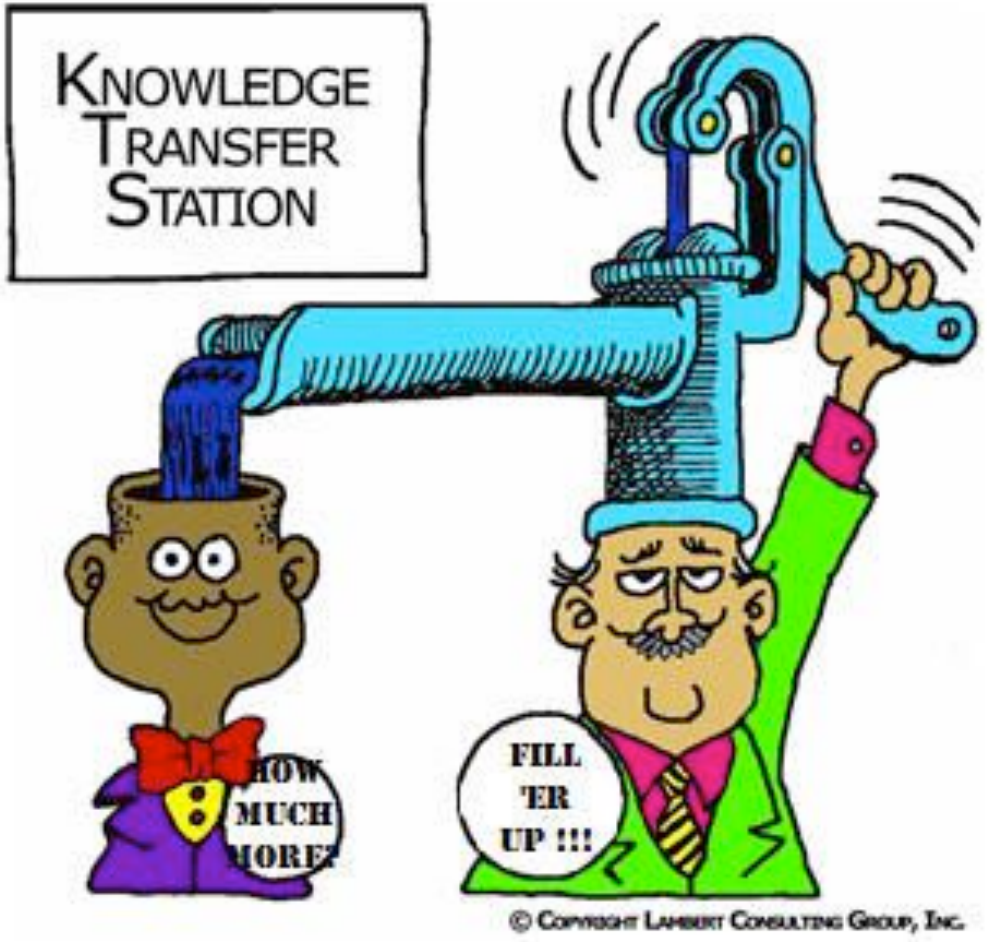
Does A Person Learn This Way?



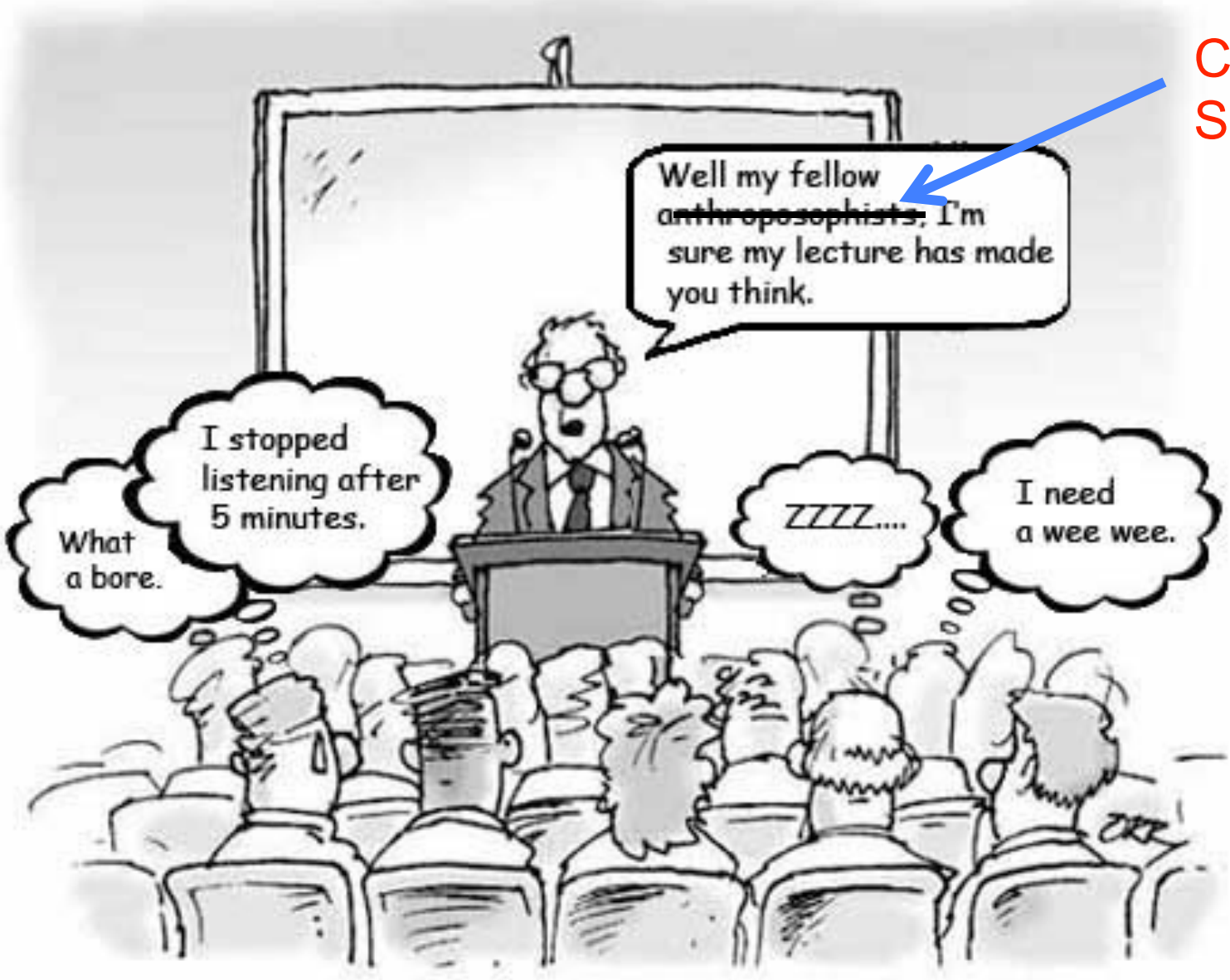
Yes?

or

No?

Student Teacher

http://pmblog.ninethsense.com/2013/12/kill-concept-of-knowledge-transfer-and.html



Chemistry Students

https://ed240s12a.wikispaces.com/Mindtool+-+Jonassen

We learn ____ % of what we hear.

"*You don't really understand something until you can explain it to your grandmother.*"

- Einstein

We learn ____ % of what we teach.

We Learn:

10%	of what we read
20%	of what we hear
30%	of what we see
50%	of what we see and hear
60%	of what we write
70%	of what we discuss
80%	of what we experience
95%	of what we teach

What is the best way to learn Organic Chemistry?

a) Sit passively in lecture and stay awake

b) Re-write your notes

c) Do experiments in lab and discuss with your lab partner

d) Discuss and try to teach someone what you learned

Work in the SAME Group of 4

Form your Group this Wednesday:

1. your Lab partner
2. Student from other side of lab room (not your grandmother)
3. At least 1 person with a mobile device with internet

- Studies show students who work in cooperative GROUPS tend to get BETTER GRADES and enjoy course more than students who work individually and competitively.
- Work in teams in industry
- Build and develop social skills (introduce self, listen, encourage, check, accountable)

Coordinator – make sure all group members know their responsibilities and understand problem solution

Recorder – write ideas, possible solutions, and final answer

Checkers – check solution for accuracy before submitting

"Problem solving is what you do when you don't know what to do, otherwise it is not a problem."

Problem Solving Model 1:

- Understand the Problem
- Devise a Plan
- Carry out the Plan
- Look Back

G. Bodner, “Problem Solving: The Difference Between What We Do and What We Tell Students To Do,” U. Chem. Ed., 2003, **7**, 37.

"Problem solving is what you do when you don't know what to do, otherwise it is not a problem."

Problem Solving Model 2:

- Read the Problem
- Read the Problem AGAIN
- Write down what you think is the relevant information
- Draw a picture, make a list, write an equation or formula to help you begin to understand the problem
- Try Something (*Trial And Error*)
- Try Something ELSE
- *SEE where this gets you*

To be continued …

G. Bodner, "Problem Solving: The Difference Between What We Do and What We Tell Students To Do," U. Chem. Ed., 2003, **7**, 37.

"Problem solving is what you do when you don't know what to do, otherwise it is not a problem."

Problem Solving Model 2: Continued …

- TEST intermediate results to see whether you are making any progress toward an answer
- Read the Problem AGAIN
- When appropriate, strike your forehead and say, "Son of a …"
- Write down "an" answer (not necessarily "**the**" answer)
- TEST the answer to see if it makes sense
- Start over if you have to, *CELEBRATE* if you don't

G. Bodner, "Problem Solving: The Difference Between What We Do and What We Tell Students To Do," U. Chem. Ed., 2003, **7**, 37.

Objective 1. Review CHM 12A substitution, elimination, addition, and acid-base reactions.

Skills: Represent organic compounds (Lewis, skeletal, resonance, Newman, Fischer, etc.)
ID structural features and reactive sites (atom that is being oxidized or reduced)
ID Nu^- and E^+ (Note: some redox reaction do **not** involve Nu^- and E^+.)
Use curved arrows to show bonds breaking and forming

Key ideas:
Nucleophile (base, lone pair, pi bond, *more*) reacts with an
Electrophile (acid, carbocation, α-C, H on β-C, *more*)

Organic Chemistry Skills: (from Chem 12A)

1. Represent structure in different ways (Lewis, skeletal, Newman, Fisher, etc.),

2. ID structural features and reactive sites (alpha C, beta C, LG, etc.),

3. ID Nu^- and E^+,

4. use curved arrows to show bonds breaking and forming,

5. show delocalized electrons with resonance structures.

Apply Organic Chemistry Skills to:

- acid-base reactions,
- nucleophilic substitution reactions,
- elimination reactions, and
- electrophilic addition reactions
- Chem 12B reactions (EAS, $Nu:^-$ addition, $Nu:^-$ acyl sub)

To

- predict products,
- determine reaction conditions,
- describe mechanisms,
- synthesis.

Practice, Practice, Practice to improve Skills

Organic Chemistry Lab Skills:

1. proper use of organic lab chemicals,

2. proper use and operation of equipment,

3. proper use and operation of instruments, and

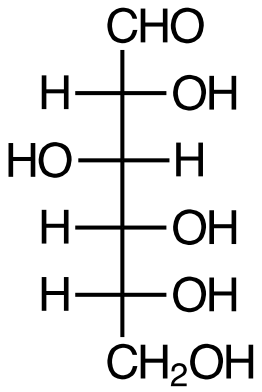
4. proper use of lab techniques (give correct names and formulas),

And

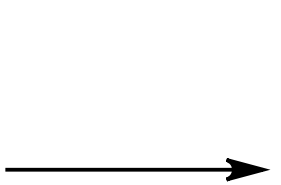
Applying these Lab Skills in each experiment.

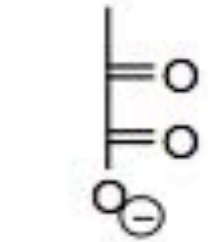
Lab 1: **Fermentation**: Moonshine

How many stereoisomers does glucose have?

