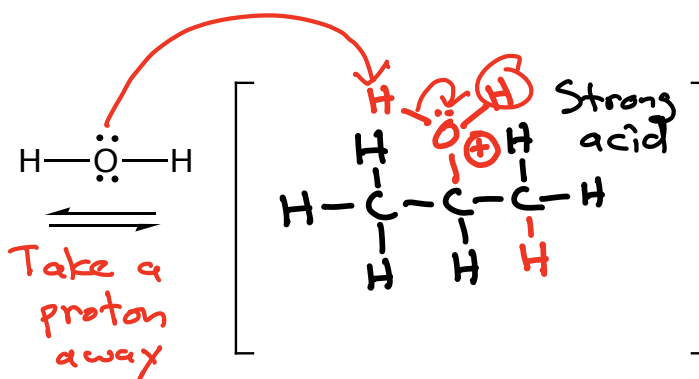
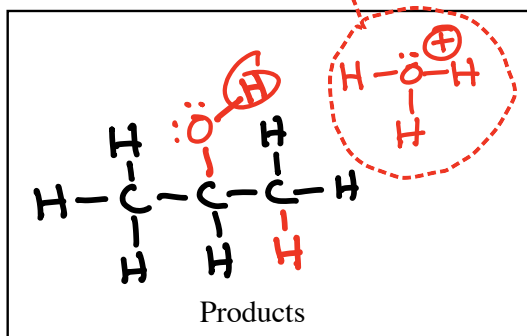
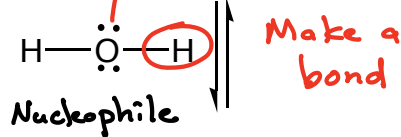


Add a proton



Catalytic in Acid!
 $\Rightarrow$ The $[\text{H}_3\text{O}^+]$ does not change during the reaction

strong acid

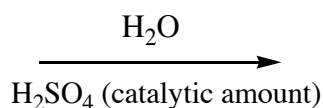
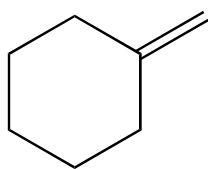


Summary: Proton adds to make a carbocation intermediate, water attacks to make a new bond, take a proton away to make the product alcohol. Catalytic in H_3O^+

Regiochemistry: Markovnikov's Rule

Stereochemistry: Mixed (time capsule)

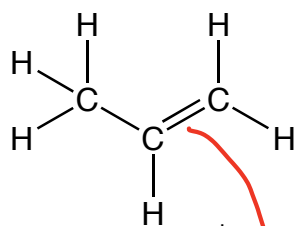
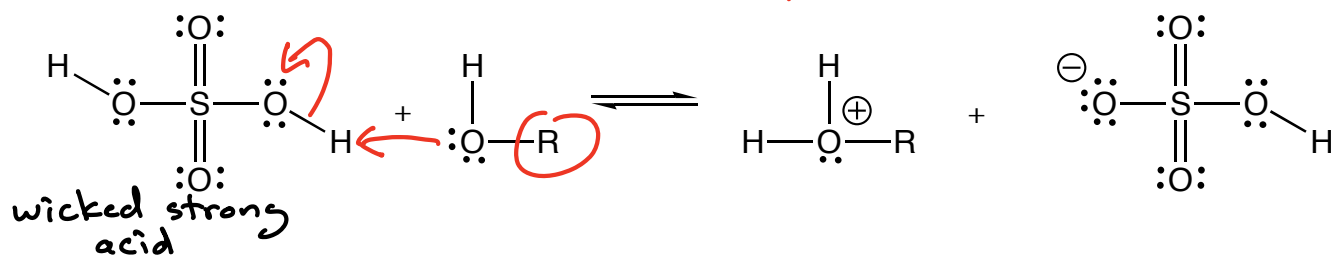
Example:



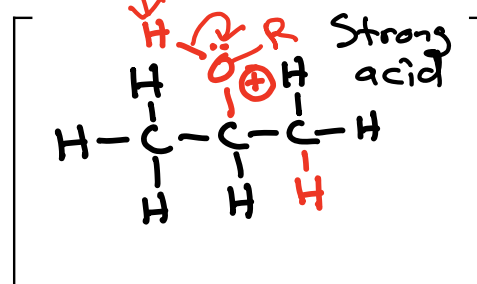
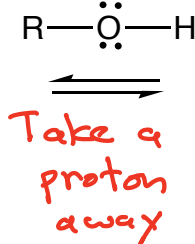
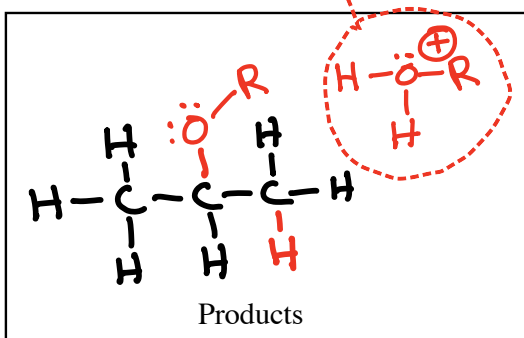
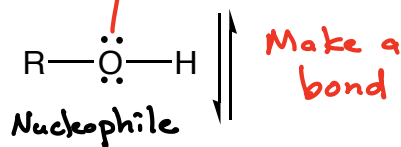
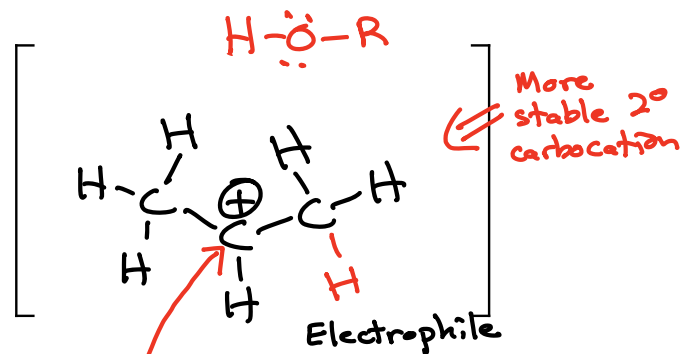
(Not chiral)

