

Chapter 17

Reactions of Organic Functional Groups Part 2

Rxns of Organic Functional Groups Part 2: Redox – A Closer Look

Oxidation & Reduction Reactions of Inorganic Molecules

We ALWAYS know the charge of the following elements & will not use the exceptions.

	Oxidation Number	Examples	Exceptions
Pure elements	0	The oxidation numbers for each atom in Fe(s) or O ₂ is zero.	none
Fixed charge metals	The oxidation number is equal to its charge.	Alkali metals → +1 Alkaline earth metals → +2 Aluminum → +3	none
X in ionic & organic cpds	-1	X in CaX ₂ is -1. C in CX ₄ is -1.	none
O in compounds	-2	O in MgO is -2. O in H ₂ O is -2.	O is -1 in peroxides.
H in compounds	+1	H in H ₂ O is +1.	H is -1 when combined with metals.

Determine the oxidation number of EACH element in the compounds below.

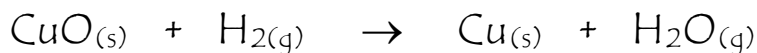


Recognizing Inorganic Redox Rxns

$\frac{1}{2}$ Reactions – ONLY look at the element being oxidized or reduced

2 Steps

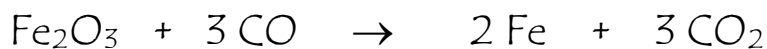
1. Assign oxidation numbers to each atom in the reaction.
2. Write the $\frac{1}{2}$ reactions for the elements with changing charges.



$\frac{1}{2}$ rxn for hydrogen:

$\frac{1}{2}$ rxn for copper:

- a) Which element is oxidized?
- b) Which element is reduced?



$\frac{1}{2}$ rxn for carbon:

$\frac{1}{2}$ rxn for iron:

- a) Which element is oxidized?
- b) Which element is reduced?

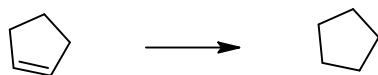
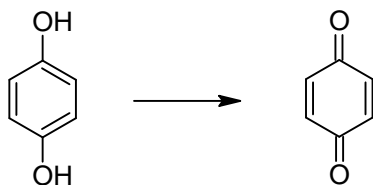
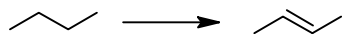
Chemical reactions look at all the compounds in the reaction.

Oxidation & Reduction of Organic Molecules

Oxidation: Gain bonds to Oxygen
Lose bonds to Hydrogen

Reduction: Lose bonds to Oxygen
Gain bonds to Hydrogen

Classify the following reactions as oxidation or reduction.

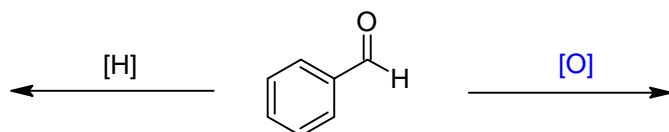


For the reactions below,

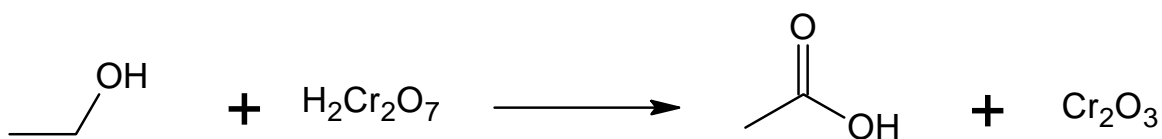
a) Predict the products for the reactions below.

Remember: benzene rings are very stable so they will not react.

b) Classify each function group. For alcohols, indicate 1°, 2°, or 3°.



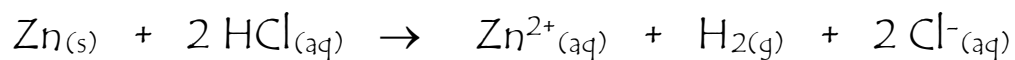
Example – Breathalyzer Test (Organic and Inorganic Redox Combined)



Oxidizing Agents: reactant that gets reduced

Reducing Agents: reactant that gets oxidized

For the following reaction



a) Write the oxidation half reaction.

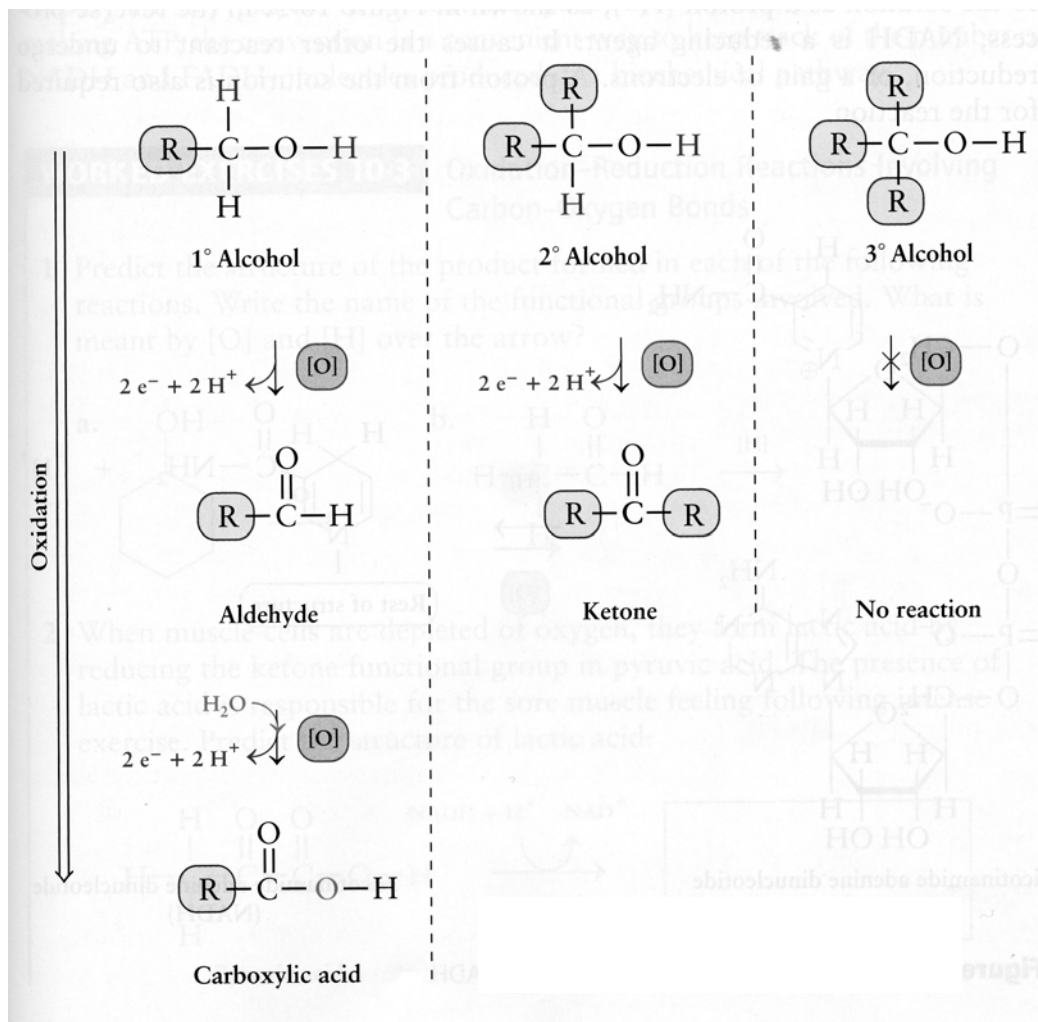
b) Write the reduction half reaction.

c) Which reactant is the oxidizing agent?

d) Which reactant is the reducing agent?