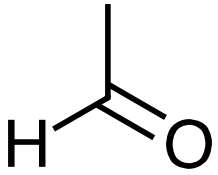


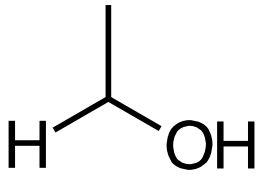
glucose





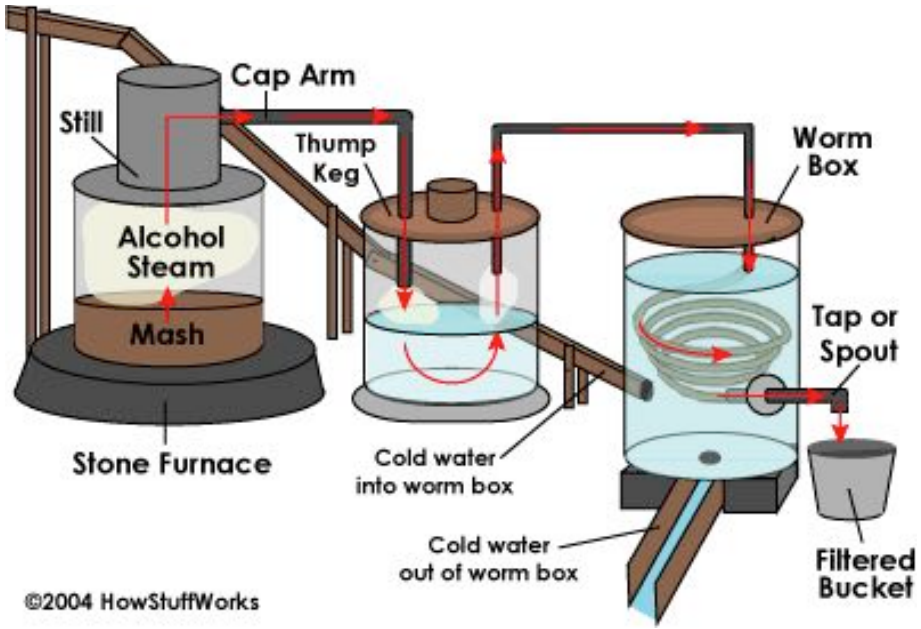
pyruvate





http://www.sheknows.com/parenting/articles/819002/Are-you-sending-mixed-messages-about-alcohol

Lab 1. Sugar → Ethanol



http://science.howstuffworks.com/innovation/edible-innovations/moonshine2.htm

What happens to the C_2H_5OH when it gets in our body?

http://www.cafepress.com/+moonshine_cowsbeer_label,654653133

http://www.mealsonwheelswest.org/the-nutritional-value-of-corn/

Corn use in U.S.:

1/3 to feed livestock

13% exported (most to feed livestock)

40% to produce ethanol

Rest for food and beverages

http://www.nytimes.com/2012/07/31/opinion/corn-for-food-not-fuel.html?_r=0

There are many companies that are converting corn to ethanol, e.g., Archers Daniels Midland.

a. Calculate the heat of combustion of ethanol in kJ/mole and kJ/g. Determine the work produced by ethanol in this reaction. Compare this heat and work to that of octane. Which fuel is the better fuel? Give reasons.

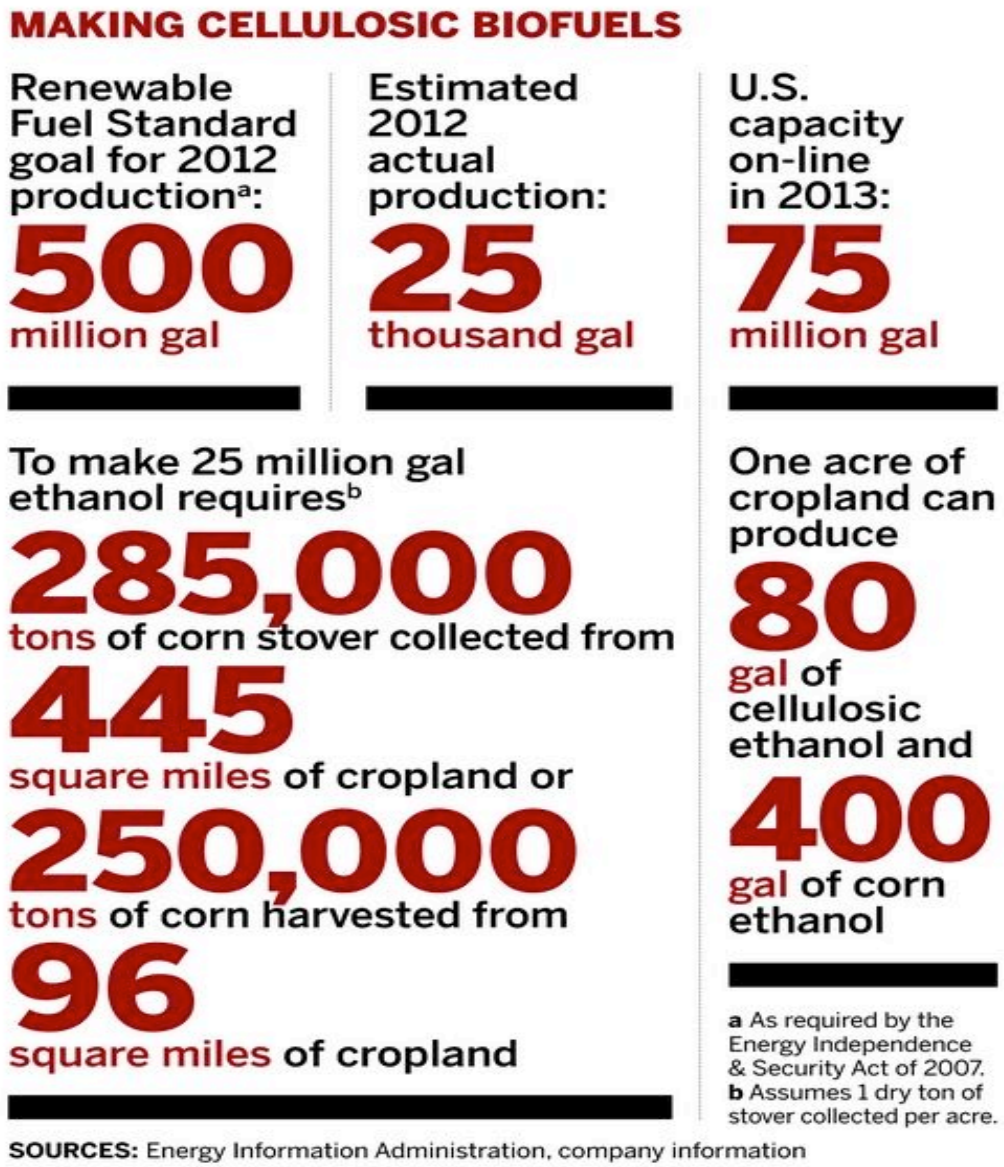
b. However, some scientists believe ethanol is not the solution. See

(i) Ethanol Fuel from Corn Faulted as 'Unsustainable Subsidized Food Burning' http://healthandenergy.com/ethanol.htm

(ii) Ethanol can replace gasoline with significant energy savings, comparable impact on greenhouse gases http://berkeley.edu/news/media/releases/2006/01/26_ethanol.shtml

(iii) Food vs. fuel http://en.wikipedia.org/wiki/Food_vs._fuel

Is ethanol a good alternative to fossil fuels?



http://cen.acs.org/articles/91/i4/Building-New-Biofuels-Industry.html

Chem 12B Objective: Understand Glycolysis via Organic Chemistry

Glucose Metabolism produces _____!

$C_6H_{12}O_6 + 6\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O$

Consists of three metabolic cycles:

1. Glycolysis

   Glucose → 2 pyruvate

1a. 2 pyruvate → 2 acetyl CoA + 2 CO_2

2. Kreb's cycle (citric acid cycle, tricarboxylic acid (TCA) cycle)

   2 acetyl CoA + 2 oxaloacetate → 2 citrate + 4 CO_2

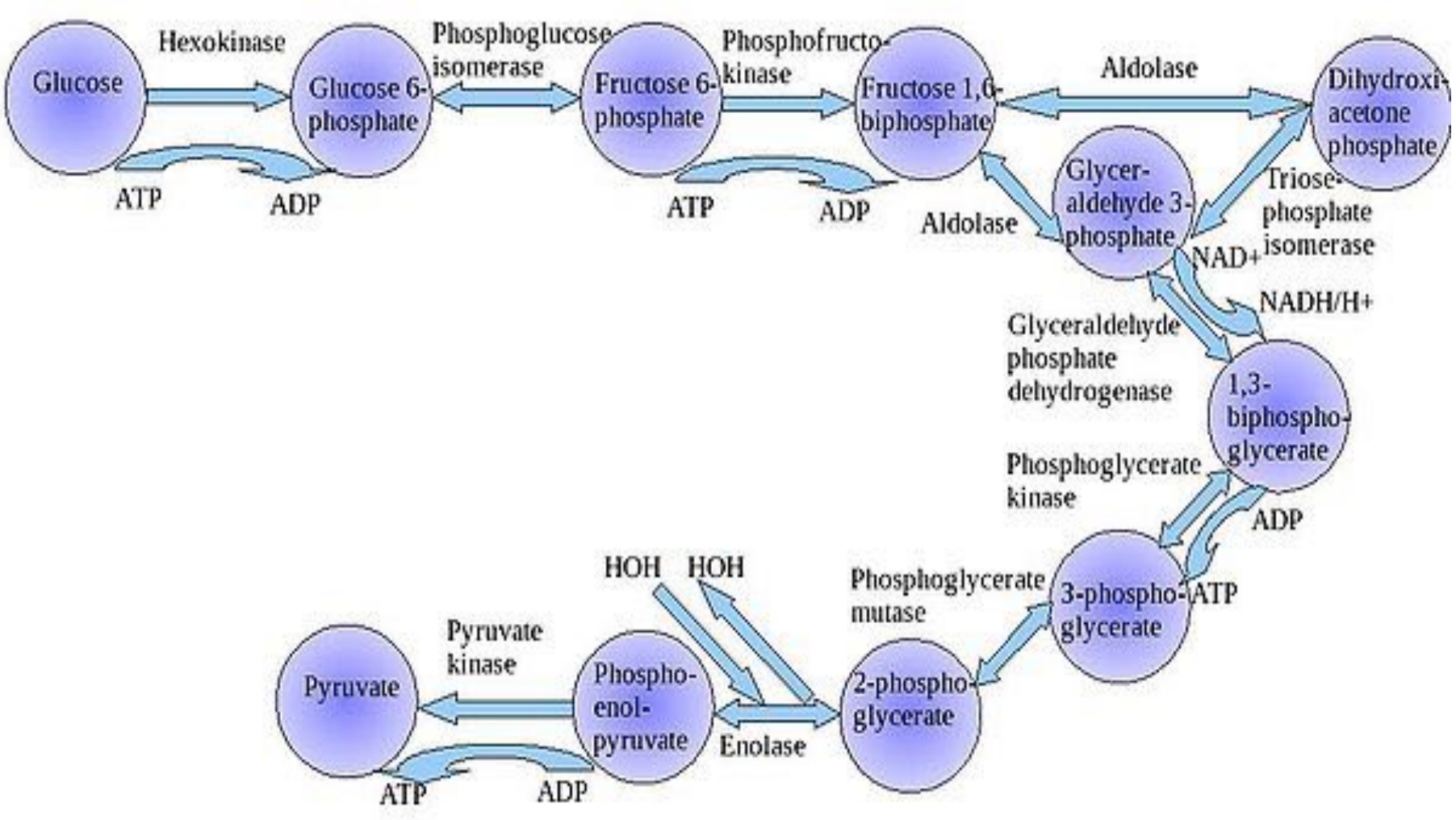
3. Electron transport chain (http://www.elmhurst.edu/~chm/vchembook/596electransport.html)

   $2\ H^+ + 2\ e^- + ½\ O_2 \rightarrow H_2O$

Glycolysis: glucose → pyruvate

http://en.wikipedia.org/wiki/Glycolysis

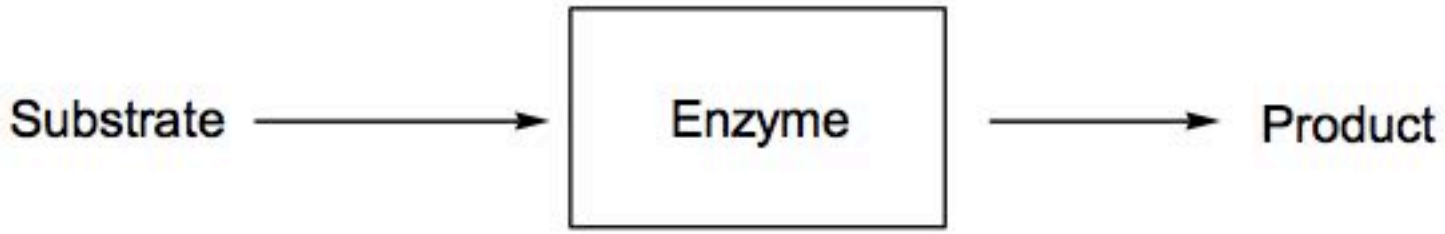
What organic reactions are involved in these reactions?



Biology: What Happens Inside the Box?

Enzymes Do Five Things (Reaction Types):

(Reference: I.D. Reingold, "Organic Chemistry: An Introduction Emphasizing Biological Connections", 2002)



1. Oxidation-Reduction

carbon-oxygen bonds

bio redox agent

$NAD^+ \rightleftharpoons NADH$

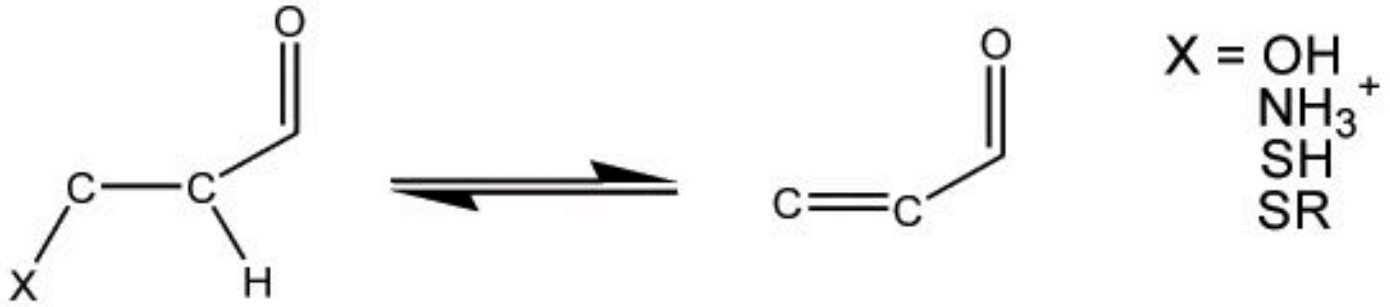
carbon-nitrogen bonds

$NAD^+ \rightleftharpoons NADH$

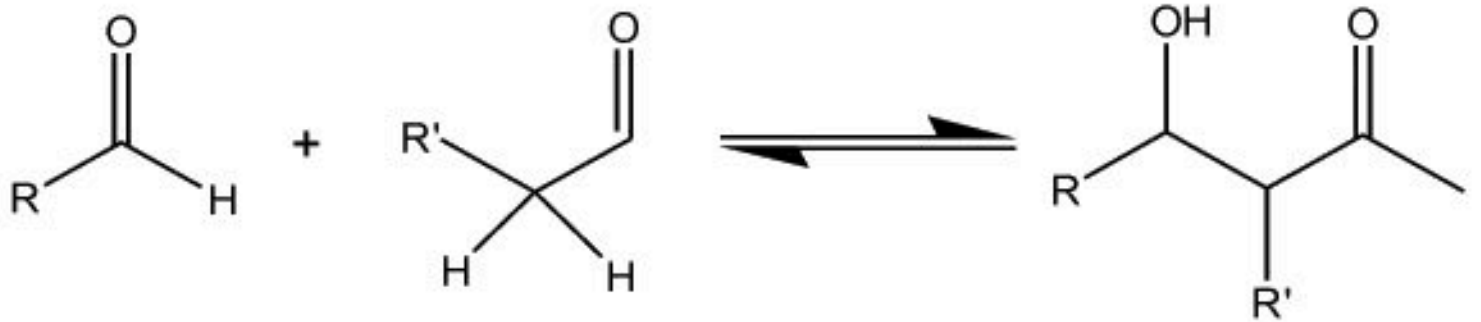
carbon-carbon bonds

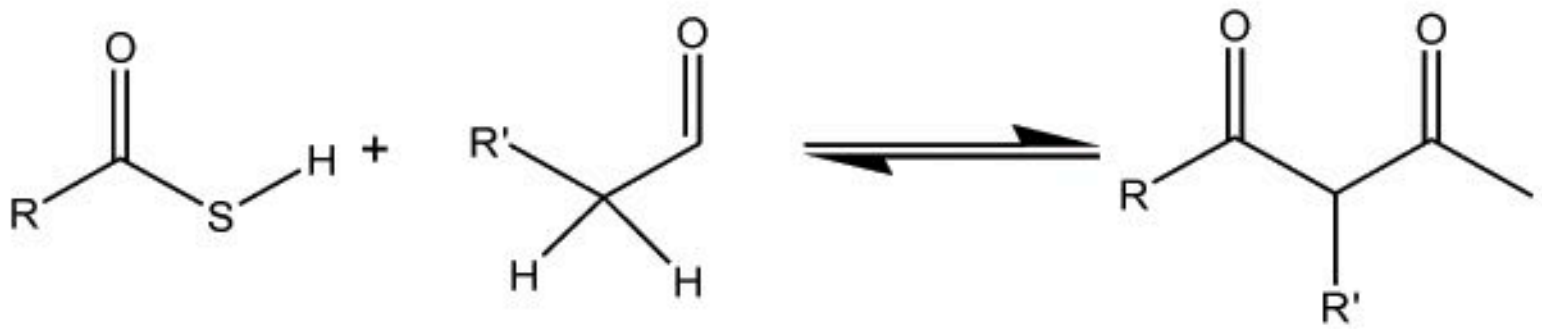
$FAD \rightleftharpoons FADH_2$

2. Elimination-Addition: restricted to double bonds conjugated to carbonyl groups, i.e., α,β-unsaturated carbonyls.

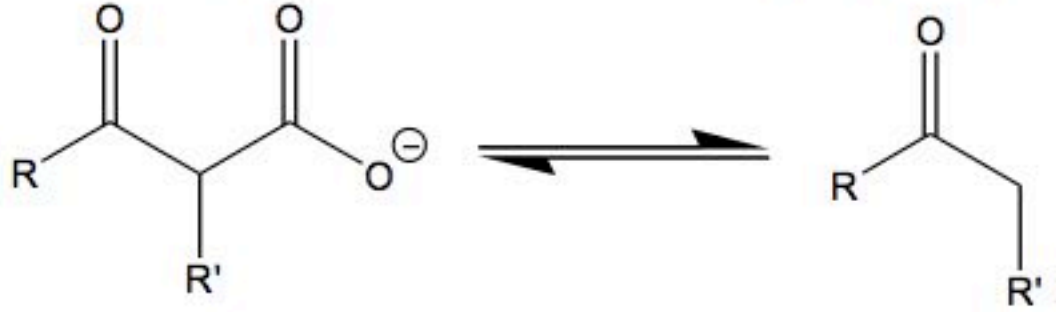


3. Aldol/Claisen: in biology, esters are usually thioesters

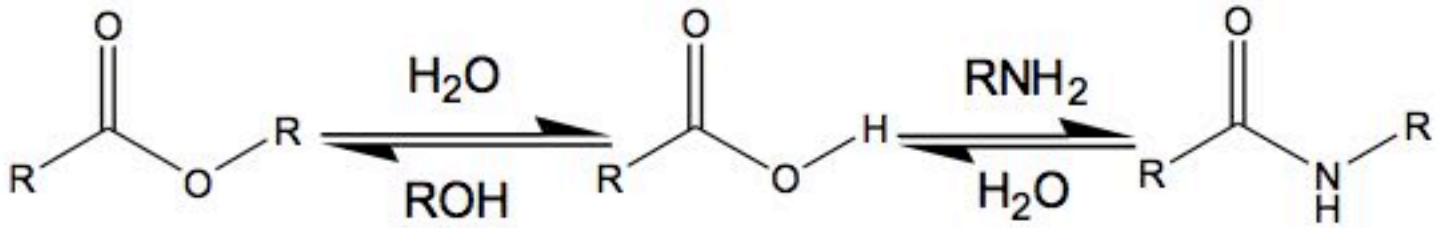


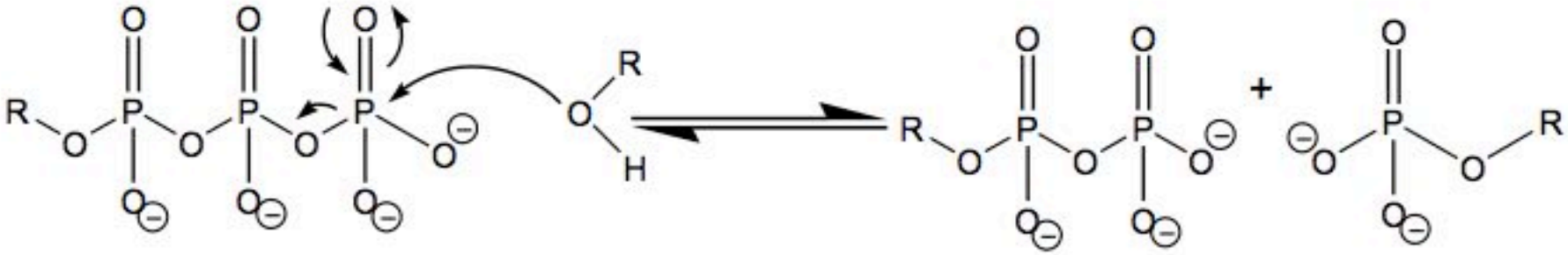


4. Decarboxylation: pH is around 7 in biology so conjugate base is present.



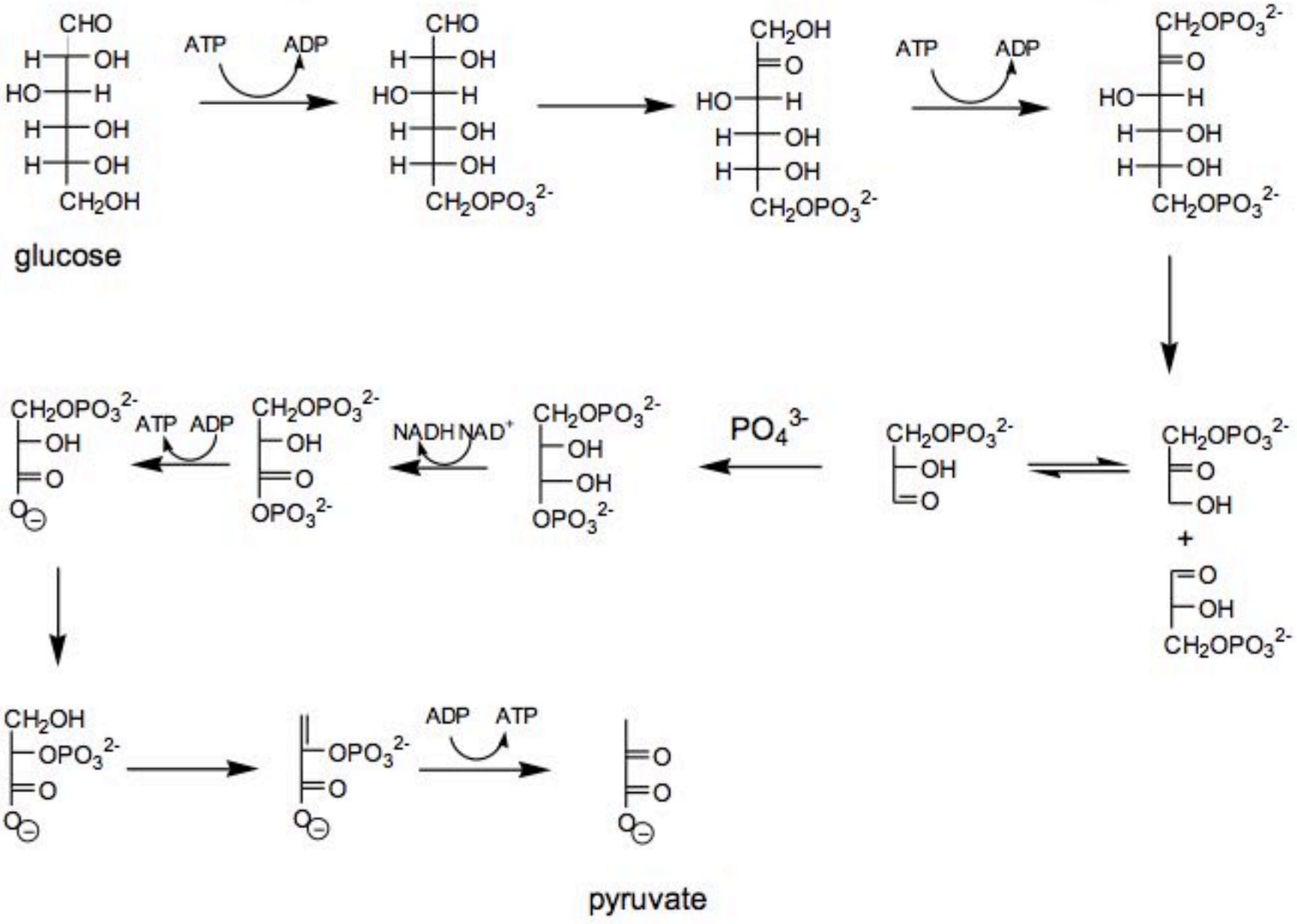
5. Acyl Transfer and Phosphoryl Transfer: Think of P as a C.