-OH on more substituted C atom $\Rightarrow$ Markovnikov's Rule

Acid-catalyzed Reaction of an Alcohol with an Alkene



Add a proton



Summary: Proton adds to make a carbocation intermediate, alcohol attacks to make a new bond, take a proton away to make the product ether. Catalytic in H_3O^+

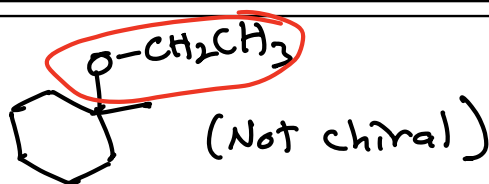
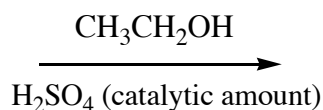
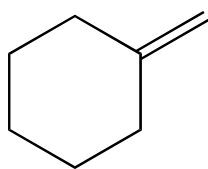
Regiochemistry:

Markovnikov's Rule

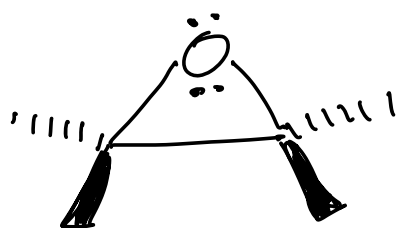
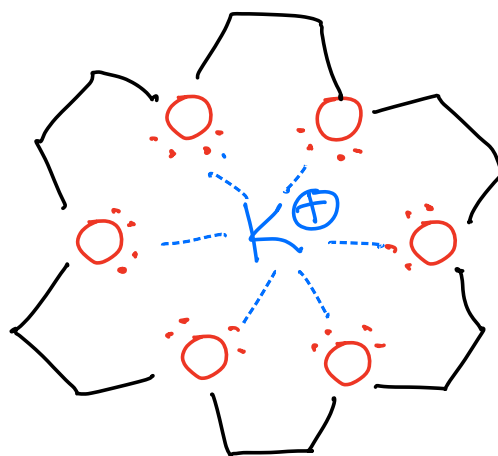
Stereochemistry:

Mixed

Example:



Crown Ethers →
bind cations
based on the
radius of the
ion



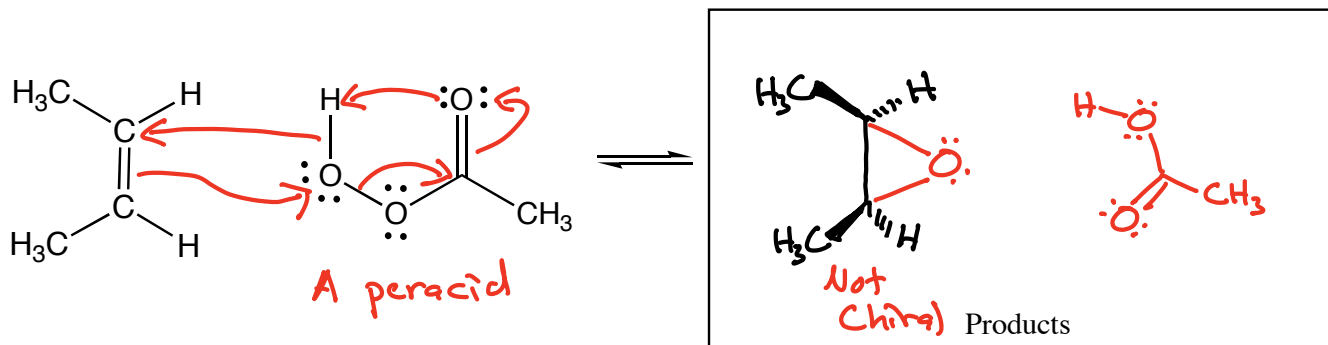
Epoxide

Epoxides
are also
involved in
a number of
biological
processes
including
oxidative
damage

Important because they
can be formed from
alkenes or halohydrins
AND they are
good electrophiles →
reactions open up
three-membered
ring, relieving angle
strain

Synthesis of epoxides

Epoxide Formation

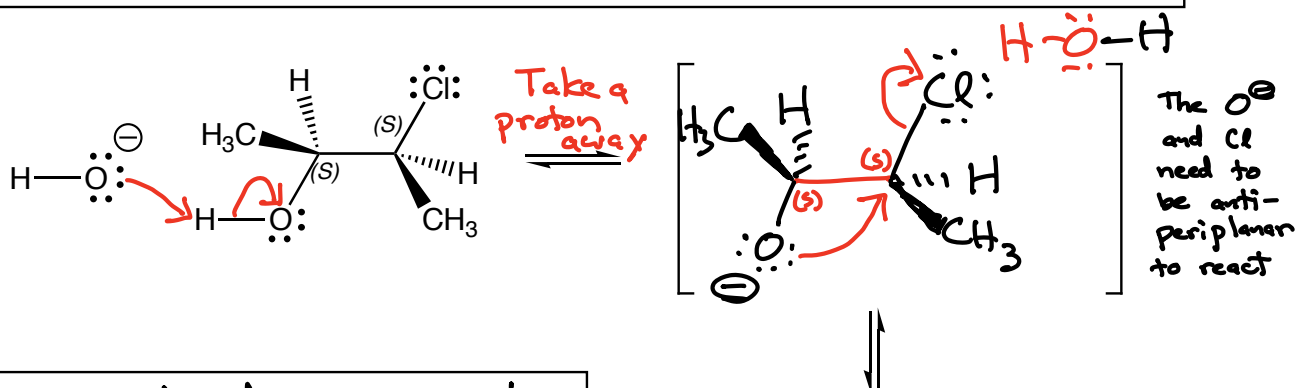
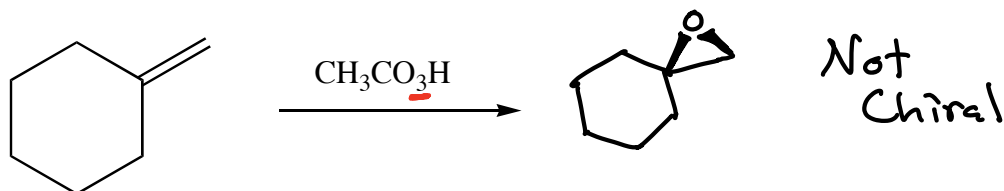


Summary: Alkenes react with peracids in a single concerted step

Regiochemistry: N/A

Stereochemistry: Mixed when new chiral centers are created

Example:

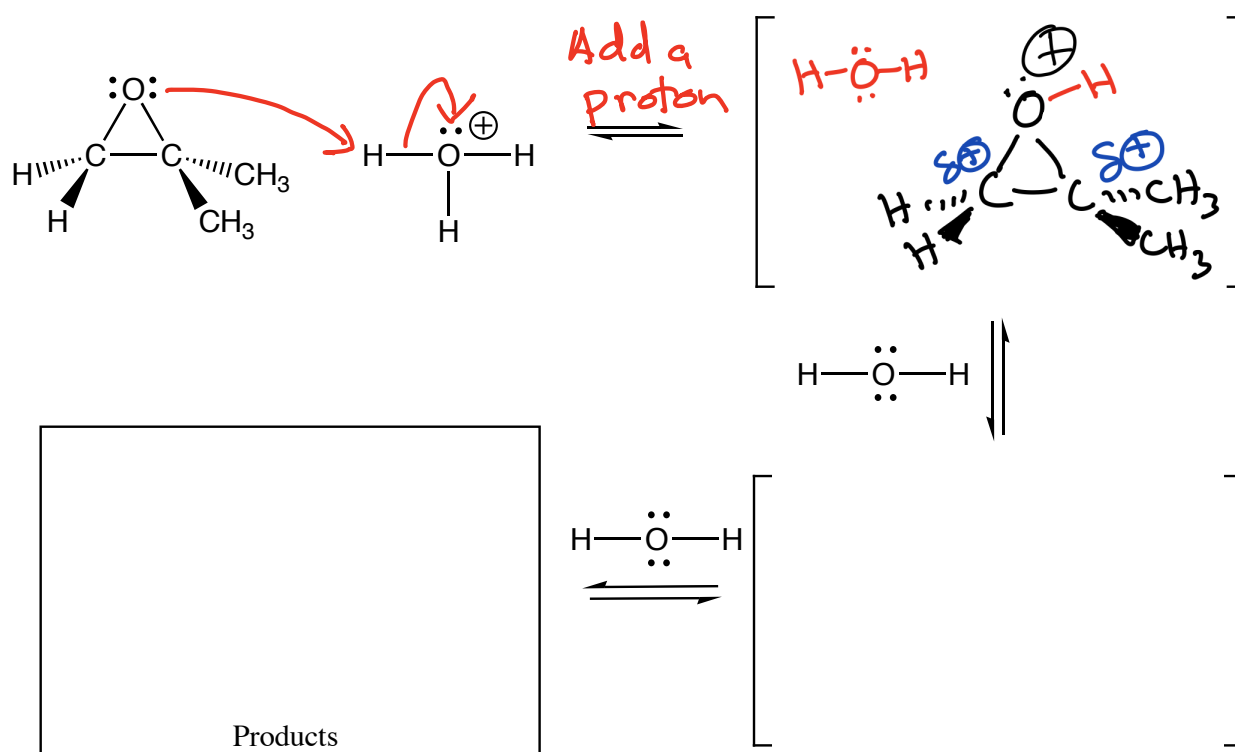


Summary: Halohydrins react in base to give the alkoxide that reacts antiperiplanar to give the epoxide.

Regiochemistry: N/A

Stereochemistry: Antiperiplanar transition state

Acid-Catalyzed Epoxide Opening

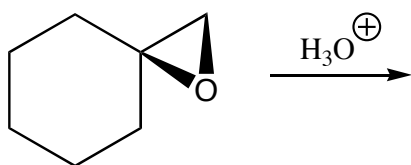


Summary: In acid, epoxides are protonated to give a highly reactive cation intermediate that reacts with nucleophiles at the more highly substituted carbon atom

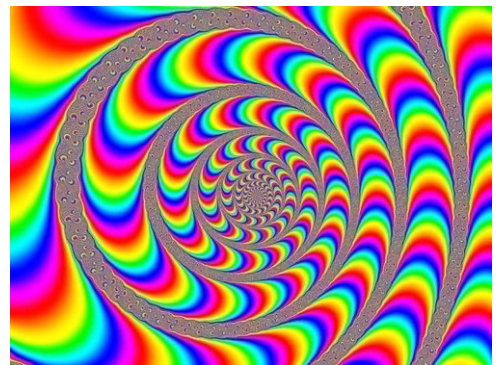
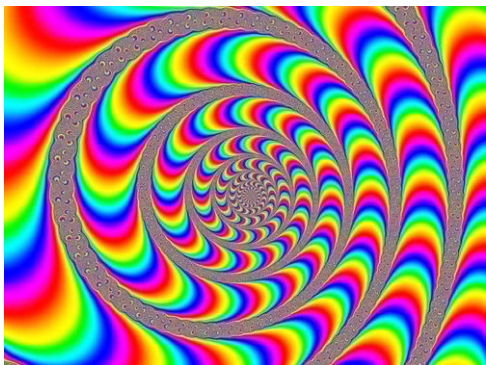
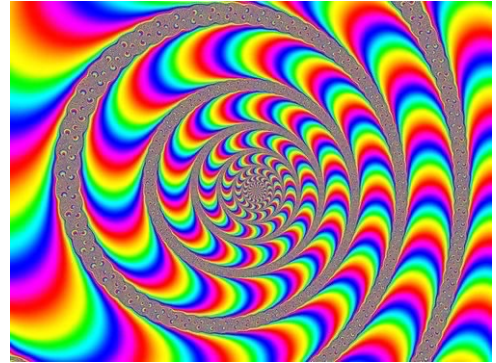
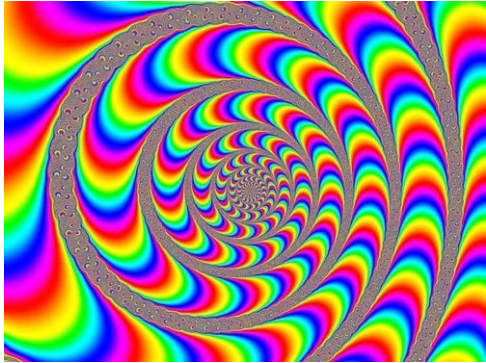
Regiochemistry: "Markovnikov" Attack at more highly substituted carbon