Reactions of Organic Functional Groups Part 3: Redox of ROH & Carbonyls

Oxidation of Alcohols

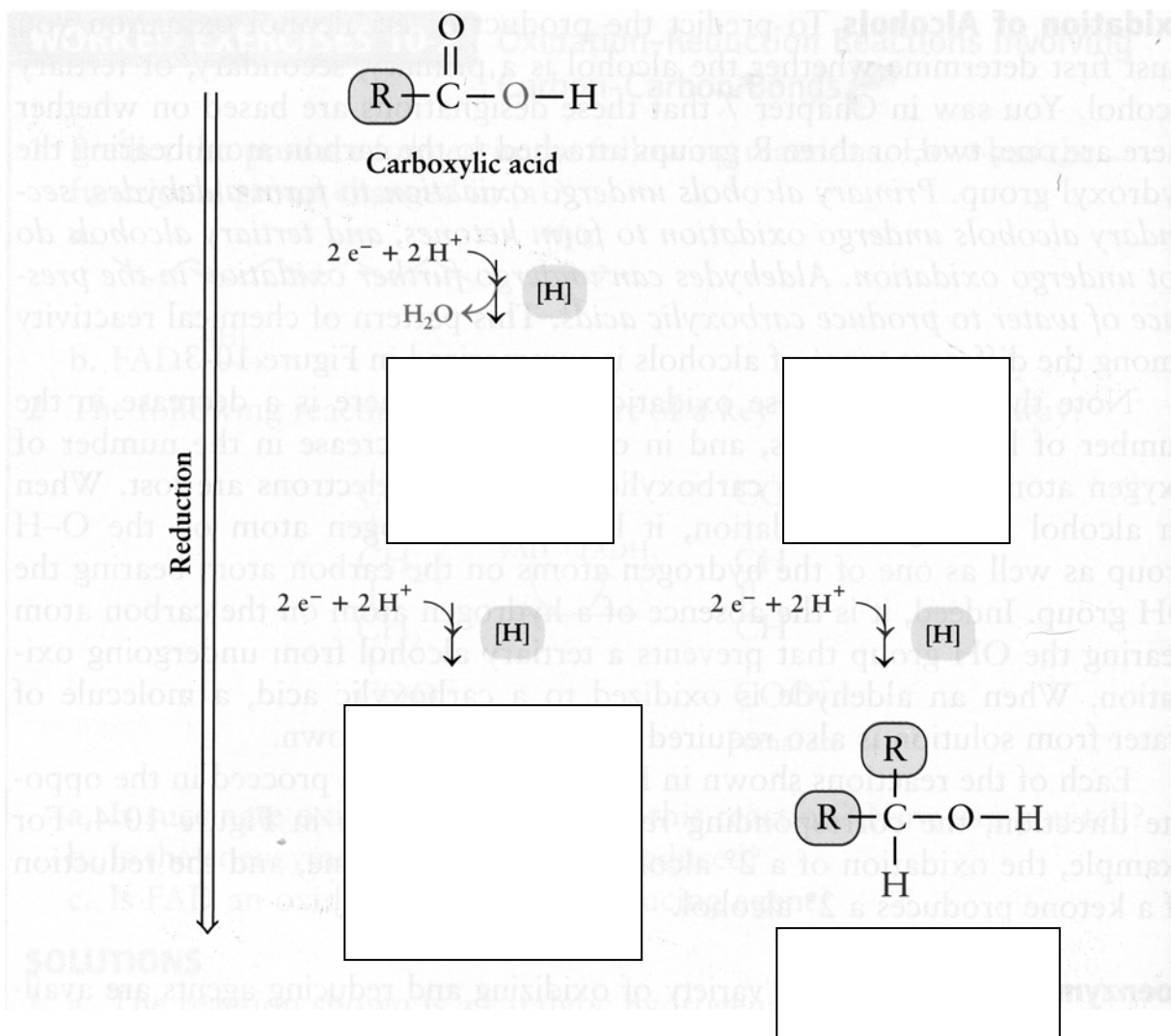


Ethanol Metabolism – The oxidation of a 1° alcohol

Reduction of Carbonyl Groups

Use your knowledge of oxidation reactions to complete the reduction pathways in the following diagram.

Classify the functional groups (aldehydes, ketones or alcohols)
– for the alcohols indicate whether they are 1°, 2°, 3°.



In biochemical reactions, reduction of carbonyl groups is carried out by NAD^+ or NADH ?

Antioxidants

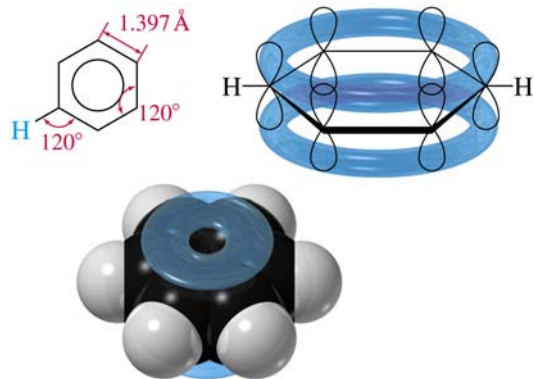
Not ALL Oxidation is Beneficial.

Oxidation reactions form Free Radicals.

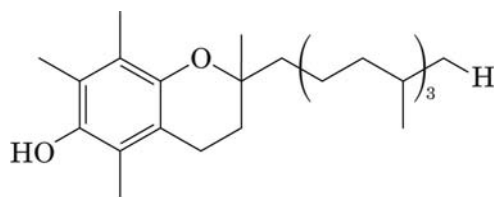
Antioxidants are substances that trap the odd valence electron to prevent it from causing damage to our biomolecules.

Oxidation from Free Radicals is linked with biological aging.

Many antioxidants trap the unpaired electron in an aromatic benzene ring.



Vitamin E is an antioxidant.



Vitamin E

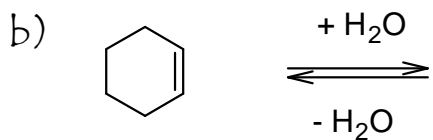
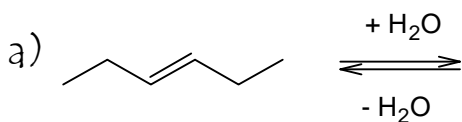
Reactions of Organic Functional Groups Part 4: Hydration-Dehydration

Hydration-Dehydration Reactions

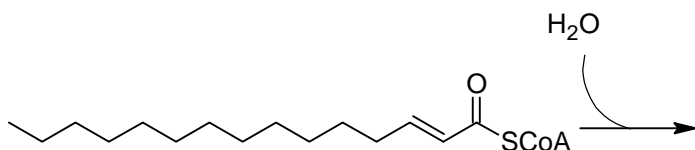
Hydration of Alkenes Produces Alcohols

Dehydration of Alcohols Produces Alkenes

Practice reactions.



c) step 2 in the break down of fatty acids



Reactions of Organic Functional Groups Part 7: Coenzymes & Redox Rxns

Oxidation and Reduction reactions ALWAYS occur together.

To oxidize or reduce a biological molecule, we need a second compound that can donate or accept the electrons. Coenzymes are the second compound.

Coenzymes: special molecules that shuttle electrons

Common Oxidizing and Reducing Agents

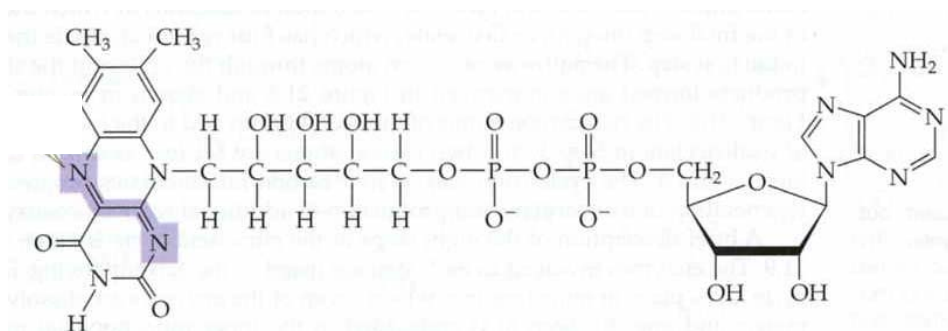
Oxidizing Agents	Formula or Rxn
Bleach	NaOCl
Oxygen	O_2
Hydrogen peroxide	H_2O_2
Chromium(VI)	Cr^{6+}
Manganese (VIII)	MnO_4^-
NAD^+	Coenzyme $\text{NAD}^+ + 2\text{H}^+ + 2\text{e}^- \rightarrow \text{NADH} + \text{H}^+$
FAD	Coenzyme $\text{FAD} + 2[\text{H}] \rightarrow \text{FADH}_2$
Reducing Agents	
Hydrogen	H_2
NADPH	Coenzyme $\text{NADPH} + \text{H}^+ \rightarrow \text{NADP}^+ + 2[\text{H}]$

Note the difference

Coenzymes – a closer look at the 3 Most Important

FAD/FADH₂

FAD is the H Acceptor when C=C (double) bonds form



Circle the reactive region of FAD and FADH₂.

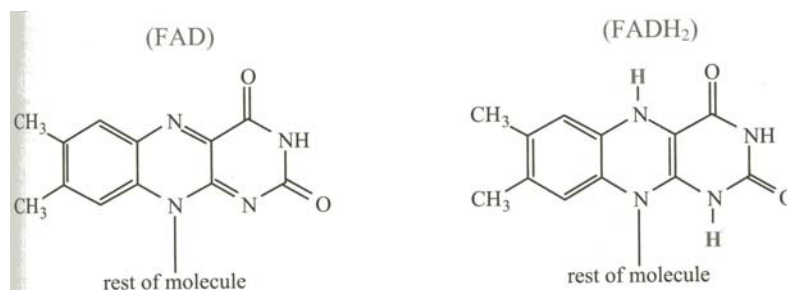
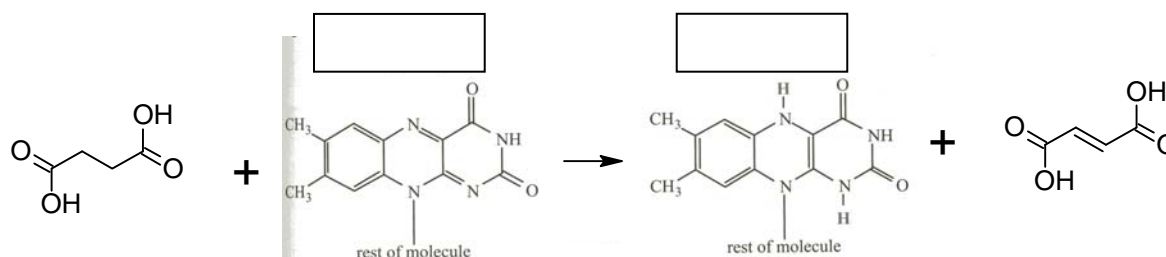


Diagram the reaction below to indicate the oxidation and reduction 1/2 reactions. Label each 1/2 reaction (oxidation or reduction). For the coenzyme, label FAD/FADH₂.



NAD⁺/NADH

NAD⁺ is the H Acceptor in Most Oxidations

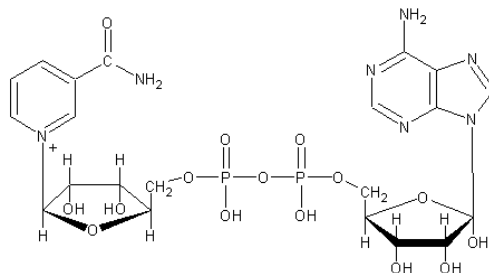
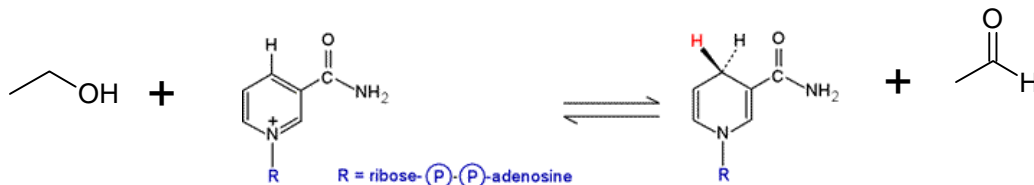


Diagram the reaction below to indicate the oxidation and reduction 1/2 reactions. Label each 1/2 reaction (oxidation or reduction). For the coenzyme, label NAD⁺/NADH.



NADPH/NADP⁺

NADPH is the H Donor in Reduction Reactions

Diagram the reaction below to indicate the oxidation and reduction 1/2 reactions. Label each 1/2 reaction (oxidation or reduction). For the coenzyme, label NADPH/NADP⁺.



The reactions for two important pairs of coenzymes are shown below.

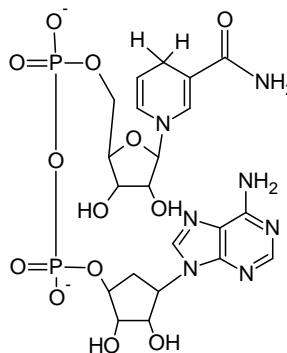
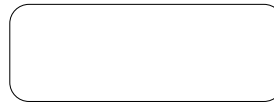
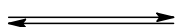
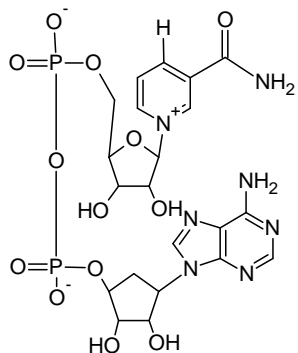
a) Name them: NAD⁺, NADH, FAD, and FADH₂.

Hint: Look closely at the chemical structures to find the differences.

b) Label each one of the coenzymes as an oxidizing agent or reducing agent.

Reaction 1

a)

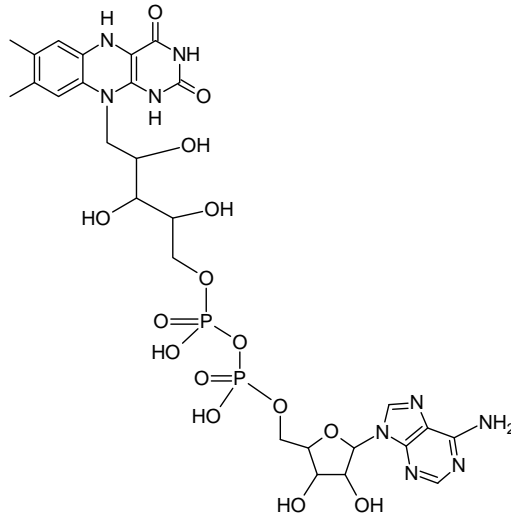
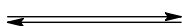
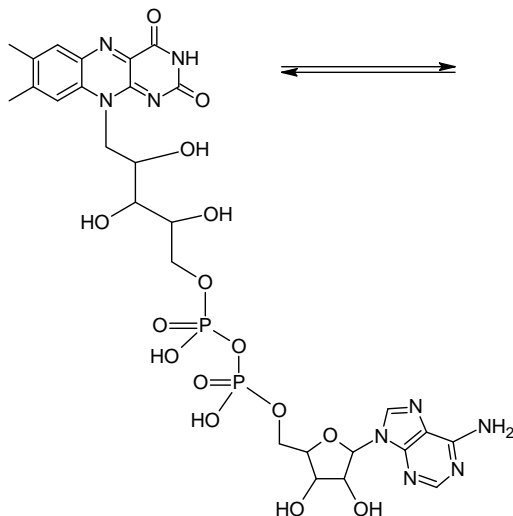


b)



Reaction 2

a)



b)