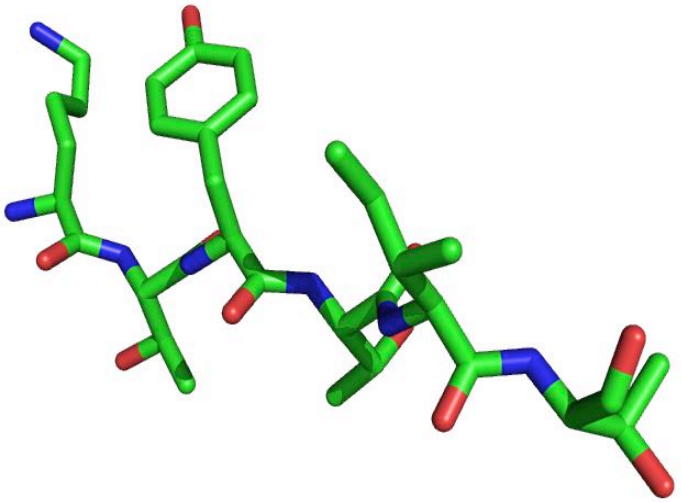


Acyl Transfer is the same as a _____ reaction.

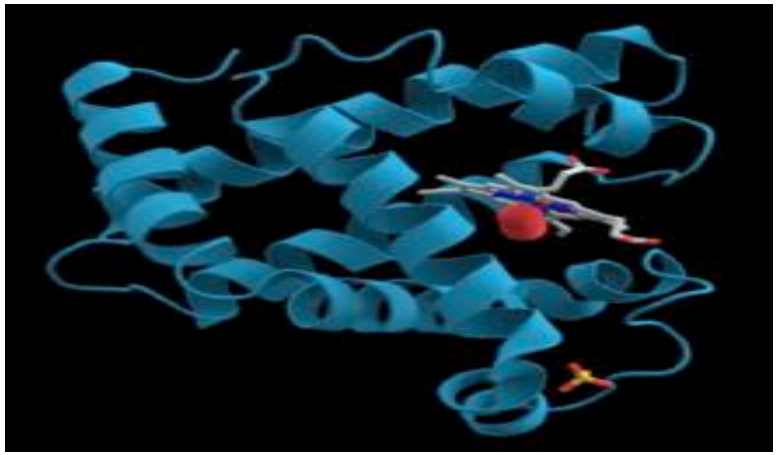
Glycolysis Consists of 10 Reaction Steps



http://www.voxxi.com/vegetarian-animal-protein-diet/



http://www.doctortipster.com/7763-malfunctioning-fat-sensor-obesity-and-liver-disease.html



http://en.wikipedia.org/wiki/Protein

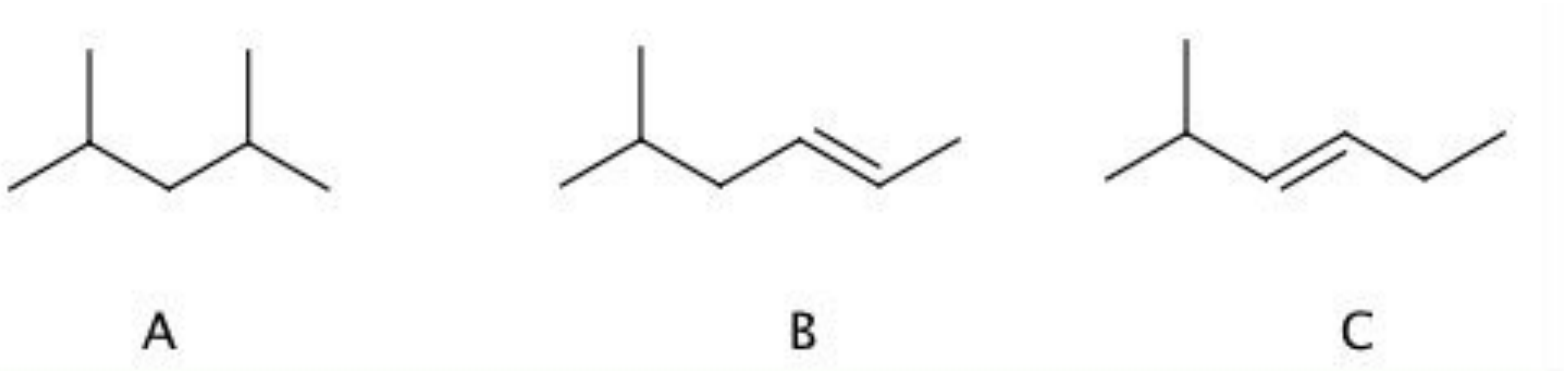
What do organic compounds look like?

Structure is how atoms are bonded together.

Structure is how atoms are bonded together.

1. What type of bond is found in organic compounds?

2. Which skeletal structure matches $(CH_3)_2CHCH_2CHCHCH_3$?

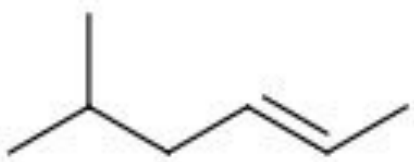


<u>Shape</u> is how a molecule looks in 3D.
VSEPR Theory is used to determine shape at each central atom.

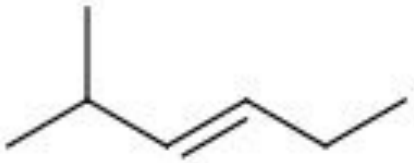
3. For Structure C, what is the shape at each C in the parent chain?

4. Which structures are isomers?
a. A and B b. A and C c. B and C

A



B



C

Bonding tells us about Reactivity

Consider the C-O bond.

Which atom has a δ+? Why?

Which atom is nucleophilic? Why?

Structure and Shape tell us about Reactivity

Chem 12A functional groups: alkanes, alkenes, alkynes, alcohols, and alkyl halides.

In general, organic reactions are:

- **Polar** (best nucleophile reacts with best electrophile).
- **Reversible** (equilibrium) reactions.
- Only a **FEW** reaction types, e.g., acid-base, substitution.
- Identify the atom(s) where a reaction occurs - **Structural Features**.

Structural Features helps figure out how an organic compound reacts:

Alpha carbon = carbon bonded to a Leaving Group

Leaving Group = group that leaves in a substitution or elimination reaction (*LG is a base* - SEE pK_a table)

Beta carbon = carbon adjacent to alpha carbon

Vinylic carbon = carbon in C=C bond

Allylic carbon = carbon adjacent to Vinylic carbon

Relate Structural Feature To Reaction Type

Substitution reactions need a leaving group. $Nu:^-$ reacts at α-C.

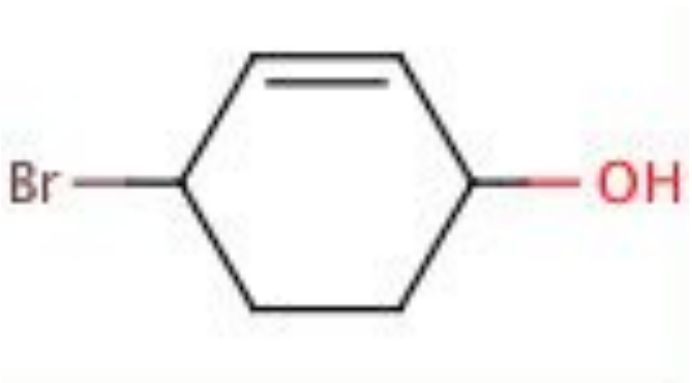
Elimination reactions need a leaving group. $Nu:^-$ reacts at H bonded to β-C.

$Nu:^-$ strength and size determine whether substitution or elimination occur.

Addition reactions need a pi bond and an electrophile.

Name an electrophile that reacts with a pi bond.

What reaction type does the compound below undergo?



Functional Groups Undergo Specific Reaction (types)

Functional Group	Structural Feature	Reaction Type
Alkane	C-H	Substitution
Alkene	Pi bond	
Alkyne	Pi bond pK_a =	
Alcohol	Leaving Group α-C, H bonded to β-C Lone pair on O	
Alkyl Halide	Leaving Group α-C, H bonded to β-C	

Identify the Reaction Type for each Functional Group

"Physicists like to think that all you have to do is say, these are the conditions, now what happens next?"

-Richard Feynman

***Note**: applies to chemistry, too.*

***Ochem Objective**: given reactants, predict products*

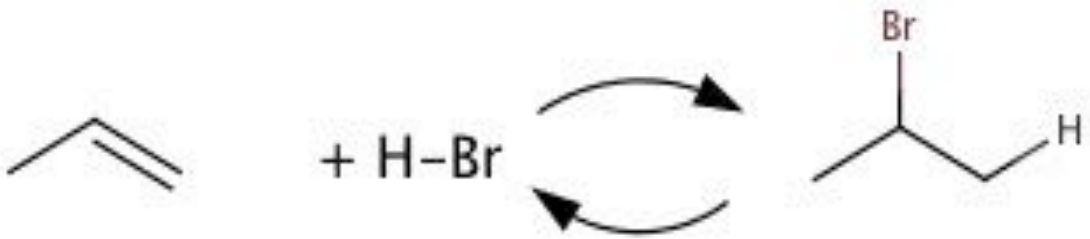
Reagent/Condition	Function
H_2SO_4	Acid, reacts with base or pi bond
O_3/Zn, H^+	
BH_3/H_2O_2, OH^-	
H_2/Pd	Hydrogenation, reacts pi bond
HBr, peroxides	Addition, reacts pi bond, non-Markovnikov
NBS	
$h\nu$, Br_2	
$NaNH_2$	
Br_2	
KOH (aq)	

