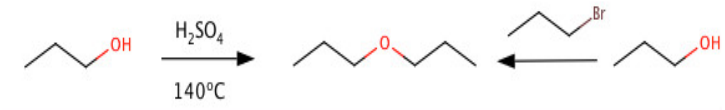
Objective 3: Apply substitution and elimination concepts to ethers and epoxides.
Quiz Practice problems
Key ideas:
You looked at substitution and elimination reactions in Chem 12A.

Skills:
Identify alpha carbon in a compound.
Identify H bonded to beta carbon in a compound.
Identify alpha carbon as 1^o, 2^o, 3^o.
Identify leaving group in a compound.
Identify leaving group as good or poor.
Describe how to make a poor leaving group into a good leaving group.
Identify a nucleophile as strong or weak.
Identify a nucleophile as big or small.
Given reactants, use curved arrows to show how nucleophile reacts at alpha carbon to form substitution products.
Given reactants, use curved arrows to show how nucleophile reacts at H bonded to beta carbon to form elimination products.
Identify the major product. Give reasons based on substrate type, size and strength of nucleophile.

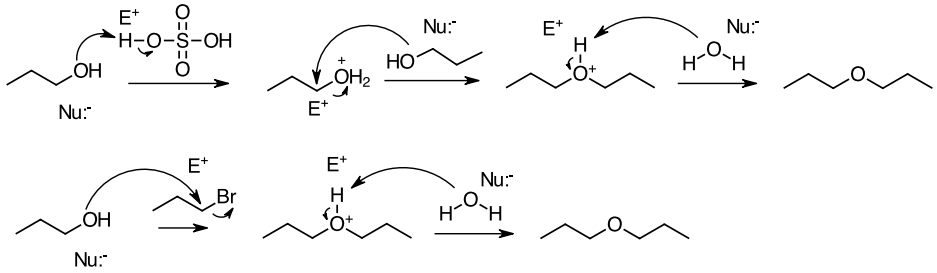
1. An ether can behave like a base. What is the pK_a of the conjugate acid of an ether? Is the conjugate acid a strong acid or weak acid?
Answers: R-O-R + H^+ --> R-(O^+H)R. pK_a = -3.5
The conjugate acid is a strong acid.
This means an ether is a weak base.

2. a. ROH is a poor leaving group. It can be made into a better leaving group by ___.
b. ROR is a poor leaving group. It can be made into a better leaving group by ___.
Answers:
a. protonating the alcohol group by reacting ROH with an acid.
b. protonating the ether group by reacting ROR with an acid.

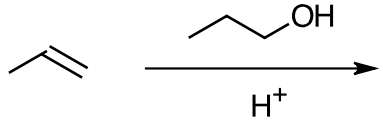
3. Show the mechanism of each reaction. Identify the nucleophile and electrophile in each step. Use curved arrows to show bonds breaking and forming. Draw intermediate structures as needed.



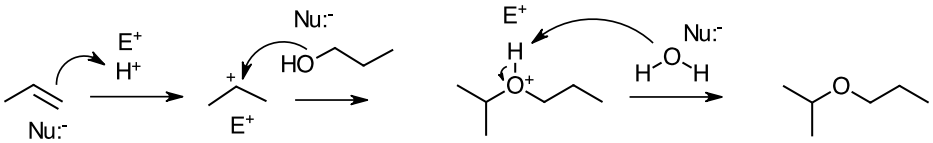
Answers:



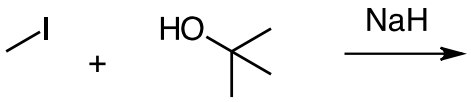
4. Predict the product of the reaction. Identify the nucleophile and electrophile in each step. Use curved arrows to show bonds breaking and forming. Draw intermediate structures as needed. (Hint: react the alkene with H^+ first.)



Answers:



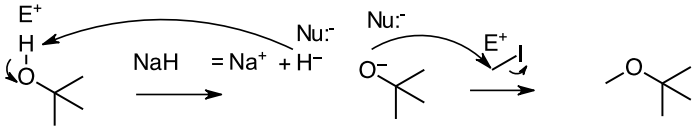
5. a. Predict the product of the reaction. Identify the nucleophile and electrophile in each step. Use curved arrows to show bonds breaking and forming. NaH is sodium hydride. Hydride = $H:^-$. Is hydride a nucleophile or electrophile?



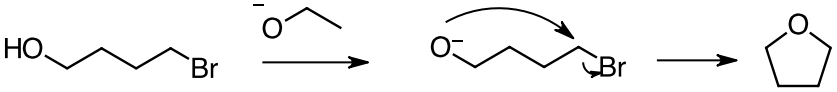
b. Propose a synthesis of the ether. Hint: there are at least two ways to accomplish this synthesis. Identify the functional groups that can form an ether.

