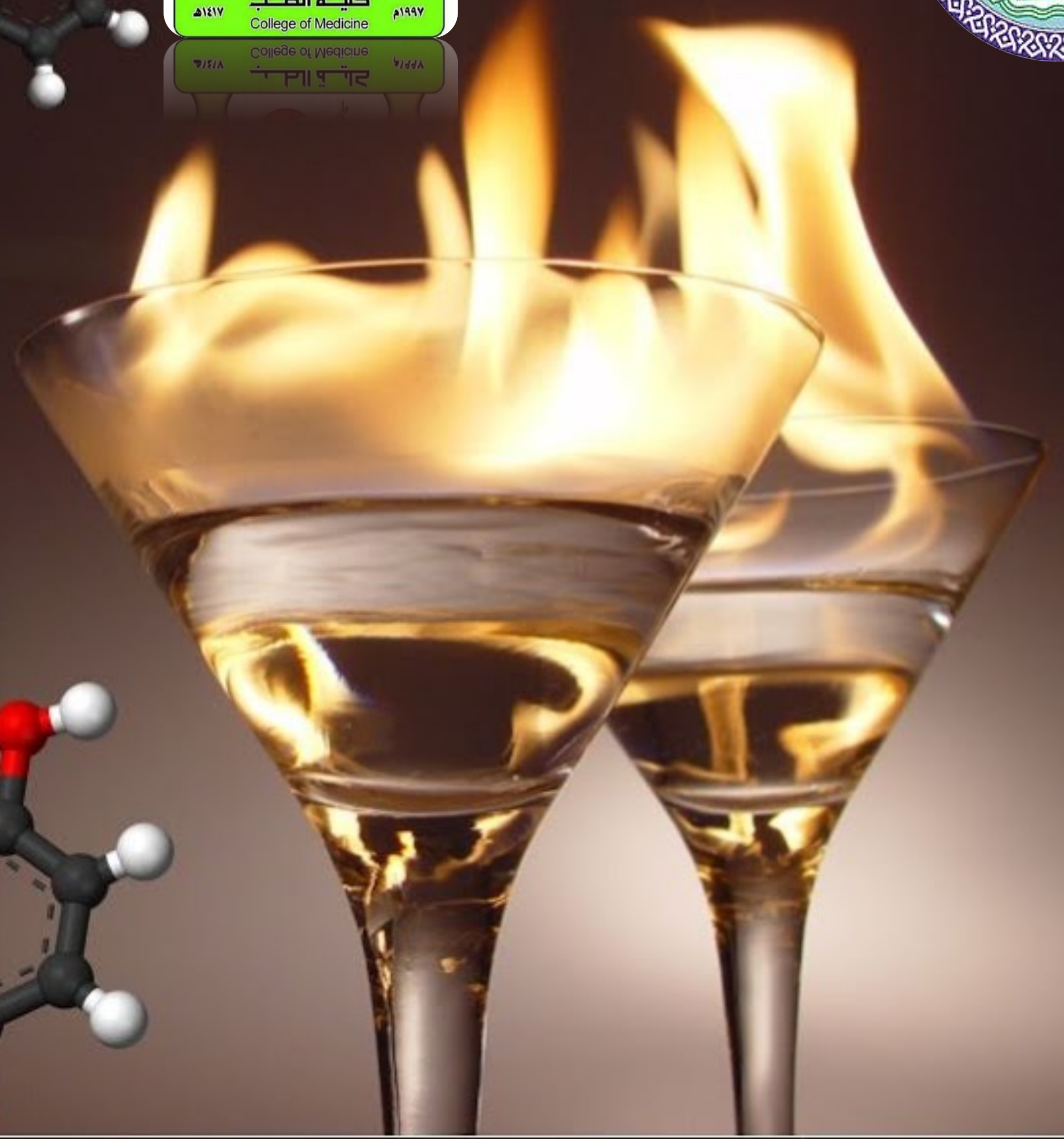
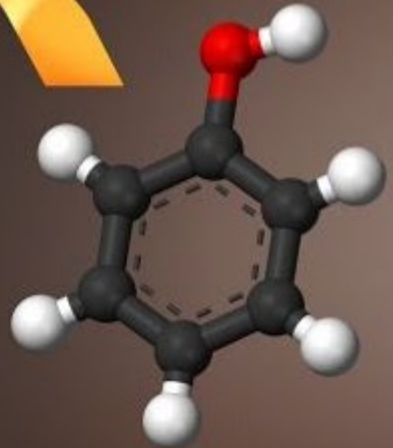
ALCOHOL PHENOL & ETHER

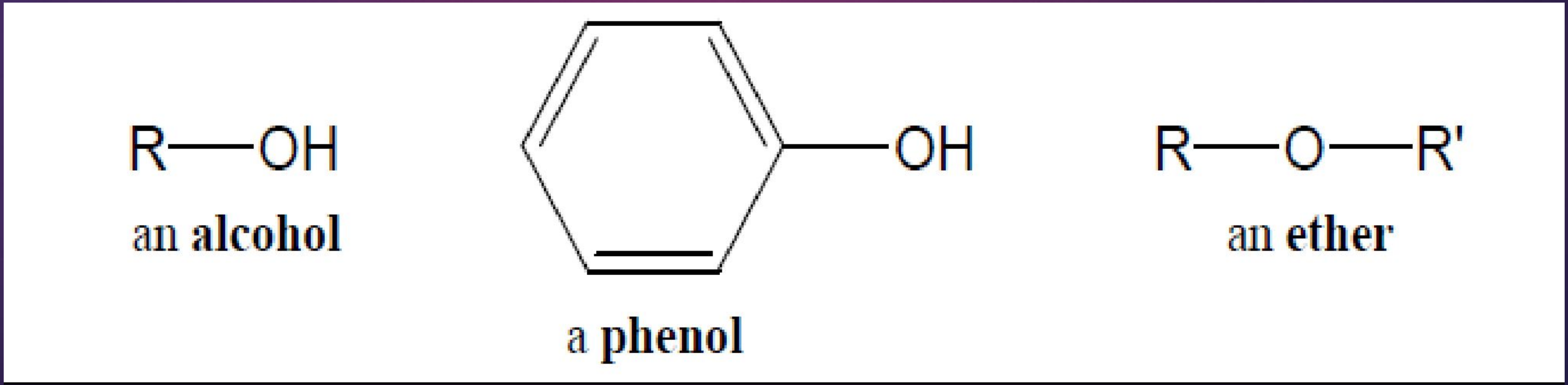




Prof. Dr. May Jaleel

Alcohols

- *The Hydroxy (—OH) Functional Group*• The hydroxyl group (—OH) is found in the alcohol and phenol functional groups. (*Note:* that's not the same as hydroxide, OH-, which is ionic.)– in alcohols, a hydroxyl group is connected to a carbon atom.– in phenols, —OH is connected to a benzene ring.
- (The "parent" molecule of this class is also named phenol: PhOH or C6H5OH.) • When two carbon groups are connected by single bonds to an oxygen, this is classified as the ether.



Some Common Alcohols

CH_3OH

methanol

methyl alcohol

(wood alcohol)

("methy" = wine, "hule" = wood)

Found in wood smoke; contributes to the bouqet of new wine; metabolized in the body to formaldehyde and formic acid, and can cause blindness or death (> 50 mL)

CH_3CH_2OH

ethanol

ethyl alcohol

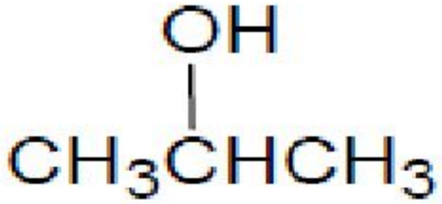
(grain alcohol)

The acohol of alcoholic beverages; the fermentation of honey, grain, or fruit juices to yield beers and wines was probably the first chemical reaction to be discovered; metabolized in the body to produce acetaldehyde