Many Organic Reactions are Reversible

E.g.,

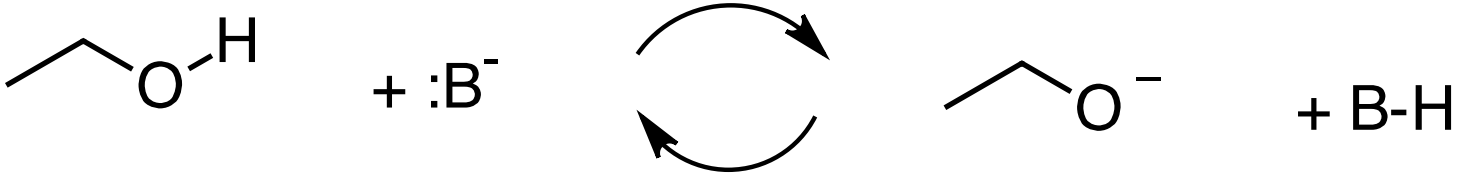
Acid-base

Addition and Elimination

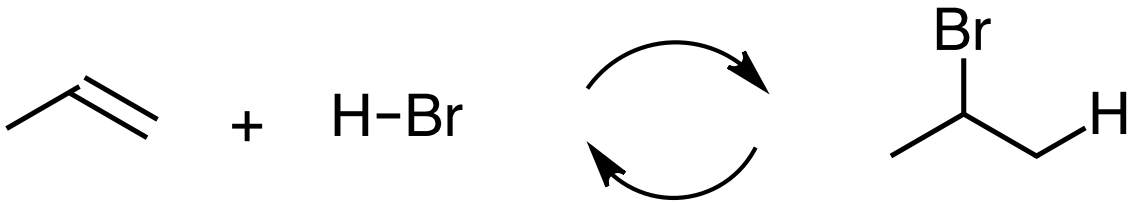


Use Curved Arrows to Show Bonds Breaking and Forming

Acid-base

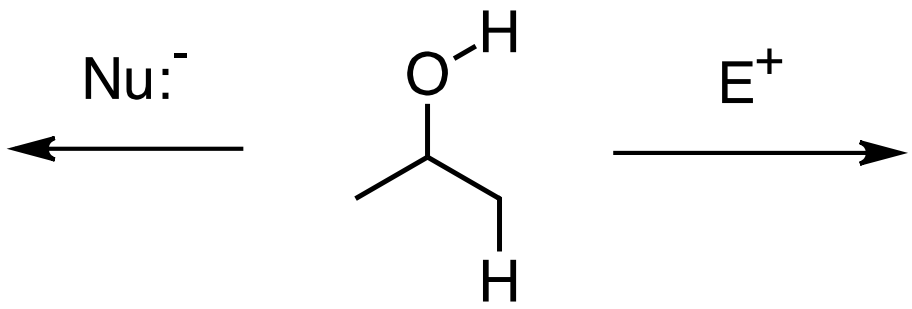


Addition and Elimination



OChem Objectives:

(1) given reactants and reaction conditions ==> predict products. Determine all possible products. Hint: ID $Nu:^-$ and E^+.



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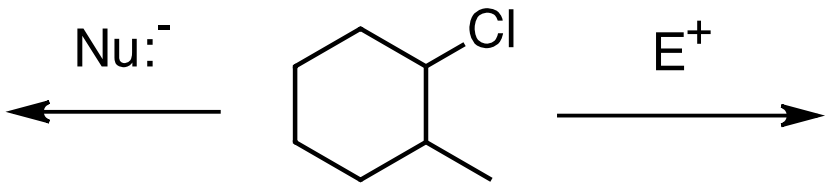
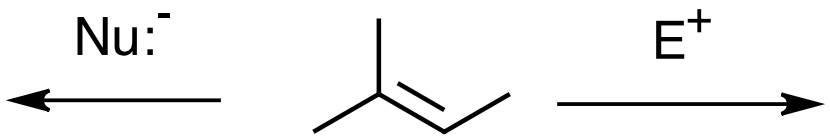
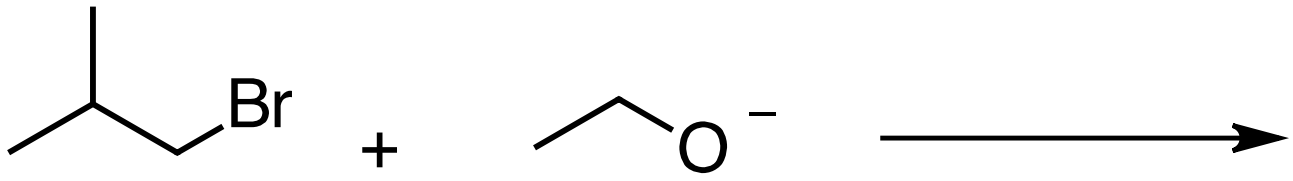
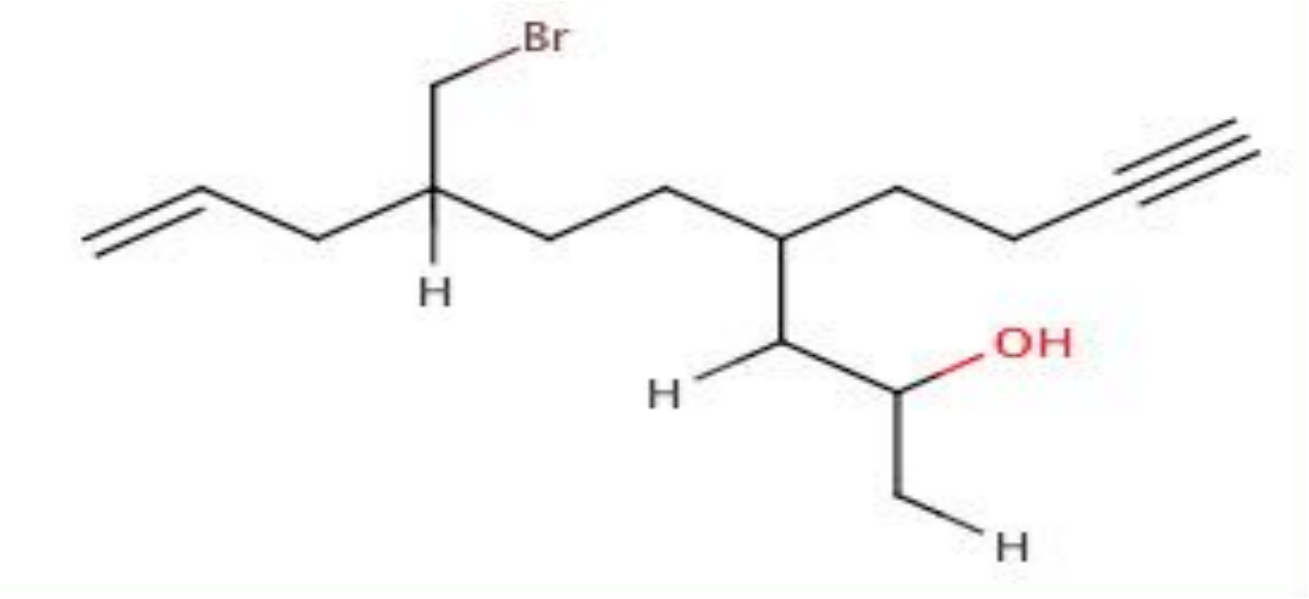




Predict the product of the following reaction.
Hint: Determine all possible products. Choose the "best" solution.



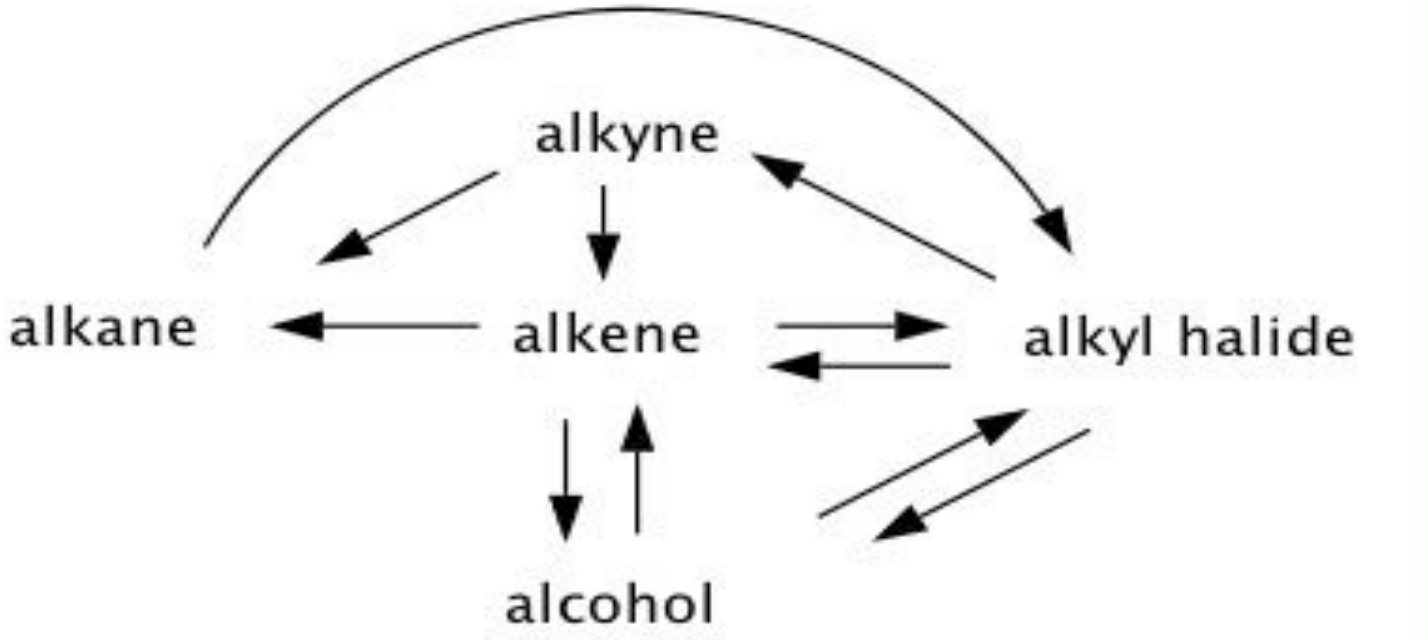
Practice Problems



1. How many substitution reactions can occur? 1, 2, or 3?
2. How many elimination reactions can occur? 1, 2, or 3?
3. How many addition reactions can occur? 1, 2, or 3?
4. How many acid-base reactions can occur? 1, 2, or 3?

Hint: ID structural features. E.g., α-C, H on β-C, LG

Practice Problems: CHM 12A Functional Group Conversions (useful in Organic Synthesis)



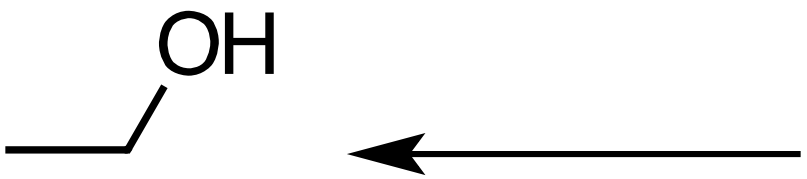
There are 11 reactions shown (count the arrows).
How many reactions are substitution reactions? 2, 3, or 4?
How many reactions are elimination reactions? 2, 3, or 4?
How many reactions are addition reactions? 2, 3, or 5?
How many reactions are acid-base reactions? 0, 3, or 4?

OChem Objectives:
(1) given reactants and reaction conditions ==> predict products.
(2) given product, determine reactants and reaction conditions. In other words, ***WORK BACKWARDS***.

Synthesis Strategy:
Retrosynthetic Analysis involves (2) ***WORKING BACKWARDS*** from the target compound.

ID functional group.
How is this group made?

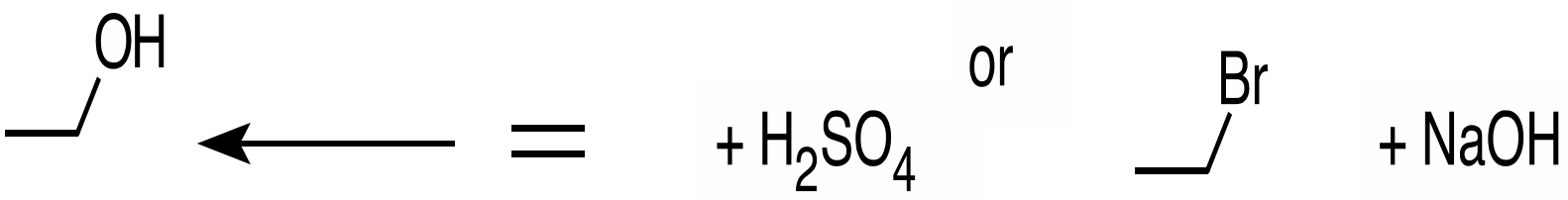
Target Compound: Ethanol from acetylene

1. 