Stereochemistry: Anti

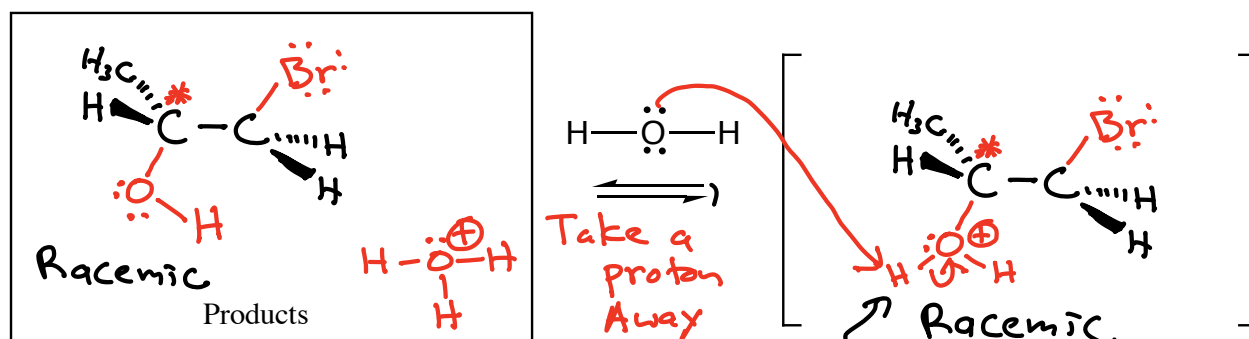
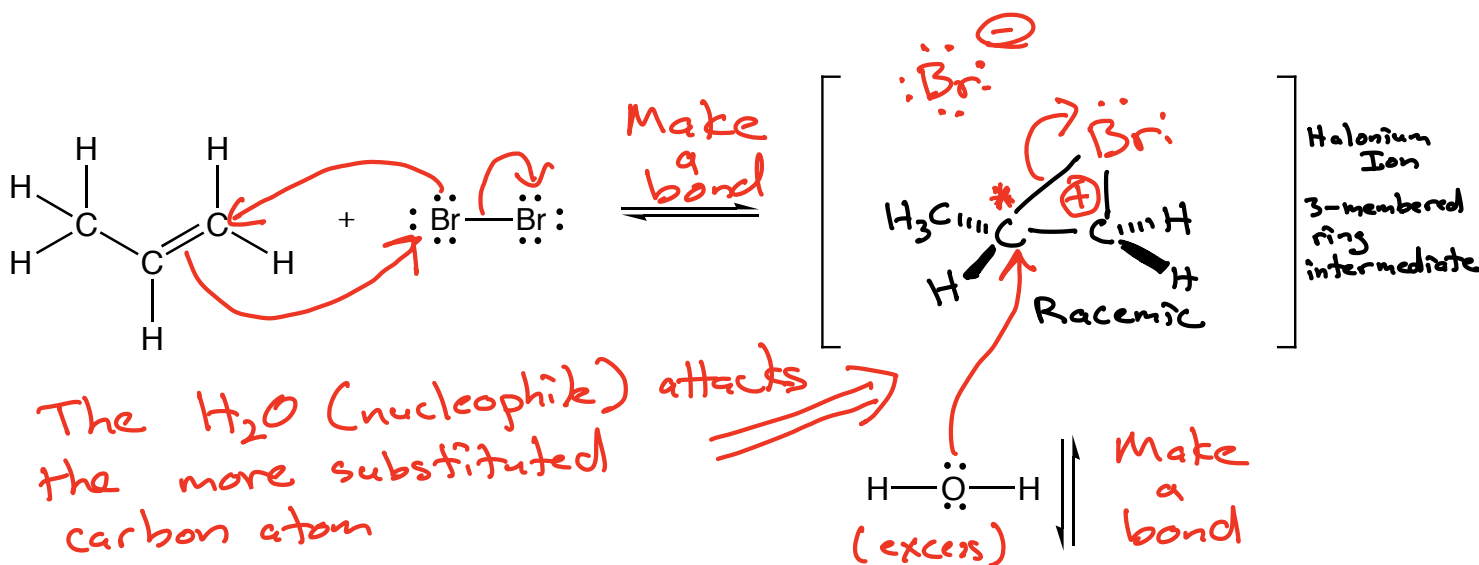
Example:



Flashback!



Alkene Hydrohalogenation



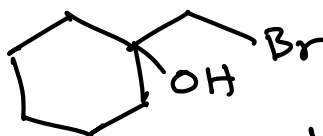
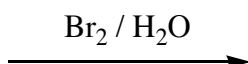
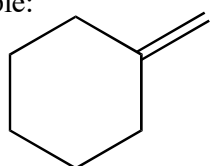
pH drops during the reaction!

Summary: Alkene reacts with X_2 to give a 3-membered ring intermediate (halonium ion) $\rightarrow$ H_2O attacks the more substituted C atom and we take a proton away to give the halohydrin product.

Regiochemistry: Markovnikov (OH on more substituted C atom)

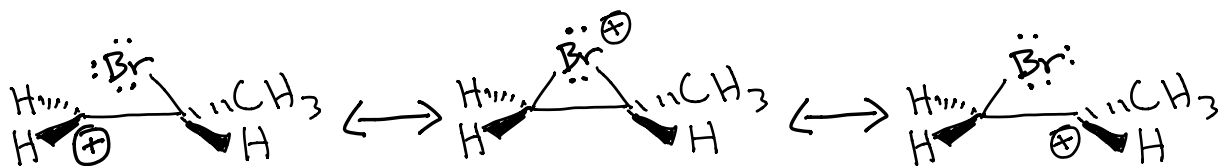
Stereochemistry: Anti

Example:



Not Chiral

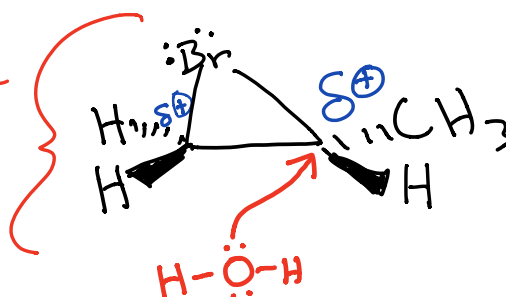
Flashback → Halohydrin Mechanism



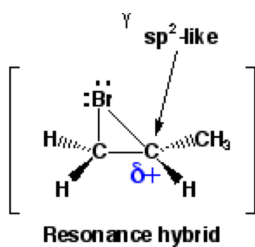
Minor Contributor

Major Contributor

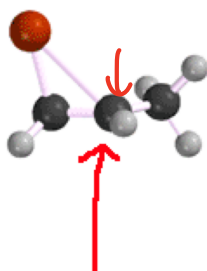
Resonance Hybrid



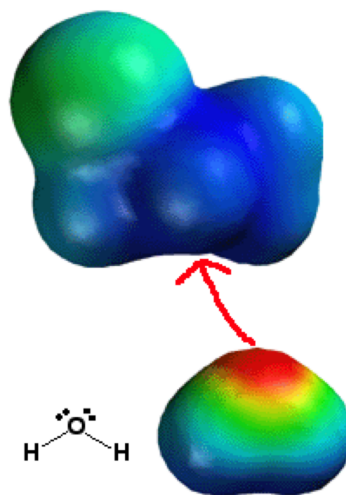
Water attacks the more substituted carbon atom because there is more partial $\oplus$ charge



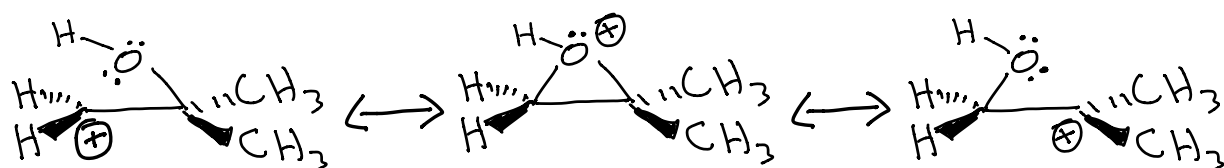
From
"Pictures of the
Day (PoTD)"
10-9-20



Nucleophiles Attack the More Positively-Charged Carbon Atom From This Face Leading to Markovnikov Regiochemistry and Trans Stereochemistry of Addition

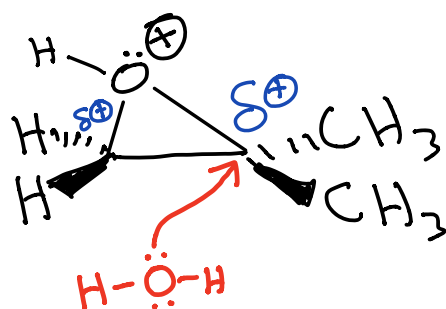


Epoxide in acid



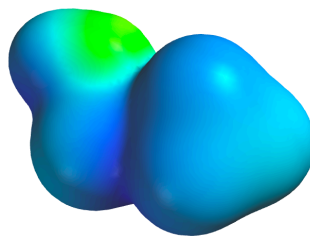
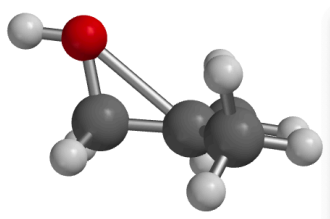
Minor
Contributor

Major
Contributor

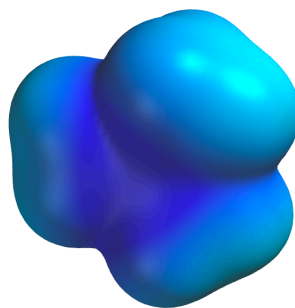
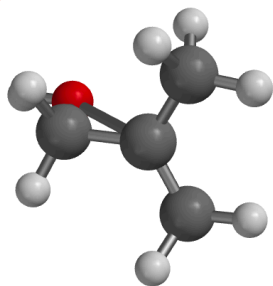


Water attacks
the more
substituted
carbon atom
because there
is more partial
 $\oplus$ charge