$CH_3CH_2CH_2OH$

1-propanol

n-propyl alcohol



2-propanol

isopropyl alcohol

Rubbing alcohol is 70% isopropyl alcohol and 30% water

Nomenclature of

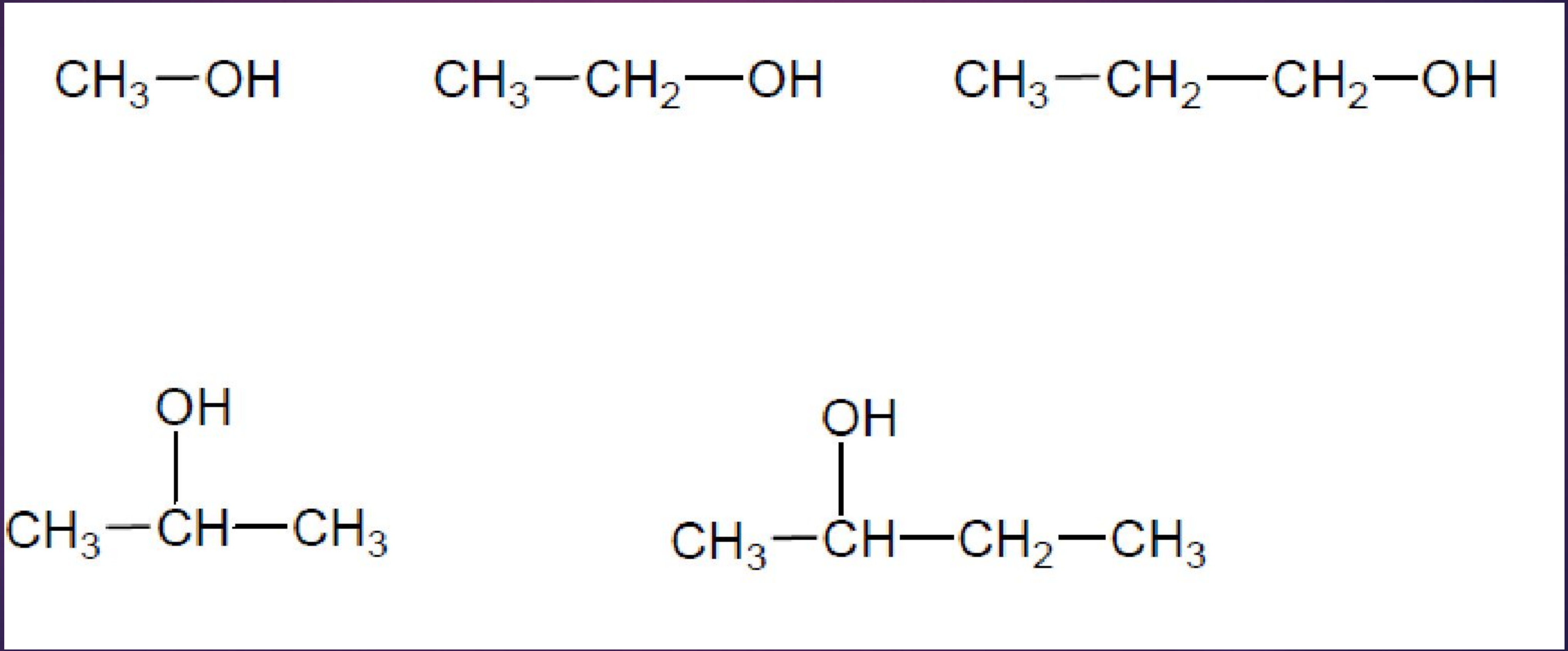
ALCOHOLS, PHENOLS & ETHERS

Nomenclature of Alcohols and Phenols

- ***Step 1***. Name the longest chain to which the hydroxyl (—OH) group is attached. The name for this chain is obtained by dropping the final -e from the name of the hydrocarbon parent name and adding the ending -ol.
- • ***Step 2***. Number the longest chain to give the lowest possible number to the carbon bearing the hydroxyl group.
- • ***Step 3***. Locate the position of the hydroxyl group by the number of the C to which it is attached.
- • ***Step 4***. Locate and name any other substituents.
- • ***Step 5***. Combine the name and location for other groups, the hydroxyl group location, and the longest chain into the final name.

Examples: Naming Alcohols and Phenols

- **Provide acceptable IUPAC names for the following compounds:**



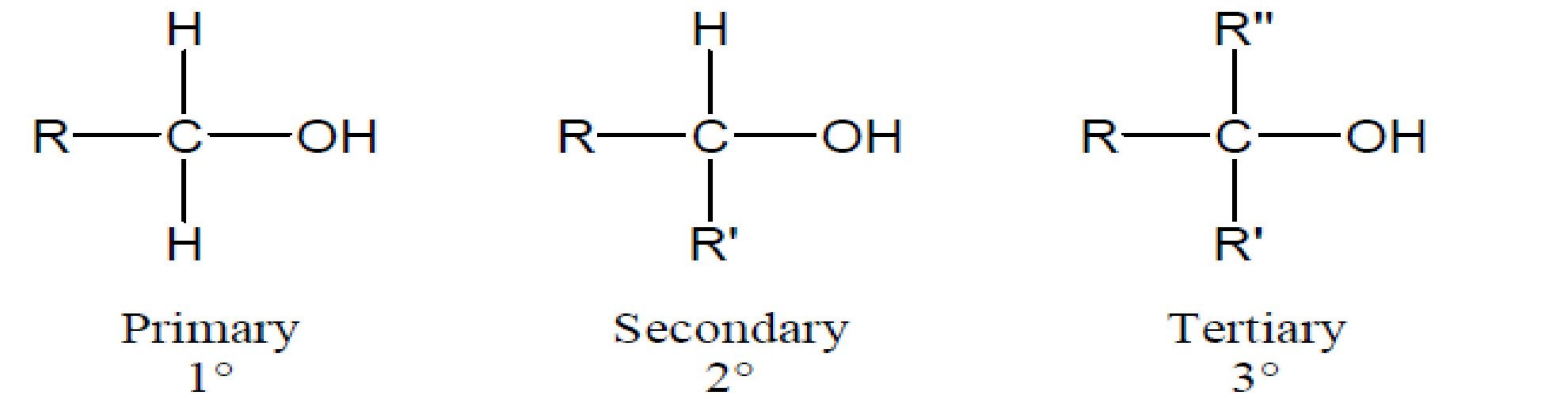
- If there is more than one OH group, a counting prefix (di-, tri-, tetra-, etc.) is placed immediately in front of the suffix -ol (*di*ol, *tri*ol, *tetra*ol, etc.).
- – Usually, the final "e" of the parent hydrocarbon is not dropped (e.g., 1,2propanediol).
- – The position of each alcohol group is indicated by carbon number, separated by commas (e.g., *1,3*- butanediol).
- • For cyclic alcohols, the carbon bearing the OH is numbered as "1."
- • Phenols are named after the parent compound phenol; the C bearing the OH is numbered as "1."

CLASSIFICATION OF

ALCOHOL, PHENOL AND ETHER

Classification of Alcohols

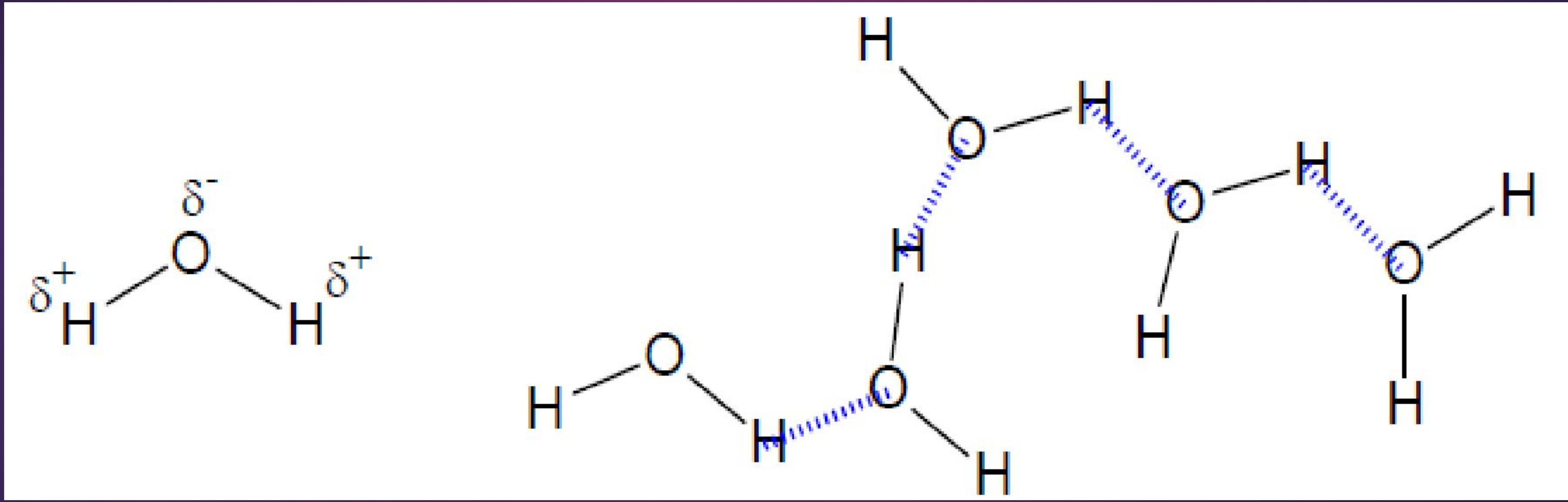
- **Alcohols are classified as primary (1°), secondary (2°), or tertiary (3°) according to how many carbon groups are attached to the carbon bearing the OH group:**



- **The number of hydrogens on the carbon bearing the OH group does affect some chemical properties.**

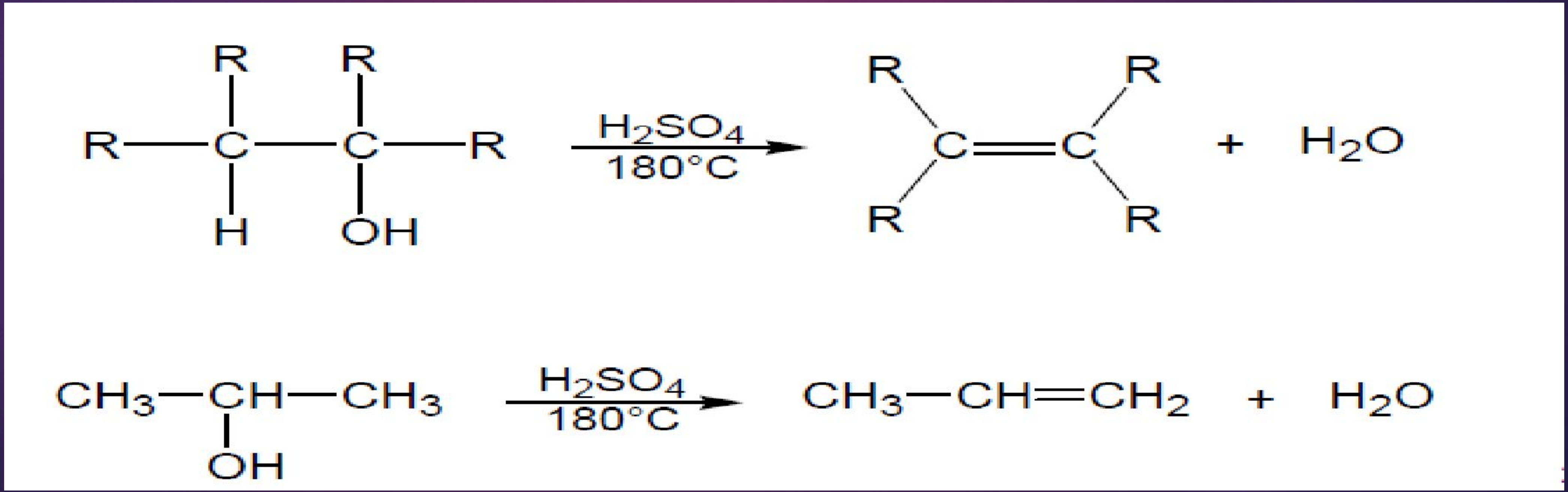
Hydrogen Bonding

- **The oxygen-hydrogen bond is an especially polar bond because oxygen is much more electronegative than hydrogen is.**
- **The O—H bond is therefore a polar bond, and any molecule which contains an O—H bond (like an alcohol) is a polar molecule.**

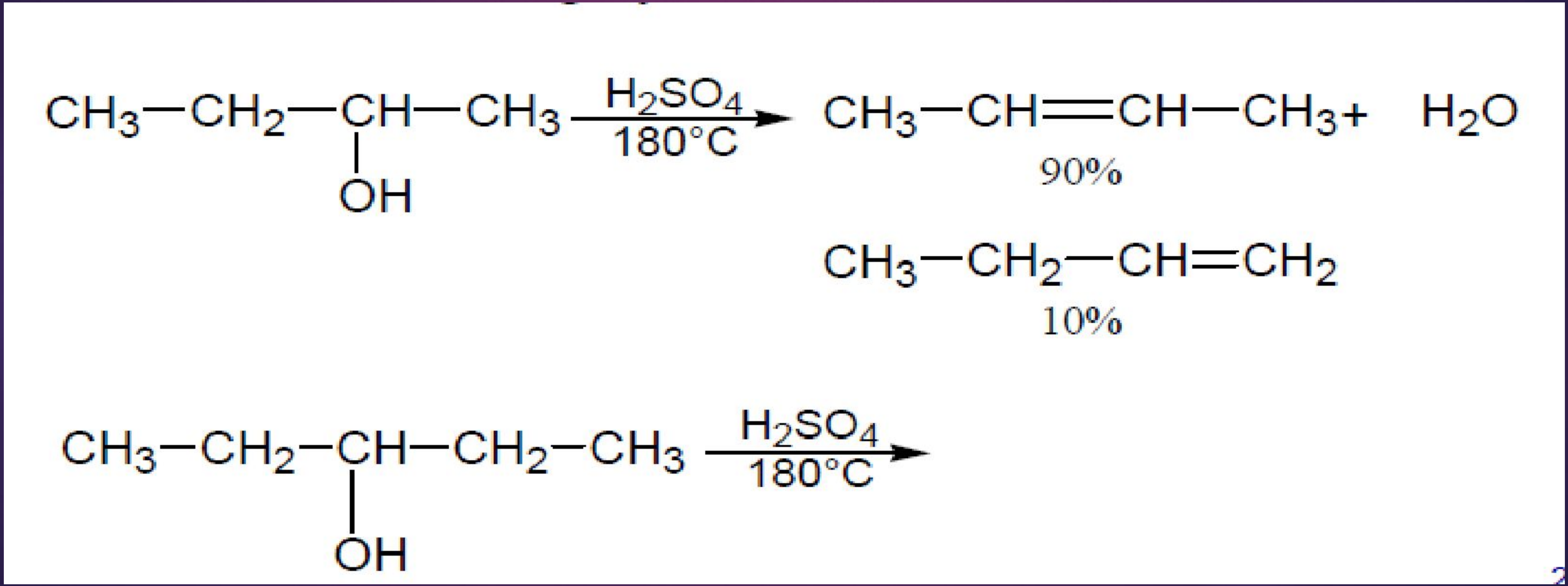


Reactions of Alcohols

- *Dehydration of Alcohols to Produce Alkenes,* Heating alcohols in concentrated sulfuric acid (H2SO4) at 180°C removes the OH group and a H from an adjacent carbon to produce an alkene, with water as a by-product. Since water is "removed"
- from the alcohol, this reaction is known as a dehydration reaction (or an *elimination reaction*):

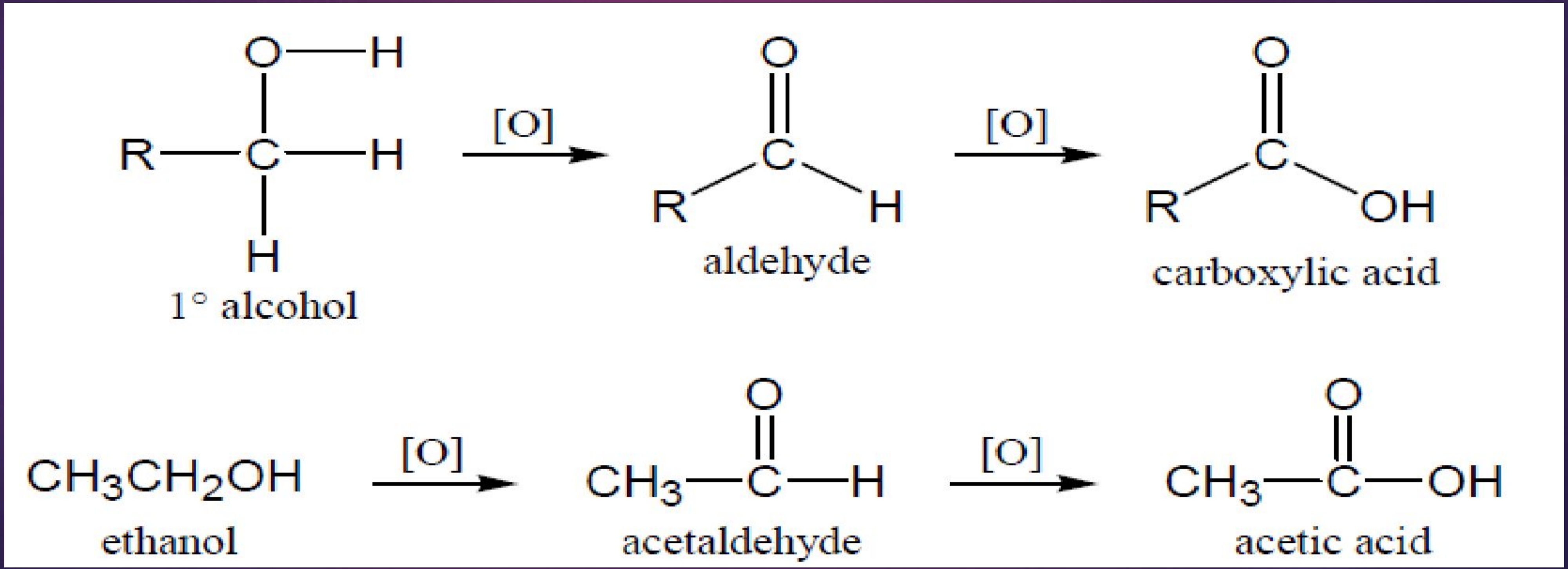


- If there is more than one possible product of a dehydration reaction, the major product can be predicted from Zaitsev’s Rule:
- • Zaitsev’s Rule — when an alkene is produced in an elimination reaction, the major product is the one with the more highly substituted double bond.

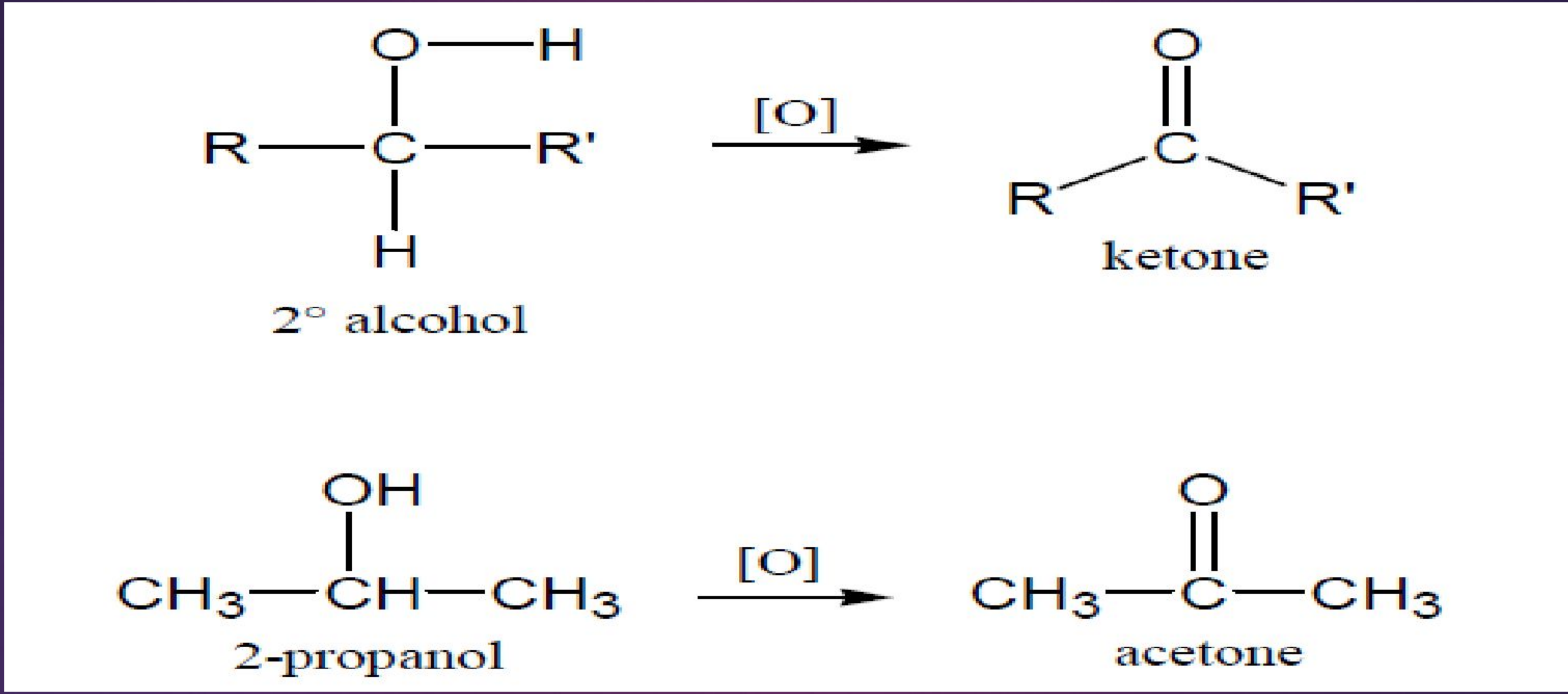


Oxidation of 1° Alcohols

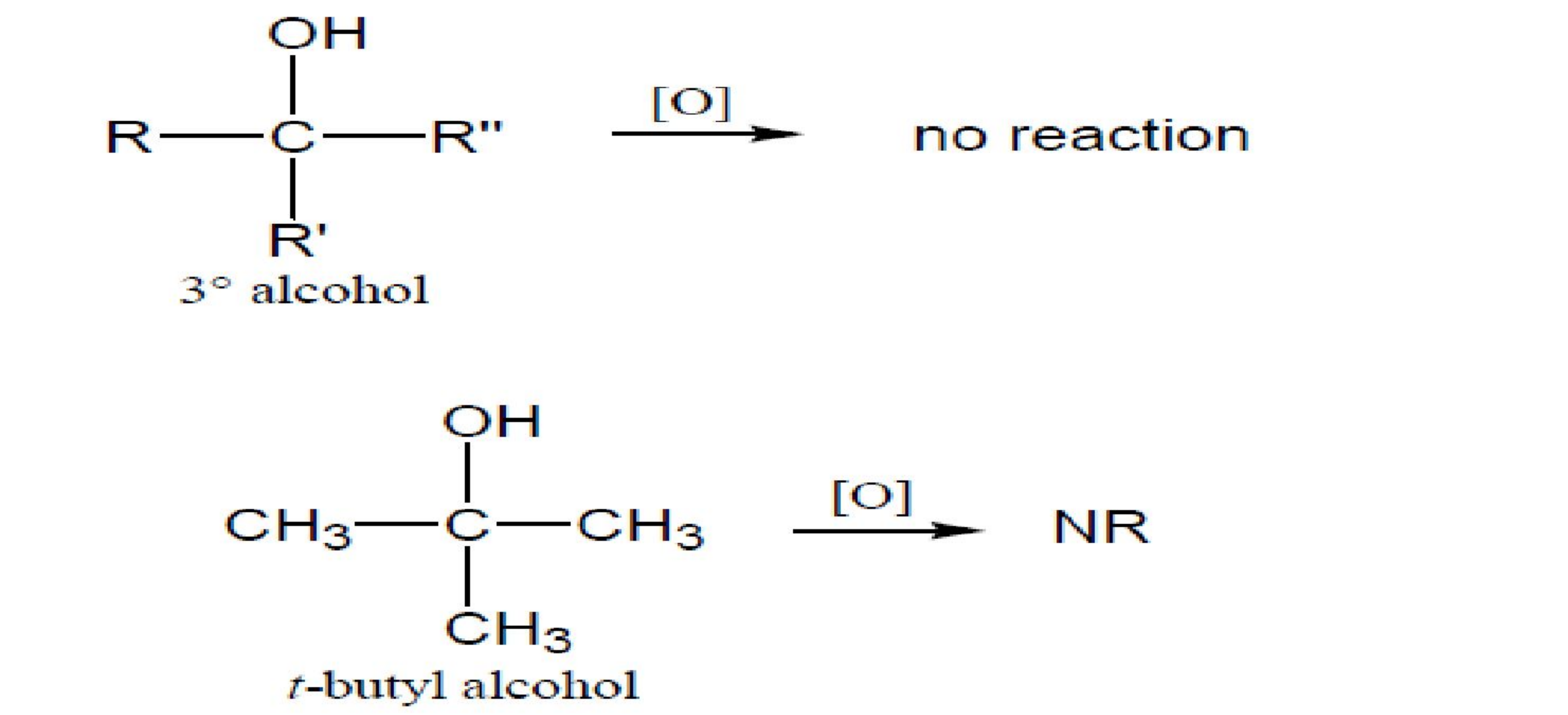
- **Primary alcohols are oxidized first to aldehydes, but the aldehydes are then usually oxidized into carboxylic acids**



- **Secondary alcohols are oxidized to ketones, which cannot be oxidized any further:**

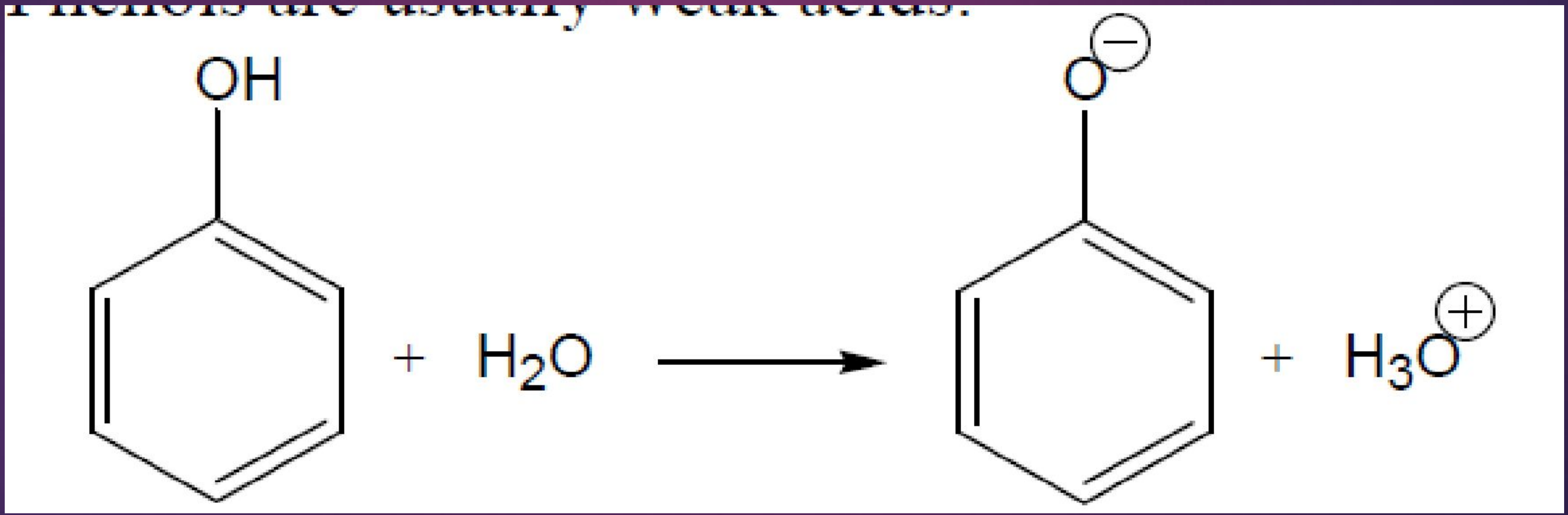


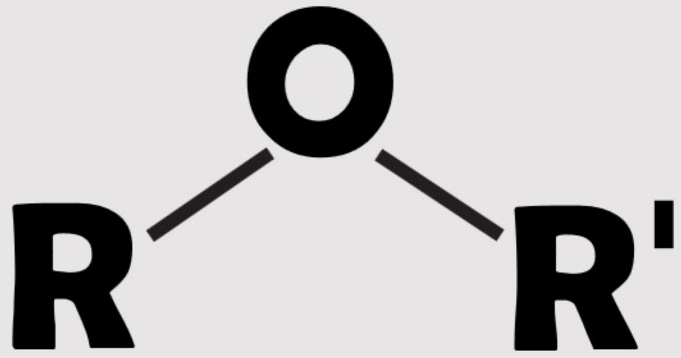
- **Tertiary alcohols, because there is by definition no hydrogen on the alcoholic carbon, cannot be oxidized:**



Phenols

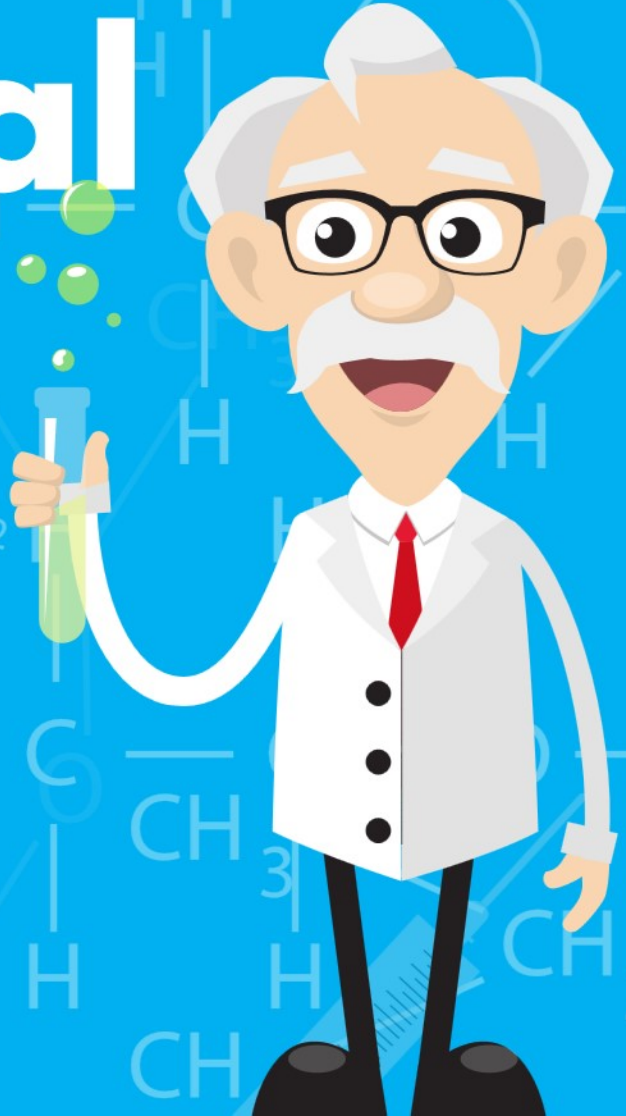
- **Phenols are usually weak acids: A solution of phenol in water (carbolic acid) can be used as an antiseptic and disinfectant. Joseph Lister introduced the use of phenol as a hospital antiseptic in 1867, which cut down drastically on deaths due to complications resulting from the use of unsterile equipment.**





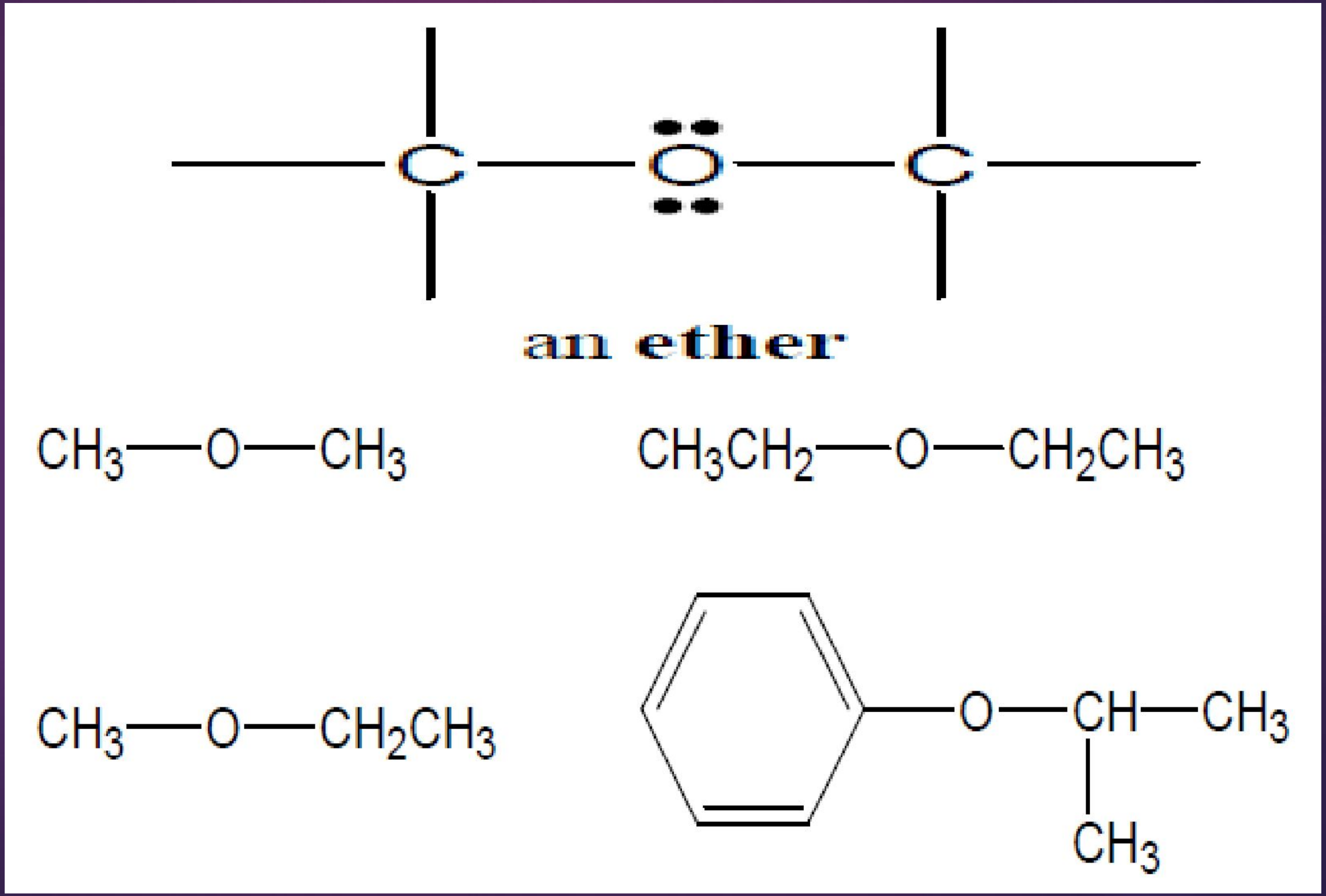
Chemical
Ethers

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Cras finibus pretium vehicula



Ethers

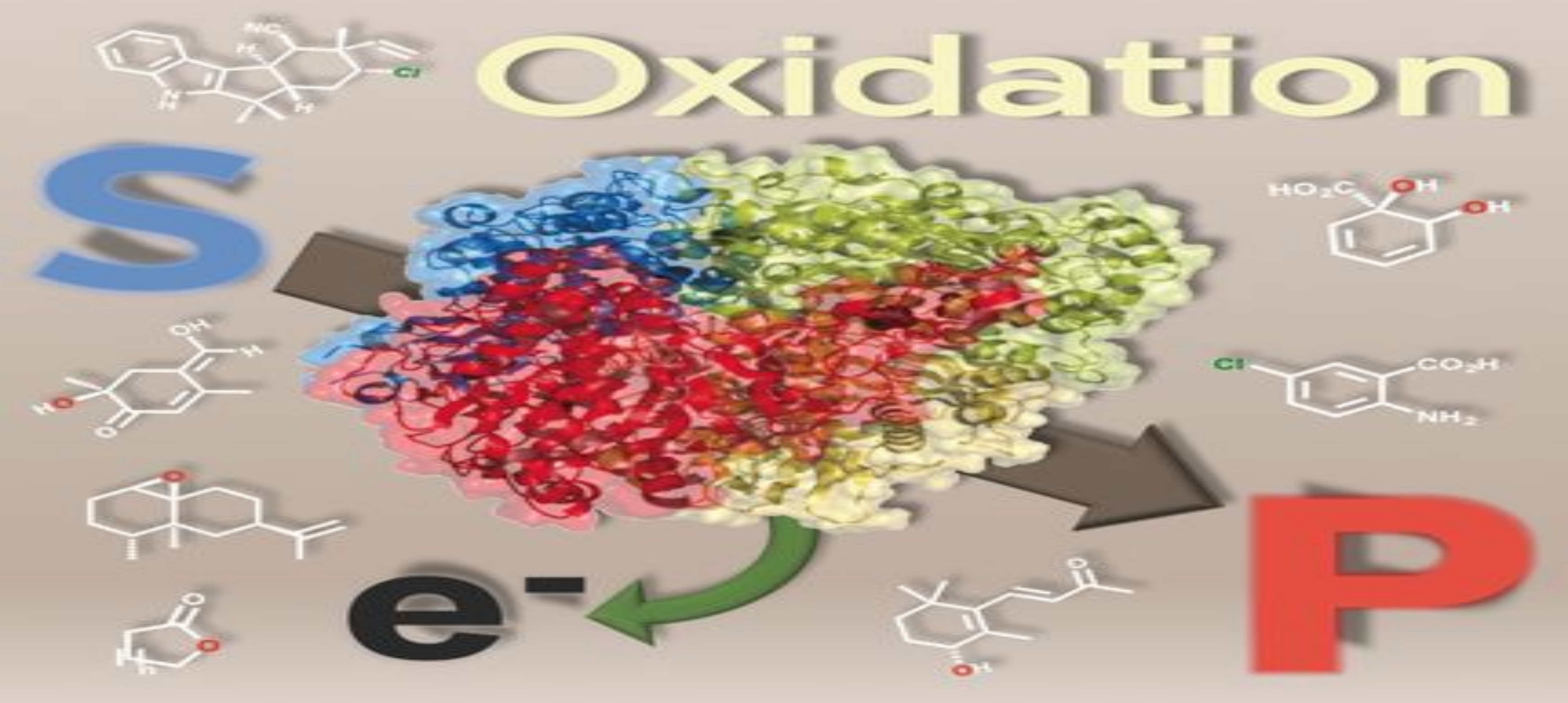
- **In the ether functional group, two carbon groups are connected to a single oxygen.**



- **Common names for ethers are obtained by first naming the two carbon groups attached to the oxygen (in alphabetical order) and then adding the word "ether" to the end. If the two groups are the same, the prefix "di-" is used, although sometimes this is simply dropped ("ethyl ether"). In the IUPAC system, ethers are named as alkoxy substituents (—OR = alkoxy group). The *-yl* ending of alkyl substituents is replaced by *–oxy***

$—CH_3$	methyl	$—OCH_3$	methoxy
$—CH_2CH_3$	ethyl	$—OCH_2CH_3$	ethoxy

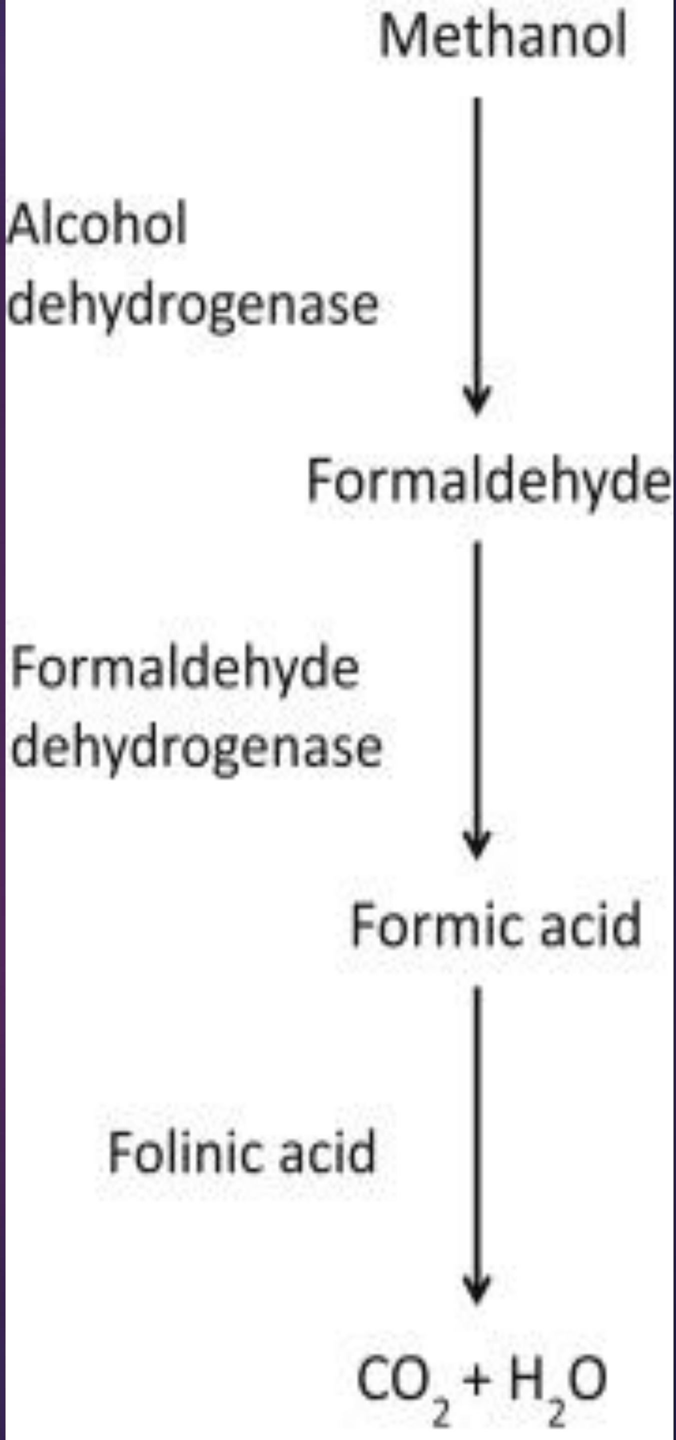
Role Of Alcohols in Living System

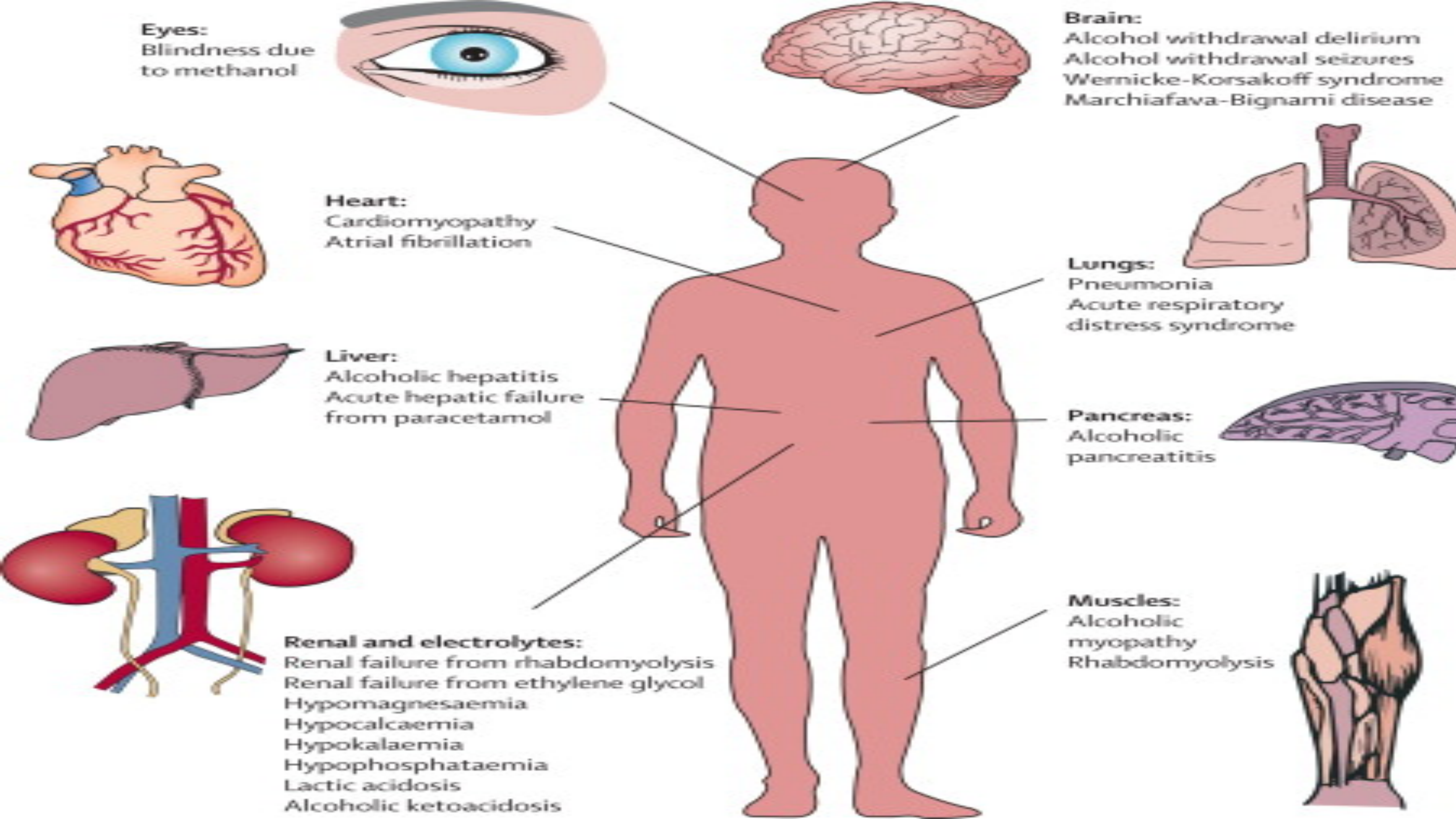


Biological oxidation of methanol

- Methanol has the chemical formula of CH3OH This subtle difference in structure makes a significant difference in its effect. Methanol is exceptionally poisonous as it can cause blindness after consuming just less than 2 teaspoons, and a lethal dose is only about 2 tablespoons! Many people were blinded or died from drinking methanol during prohibition. The initial symptoms of methanol intoxication include depression, headache, dizziness, nausea, lack of coordination, and confusion. Sufficiently large doses of methanol can cause unconsciousness and ultimately death. So why is methanol so toxic to the human body? The answer lies in the products that are formed when it is oxidized within our body. compared to CH3CH2OH ethanol. Methanol is metabolized in exactly the same way as ethanol. It is an oxidation reaction from an –OH to an –OOH. Just like ethanol, the first step changes the alcohol to the aldehyde,

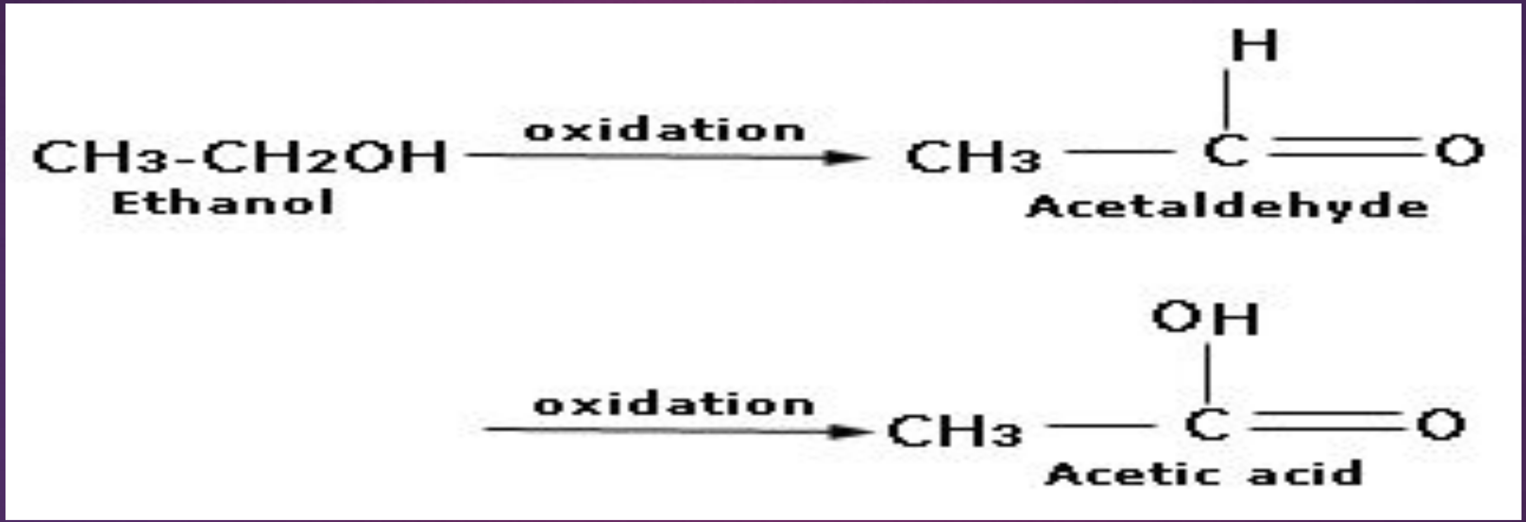
- and the second step changes the aldehyde to the carboxylic acid. From methanol though, formaldehyde and formic acid are produced instead of the harmless acetic acid (as in the case of ethanol).
- Both formaldehyde and formic acid (methanoic acid) are deadly, first attacking cells in the retina and then the cells of other vital organs. It is for this reason that methanol should never, ever be consumed.




Eyes:
Blindness due to methanol
Brain:
Alcohol withdrawal delirium
Alcohol withdrawal seizures
Wernicke-Korsakoff syndrome
Marchiafava-Bignami disease
Heart:
Cardiomyopathy
Atrial fibrillation
Lungs:
Pneumonia
Acute respiratory distress syndrome
Liver:
Alcoholic hepatitis
Acute hepatic failure from paracetamol
Pancreas:
Alcoholic pancreatitis
Muscles:
Alcoholic myopathy
Rhabdomyolysis
Renal and electrolytes:
Renal failure from rhabdomyolysis
Renal failure from ethylene glycol
Hypomagnesaemia
Hypocalcaemia
Hypokalaemia
Hypophosphataemia
Lactic acidosis
Alcoholic ketoacidosis

Biological oxidation of ethanol

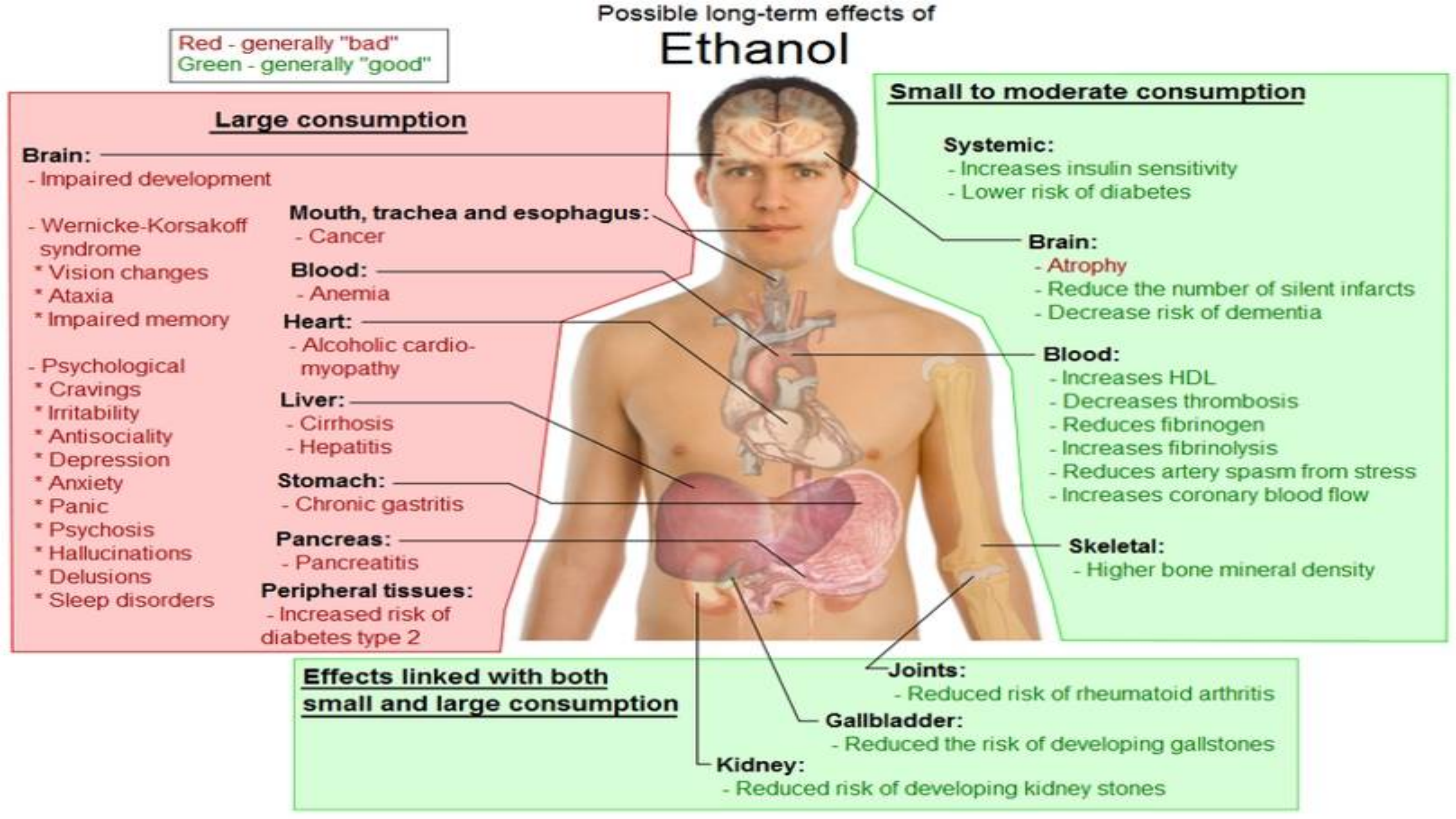
- ethanol, the main alcohol found in wine, and spirits has the chemical formula of CH3CH2OH. Different alcohols will have different carbon/hydrogen chains. The metabolism (or breakdown) of ethanol in the liver occurs in two steps, as illustrated below:



The first step of the alcohol metabolism process is the conversion of the alcohol to another class of organic molecules called an aldehyde.

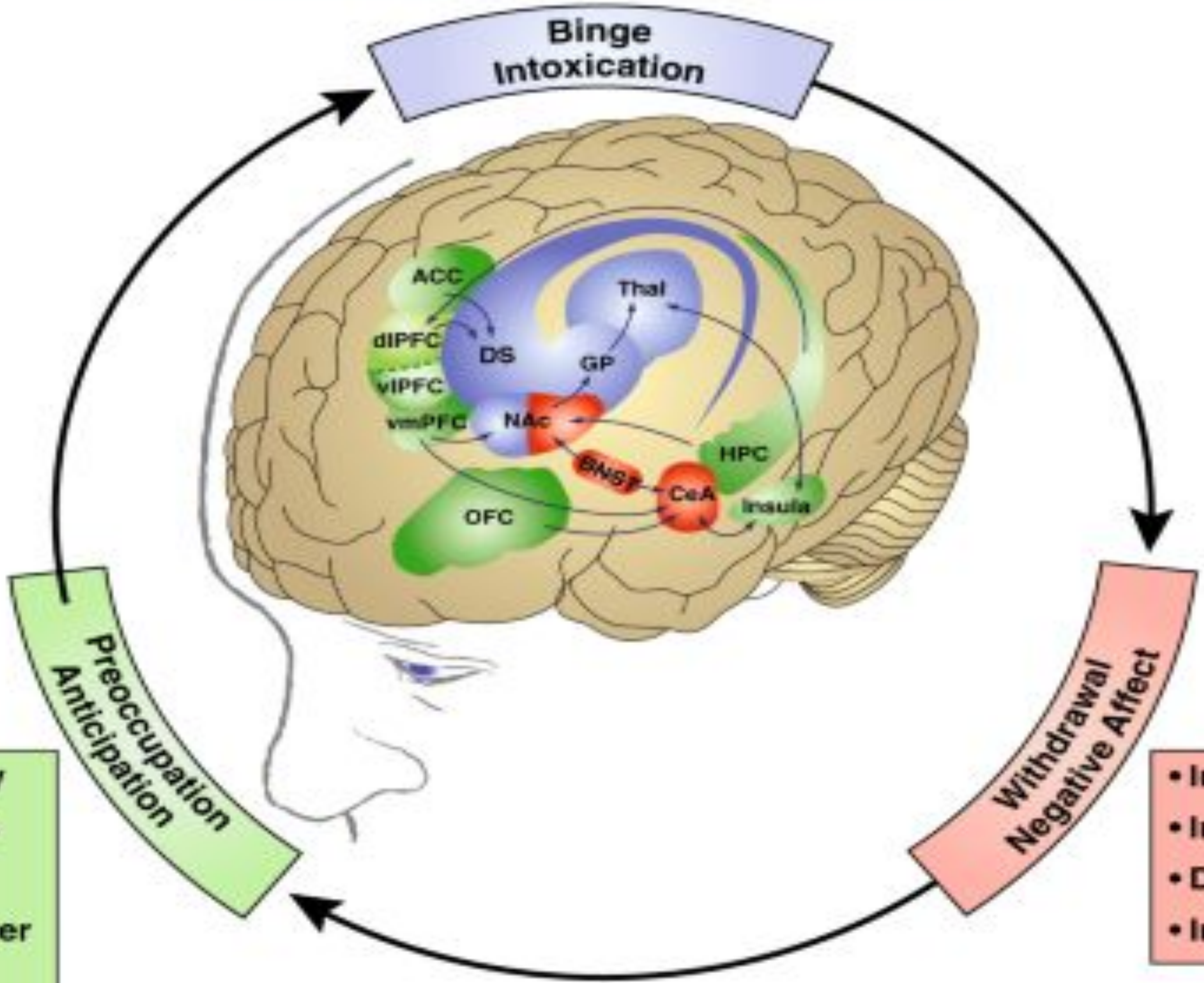
$$CH_3CH_2OH + NAD^+ \rightarrow CH_3CHO + NADH + H^+$$

- This aldehyde is called acetaldehyde or ethanal. Ignore the $NAD^+/NADH$ in this equation for now; we will come back to that in a moment.
- The second step is the conversion of acetaldehyde into acetic acid.
  - $CH_3CHO+NAD^++H2O \rightarrow CH_3COOH+NADH+H^+$
- Acetic acid is an example of another class of organic molecules called a carboxylic acid. The overall reaction shows how an alcohol is oxidized in biochemistry.
- alcohols also play a significant role in the chemistry of living systems. The OH group can act through H-bonding as a center for chemical recognition and binding to enzyme sites. These can become signaling and regulatory agents in living systems. Here are several examples:
- Geraniol and citronellol are both relatively small molecules that contribute to the odor of roses, geraniums and other flowers. Geraniol is also a key intermediate in the synthesis of terpenes, a large class of secondary metabolites found in both plants and animals



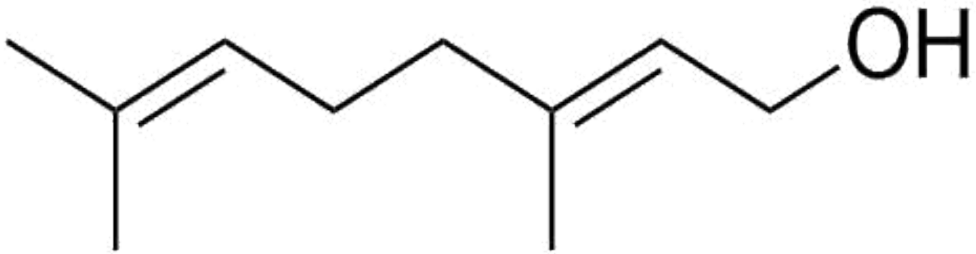
Possible long-term effects of
Ethanol
Red - generally "bad"
Green - generally "good"
Large consumption
Brain:
- Impaired development
- Wernicke-Korsakoff syndrome
* Vision changes
* Ataxia
* Impaired memory
- Psychological
* Cravings
* Irritability
* Antisociality
* Depression
* Anxiety
* Panic
* Psychosis
* Hallucinations
* Delusions
* Sleep disorders
Mouth, trachea and esophagus:
- Cancer
Blood:
- Anemia
Heart:
- Alcoholic cardio-myopathy
Liver:
- Cirrhosis
- Hepatitis
Stomach:
- Chronic gastritis
Pancreas:
- Pancreatitis
Peripheral tissues:
- Increased risk of diabetes type 2
Small to moderate consumption
Systemic:
- Increases insulin sensitivity
- Lower risk of diabetes
Brain:
- Atrophy
- Reduce the number of silent infarcts
- Decrease risk of dementia
Blood:
- Increases HDL
- Decreases thrombosis
- Reduces fibrinogen
- Increases fibrinolysis
- Reduces artery spasm from stress
- Increases coronary blood flow
Skeletal:
- Higher bone mineral density
Effects linked with both small and large consumption
Joints:
- Reduced risk of rheumatoid arthritis
Gallbladder:
- Reduced the risk of developing gallstones
Kidney:
- Reduced risk of developing kidney stones

- Decreased Sleep Onset Latency
- Increased wakefulness during sleep
- Modest decrease in REM, with some recovery later in the night
- Increased SWS and Delta EEG early in the night (alpha power also increased)

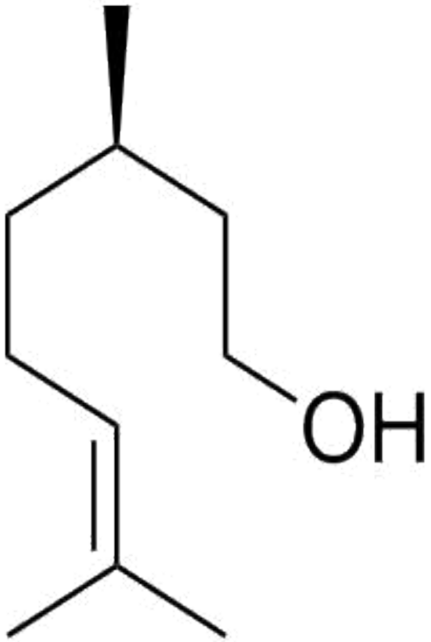


- Increased Sleep Onset Latency
- Increased wakefulness and N1 sleep
- Decreased SWS and Delta EEG power
- Increased REM

- Increased Sleep Onset Latency
- Some recovery in wakefulness
- Increased N1 sleep
- Decreased SWS and delta power (some recovery)
- Increased REM (some recovery)

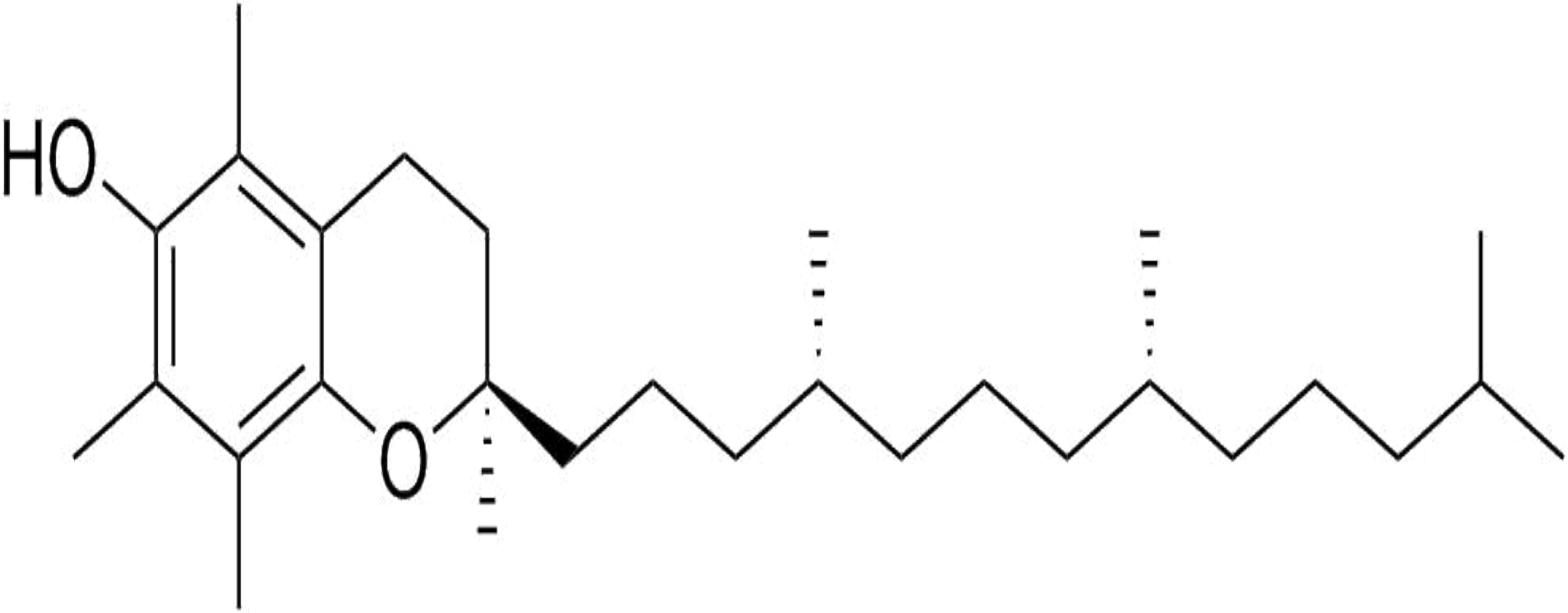


Geraniol



Citronellol

Vitamins are often used as "coenzymes" and can be thought of as "reagents" that interact with enzymes to promote specific chemical functions. Vitamin E is thought to be primarily an antioxidant (the phenol group is similar to BHA and BHT food additives), but it is also involved in a variety of other functions such as kinase protein regulation, .gene expression and neurologic functions



α-Tocopherol (Vitamin E)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You
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