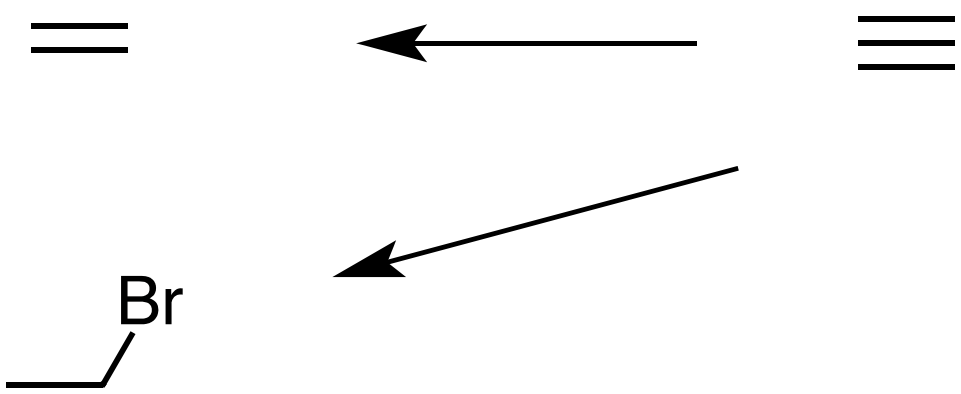
What functional group makes an alcohol?

2. If this functional group is not acetylene, how do I make this group from acetylene?

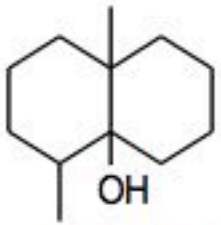
2 ways to make ROH



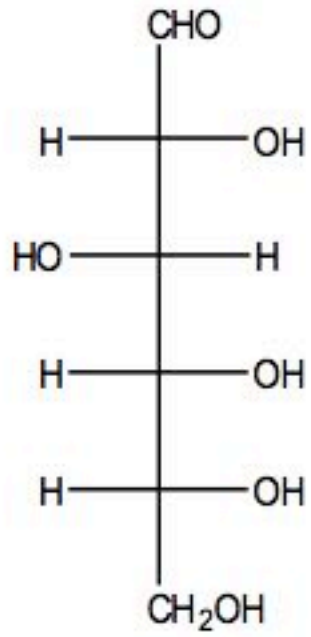
Can I make ethylene or ethyl bromide from acetylene?

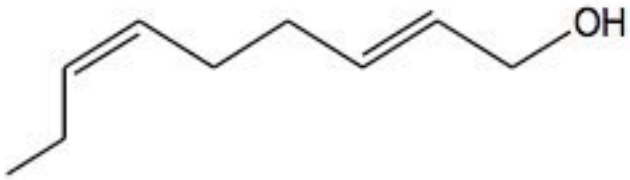


Many Alcohols Are Found in Nature (see Carey, 8th ed., p. 649, Fig. 15.1).

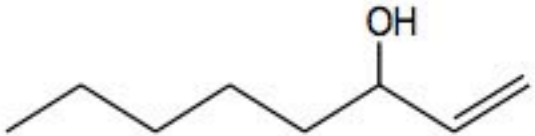


geosmin - smell of plowed earth





(2__, 6__)-nona-2,6-dien-1-ol
cucumber odor from violet leaves



oct-1-en-3-ol
button mushroom flavor

(+)-D-glucose

Carbohydrate chemistry is the chemistry of alcohols (and other functional groups)

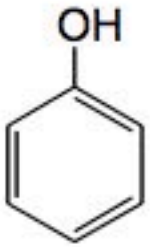
Alcohols are Solvents

Small ROH are soluble in water but large ROH are not.
Adding polar -OH groups makes a compound more soluble.

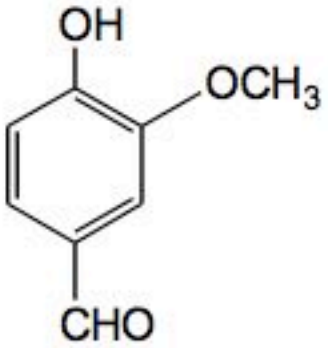
Chain Length as a Factor in Drug Design (Klein, p. 570)
Potency vs. Chain Length:
Larger ROH exhibits greater ability to penetrate microbial membranes ==> potency should increase with chain length
Longer ROH is less soluble in water ==> decreased ability to be transported through membranes.

Potency optimized at 8 or 9 carbon chain length

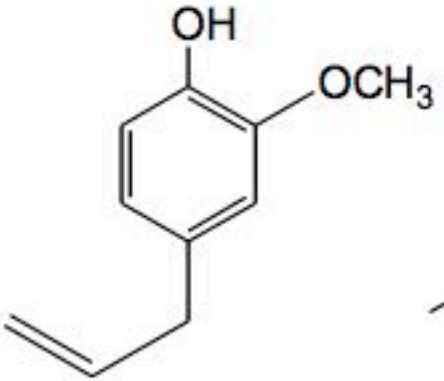
Phenols Are Found in Many Products



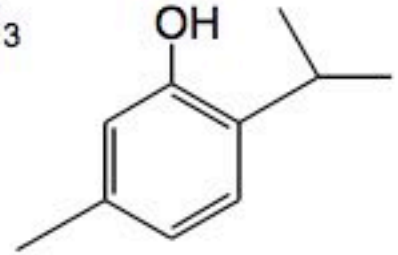
phenol - antiseptic
in Chloraseptic
and Carmex



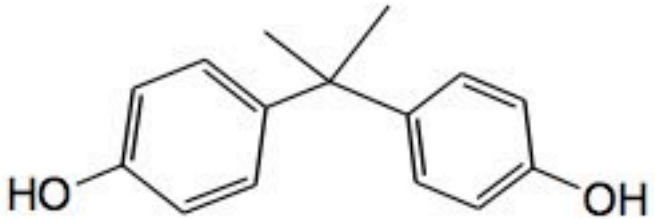
vanillan
(vanilla)



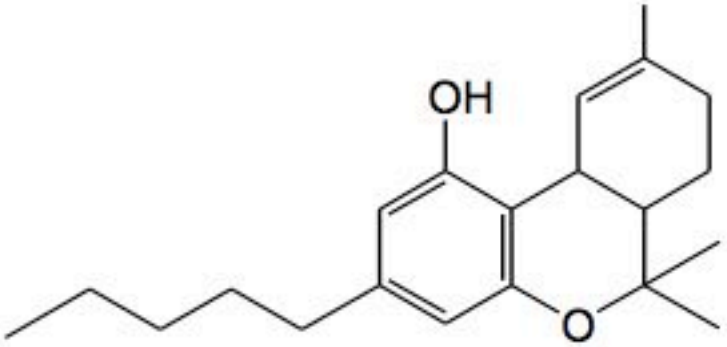
eugenol
(cloves)



thymol
(thyme)



Bisphenol A



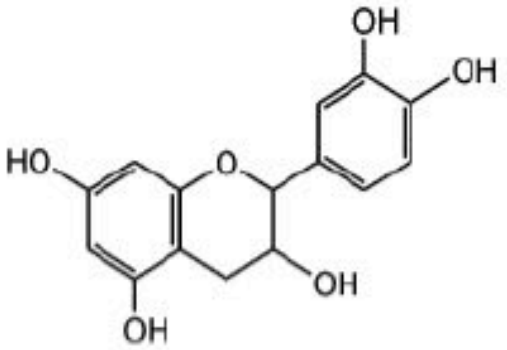
THC

Some **Antioxidants** Are Phenols

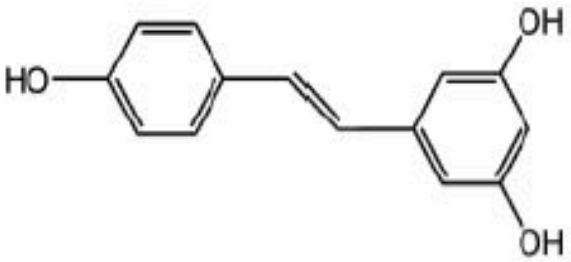
Reactive oxygen species (ROS) are byproducts of energy production and storage. ROS include peroxides and radicals.

Oxidative stress is an imbalance in ROS levels.

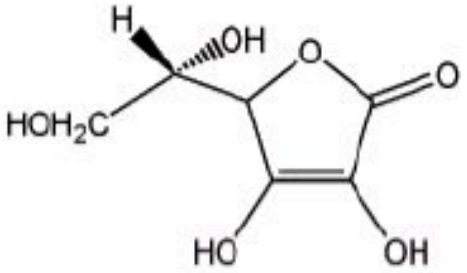
Antioxidants scavenge radicals and lower ROS levels.



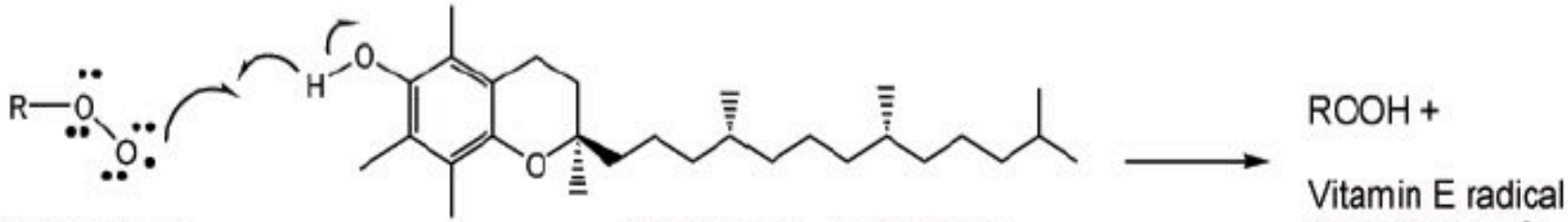
catechin - flavanoid antioxidant in green tea and red wine



resveratrol - in red grapes and red wine



Vitamin C



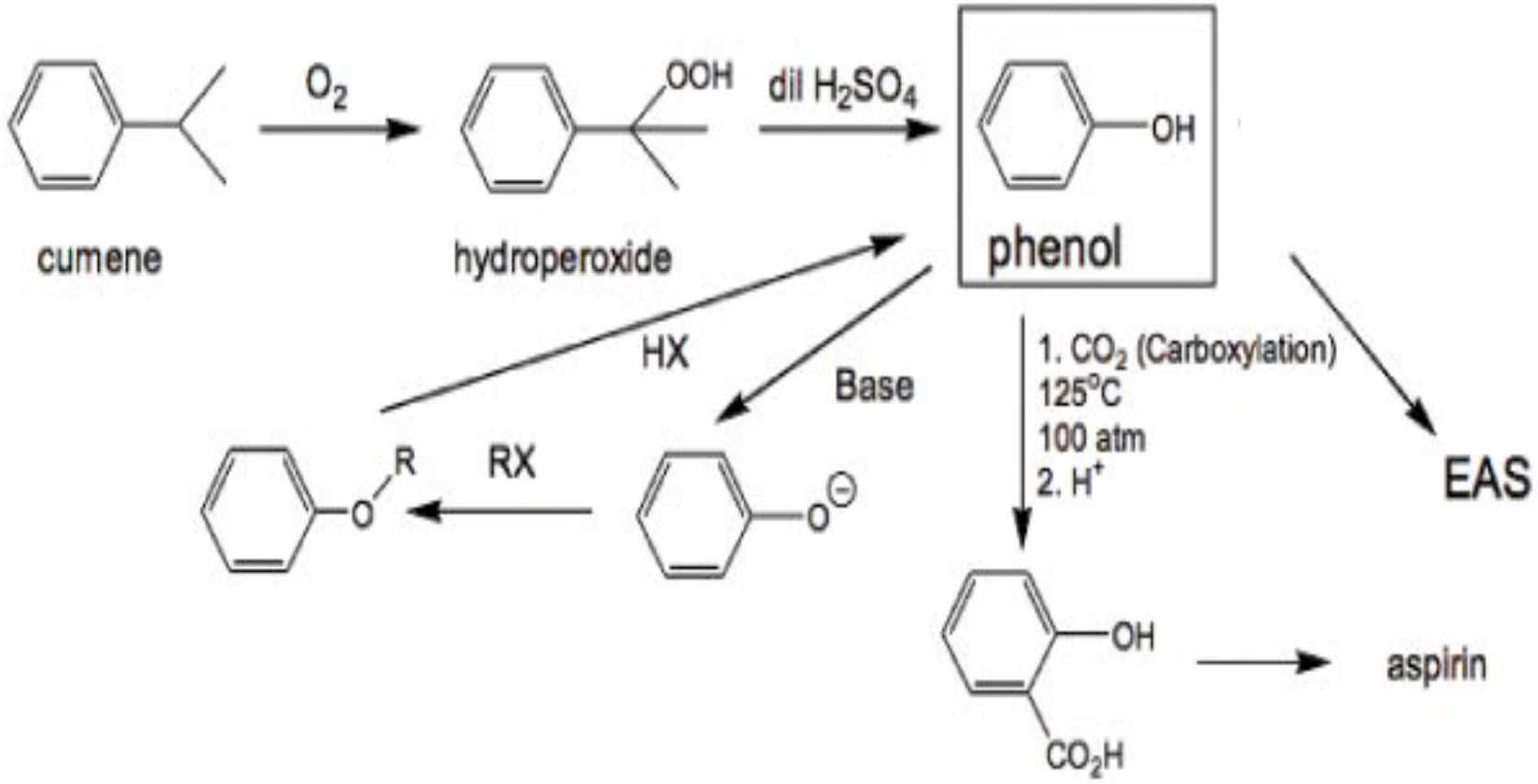
peroxyl radical

Vitamin E (α-tocopherol)

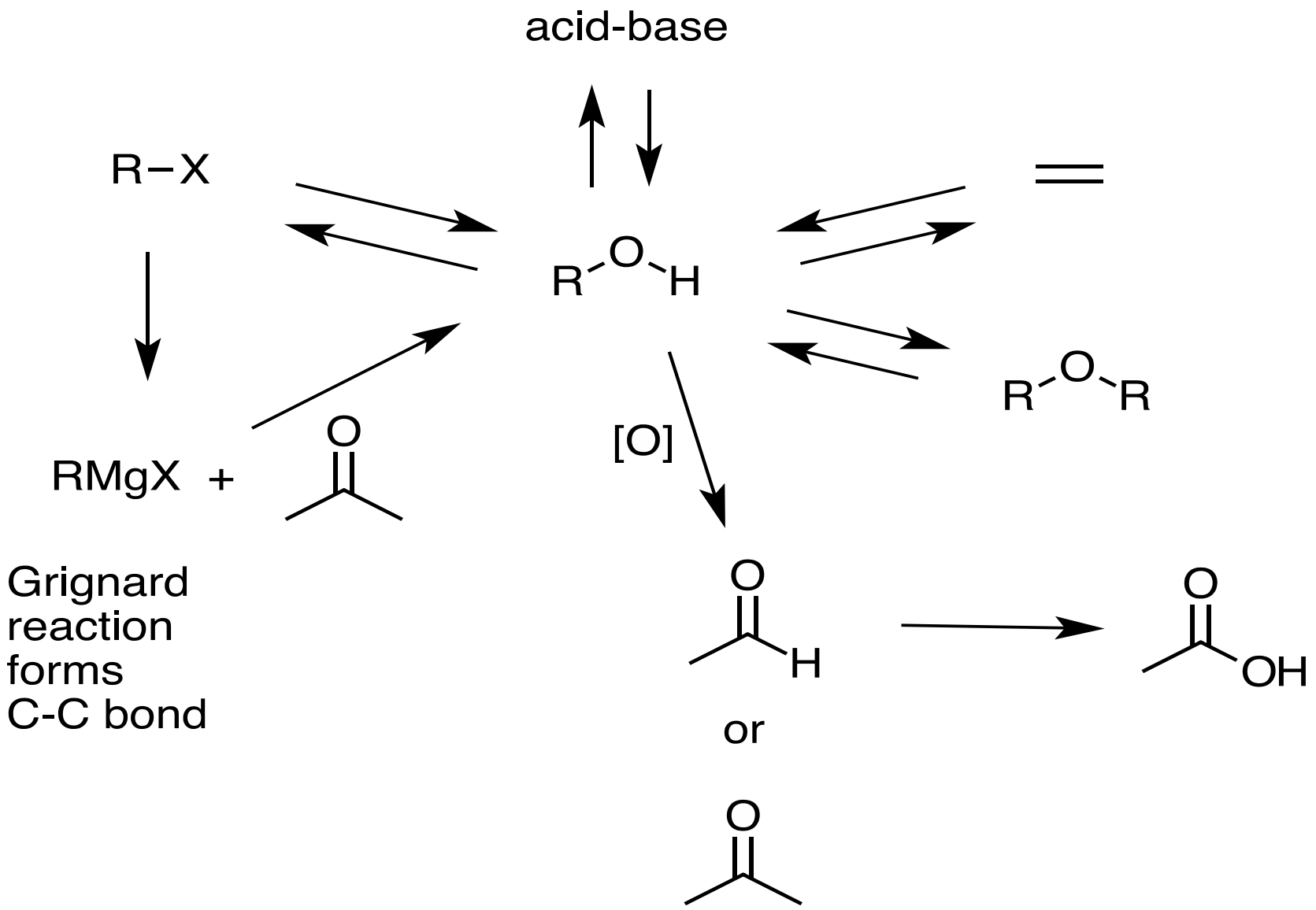
Health effects of foods (CEN, 10/31/05, p. 36):

1. Coffee is the #1 source of potentially healthful antioxidants in the U.S. diet
2. Diet high in phytoestrogens (from soy, grains, and vegetables) correlates to a lower risk of lung cancer
3. Folate in leafy green vegetables and citrus fruits may protect against cognitive decline in older adults.
4. Inositol pentakisphosphate, found in beans, nuts, and cereals, limits the supply of blood to tumor cells and inhibits tumor growth in mice
5. Isothiocyanate derivatives found in cruciferous vegetables block lung cancer progression in animal studies and in tests with human cancer cells
6. Pomegranate extract slows prostate cancer progression and decreases levels of prostate-specific antigen in mice and blocks enzymes that contribute to osteoarthritis

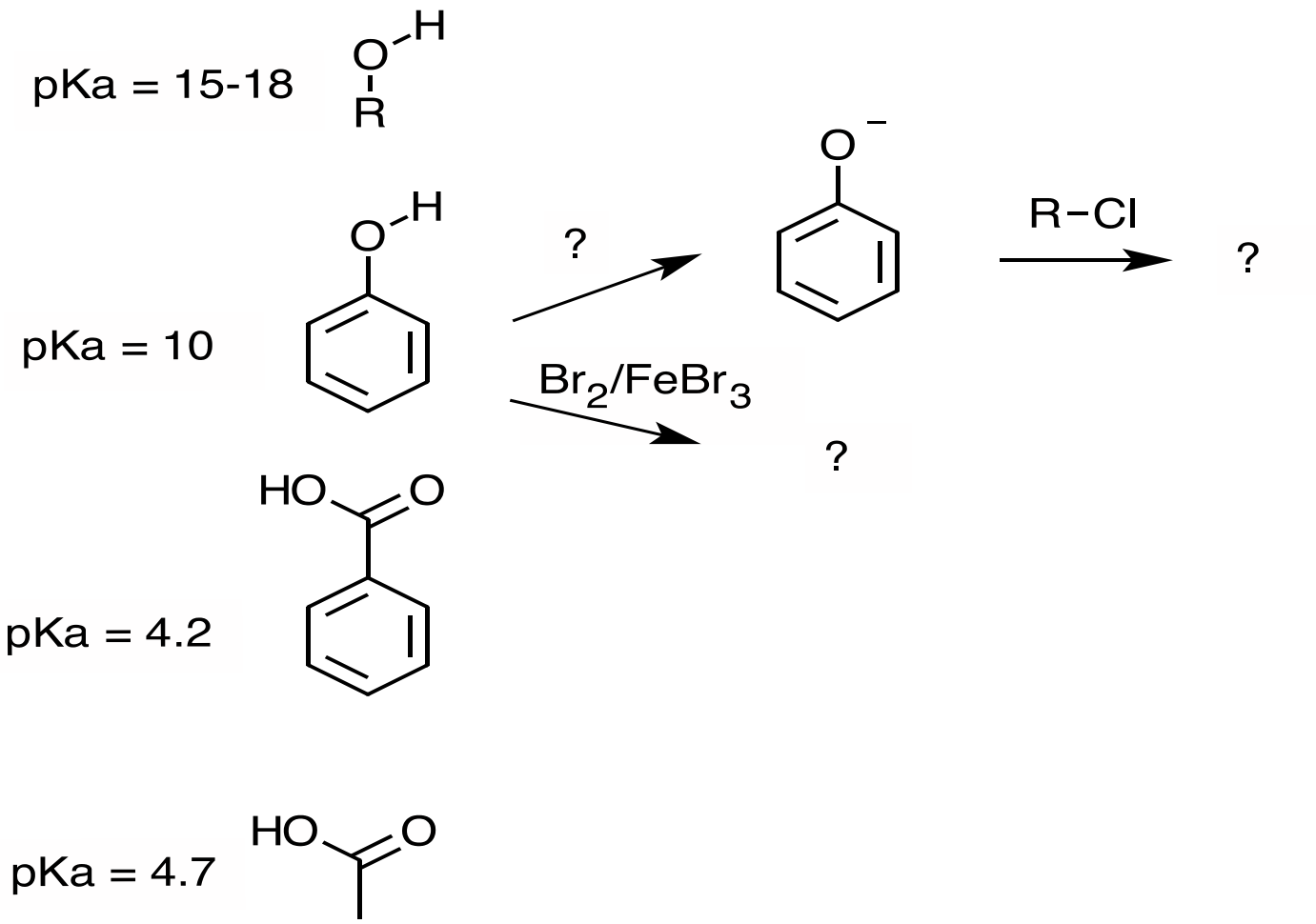
4 billion lbs of Phenols Are Produced Annually
Most of the Phenol Is Use to Make Phenolic Resins in Adhesives and Plastics (see BPA)



Alcohols are Prepared from and Make Many Groups (Klein, Ch. 13)



Acid-base properties of ROH

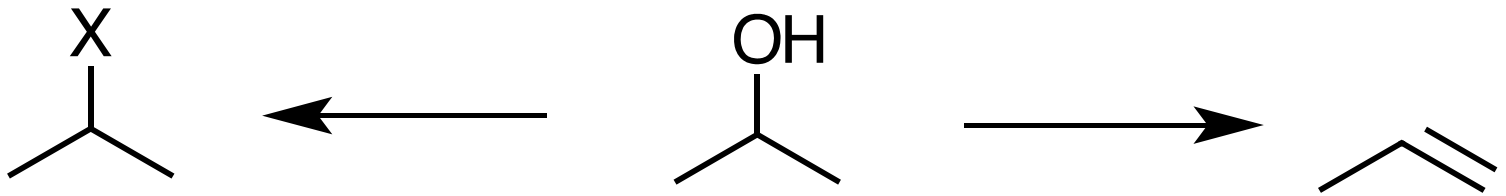


Circle the acidic H's. Where does phenol rank in acid strength?
Predict the product or reaction conditions for each "?"