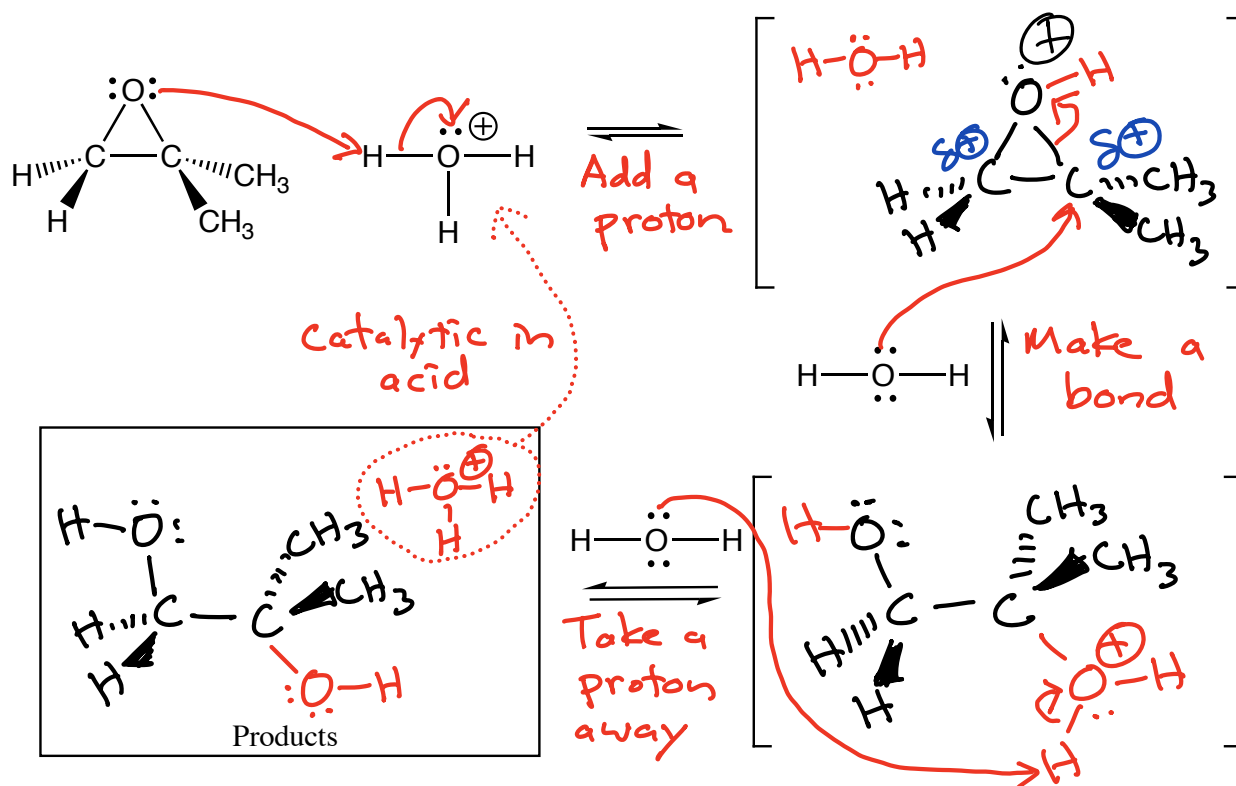
Side
View



View
from Bottom



Acid-Catalyzed Epoxide Opening

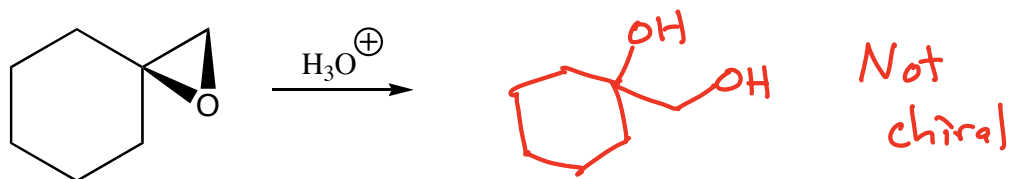


Summary: In acid, epoxides are protonated to give a highly reactive cation intermediate that reacts with nucleophiles at the more highly substituted carbon atom

Regiochemistry: "Markovnikov" Attack at more highly substituted C atom

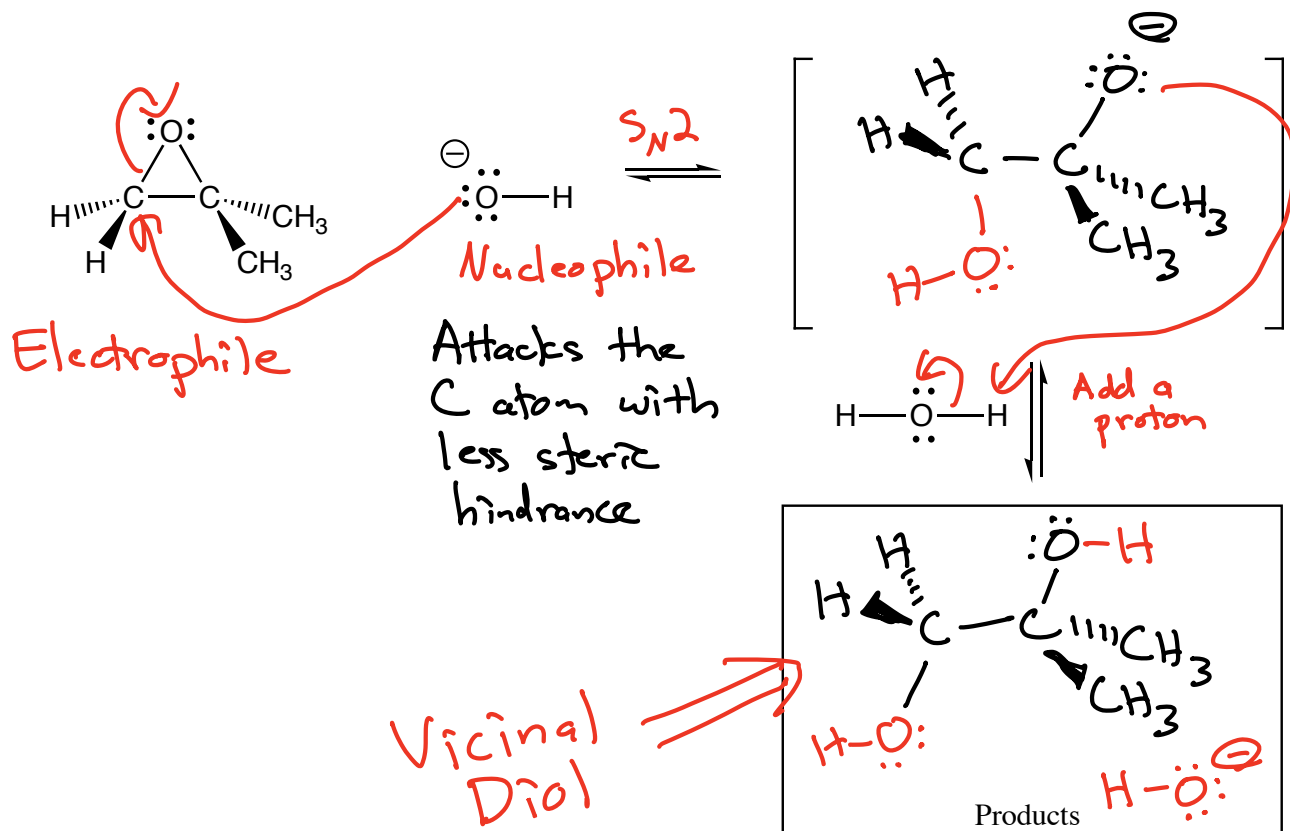
Stereochemistry: Anti $\leftarrow$!!!