Answers:

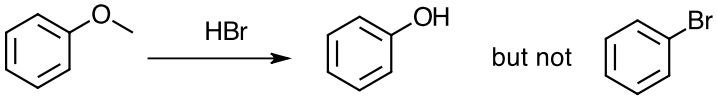
a. Hydride is a nucleophile.



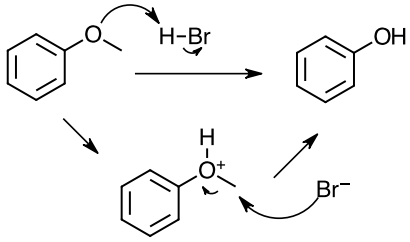
b. Use a substitution reaction.
E.g., RO^- + RBr --> ether
ROH + HBr --> ROH_2^+ -- ROH --> ether



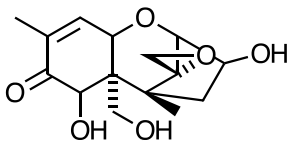
6. Explain the following observation by using curved arrows to show how bonds break and form.



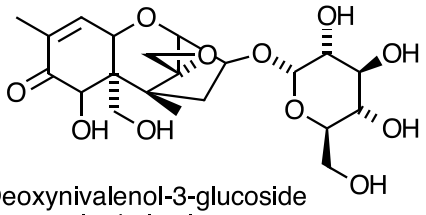
Answers:
Structural features: lone pairs on O = $Nu:^-$, C in CH_3 group is alpha C. C in phenyl group is NOT an alpha C – this carbon has a pi bond.



7. CEN, 2/11/13 “Gut Bacteria Free Hidden Toxins”, p. 9
Fungal toxins (mycotoxins) cause ailments from diarrhea to cancer. ***Plants modify these toxins to protect themselves, e.g., add a sugar or sulfate group, ==> “masked” mycotoxin derivative***. Gut bacteria converts masked derivative to toxin.



Deoxynivalenol
mycotoxin

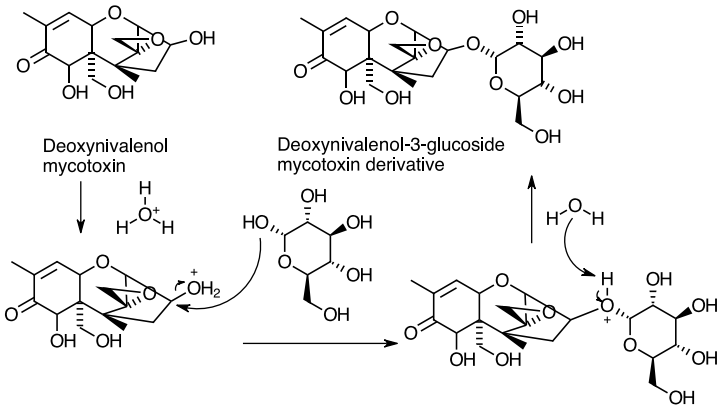


Deoxynivalenol-3-glucoside
mycotoxin derivative

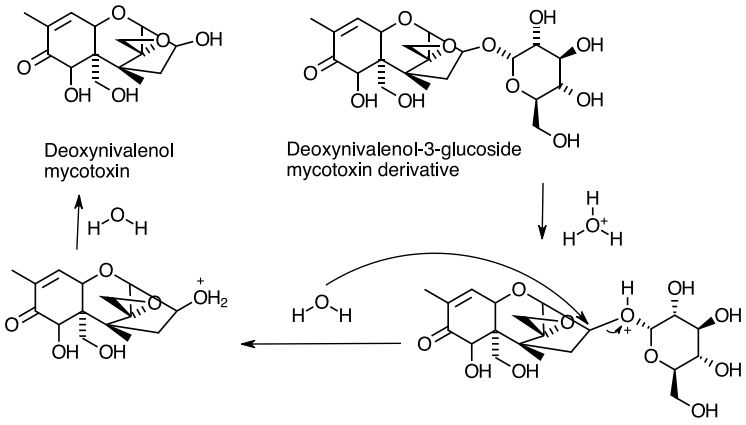
a. Show how Deoxynivalenol reacts with glucose to form Deoxynivalenol-3-glucoside.
b. Show how Deoxynivalenol-3-glucoside is converted to Deoxynivalenol.

Answers:

a.

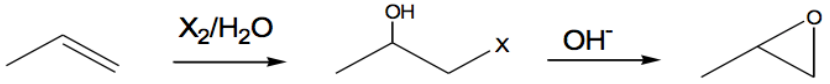


b.

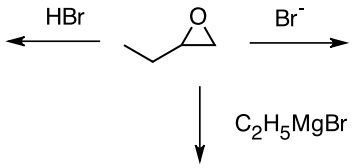


8. Epoxides are more reactive and much more useful in organic synthesis than ethers. Identify the nucleophile and electrophile in each step. Use curved arrows to show bonds breaking and forming.

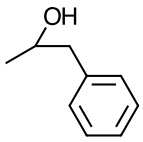
a.



b. Predict the product of each reaction. Use curved arrows to show bonds breaking and forming.



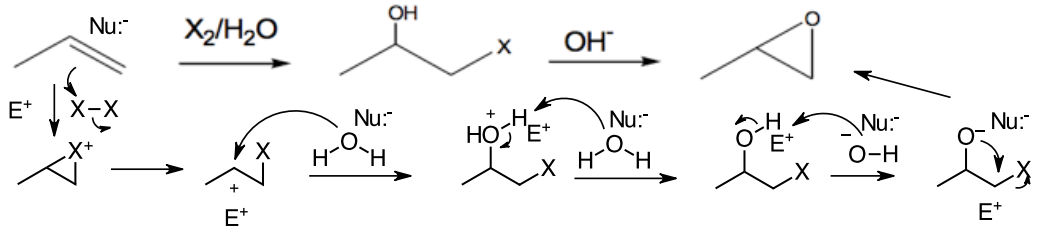
c. Starting from an epoxide and a Grignard reagent, show how to make this compound.



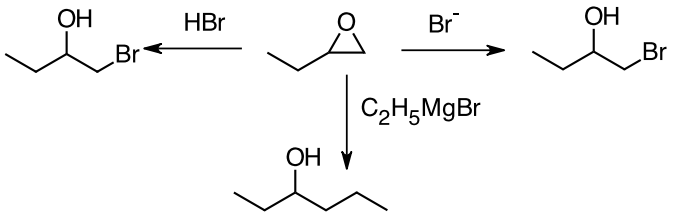
d. Ethylene oxide and propylene oxide (the two simplest epoxides) are used to make ethylene glycol (used in antifreeze), polyethylene glycol (PEG, many applications from medicine (as a laxative) to skin creams (as a lubricant) to industrial uses), and polyether polyols (used to make polyurethane plastics and epoxy resins). If interested, use as your Biology or Industrial Reaction Application project.

Answers:

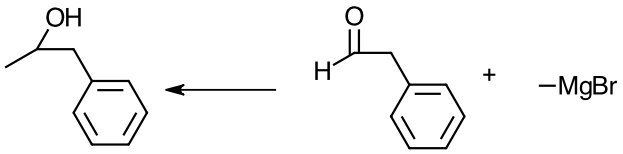
a.



b. For acid (HBr) catalyzed reaction, Nu:- reacts at more substituted C only for 3° C.

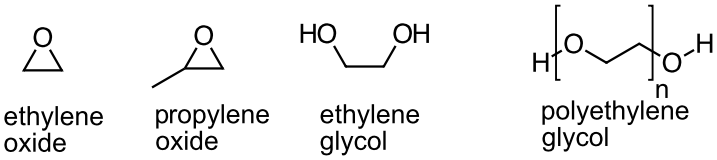


c.

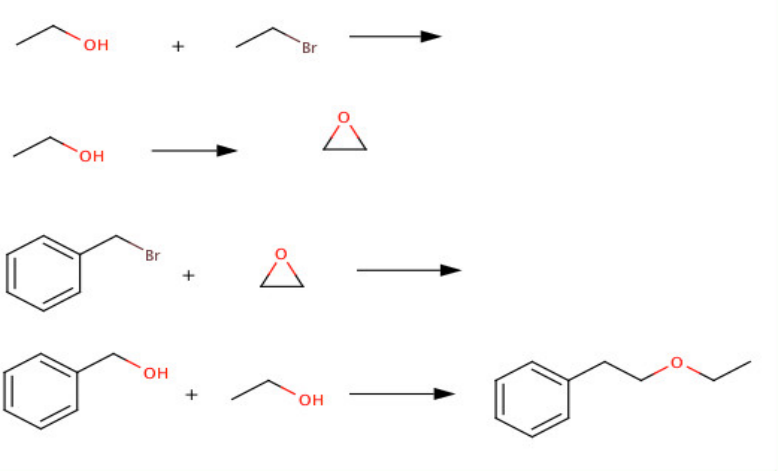


Or use acetaldehyde (CH_3CHO) and benzyl magnesium bromide.

d.



9. Predict the product or propose a synthesis. In the 3rd reaction, Mg is another reactant. Use curved arrows to show bonds breaking and forming.



Answers: