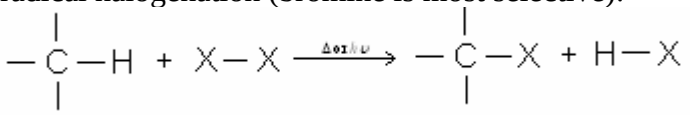
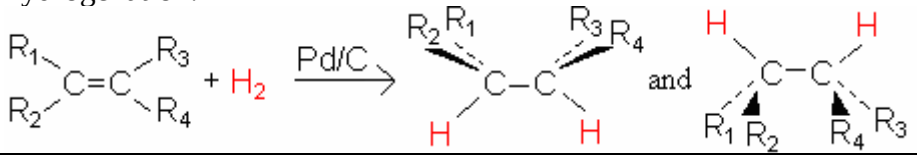
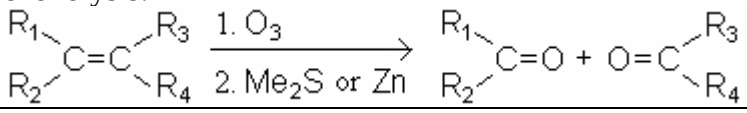
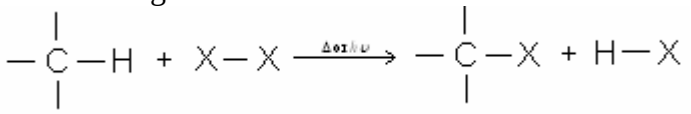
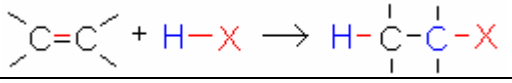
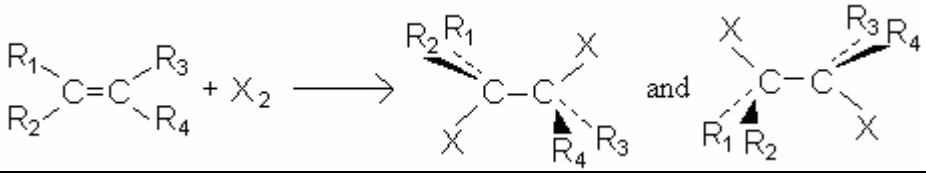
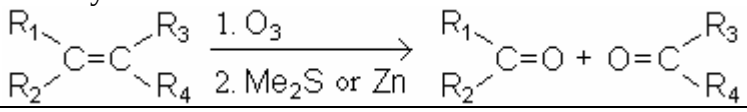
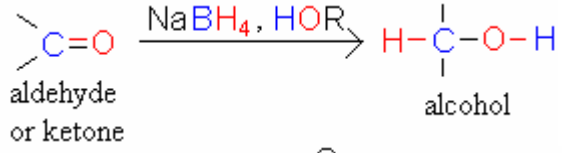
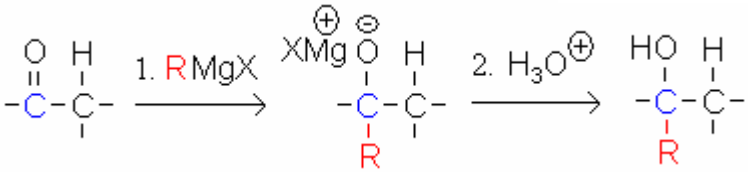
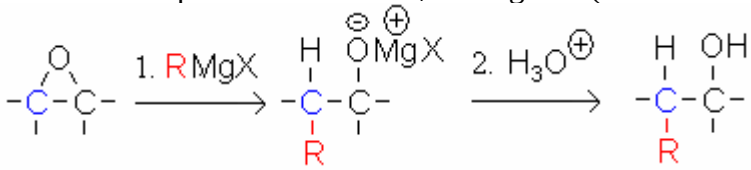
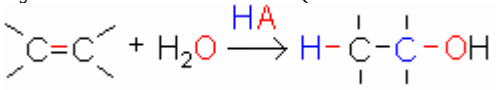
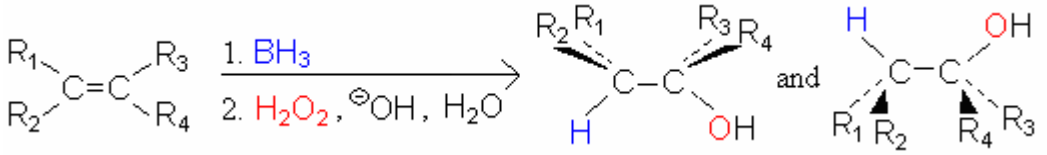
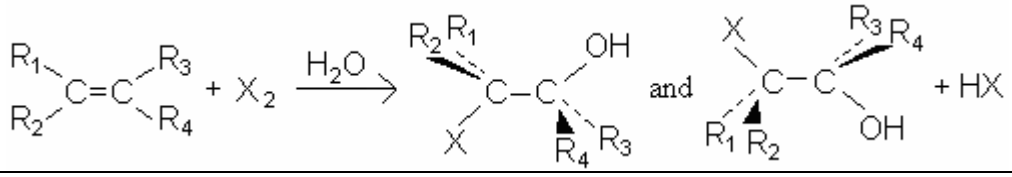
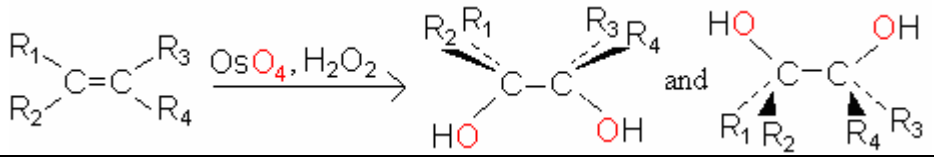
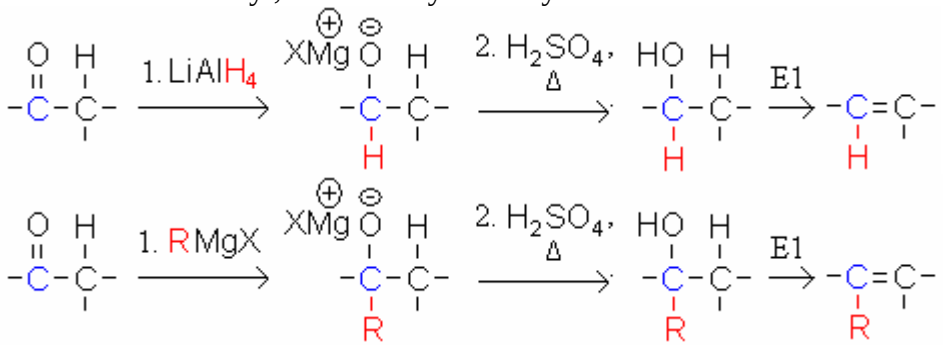
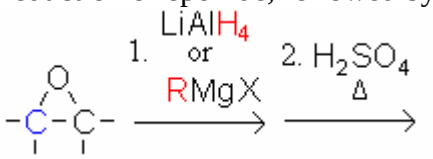
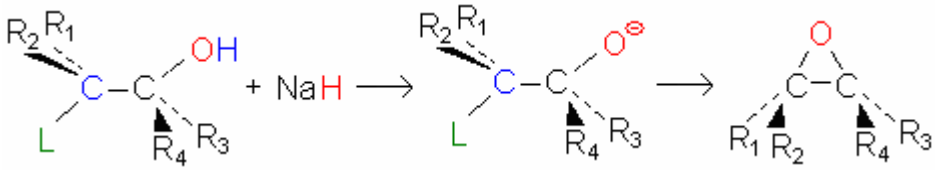
SYNTHETIC TOOLBOX