Example:



Nucleophilic

~~Base Promoted~~ Epoxide Opening

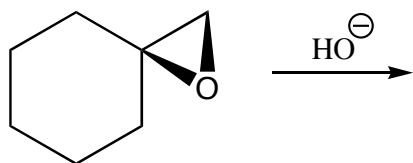


Summary: Epoxides add strong nucleophiles at the less hindered carbon atom

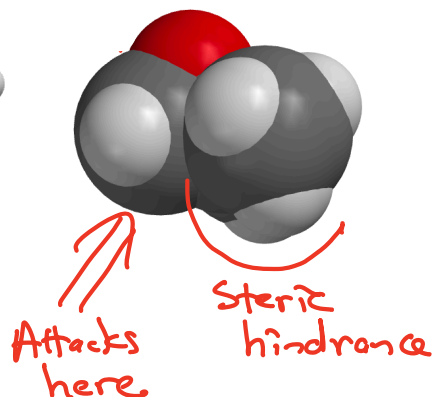
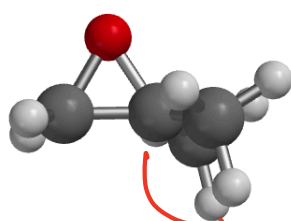
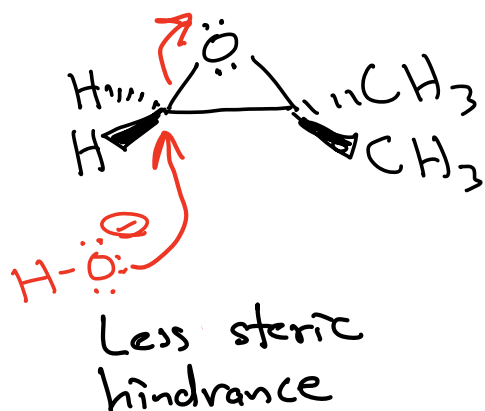
Regiochemistry: Less hindered (non-Markovnikov)

Stereochemistry: Anti addition

Example:

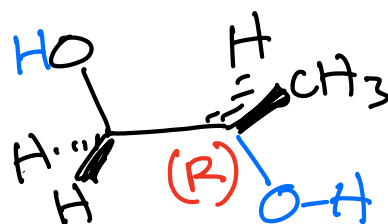
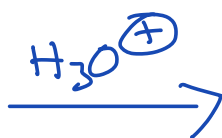
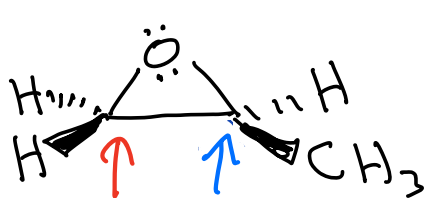


Epoxide reacting with nucleophile

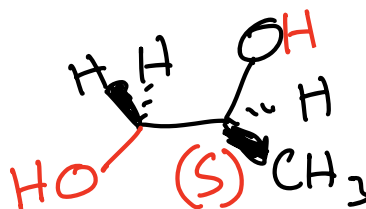


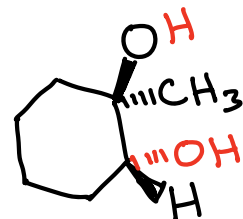
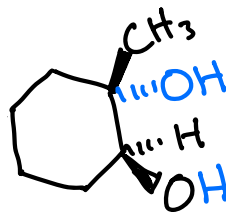
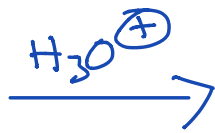
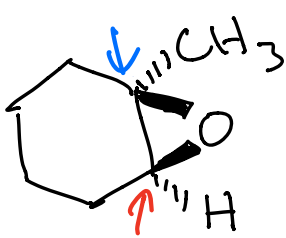
Watch out for the stereochemistry!

Single enantiomer



Anti products only!!

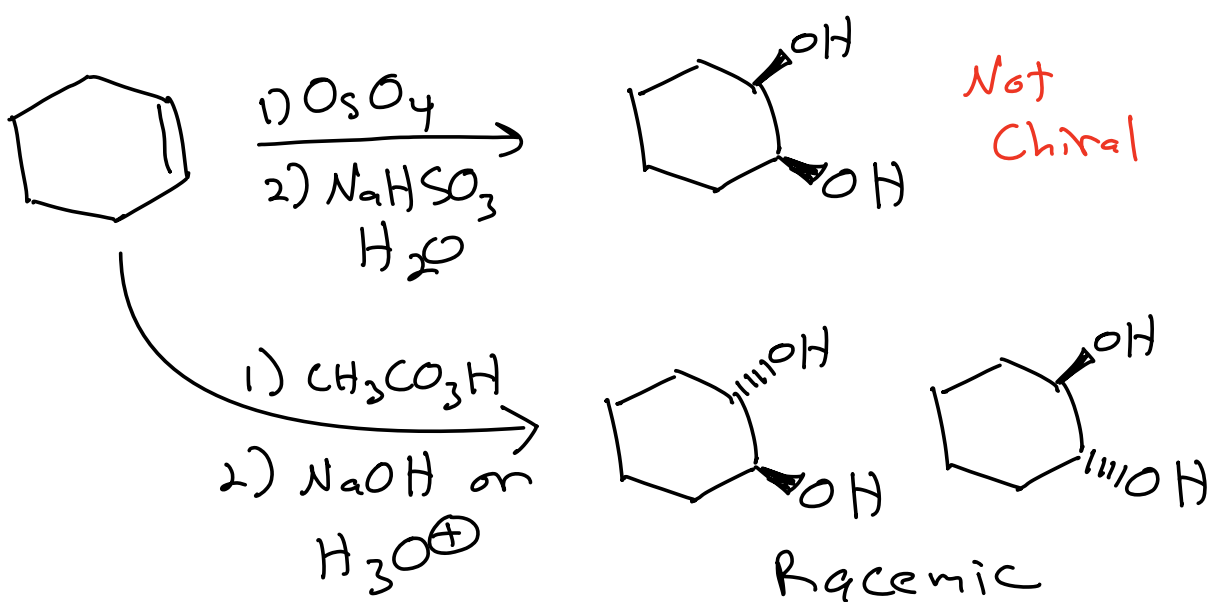




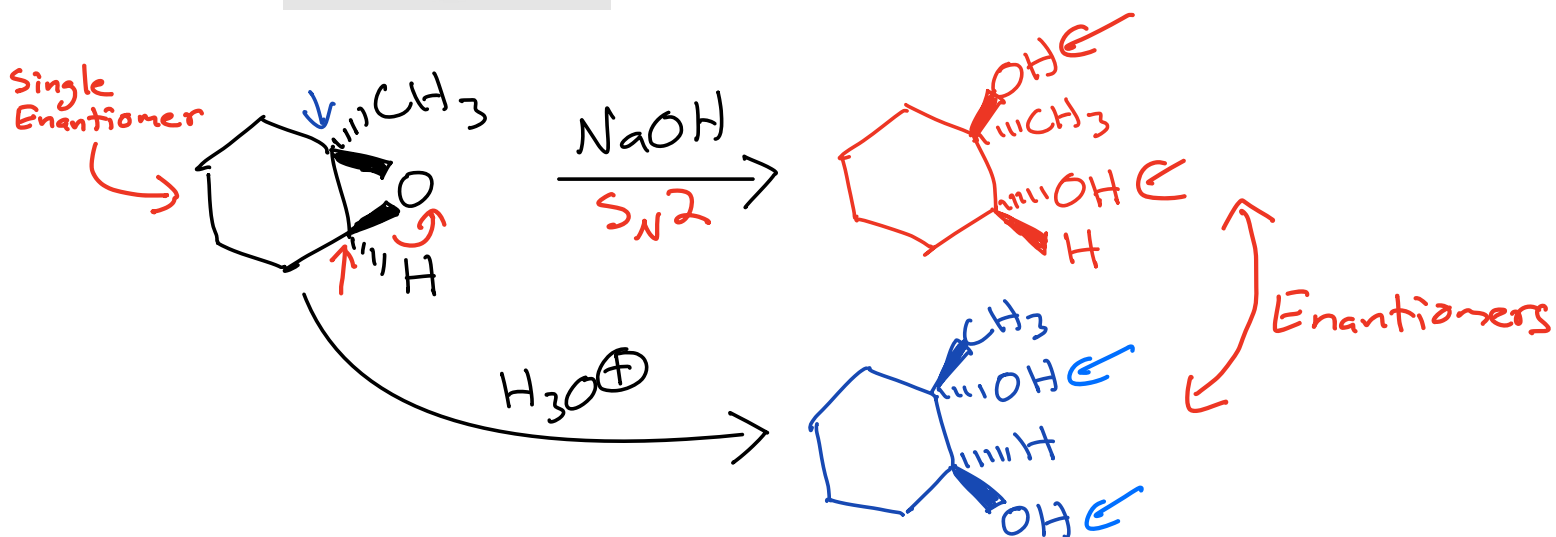
Enantiomers

Nucleophile
attacks from
underneath

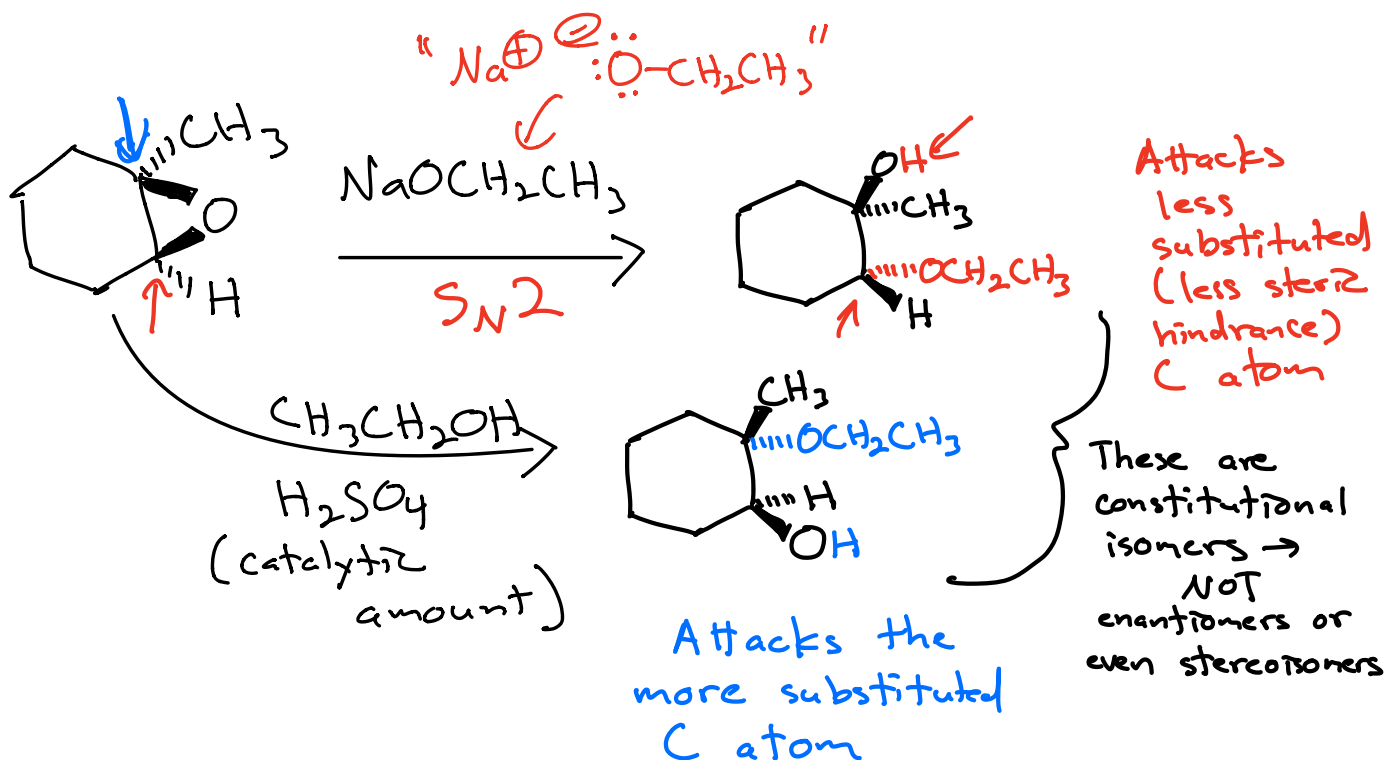




Watch out for the stereochemistry!



Works with alkoxides and alcohols as well)



Note: The attack always comes from behind the C-O bond of the epoxide