ID reagent to convert ROH to RX or Alkene

Remember: -OH is a Poor Leaving Group,

Several Ways to make it a Better LG



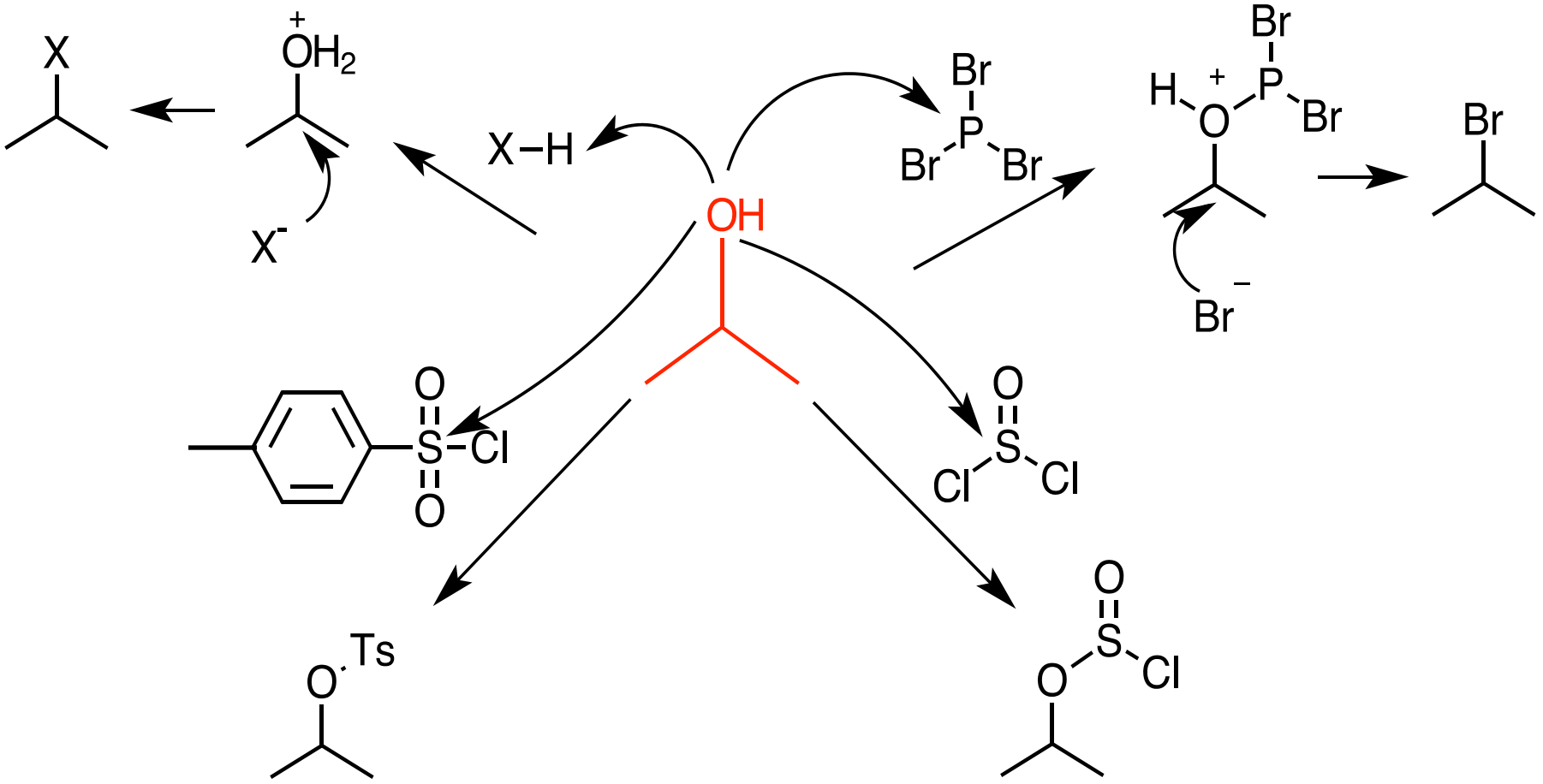
Substitution (when to use PBr_3 and $SOCl_2$):

1º ROH ---> 1º RBr	Use HBr or PBr_3
1º ROH ---> 1º RCl	Use $SOCl_2$
2º ROH ---> 2º RX	Use $SOCl_2$ or PBr_3
(With HX, C^+ rearrangement may occur)	
3º ROH ---> 3º RX	Use HX

Elimination: use H_2SO_4

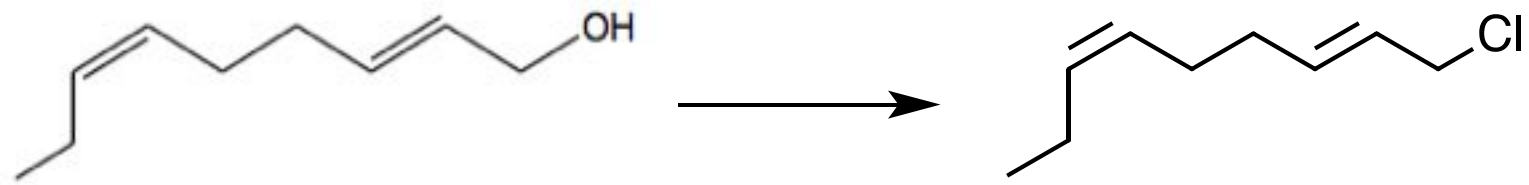
Describe the mechanism of ROH --> RX

Make -OH into a ***Better Leaving Group*** (use HX, H_2SO_4, PBr_3, $SOCl_2$, TsCl), then **Nu:$^-$ reacts at α-C**.



What is the structure of -OTs?

ID reagent to convert ROH to RX or Alkene



(2__, 6__)-nona-2,6-dien-1-ol
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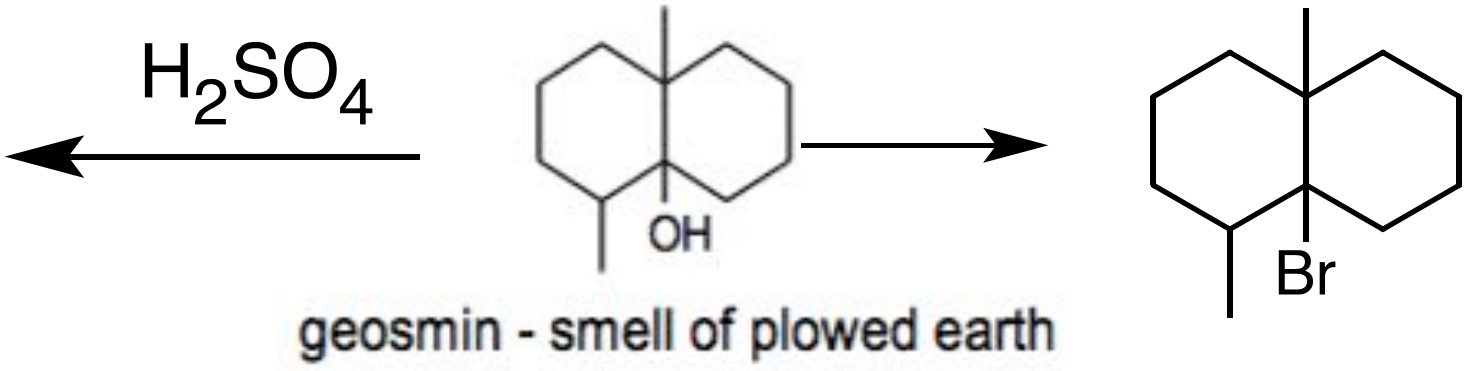
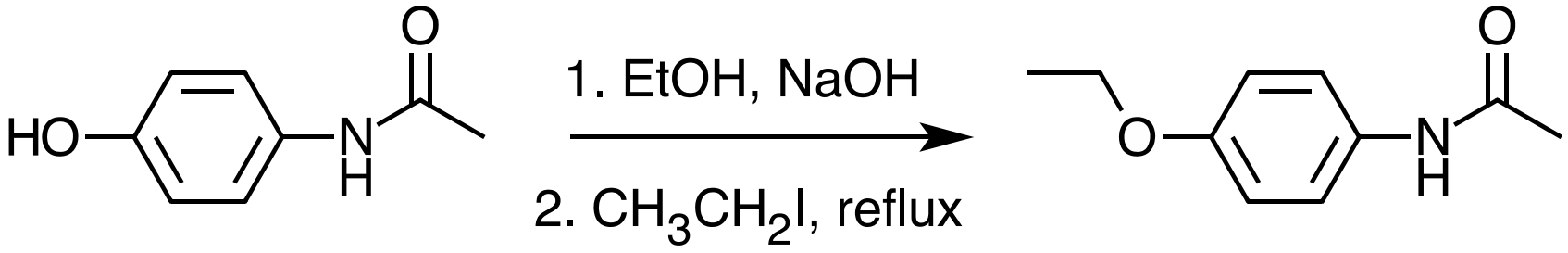


geosmin - smell of plowed earth

Substitution Reaction: Convert ROH to ROR

Lab 2: Acetaminophen --> Phenacetin



Substitution Reaction: What structural features are needed?
At what atom does substitution occur?

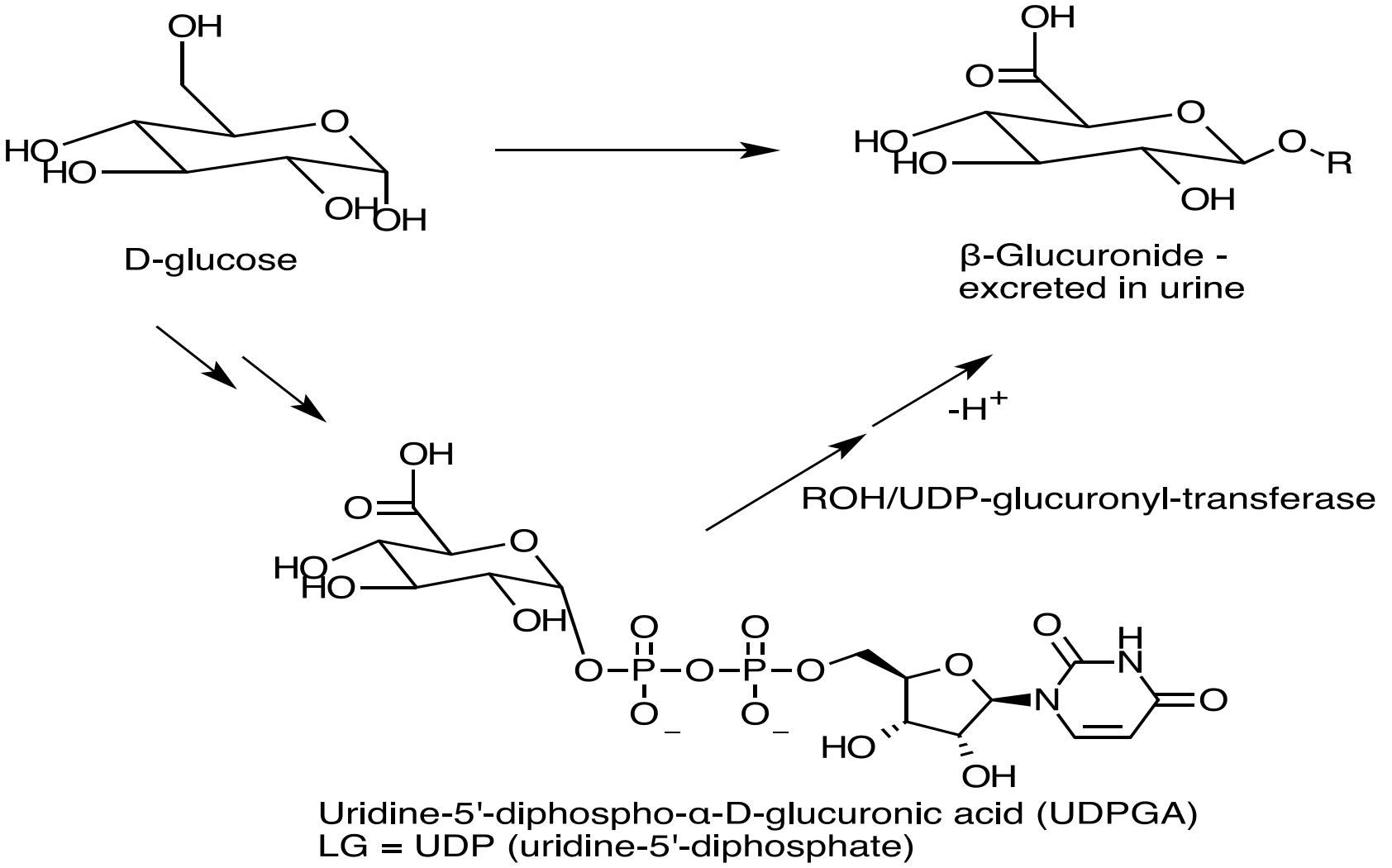
What is the function of EtOH and NaOH?

What is the function of CH_3CH_2I?

Use curved arrows to show how products are formed.

Bio Sub Rxns: **Glucuronidation** is the Main Metabolic Pathway by which many Drugs (with -OH groups, e.g., morphine, acetaminophen) are excreted from our body.

Why inversion of configuration?



Reference: D. Klein, "Organic Chemistry", 1st ed., p. 595