Some of the reactions in this handout may not have been covered in your course. Some of the reactions covered in your course may not be included in this handout. You should come up with your own synthetic toolbox that matches the reactions covered in your course; as your course proceeds and new reactions are introduced, keep updating your toolbox.

goals	reactions
functionalize—i.e., replace a H with a functional group	radical halogenation (bromine is most selective): 
defunctionalize—i.e., replace a functional group with a H or D	RMgX + H_3O^+ → R–H + H_2O + $^+$MgX hydrogenation: 
add C's—i.e., create a C-C bond	Grignard reagent + carbonyl Grignard reagent + epoxide alkene + H_2SO_4 (cationic polymerization)
remove C's—i.e., cleave a C-C bond	ozonolysis: 
synthesize an alkyl halide	radical halogenation:  alkyl bromide from a methyl, 1°, or 2° alcohol: R–OH + PBr_3 → R–Br + $HOPBr_2$ alkyl chloride, bromide, or iodide from a 3° alcohol (S_N1): R–OH + HX → R–X + H_2O hydrohalogenation of an alkene (X on less substituted C): 
synthesize a 1,2-dihalide (X's on adjacent C's)	
synthesize a carbonyl (aldehyde or ketone)	methyl, 1°, or 2° alcohol + PCC, no H_2O ozonolysis: 
synthesize a Grignard reagant	RX + Mg → RMgX, X = Cl, Br, or I

goals	reactions
synthesize an alcohol	reduction of carbonyl (OH on attacked C):   reduction of epoxide with $LiAlH_4$ or Grignard (OH on C adjacent to attacked C):  hydration of an alkene (OH on more substituted C):  hydroboration-oxidation (OH on less substituted C): 
synthesize a 1,2-haloalcohol (X and OH on adjacent C's)	
synthesize a 1,2-diol (OH's on adjacent C's)	trans dihydroxylation: epoxide plus HO^- in H_2O (S_N2), or epoxide plus H_2O with H_2SO_4 (S_N1) osmium catalyzed dihydroxylation is cis: 

goals	reactions
synthesize an alkene	E2: R–L + LDA (major product: less substituted alkene) E2: R–L (3°, 2°, or hindered 1°) + NaOH (major: more-substituted alkene) E1: R–L (2° or 3°) + H_2SO_4 + heat (major: more-substituted alkene) reduction of carbonyl, followed by E1 dehydration:  reduction of epoxide, followed by E1 dehydration: 
synthesize an epoxide	deprotonation followed by intramolecular S_N2:  MCPBA oxidation of an alkene: