ST2091101 เคมีสำหรับสุขภาพ เครื่องสำอางและการชะลอวัย

แอลกอฮอล์ และ ฟีนอล

AlcOHol & Phenol

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#แผนการเรียนรู้และการประเมินผลการเรียนรู้

6.1

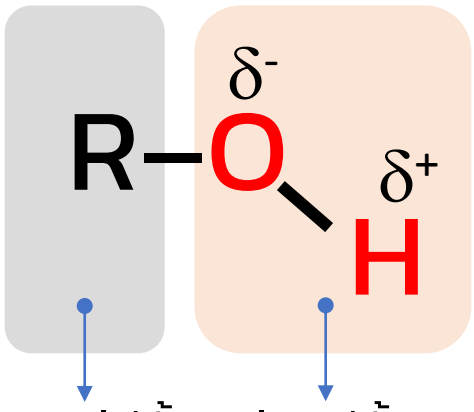
แอลกอฮอล์ (Alcohols)

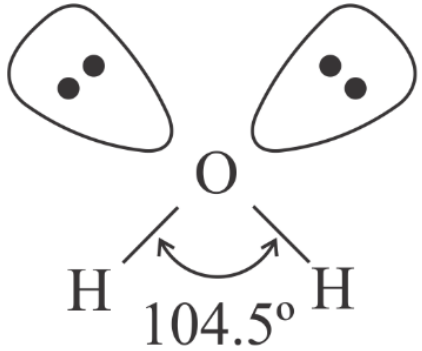
- บอกสมบัติแอลกอฮอล์และฟีนอล
- บอกปฏิกิริยาการเตรียมแอลกอฮอล์และฟีนอล
- บอกปฏิกิริยาของแอลกอฮอล์และฟีนอล
- ทำนายผลผลิตปฏิกิริยาแอลกอฮอล์และฟีนอล

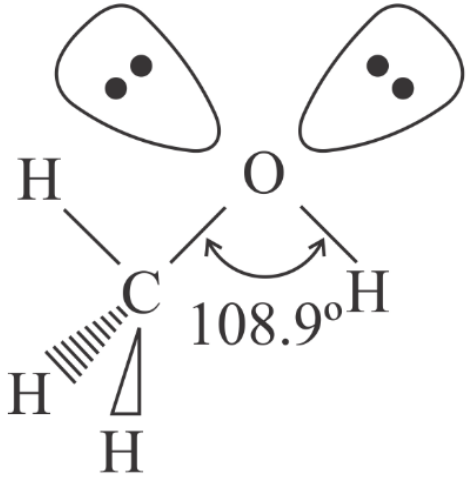
แอลกอฮอล์

สารอินทรีย์ที่มีหมู่ไฮดรอกซิล (–OH) เป็นองค์ประกอบ

R–OH



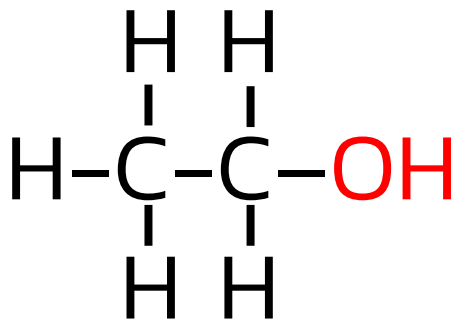




ส่วนที่มีขั้วจะเกิดพันธะ
ไฮโดรเจนกับน้ำจึงละลายน้ำได้

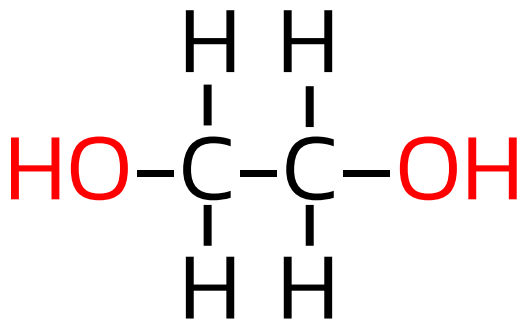
- จุดเดือดของแอลกอฮอล์ เพิ่มขึ้นตามจำนวนอะตอมของคาร์บอน
- แต่เมื่อจำนวนอะตอมของคาร์บอนเพิ่มขึ้น ความสามารถในการละลายน้ำจะลดลง

โมโนไฮดริกแอลกอฮอล์
(mono-)



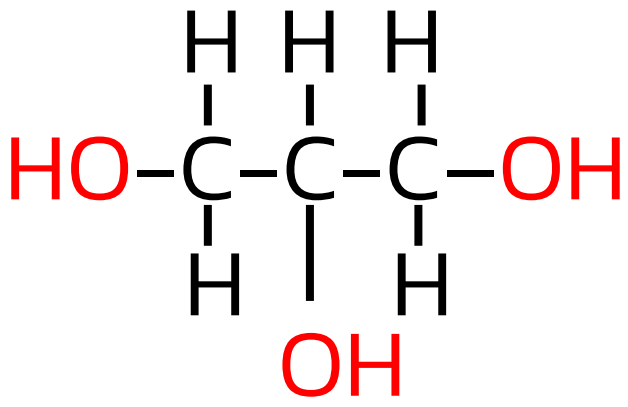
ethanol

ไดไฮดริกแอลกอฮอล์
(di-)



ethane-1,2-diol

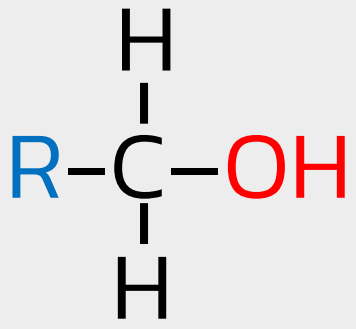
ไตรไฮดริกแอลกอฮอล์
(tri-)



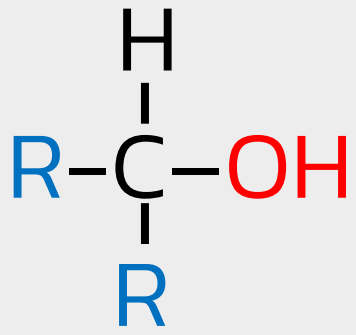
propane-1,2,3-triol

โมโนไฮดริกแอลกอฮอล์

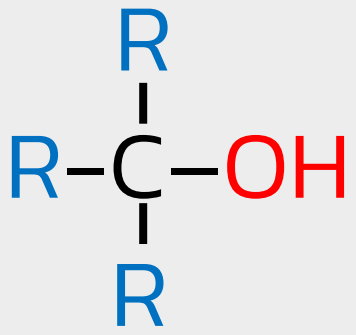
แอลกอฮอล์ปฐมภูมิ (1°)
คาร์บอนที่มีหมู่ –OH เกิด
พันธะกับคาร์บอน
ข้างเคียง 1 พันธะ

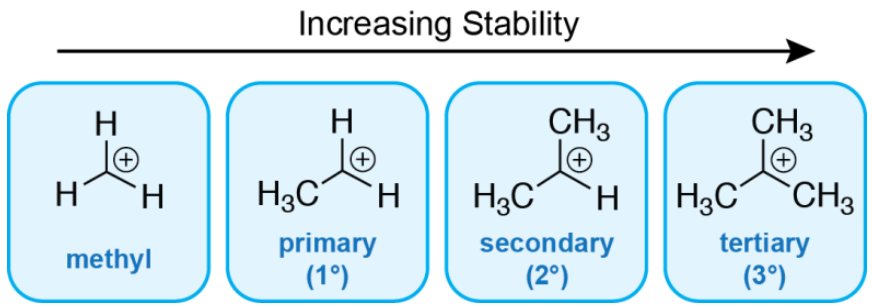


แอลกอฮอล์ทุติยภูมิ (2°)
คาร์บอนที่มีหมู่ –OH เกิด
พันธะกับคาร์บอน
ข้างเคียง 2พันธะ

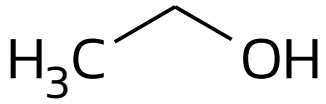


แอลกอฮอล์ตติยภูมิ (3°)
คาร์บอนที่มีหมู่ –OH เกิด
พันธะกับคาร์บอน
ข้างเคียง 3 พันธะ

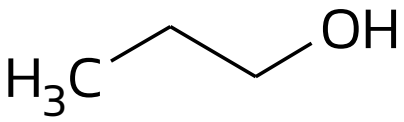




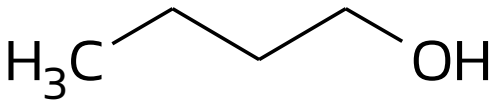
1° Alcohols



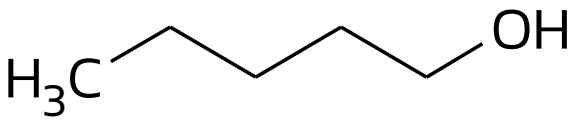
ethanol



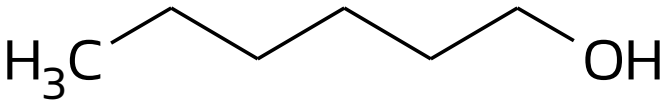
1-propanol



1-butanol

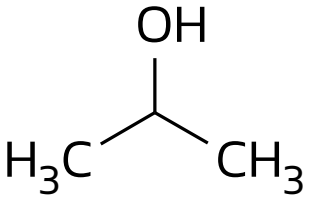


1-pentanol

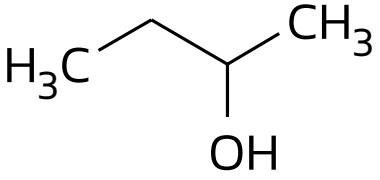


1-hexanol

2° Alcohols

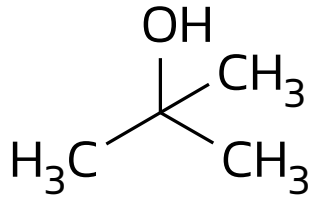


2-propanol
(iso-propyl alcohol)

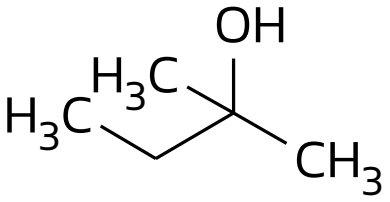


2-butanol

3° Alcohols

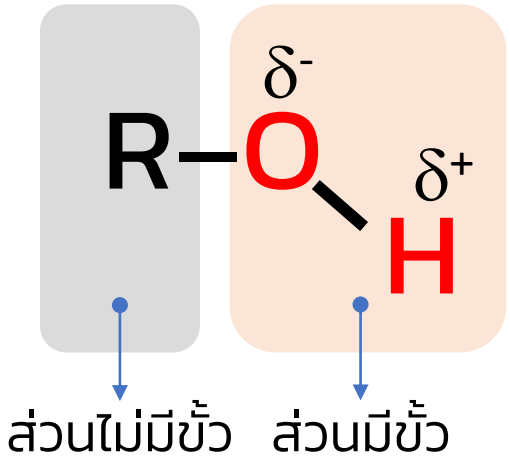


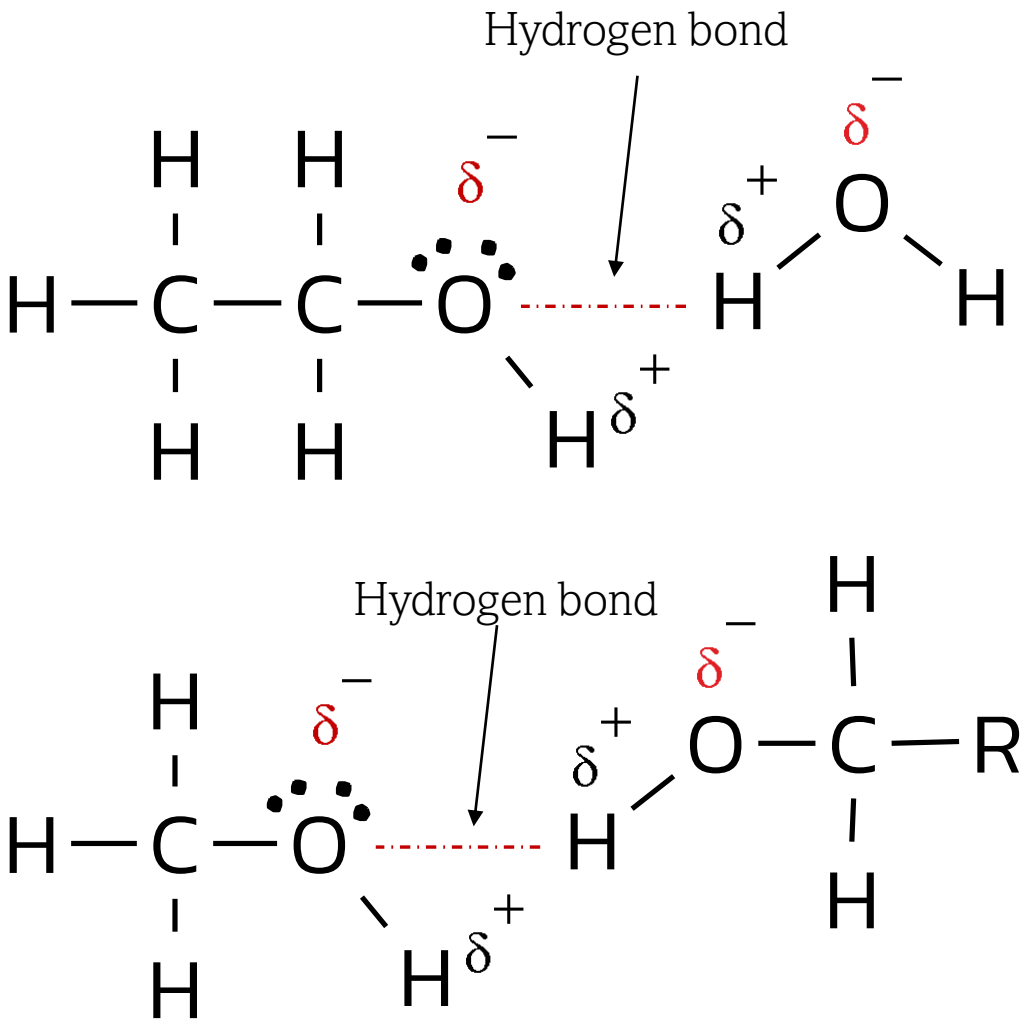
2-methyl-2-propanol



2-methyl-2-butanol

สมบัติแอลกอฮอล์





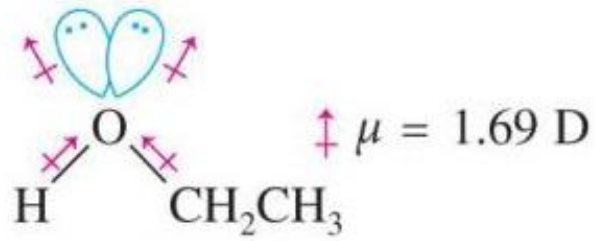
จุดเดือด (Boiling point)

ปัจจัยที่ส่งผลต่อจุดเดือด

- มวลโมเลกุล
- รูปร่างของโมเลกุล
- การเกิดพันธะไฮโดรเจน
- แรงแวนเดอร์วาลส์

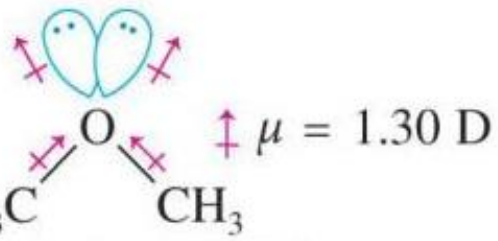
สารอินทรีย์	สูตรเคมี	น้ำหนักโมเลกุล	จุดเดือด (°C)
มีเทน (methane)	CH_4	16	-164
น้ำ (water)	H_2O	18	100
เมทานอล (methanol)	CH_3OH	32	65
อีเทน (ethane)	CH_3CH_3	30	-89
อีทีน (ethene)	$CH_2=CH_2$	28	-102
เอทานอล (ethanol)	CH_3CH_2OH	46	79
โพรเพน (propane)	$CH_3CH_2CH_3$	44	-42
โพรพีน (propene)	$CH_2=CHCH_2$	42	-48
โพรพานอล (n-propanol)	$CH_3CH_2CH_2OH$	60	97

Alkane	Boiling point (℃)	Alcohol	Boiling point (℃)
methane	- 164	methanol	65
ethane	- 89	ethanol	79
propane	- 42	1-propanol	97
butane	- 0,5	1-butanol	117
pentane	36	1-pentanol	138
hexane	69	1-hexanol	156



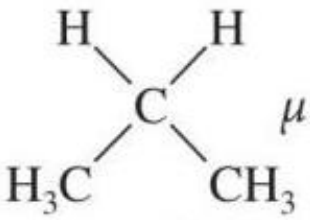
$\mu = 1.69$ D

ethanol, MW 46
bp 78 °C



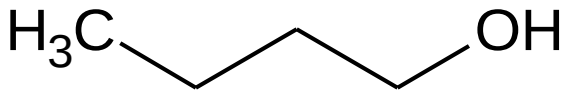
$\mu = 1.30$ D

dimethyl ether, MW 46
bp −25 °C

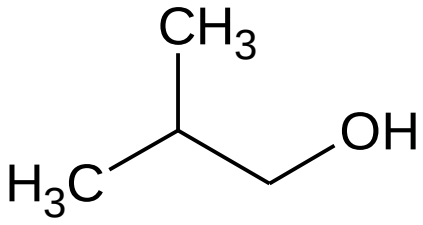


$\mu = 0.08$ D

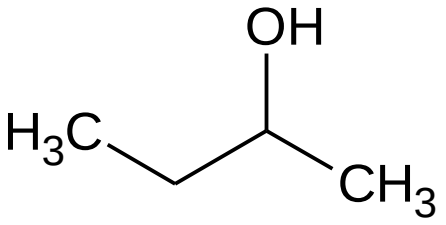
propane, MW 44
bp −42 °C



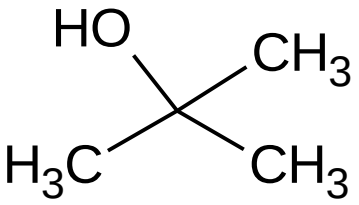
1-butanol
(*n*-butanol)
BP 117°C
(1°)



2-methyl-1-propanol
(iso-butylalcohol)
BP 107°C
(1°)



2-butanol
(*sec*-butanol)
BP 98°C
(2°)

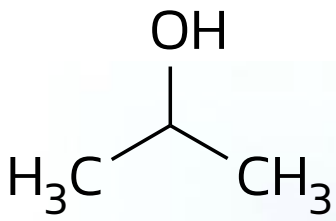


2-methylpropane-2-ol
(*tert*-butanol)
BP 82°C
(3°)

การละลาย

น้ำและแอลกอฮอล์มีสมบัติการละลายคล้ายคลึงกันมาก เพราะต่างมีหมู่ –OH ซึ่งสามารถเกิดพันธะไฮโดรเจนได้ ถ้าเป็นแอลกอฮอล์ที่มีมวลโมเลกุลต่ำจะละลายน้ำได้ดี ถ้ามีมวลโมเลกุลสูงขึ้นการละลายจะลดลง

แอลกอฮอล์	ค่าการละลาย (g/100 g ของน้ำ)
methanol	ละลาย
ethanol	ละลาย
n-propanol	ละลาย
t-butanol	ละลาย
iso-butanol	10.0
n-butanol	9.1
n-pentanol	2.7
cyclohexanol	3.6
n-hexanol	0.6
hexan-1,6-diol	ละลาย
phenol	9.3



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Catalyzing Your Growth

USES OF ISOPROPYL ALCOHOL (IPA)

SOLVENT
From Printmaking to laboratory reagents, IPA is used as a solvent in a range of industries

ANTISEPTIC
IPAs role as a bacteria killing agent makes it well suited for anti-septics, sanitisers,and cleaning minor cuts

SWIMMERS EAR
IPA evaporates quickly, It can help dry out water residue in the ear & prevent infection.

ASTRINGENT
IPA is also used in astringents to shrink body tissue, and to stop a cut from bleeding.

CLEANING AGENT
Its antibacterial properties make IPA ideal for surface disinfectants. It's used at homes & in many labs.

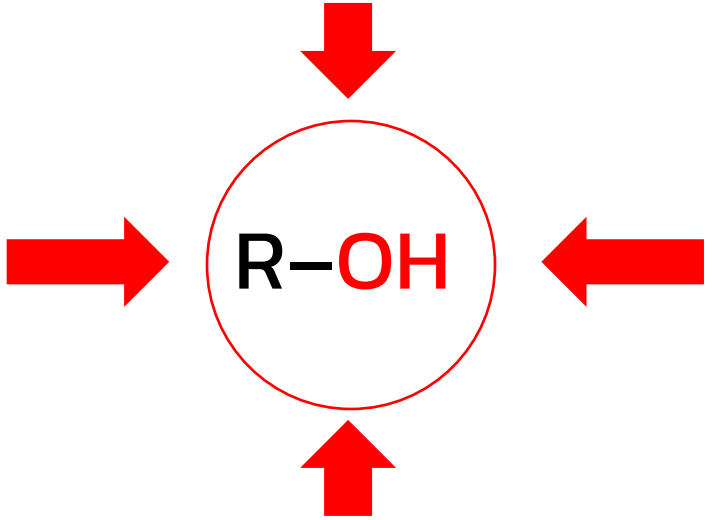
MUSCLE ACHES
IPA can be used as a liniment for muscle aches. It irritates the skin, which improves circulation and eases the ache.

Source : ReAgent Chemical Services Limited / chemicals.co.uk

#ปฏิกิริยาการเตรียมแอลกอฮอล์

Alkane
- Oxidation via acid

Carbonyl compounds
- Hydrogenation
- Reduction-$LiAlH_4$/$NaBH_4$
- Meerwein-Pondroff-Verley reduction
- Grignard Reagent

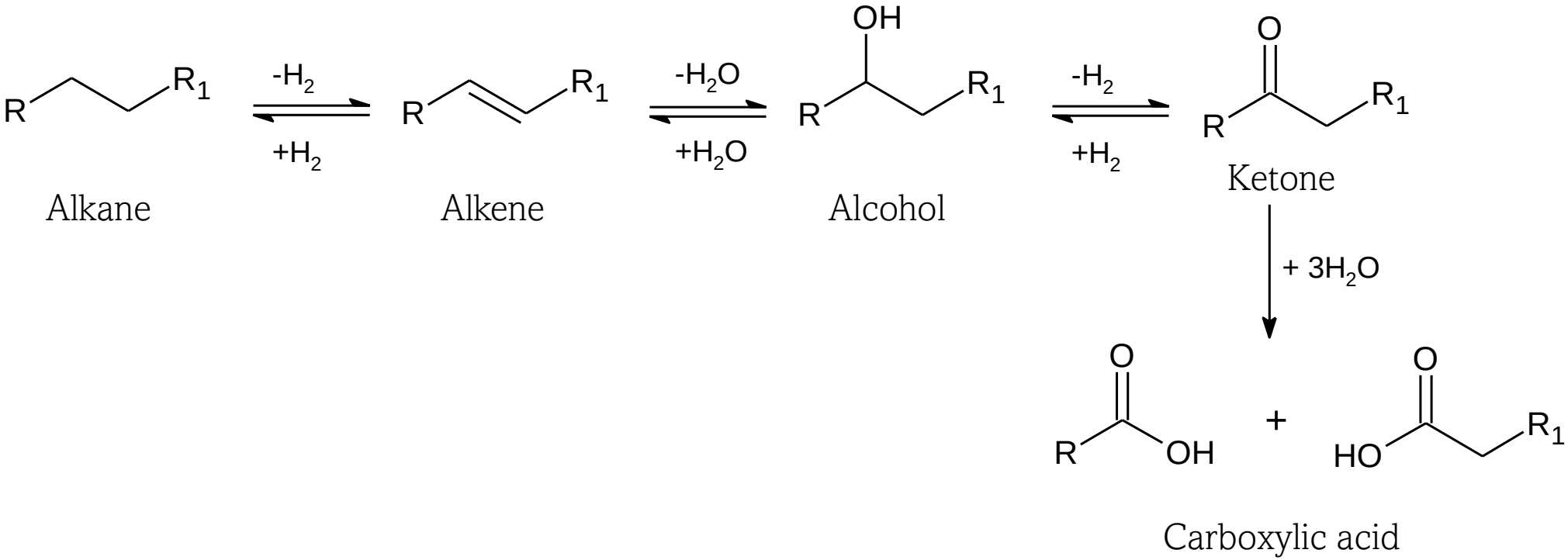


Alkyl halide
- Grignard Reagent

Alkene
- Hydration
- Hydroboration-Oxidation
- Hydroxylation to diols
- Oxymercuration-Demercuration

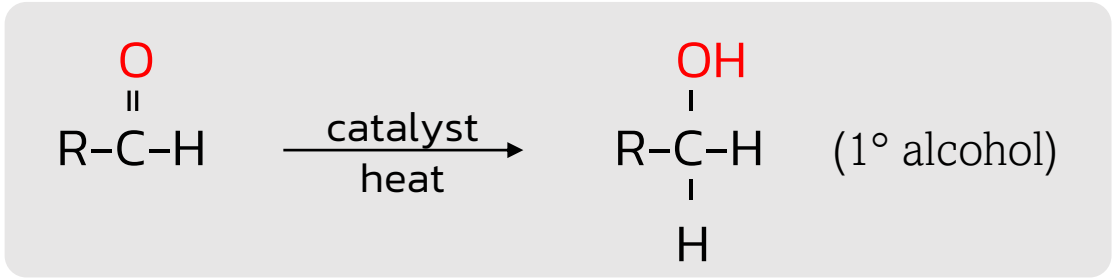
Alkane

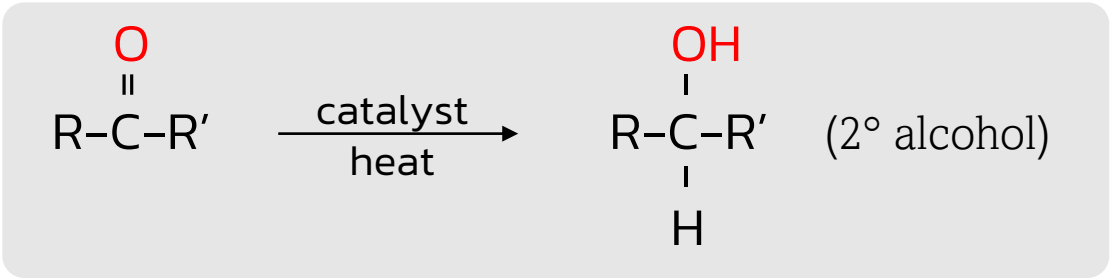
- Oxidation



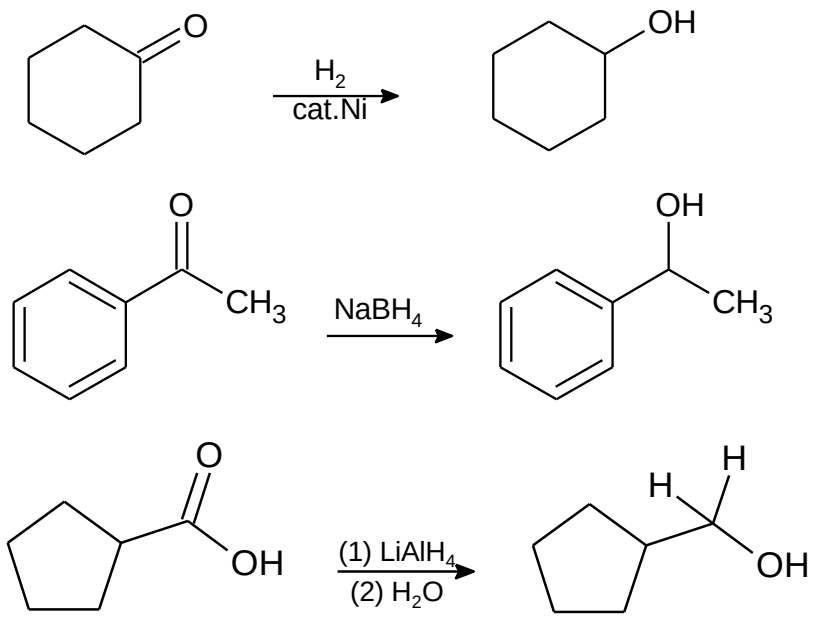
Carbonyl compounds

- Hydrogenation (reduction)
- Reduction–$LiAlH_4$/$NaBH_4$
- Meerwein–Pondroff–Verley reduction



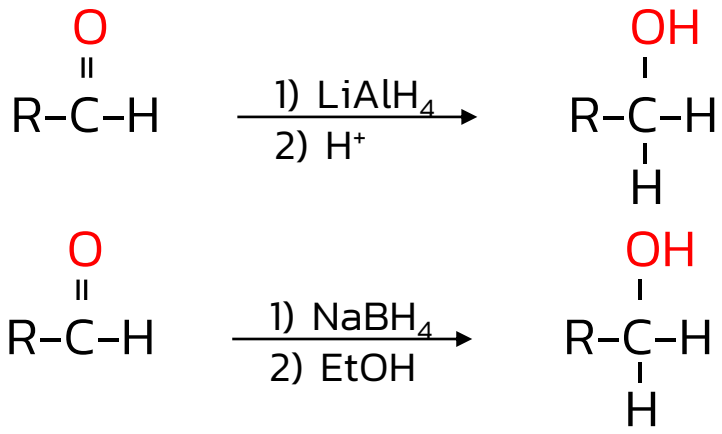


Catalyst :

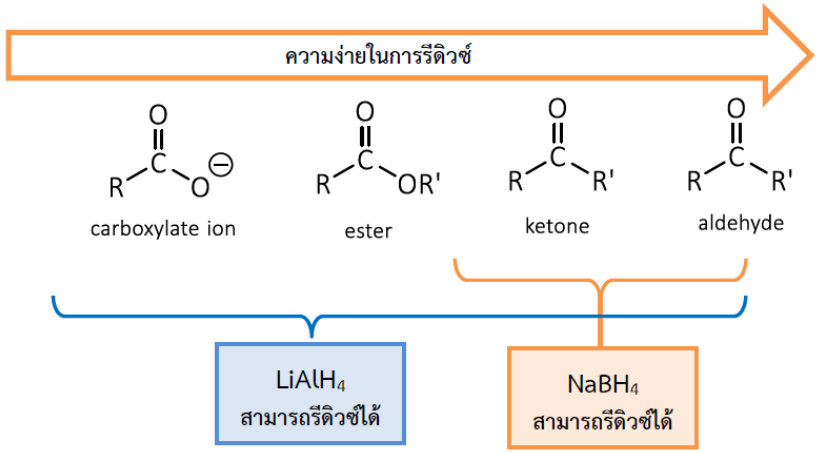


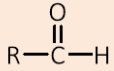
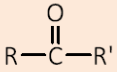
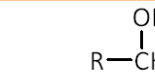
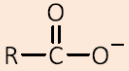
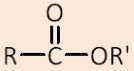
Carbonyl compounds

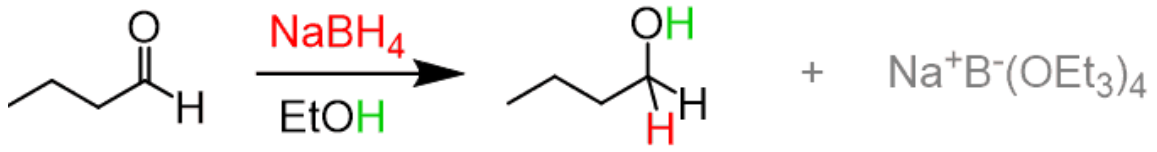
- Hydrogenation
- Reduction–$LiAlH_4$/$NaBH_4$
- Meerwein–Pondroff–Verley reduction

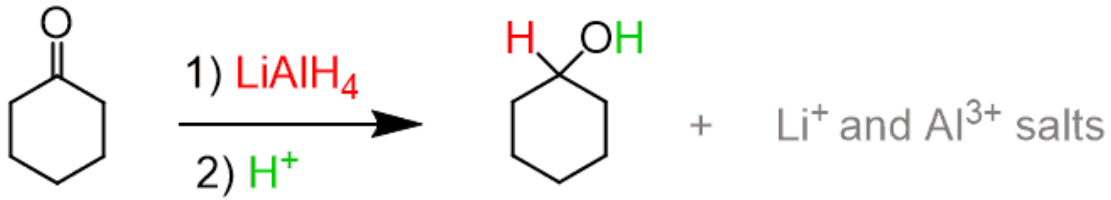


ความแรง $LiAlH_4$ > $NaBH_4$



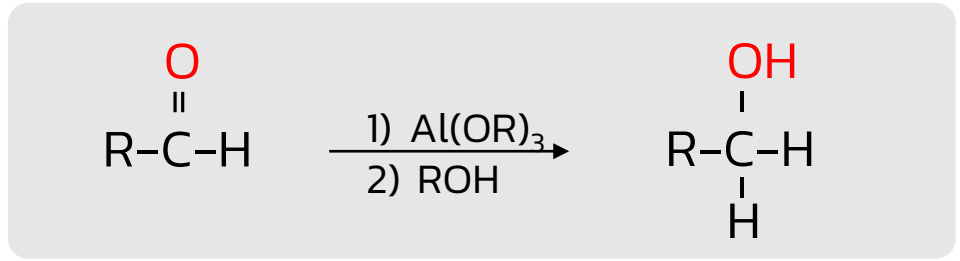
		NaBH₄	*LiAlH₄*
อัลดีไฮด์			
คีโตน			
คาร์บอกซิเลท		ไม่เกิดปฏิกิริยา	
เอสเทอร์		ไม่เกิดปฏิกิริยา	

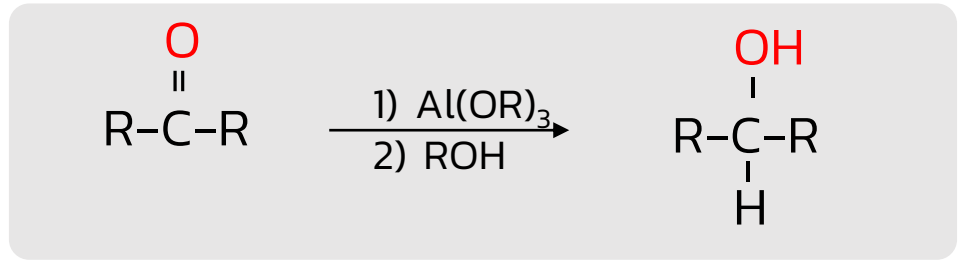




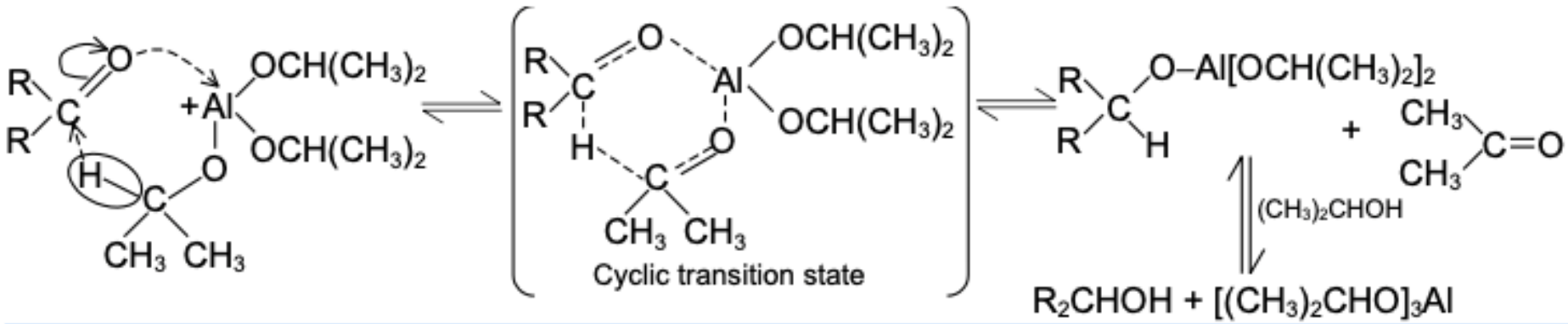
Carbonyl compounds

- Hydrogenation
- Reduction–$LiAlH_4$/$NaBH_4$
- Meerwein–Pondroff–Verley reduction



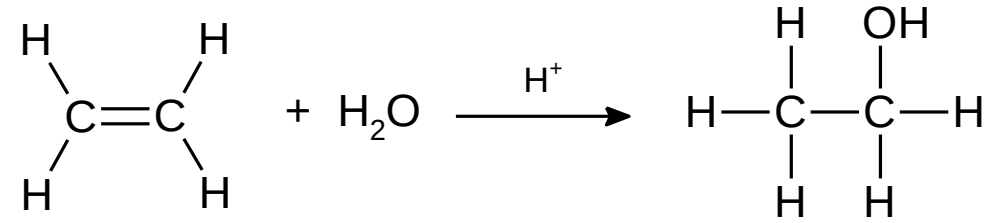


Mechanism:



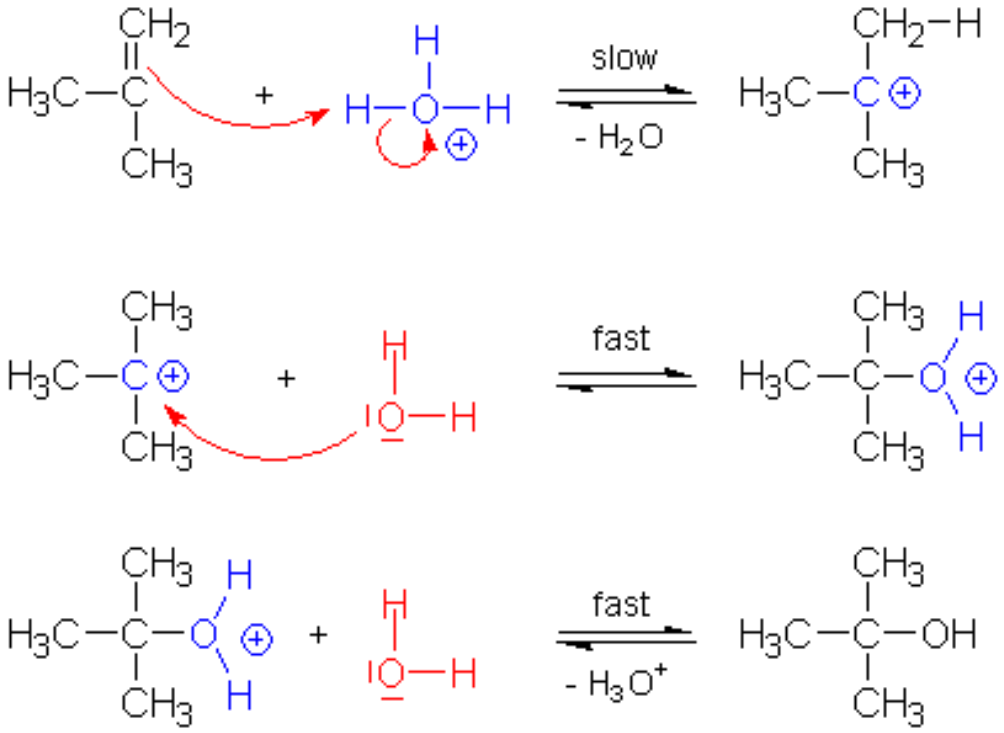
Alkene

- Hydration (Acid-catalyzed hydration)
- Hydroboration-Oxidation
- Hydroxylation to diols
- Oxymercuration-Demercuration



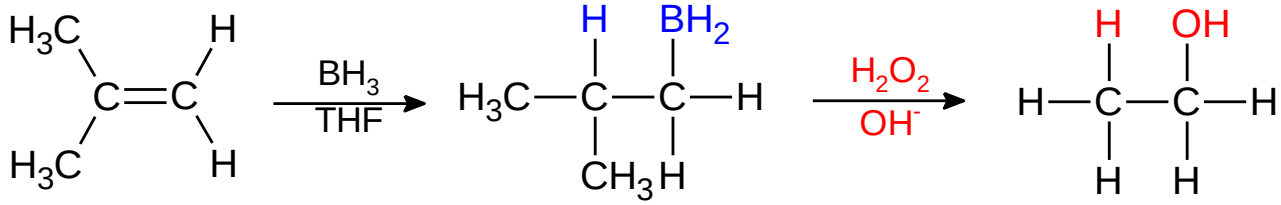
Alcohol
(Markovnikov orientation)

ปฏิกิริยาไฮเดรชัน ของแอลคีนเป็นการเพิ่มไฮโดรเจน (H) และหมู่ไฮดรอกซิล (OH) เข้าไปในพันธะคู่โดยมีกรดเป็นตัวเร่งปฏิกิริยา ได้ผลผลิตเป็นแอลกอฮอล์ ตาม Markovnikov



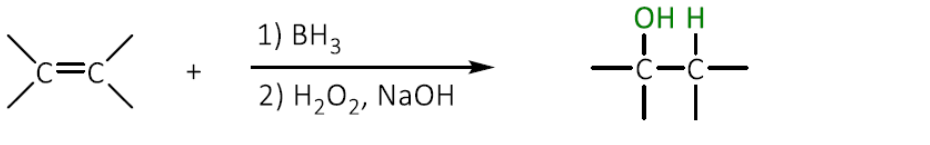
Alkene

- Hydration
- **Hydroboration–Oxidation**
- Hydroxylation to diols
- Oxymercuration–Demercuration



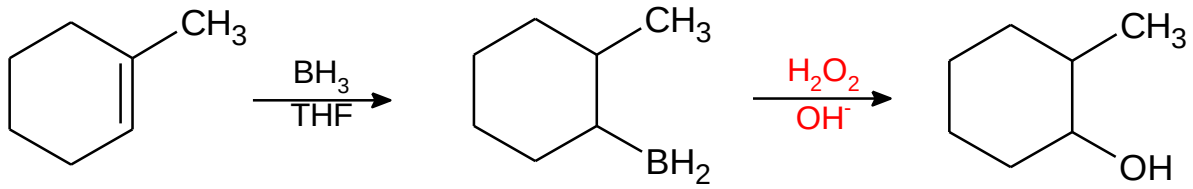
Alcohol
(Anti-Markovnikov orientation)

ปฏิกิริยาไฮโดรโบเรชัน–ออกซิเดชัน ปฏิกิริยาสุทธิเป็นการเติมน้ำเข้าไปที่พันธะไพของแอลคีน ได้ผลผลิตเป็นแอลกอฮอล์แบบ anti–Markovnikov



alkene

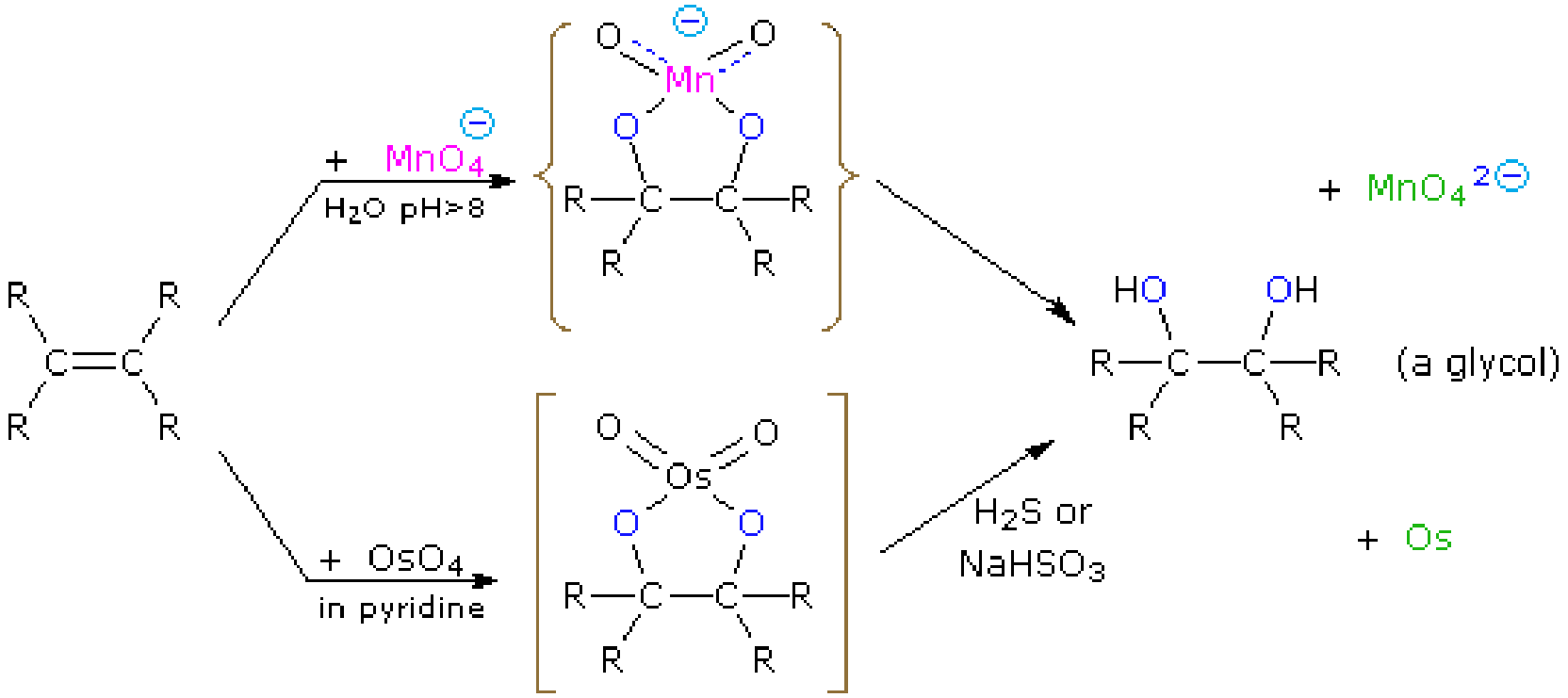
alcohol
(syn addition, anti-Markovnikov orientation)



trans-2-methylcyclohexanol (80%)

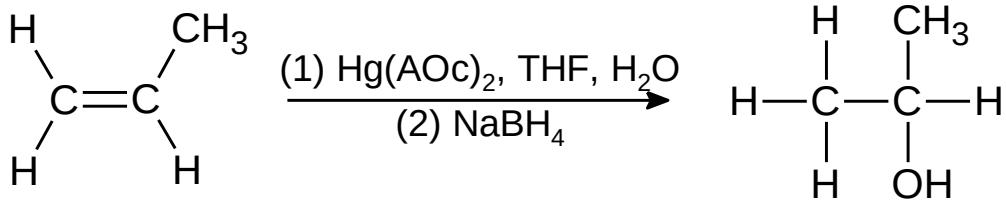
Alkene

- Hydration
- Hydroboration–Oxidation
- Hydroxylation–OsO_4/$NaHSO_3$
- Oxymercuration–Demercuration

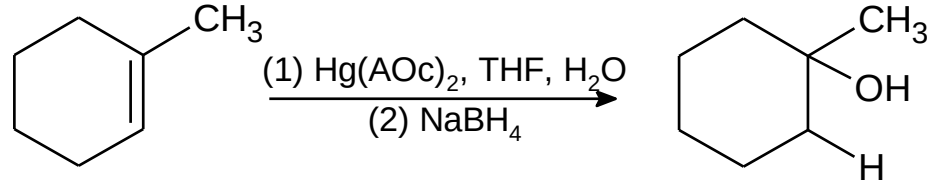


Alkene

- Hydration
- Hydroboration–Oxidation
- Hydroxylation to diols
- Oxymercuration–Reduction

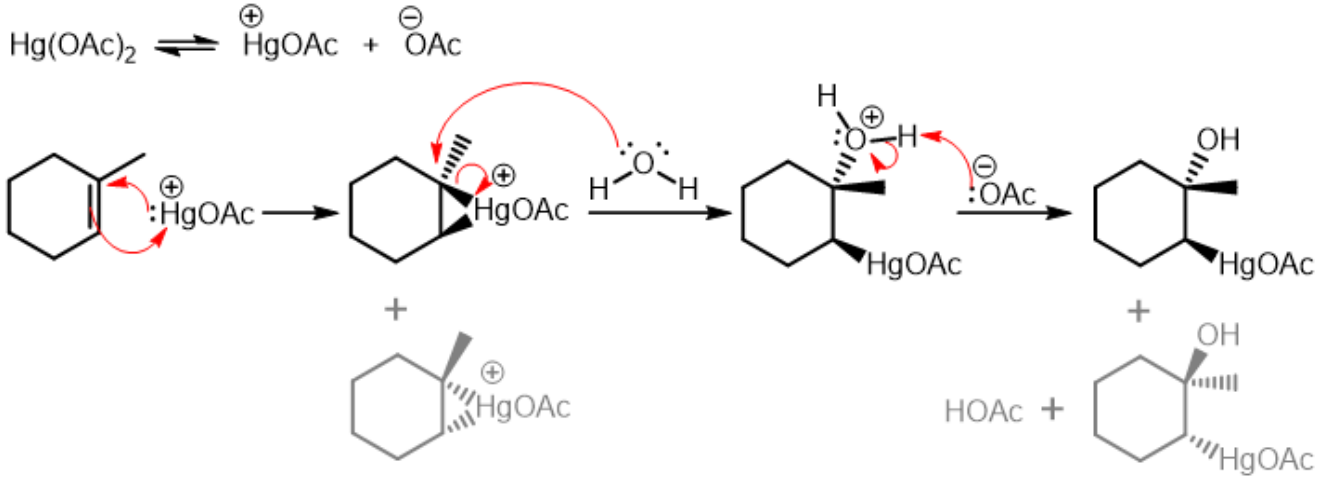


เป็นการเพิ่มไฮโดรเจน (H) และหมู่ไฮดรอกซิล (OH) เข้าไปในพันธะคู่ ที่ทำให้ได้ของผลิตภัณฑ์ที่สูง (Markovnikov hydration)

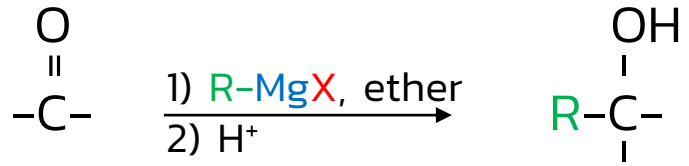


1-methylcyclohexene

1-methylcyclohexanol



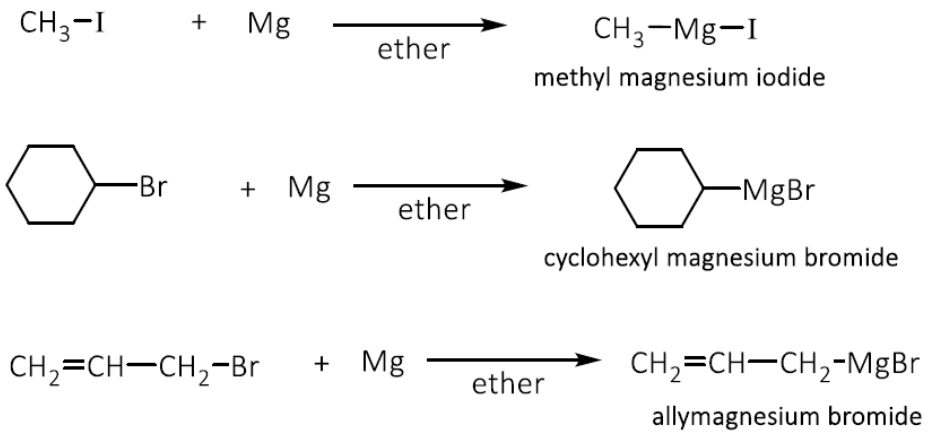
Grignard Reagent



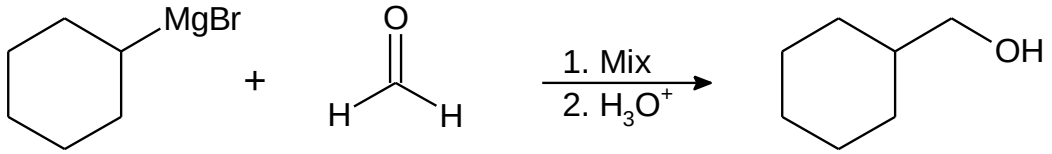
R–X + Mg → R–MgX

Grignard reagent

R = Alkyl, aryl
X = Br, Cl, I

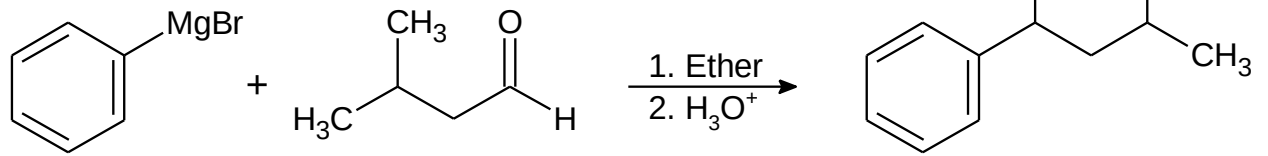


Formaldehyde reaction



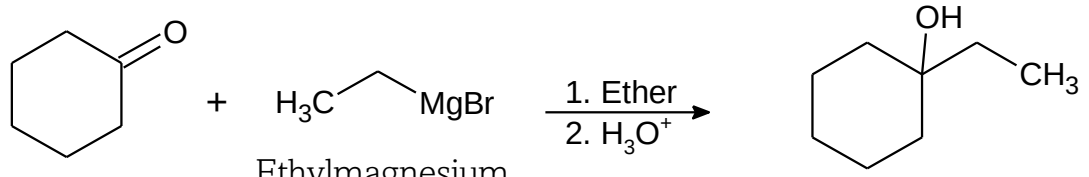
Cyclohexylmagnesium bromide + Formaldehyde → Cyclohexylmethanol (65%)

Aldehyde reaction



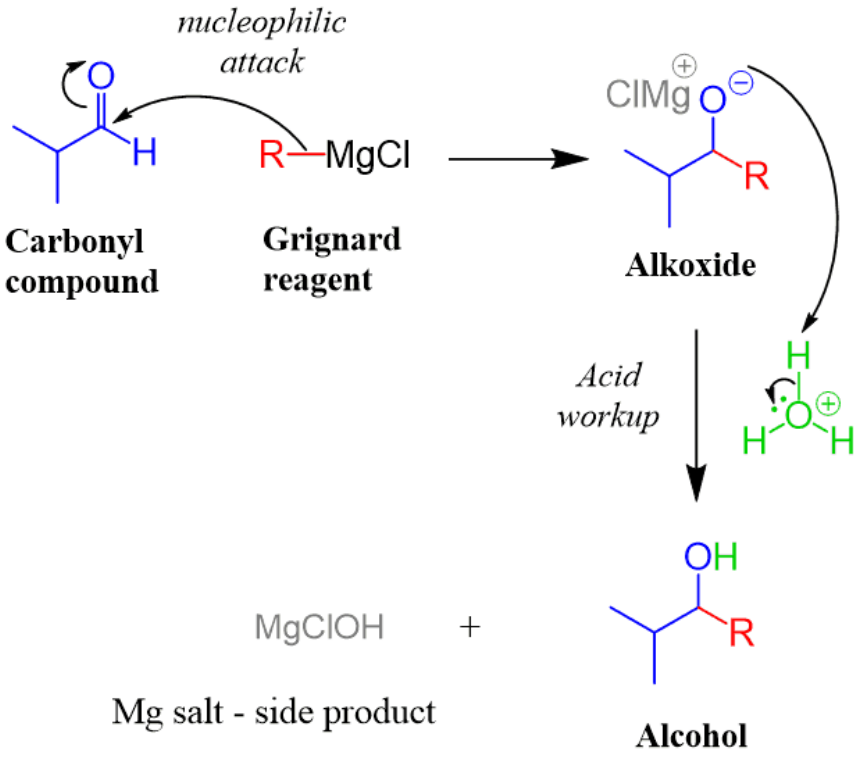
Phenylmagnesium bromide + 3-methylbutanal → 3-methyl-1-phenyl-1-butanol (73%)

Ketone reaction

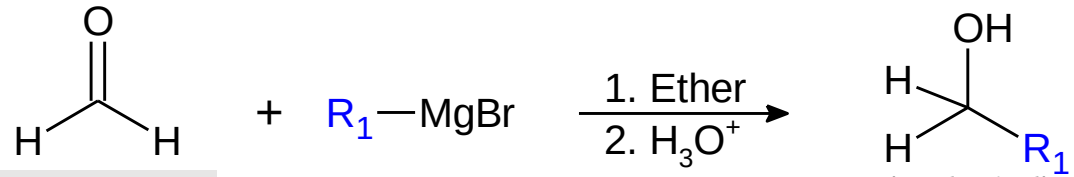


Cyclohexanone + Ethylmagnesium bromide → 1-Ethylcyclohexanol (89%)

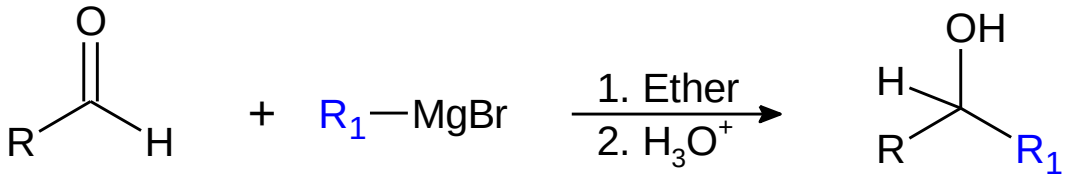
ปฏิกิริยาของกริญญารีเอเจนต์กับสารประกอบแอลดีไฮด์ คีโตน และฟอร์มาดีไฮด์ เมื่อทำปฏิกิริยาแล้วสารผลิตภัณฑ์จะได้สารประกอบแอลกอฮอล์ต่างชนิดกัน



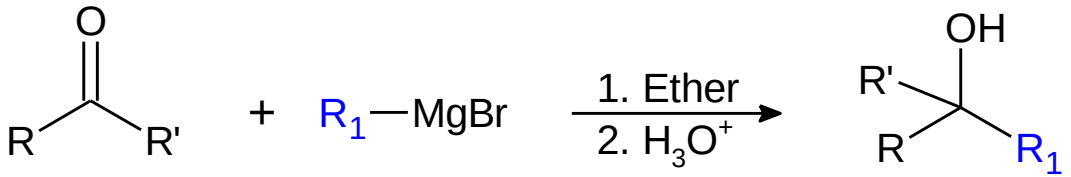
Formaldehyde



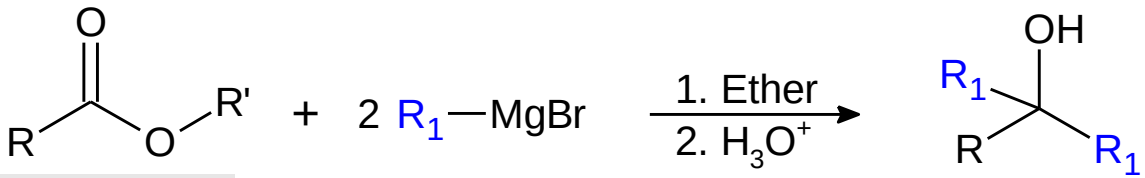
Aldehyde



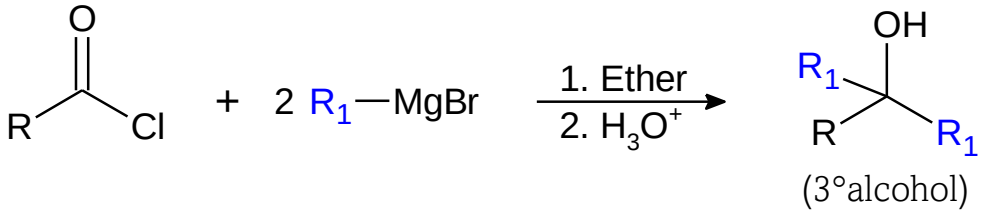
Ketone

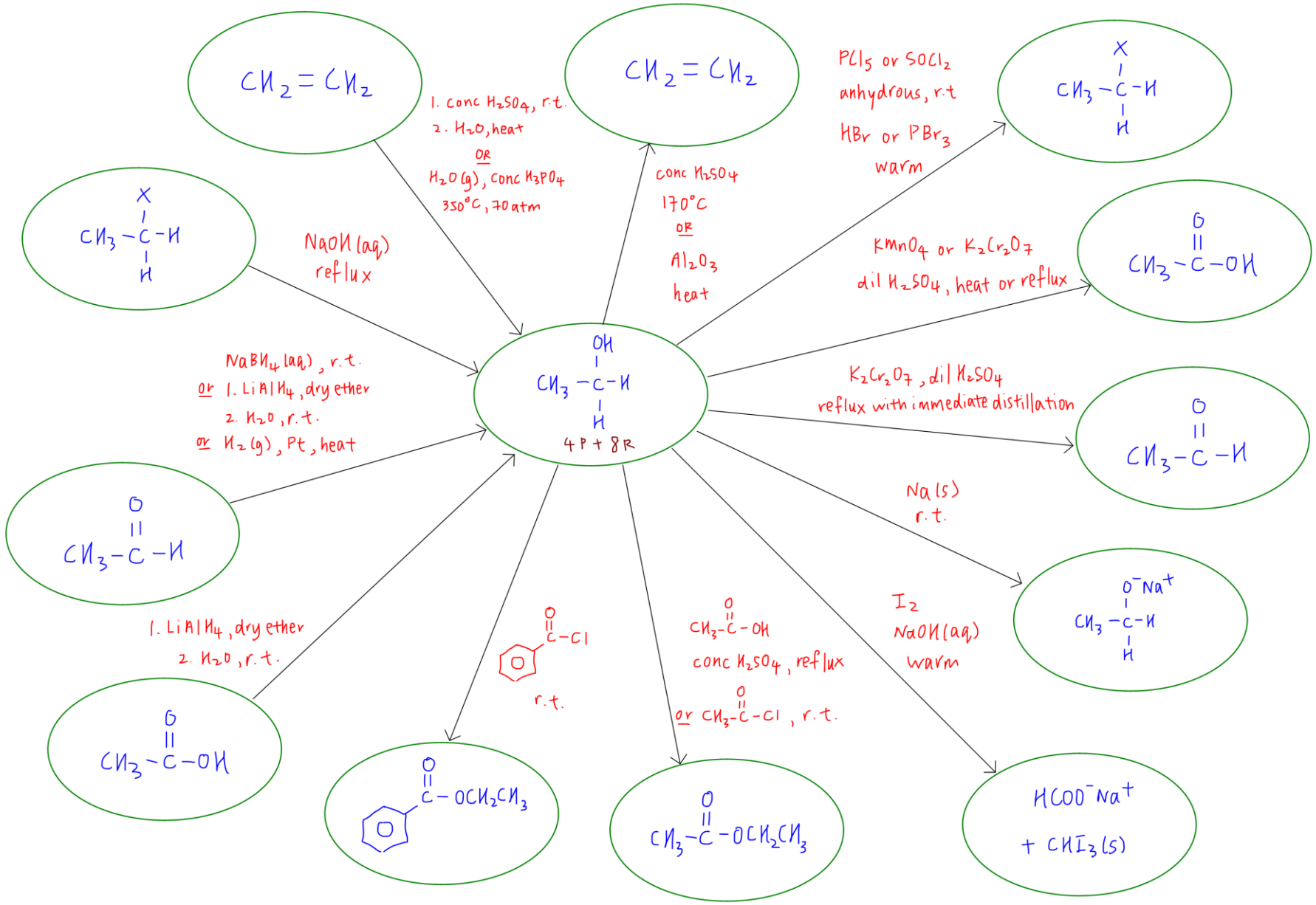


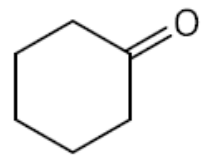
Ester

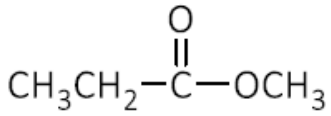


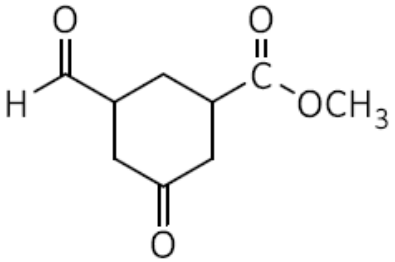
Acyl halide

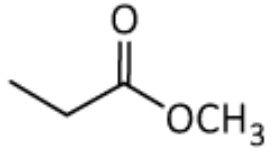


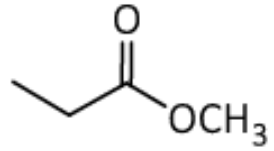

CH2=CH2
1. conc H2SO4, r.t.
2. H2O, heat
OR
H2O(g), conc H3PO4
350°C, 70 atm
CH2=CH2
conc H2SO4
170°C
OR
Al2O3
heat
PCl5 or SOCl2
anhydrous, r.t
HBr or PBr3
warm
CH3-C(X)-H
NaOH(aq)
reflux
KMnO4 or K2Cr2O7
dil H2SO4, heat or reflux
CH3-C(=O)-OH
NaBH4(aq), r.t.
or 1. LiAlH4, dry ether
2. H2O, r.t.
or H2(g), Pt, heat
CH3-C(OH)-H
4P + 8R
K2Cr2O7, dil H2SO4
reflux with immediate distillation
CH3-C(=O)-H
CH3-C(=O)-H
Na(s)
r.t.
1. LiAlH4, dry ether
2. H2O, r.t.
CH3-C(=O)-OH
C6H5-C(=O)-Cl
r.t.
CH3-C(=O)-OH
conc H2SO4, reflux
or CH3-C(=O)-Cl, r.t.
I2
NaOH(aq)
warm
CH3-C(O⁻Na⁺)-H
C6H5-C(=O)-OCH2CH3
CH3-C(=O)-OCH2CH3
HCOO⁻Na⁺
+ CHI3(s)

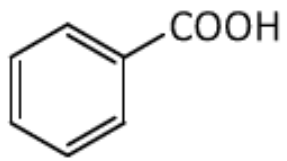
1)  1) $NaBH_4$ 2) H^+/H_2O

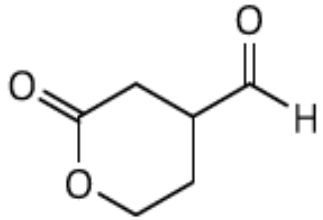
2)  1) $NaBH_4$ 2) H^+/H_2O

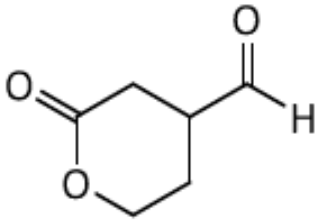
3)  1) $NaBH_4$ 2) H^+/H_2O

4)  1) $LiAlH_4$ 2) H_2O

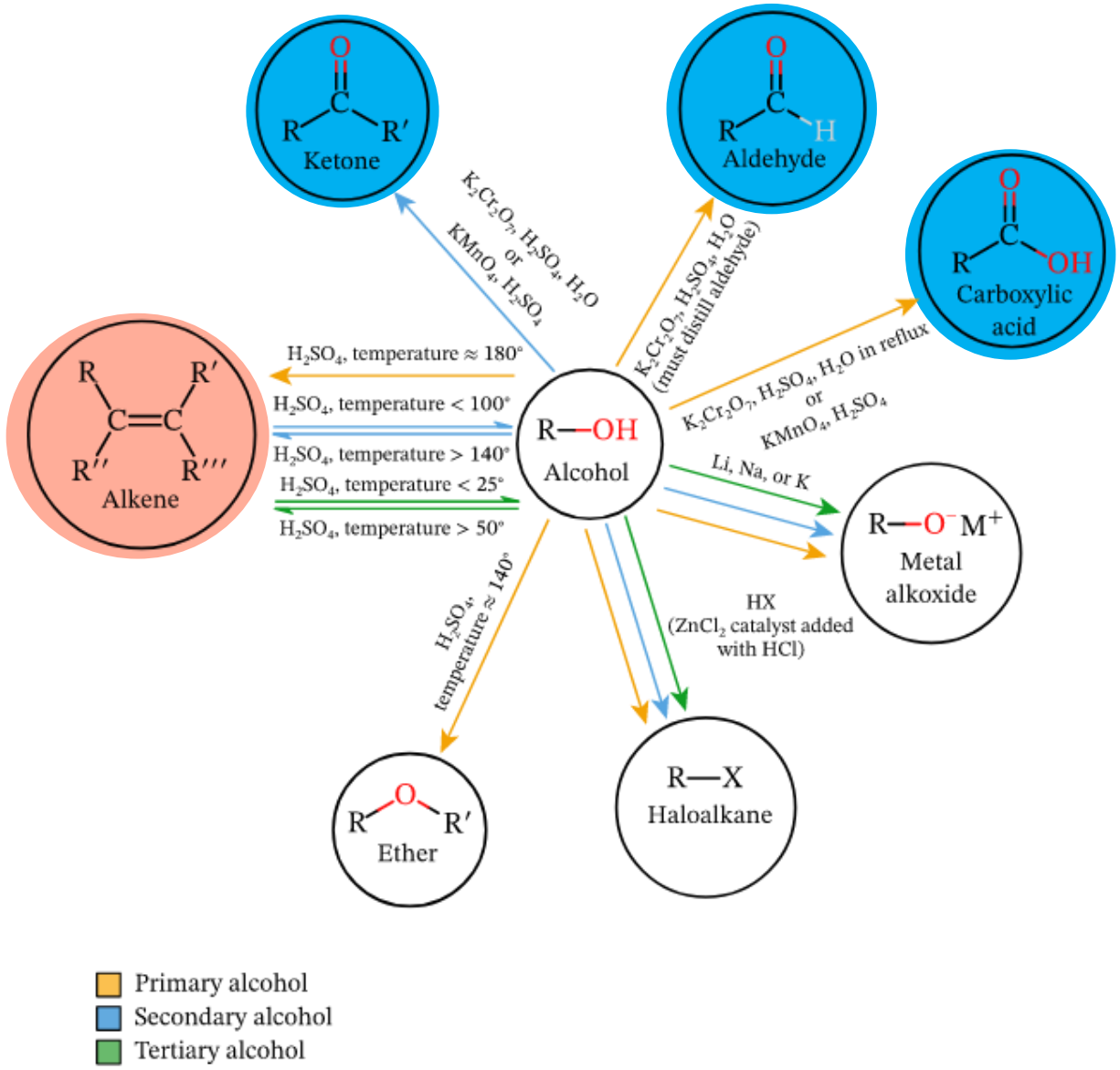
5)  1) $NaBH_4$, EtOH 2) H^+/H_2O

6)  1) $LiAlH_4$ 2) H_2O

7)  1) $NaBH_4$, EtOH 2) H^+/H_2O

8)  1) $LiAlH_4$ 2) H_2O

ปฏิกิริยาของแอลกอฮอล์

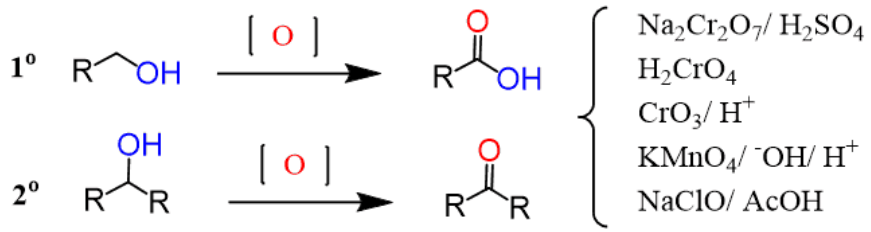


- Oxidation
- Dehydration (reduction)
- Esterification

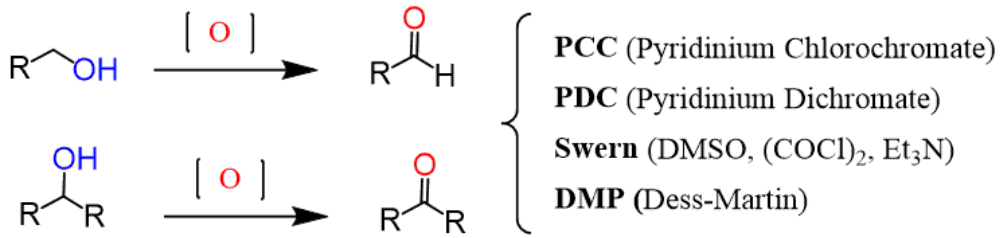
R—OH —*type of reaction*→ Product	
R—OH —dehydration→ alkenes	R—OH —esterification→ R—O—C(=O)—R' (esters)
R—OH —oxidation→ ketones, aldehydes and, carboxylic acids	R—OH —tosylation→ R—OTs (Tosylate ester (good leaving group))
R—OH —substitution→ R—X (halides)	
R—OH —reduction→ R—H (alkanes)	R—OH —1) form alkoxide, 2) R'—X→ R—O—R' (ether)

#Oxidation of alcohols

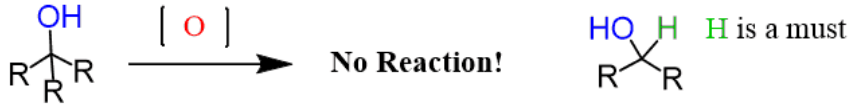
Strong oxidizing agents oxidize **primary alcohol** to **carboxylic acids** and **secondary alcohols** to **ketone**

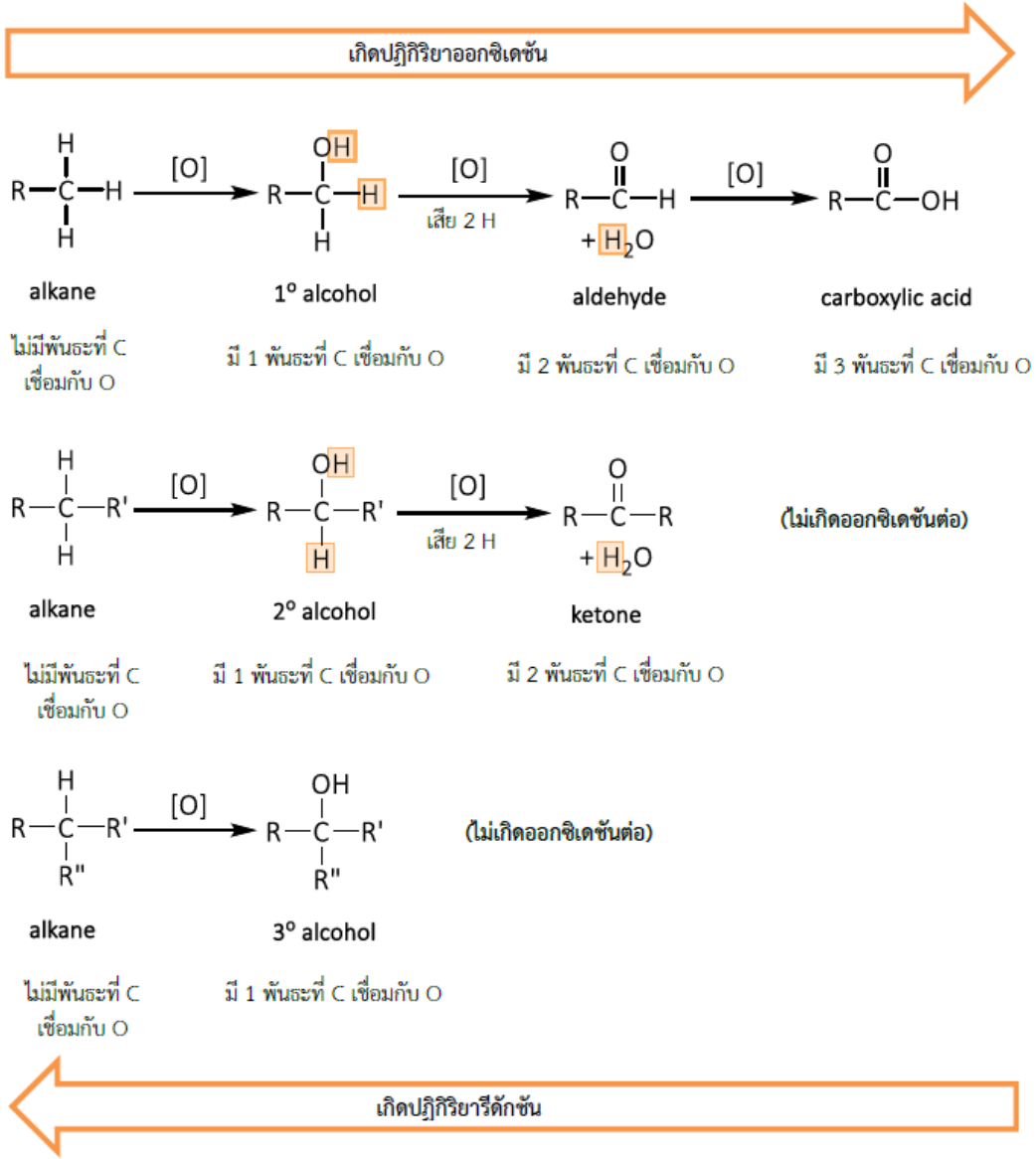


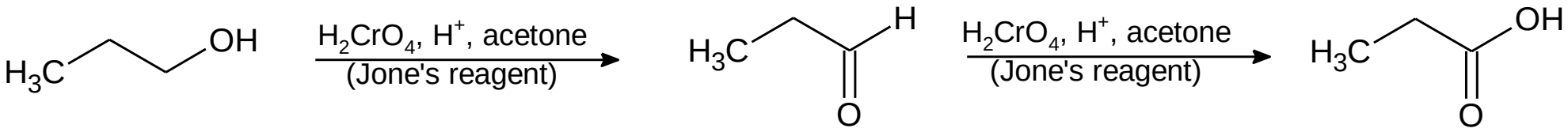
Some oxidizing agents can selectively oxidize primary alcohols to aldehyde

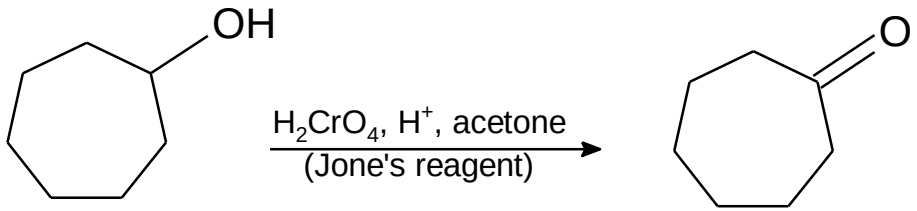


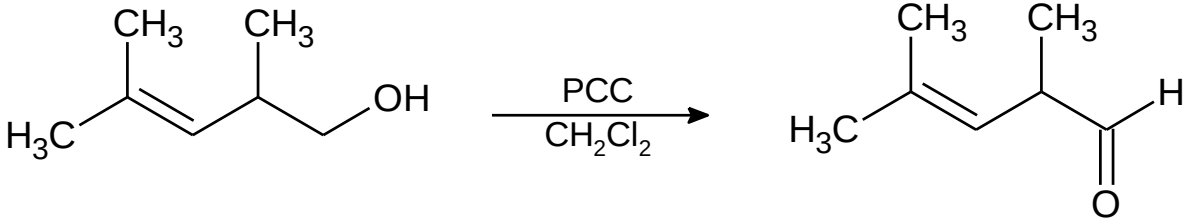
Tertiary alcohols cannot be oxidized! (well, except for burning them to CO_2)

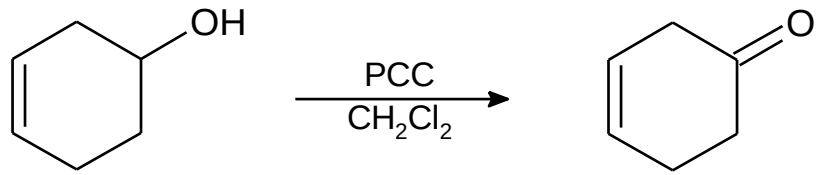




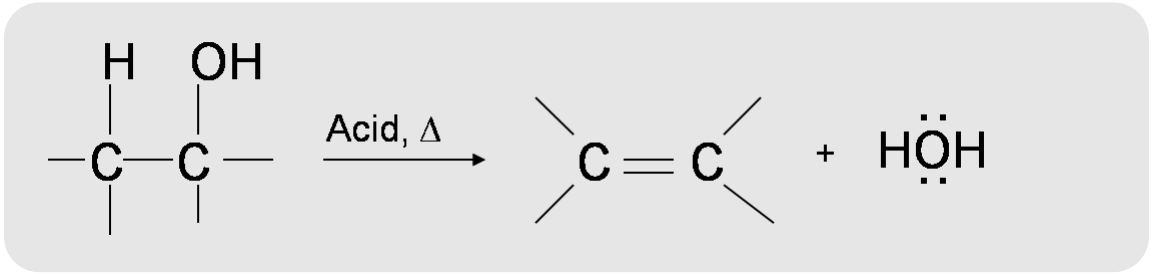

H3C
OH
H2CrO4, H+, acetone
(Jone's reagent)
H3C
H
O
H2CrO4, H+, acetone
(Jone's reagent)
H3C
OH
O


OH
H2CrO4, H+, acetone
(Jone's reagent)
O

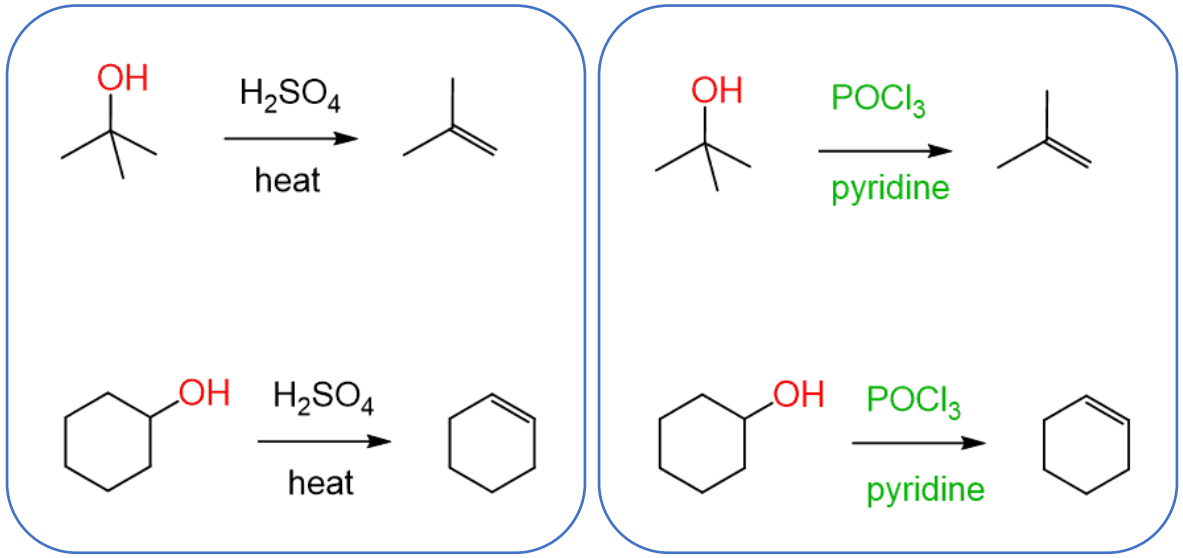

CH3
CH3
H3C
OH
PCC
CH2Cl2
CH3
CH3
H3C
H
O


OH
PCC
CH2Cl2
O

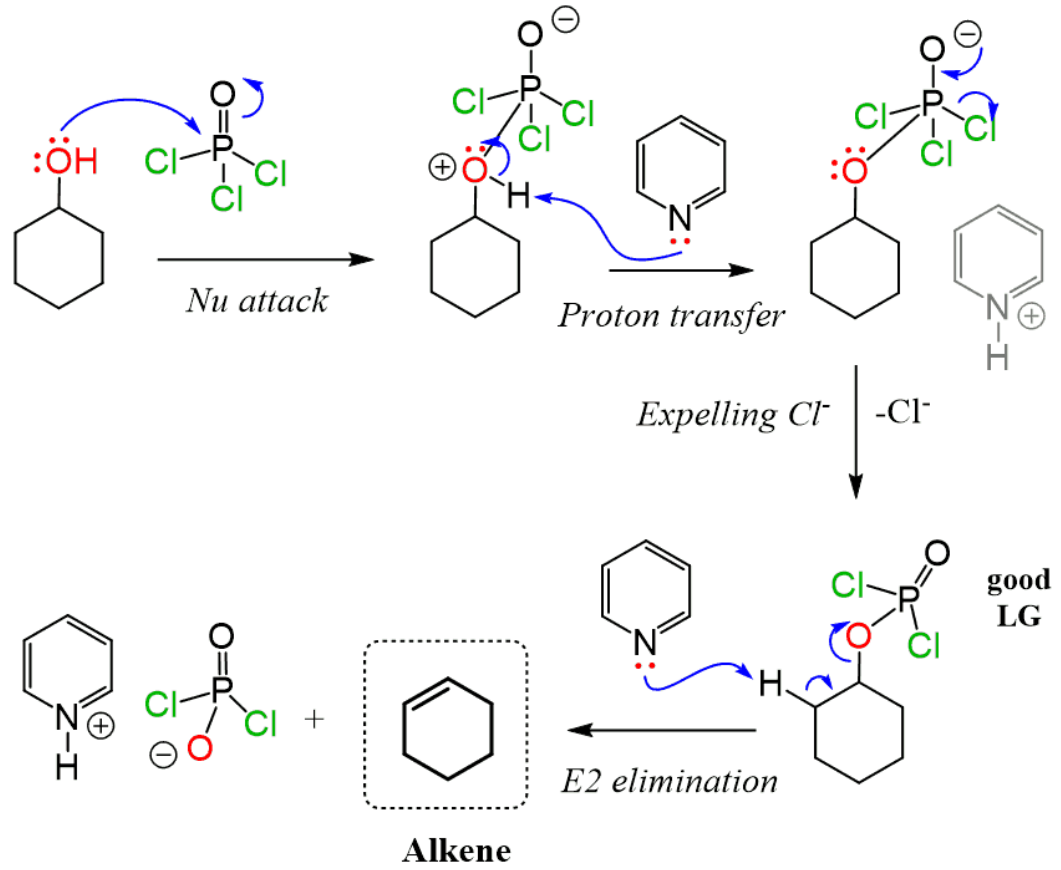
#Dehydration (Reduction of alcohols)



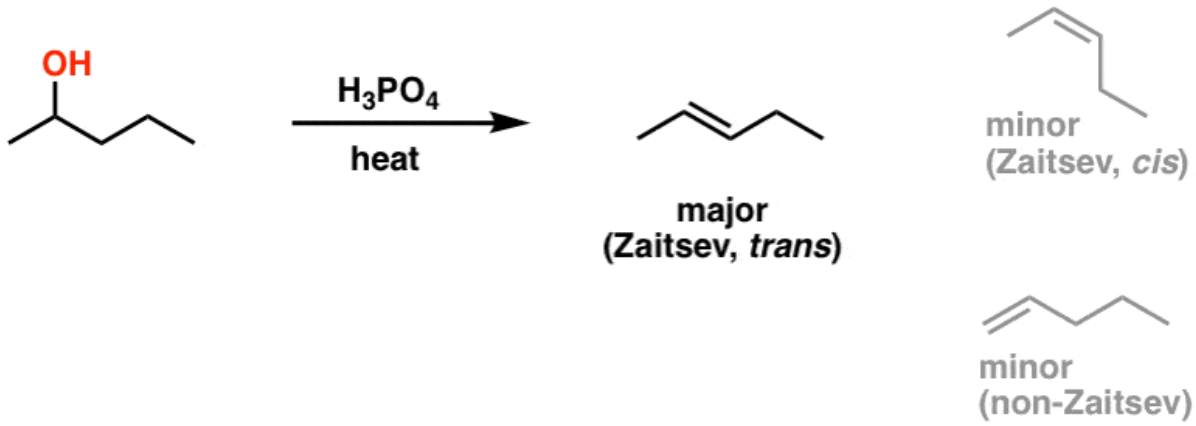
$POCl_3$ is a good alternative for the dehydration of alcohols



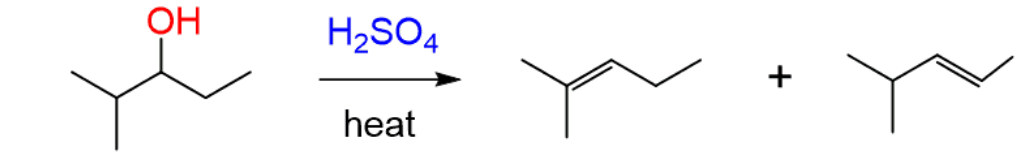
Mechanism of alcohol dehydration using $POCl_3$ with pyridine



#Zaitsev's rule

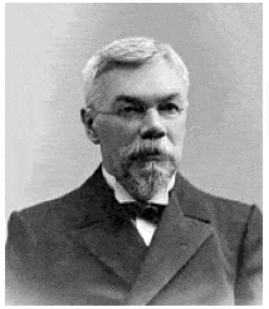


Dehydration is a Regioselective Reaction and it Follows the Zaitsev rule



2-methylpentan-3-ol — 2-methylpent-2-ene (**major**, **Zaitsev's**) + **minor**

Zaitsev's Rule



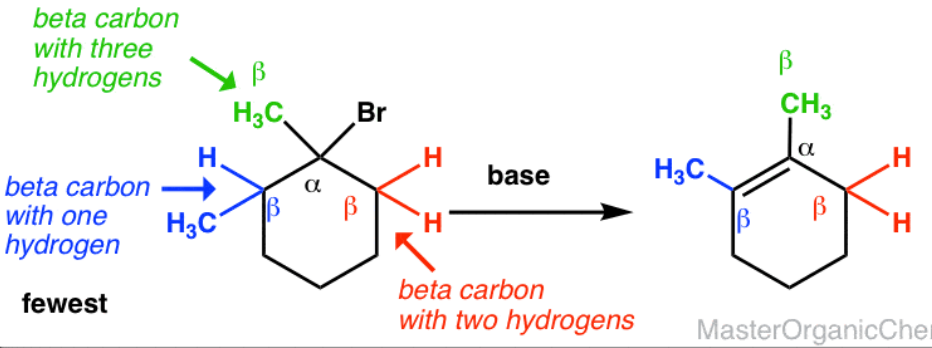
"The alkene formed in greatest amount is the one that corresponds to removal of the hydrogen from the β-carbon having the fewest hydrogen substituents"

Alexander M. Zaitsev, 1875

alpha (α) **carbon**: the carbon attached to the leaving group

beta (β) **carbon**: the carbon **adjacent** to the carbon attached to the leaving group

In this case the **blue** β carbon has the fewest hydrogens, and therefore the alkene formed from this alkyl halide in an elimination reaction would be **this:**



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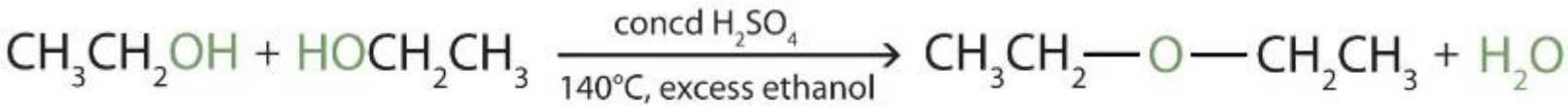
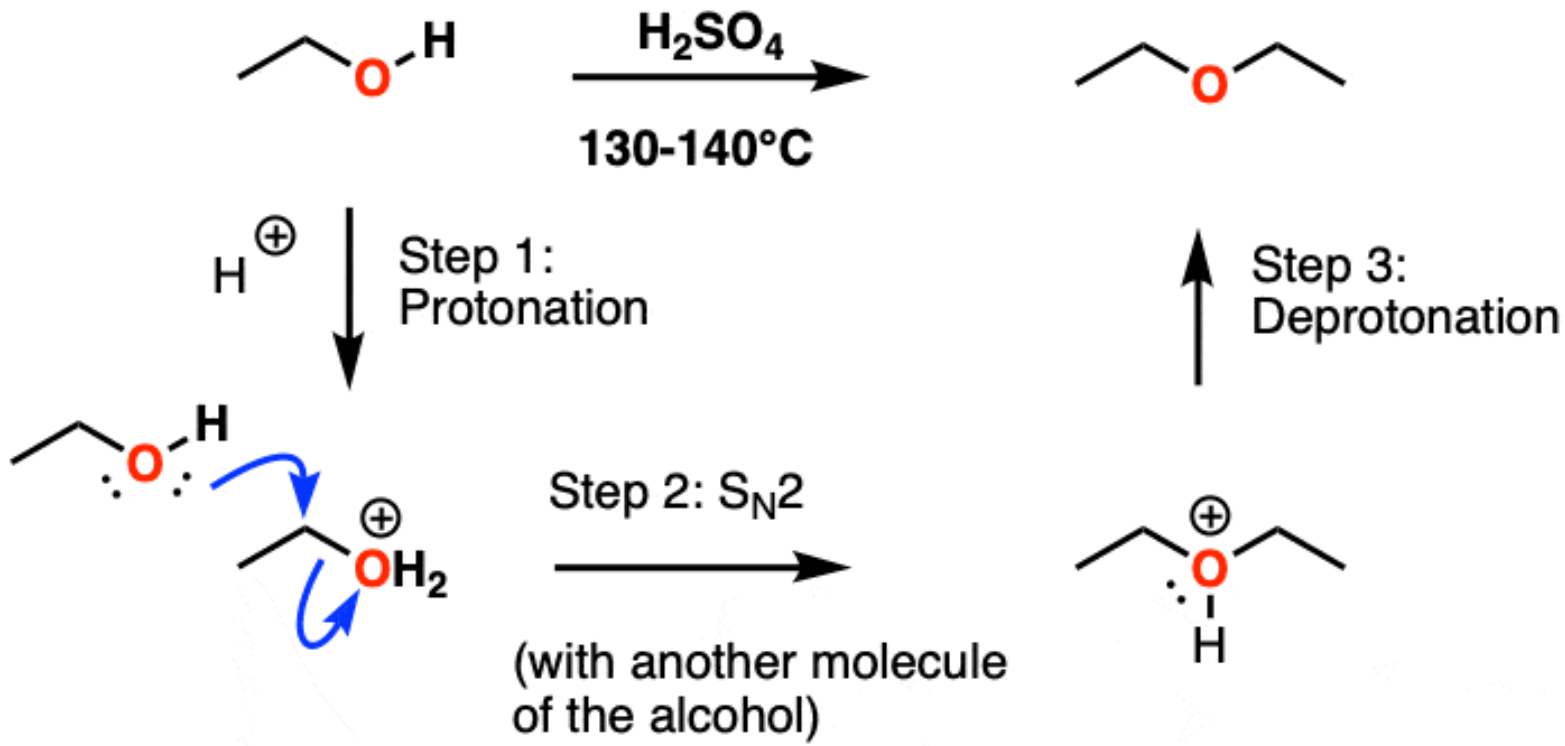
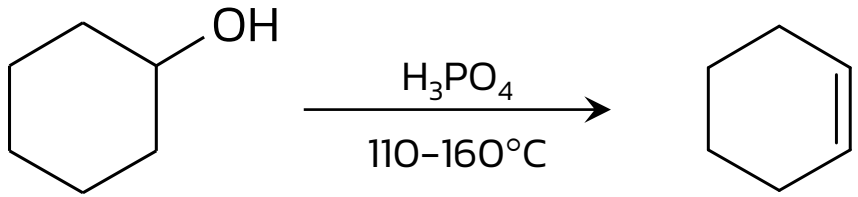
#Dehydration of alcohols to ether

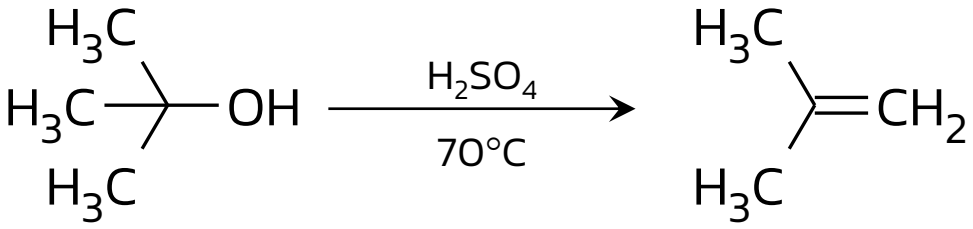


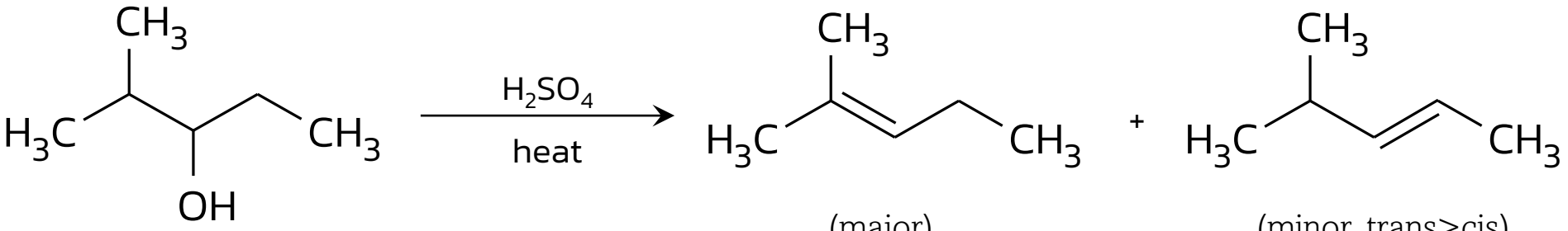
Two molecules of ethanol

Diethyl ether



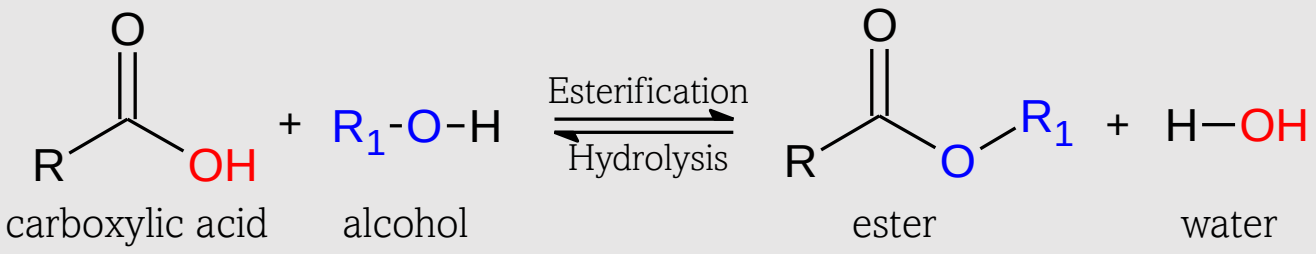


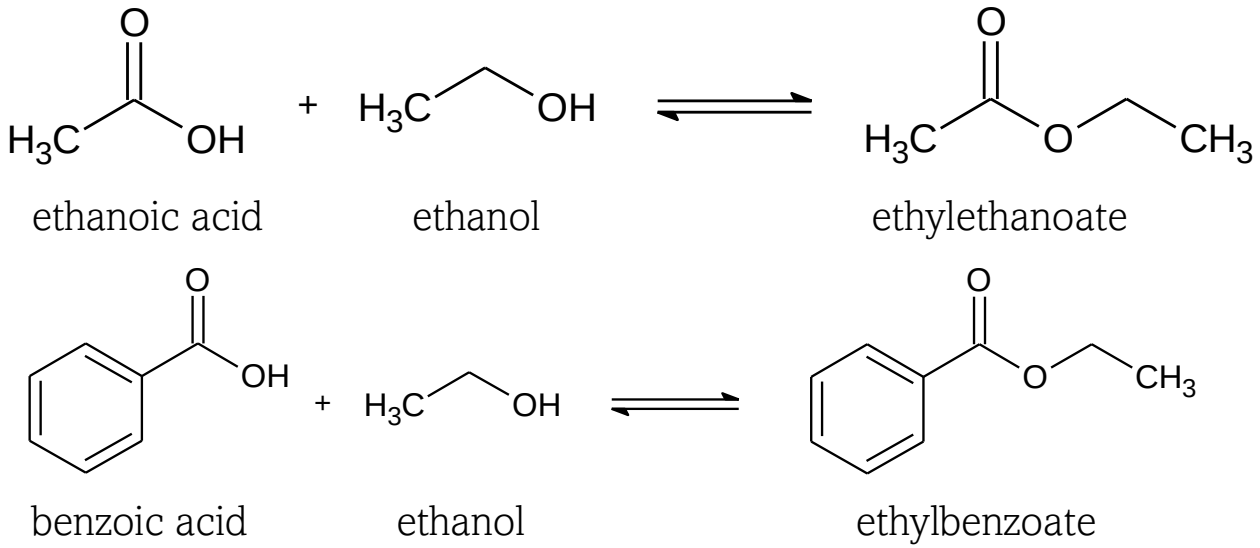




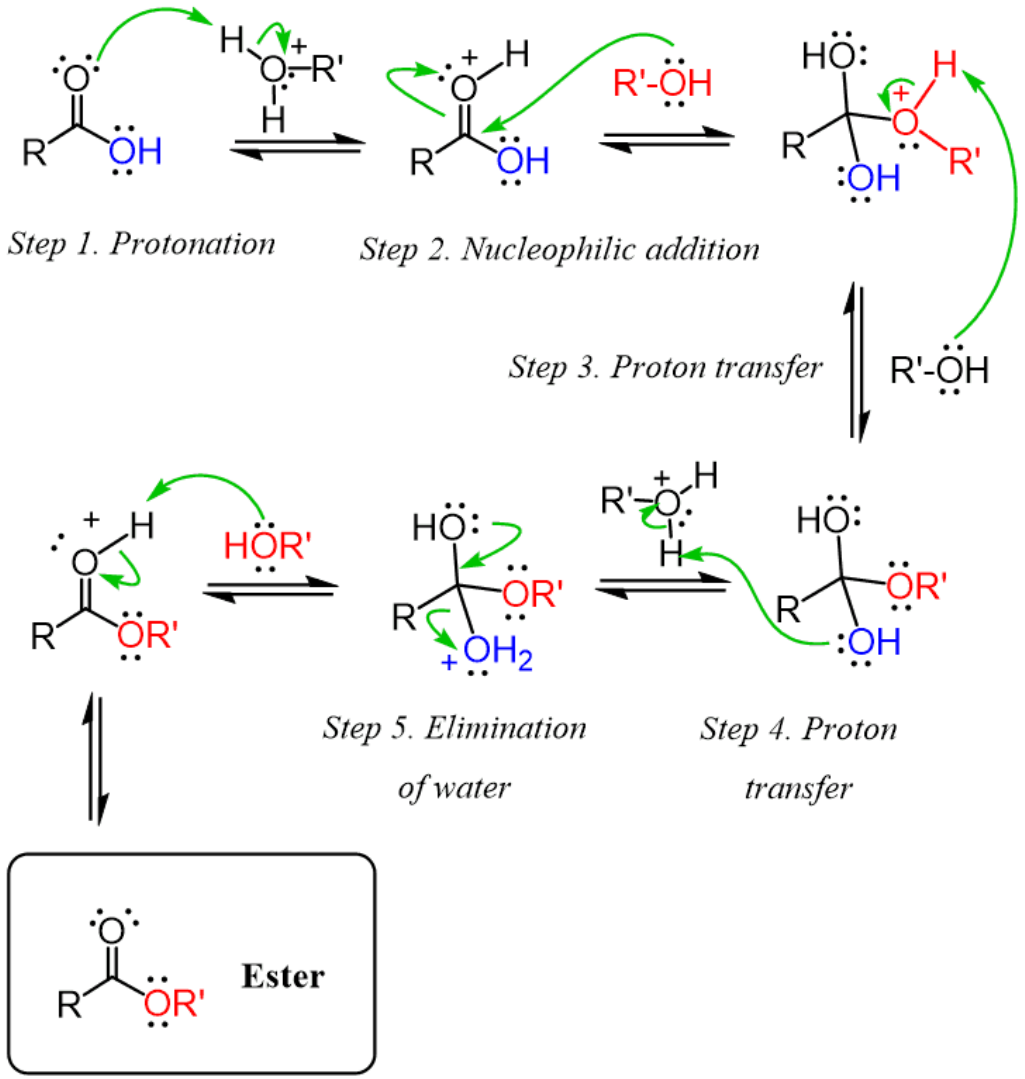
(major) (minor, trans>cis)

#Esterification (เอสเทอริฟิเคชัน)

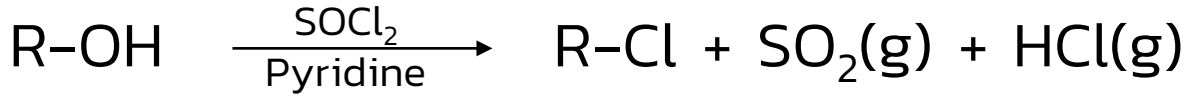


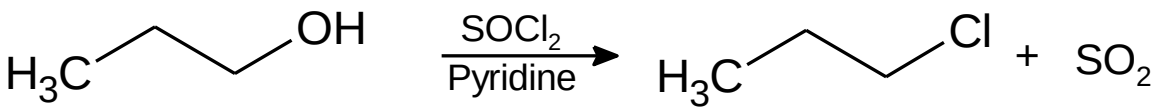


Fischer esterification mechanism

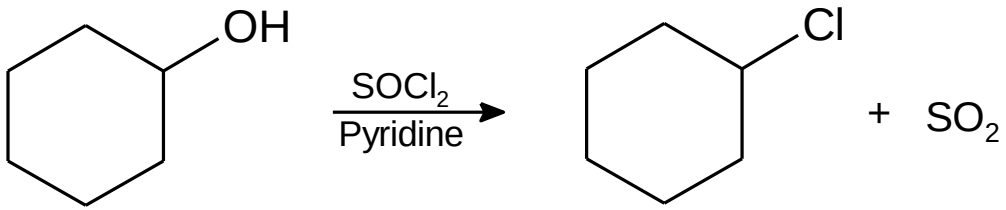


#Conversion to chloride

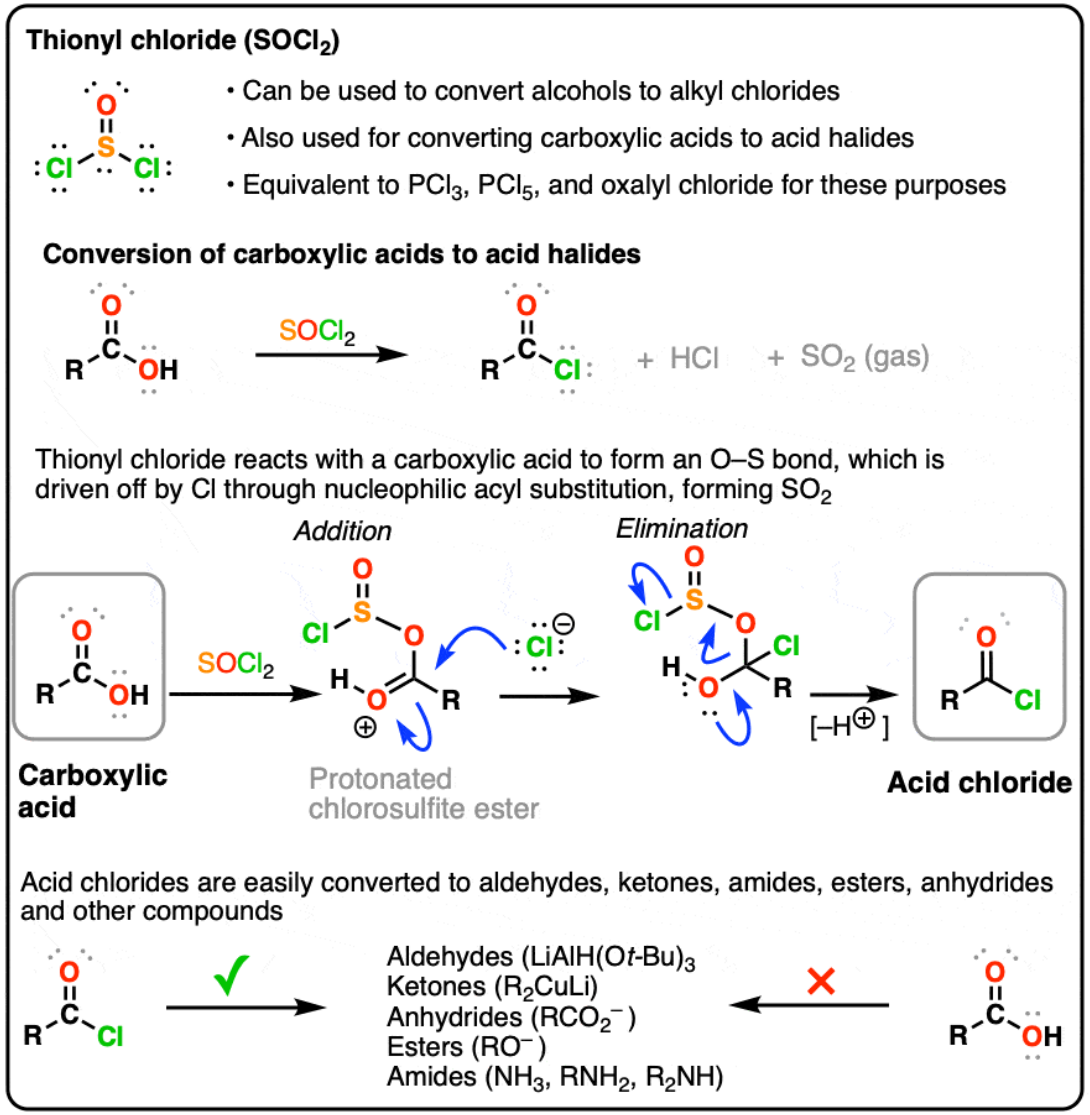




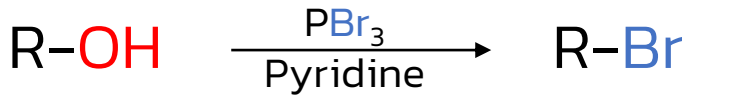
1°alcohol

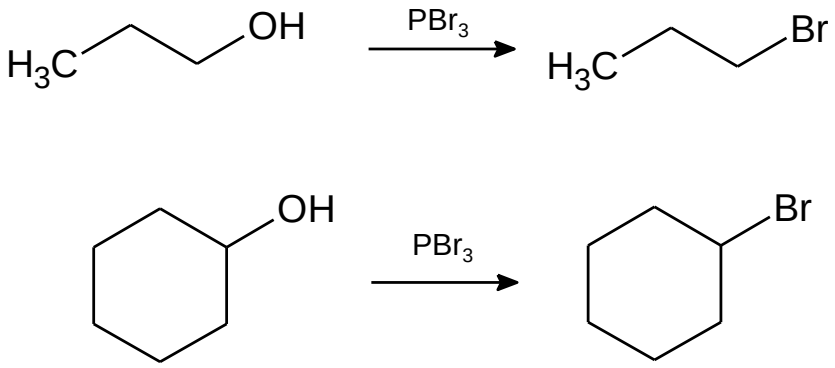


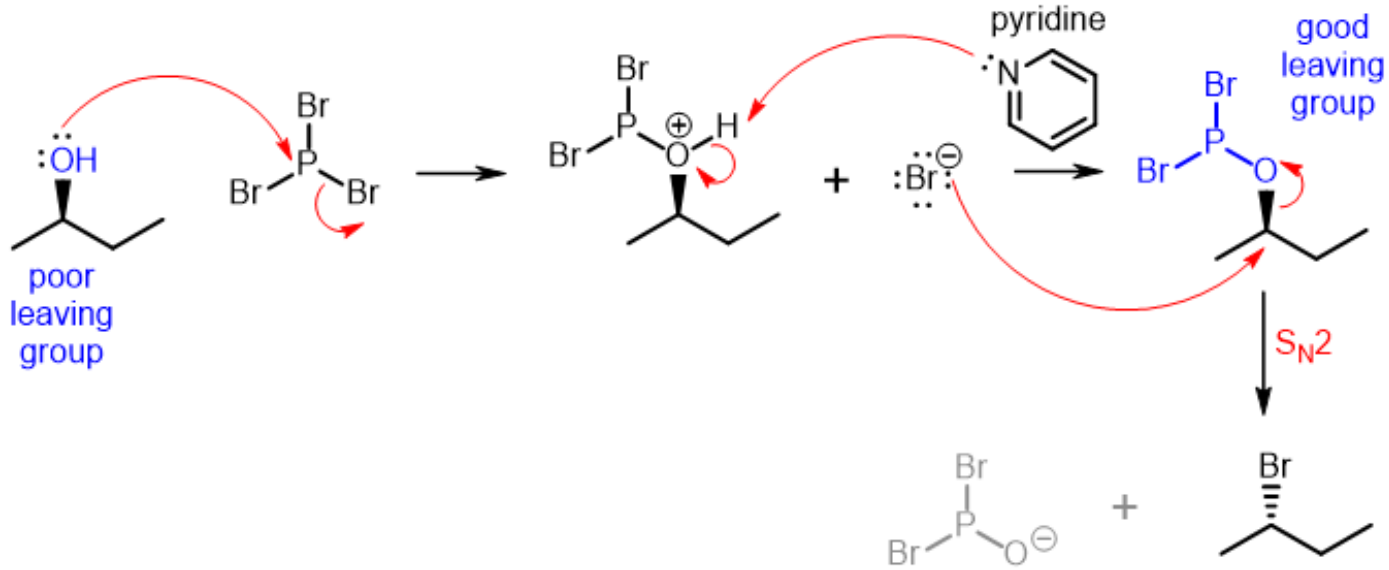
2°alcohol

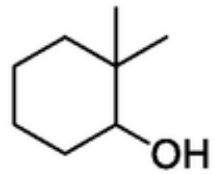


#Conversion to Bromide

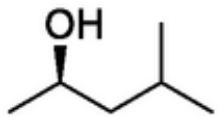




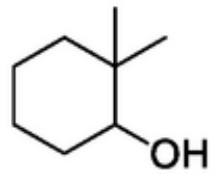


a. 

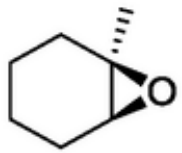
H_2SO_4

b. 

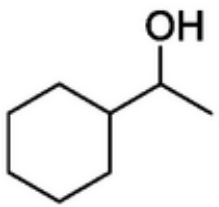
$SOCl_2$
pyridine

c. 

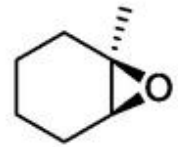
$POCl_3$
pyridine

d. 

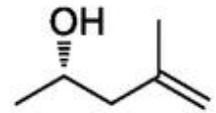
HBr

e. 

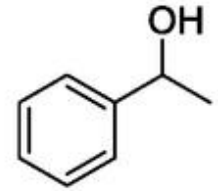
H_2SO_4

f. 

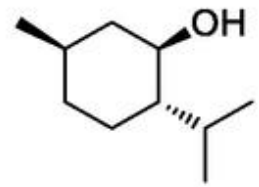
1) KCN
2) dil. H_3O^+

g. 

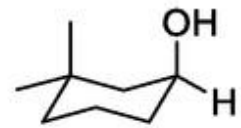
$SOCl_2$
pyridine

h. 

H_3PO_4

i. 

$POCl_3$
pyridine

j. 

PBr_3

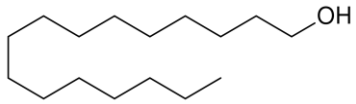
k.

1) $KOCH_3$
2) dil. H_3O^+

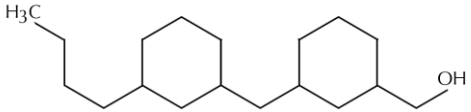
Why is alcohol used in cosmetic products?

- ตัวทำละลาย (dissolve active agents and other ingredients of the cosmetic)
- สารลดแรงตึงผิว (emulsifiers)
- ช่วยให้ผิวนุ่มและชุ่มชื้น (Emollients to moisturize and soften the skin, soothe irritation)
- น้ำหอม (Fragrances to give cosmetics a desirable scent)
- สารกันเสีย (to extend the durability of the cosmetic, inhibit the growth of microorganisms)

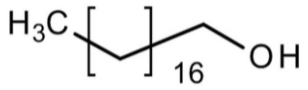
Good alcohols on the ingredient of any cosmetic product



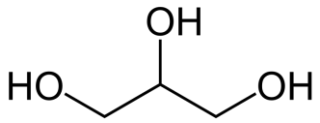
- Cetyl alcohol > emulsifier



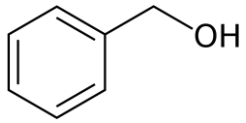
- Cetearyl alcohol > emulsifier and emollient (softens and smooth the skin)



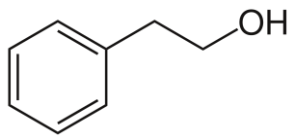
- Stearyl alcohol > emulsifier and emollient (moisturize and soften the skin)



- Glycerin moisturizes



- Benzyl alcohol > a fragrance and preservative function

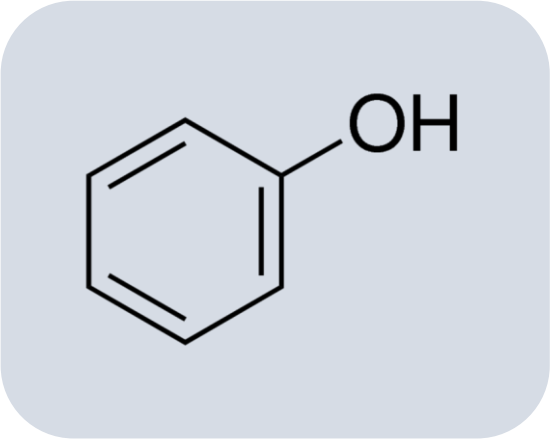


- Phenethyl alcohol > a fragrance or preservative.
- Cinnamyl alcohol, Menthol, Amycinnamyl alcohol, Anise alcohol are fragrances.

Bad alcohols on the ingredient of any cosmetic product

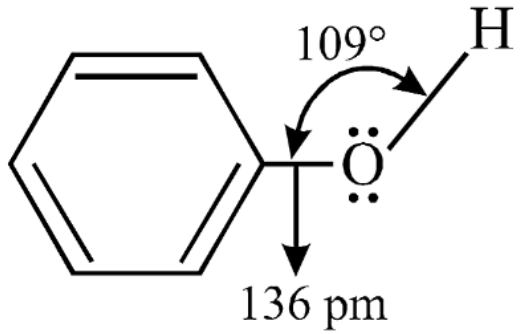
- **Ethanol** (Ethyl alcohol) is used mainly as a solvent in cosmetics. It dehydrates the skin and disturbs its microflora. It is often used in acne-prone skincare products due to its drying and antibacterial properties.
- **Alcohol Denat** is an intentionally denatured ethyl alcohol. In addition to the drying and irritating effect, it also has skin sensitizing properties. It's very harsh for the skin!
- **Isopropyl Alcohol (IPA)** is used as a solvent, preservative and anti-foaming agent. It is irritating and highly allergenic to the skin!

ฟีนอล (Phenol)

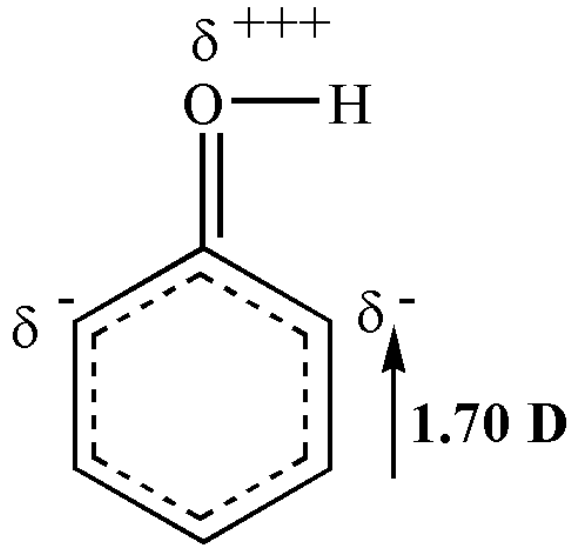


สารประกอบอินทรีย์ที่มีหมู่ไฮดรอกซิล (–OH) หนึ่งหมู่หรือมากกว่าหนึ่งหมู่ แทนที่อะตอมไฮโดรเจนของวงเบนซีน

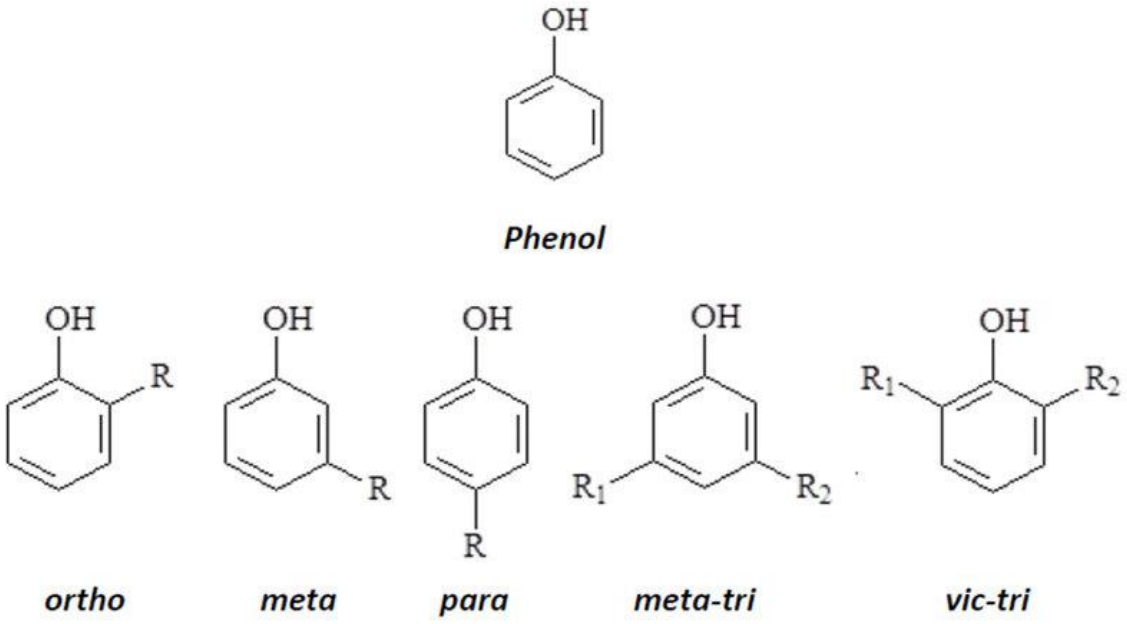
สูตรทั่วไป Ar–OH



- phenols are polar and can hydrogen bond
- phenols are water insoluble
- phenols are stronger acids than water and will dissolve in 5% NaOH
- phenols are weaker acids than carbonic acid and do not dissolve in 5% $NaHCO_3$



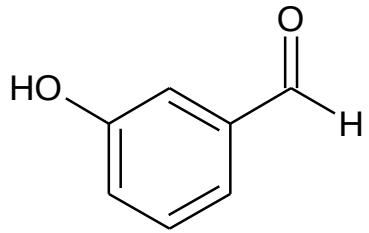
Phenols are usually named as substituted phenols. The methylphenols are given the special name, cresols. Some other phenols are named as hydroxy compounds.



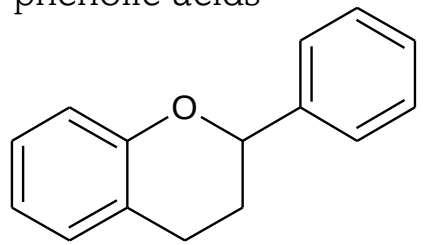
Monohydric Phenol	Monohydric phenols Common Name: Phenol; o -cresol; m-cresol; p-cresol IUPAC Name: Phenol; 2-methyl phenol; 3-methyl phenol; 4-methyl phenol
Dihydric Phenol	Dihydric phenols Common Name: Catechol; Resorcinol; Quinol IUPAC Name: 1,2-dihydroxybenzene; 1,3-dihydroxybenzene; 1,4-dihydroxybenzene
Trihydric Phenol	Trihydric phenols Common Name: Pyrogallol; Hydroxyquinol; Phloroglucinol IUPAC Name: 1,2,3-trihydroxybenzene; 1,2,4-trihydroxybenzene; 1,3,5-trihydroxybenzene
Substituted phenol	Substituted phenols o-amino phenol; o-hydroxy Benzaldehyde; p-hydroxy benzoic acid; Orcinol(or) 3,5-Dihydroxy toluene

สารประกอบฟีนอลที่พบในธรรมชาติมีจำนวนมาก และมีสูตรโครงสร้างที่แตกต่างกัน

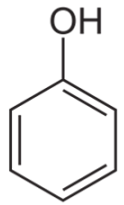
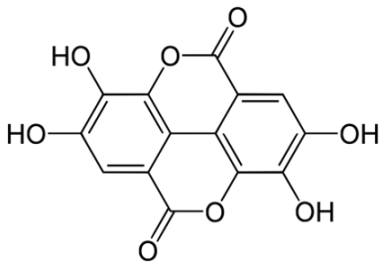
- กลุ่มที่มีโครงสร้างอย่างง่าย เช่น กรดฟีนอลิก (phenolic acids)
- กลุ่มที่มีโครงสร้างเป็นพอลิเมอร์ เช่น ลิกนิน (lignin)
- กลุ่มใหญ่ที่สุด คือ สารประกอบฟลาโวนอยด์ (flavonoid)



phenolic acids

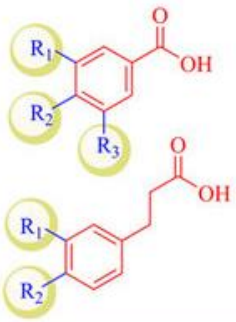


flavonoid

	
Phenol group	**Polyphenol**

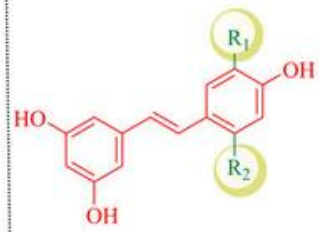
Polyphenol

Phenolic acid

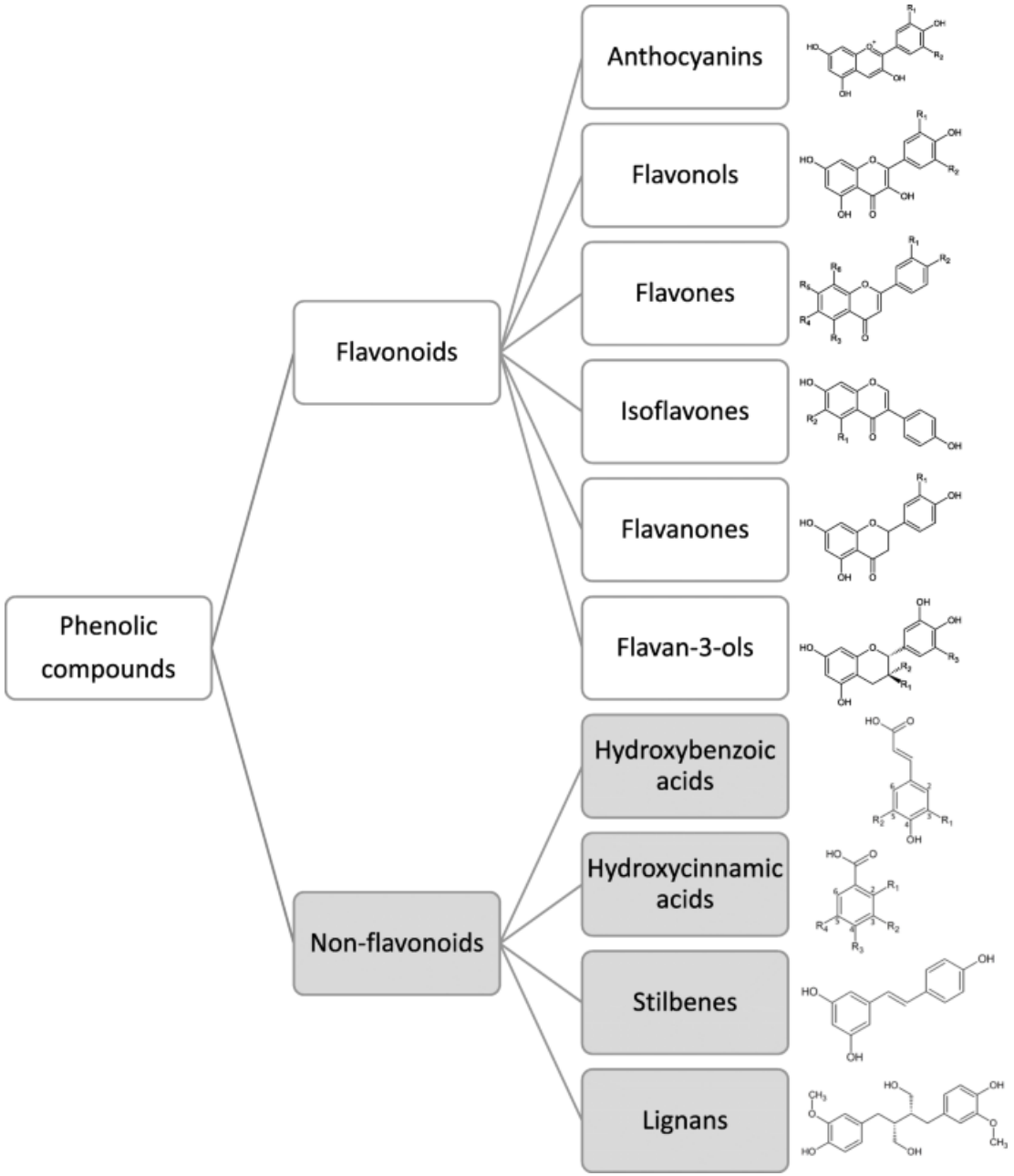


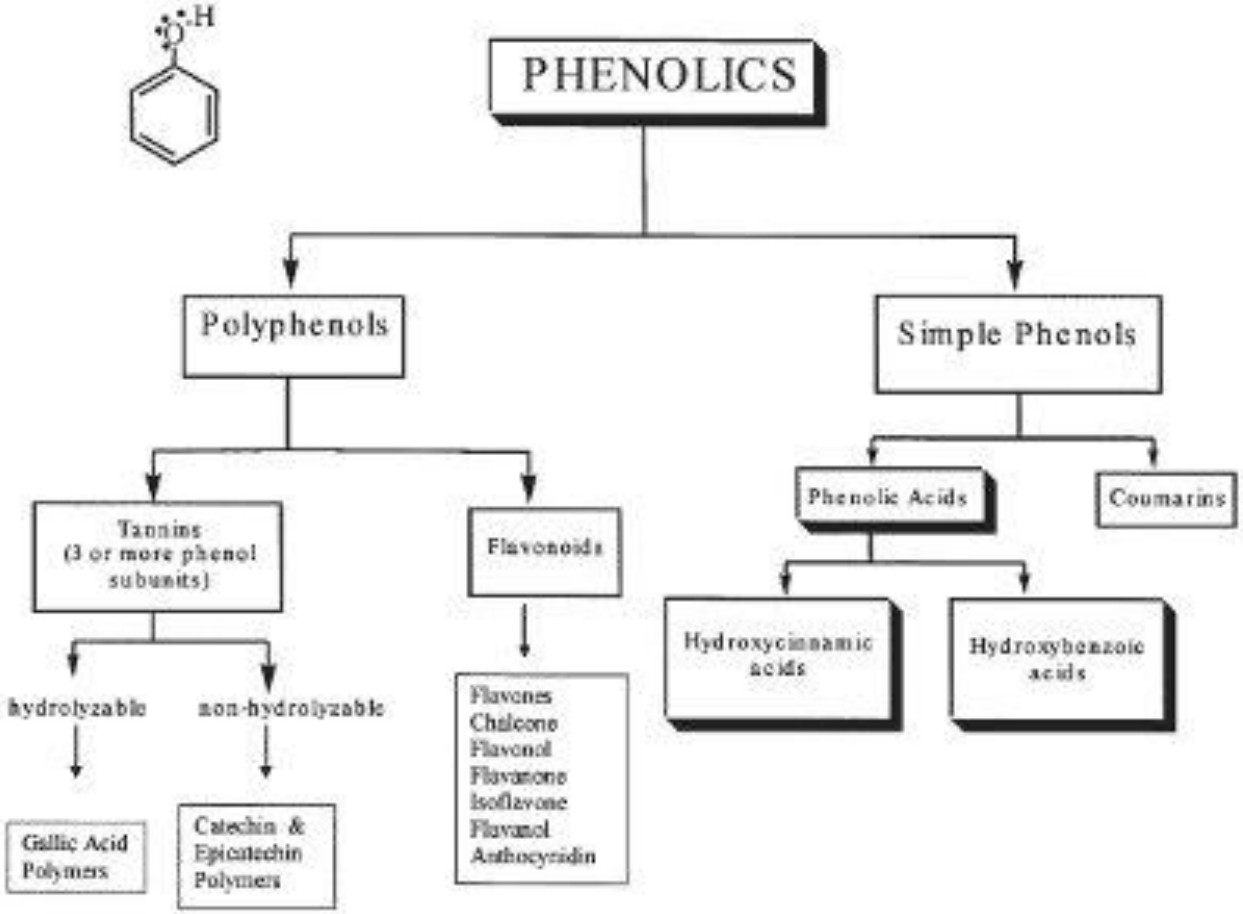
Flavonoids

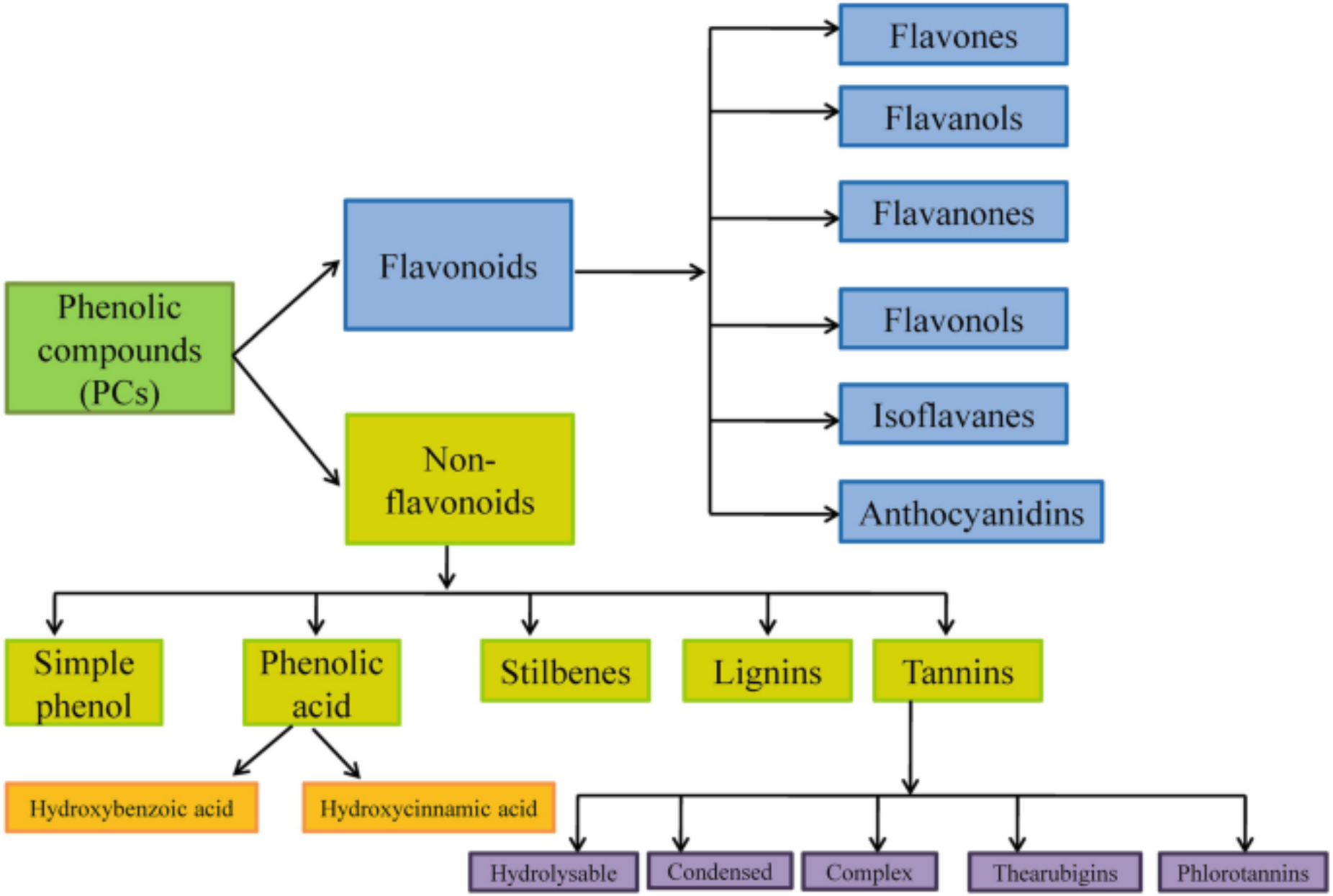
Stilbenes



Lignans


Phenolic compounds
Flavonoids
Anthocyanins
Flavonols
Flavones
Isoflavones
Flavanones
Flavan-3-ols
Non-flavonoids
Hydroxybenzoic acids
Hydroxycinnamic acids
Stilbenes
Lignans

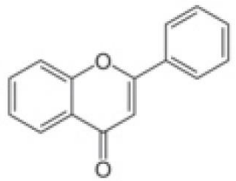

PHENOLICS
Polyphenols
Simple Phenols
Tannins (3 or more phenol subunits)
Flavonoids
Phenolic Acids
Coumarins
hydrolyzable
non-hydrolyzable
Gallic Acid Polymers
Catechin & Epicatechin Polymers
Flavones
Chalcone
Flavonol
Flavanone
Isoflavone
Flavanol
Anthocyridin
Hydroxycinnamic acids
Hydroxybenzoic acids


Phenolic compounds (PCs)
Flavonoids
Non-flavonoids
Flavones
Flavanols
Flavanones
Flavonols
Isoflavanes
Anthocyanidins
Simple phenol
Phenolic acid
Stilbenes
Lignins
Tannins
Hydroxybenzoic acid
Hydroxycinnamic acid
Hydrolysable
Condensed
Complex
Thearubigins
Phlorotannins

สถาบันวิจัยและพัฒนาเครื่องสำอางและการยืดอายุ
TH. COSMETIC & ANTI-AGING TECHNOLOGY

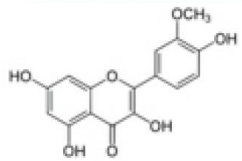
Phenolic substances

FLAVONOIDS



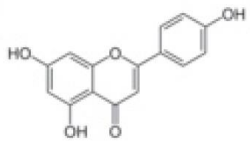
Flavonols

Quercetin
Kaempferol
Isorhamnetin



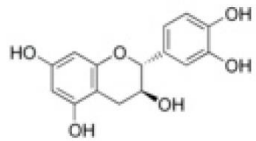
Flavones

Apigenin
Luteolin
Diosmin



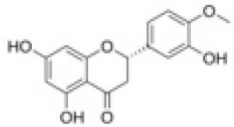
Flavanols

Catechin
Epicatechin
Epigallocatechin



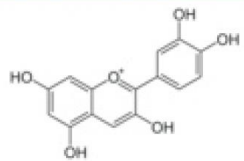
Flavanones

Naringenins
Hesperetin
Erlodictyol



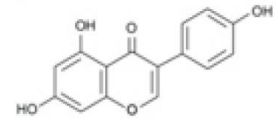
Anthocyanins

Cyanidin
Perlargonidin
Delphinidin

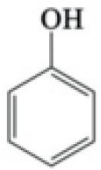


Isoflavones

Genistein
Daidzein
Equol

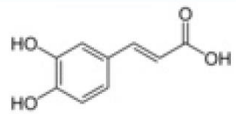


NON-FLAVONOIDS



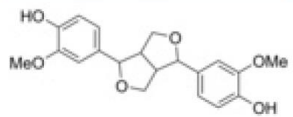
Phenolic acids

Caffeic acid
Chlorogenic acid
Ferulic acid



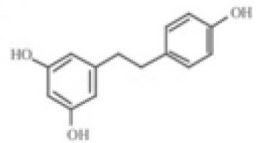
Lignans

Pinoresinol
Podophyllotoxin
Matairesinol



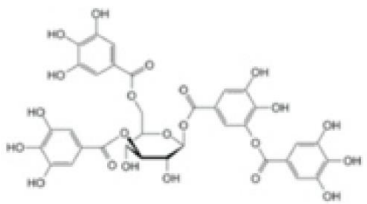
Stilbenes

Resveratrol
Pterostilbene



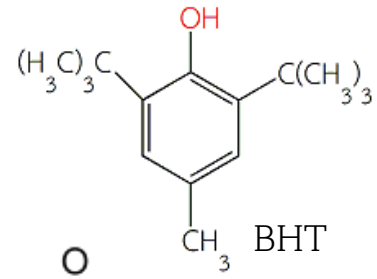
TANNINS

Condensed tannins
Hydrolysable gallotannins

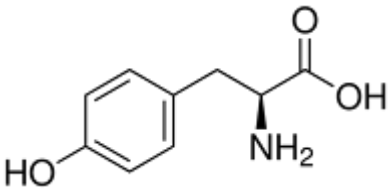


ประโยชน์ของสารประกอบฟีนอล

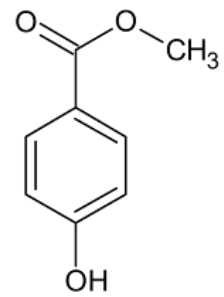
- สารประกอบฟีนอลหลายชนิดมีฤทธิ์เป็นสารต้านออกซิเดชัน (antioxidant) ยับยั้งปฏิกิริยาออกซิเดชัน และเป็นสารต้านการกลายพันธุ์ สารประกอบฟีนอล จะทำหน้าที่กำจัดอนุมูลอิสระ (free radical)
- ใช้เป็นสารหอมระเหยในสปา
- สารฟีนอล (C_6H_5OH) พบในธรรมชาติในน้ำมันดินจากถ่านหิน ฟีนอลเป็นสารพิษอันตรายและกัดผิวหนังได้ ใช้เป็นยาบรรเทาอาการปวดพวกพาราเซตามอล ยาฆ่าเชื้อโรคและแบคทีเรีย
- ใช้เป็นสารตั้งต้นในการถนอมอาหาร โดยใช้เป็นสารกันหืน ป้องกันปฏิกิริยาการออกซิเดชันของลิพิด (lipid oxidation) เช่น BHT
- สารประกอบฟีนอลชนิดอื่นๆ เช่น Tyrosine ซึ่งเป็นกรดอะมิโน และยูจินอลเป็นสารที่พบมากในน้ำมันหอมระเหยกานพลู
- ด้านความงาม เช่น methylparaben ซึ่งพบมากในผลไม้พวกบลูเบอรี่ มีคุณสมบัติเป็นสารต้านเชื้อรา เชื้อแบคทีเรีย จึงเป็นที่นิยมในการนำมาผสมในเครื่องสำอางและผลิตภัณฑ์ถนอมผิวจำนวนมากแต่ เมทิลพาราเบนถึงแม้จะเป็นสารสกัดจากธรรมชาติหากใช้ในปริมาณที่มากเกินไป อาจก่อให้เกิดการแพ้



BHT

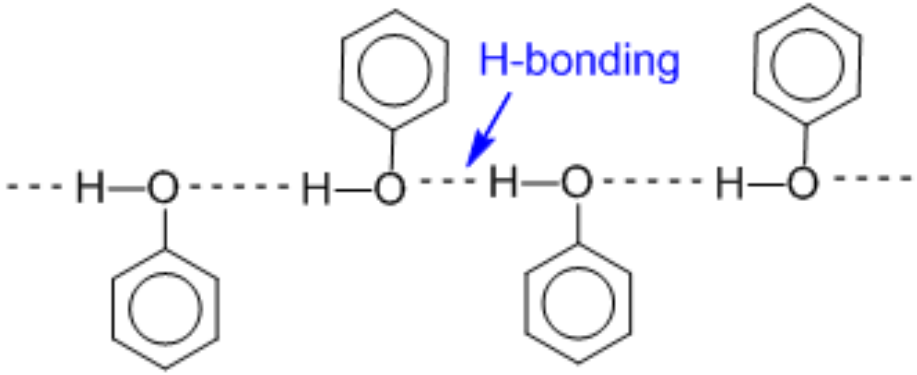


Tyrosine

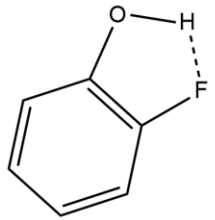


Methylparaben

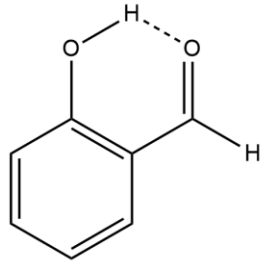
Intermolecular hydrogen bonding



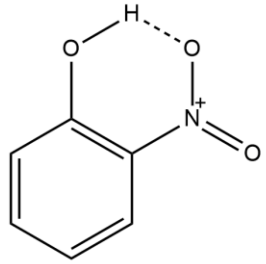
Intramolecular hydrogen bonding



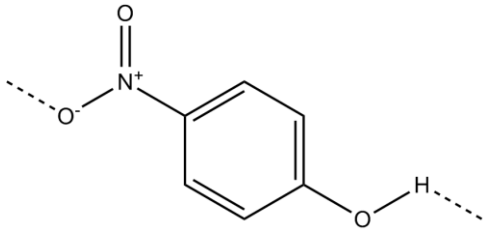
o-fluorophenol



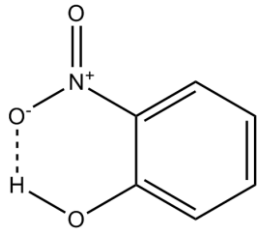
Salicyaldehyde



o-nitro phenol



p-nitrophenol



o-nitrophenol

Intramolecular hydrogen bonding reduces water solubility and increases volatility.

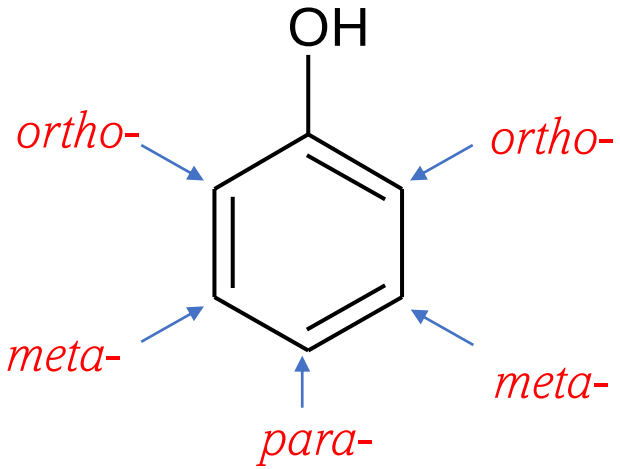
	B.p., °C at 70 mm	Solub., g/100 g H_2O	
o-Nitrophenol	100	0.2	Volatile in steam
m-Nitrophenol	194	1.35	Non-volatile in steam
p-Nitrophenol	*dec.*	1.69	Non-volatile in steam

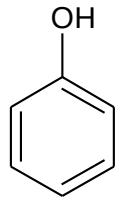
การเรียกชื่อฟีนอล

ชื่อสามัญ : เรียกตำแหน่งคาร์บอนที่อยู่ถัดจากคาร์บอนที่มีหมู่ไฮดรอกซิลต่ออยู่ทั้งสองข้าง

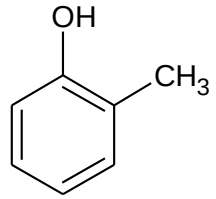
- ตำแหน่งออโท (*ortho*–)
- ตำแหน่งเมตา (*meta*–)
- ตำแหน่งพารา (*para*–) ตรงข้าม –OH

ลงท้ายด้วย phenol หรือเรียกตามชื่อเฉพาะ

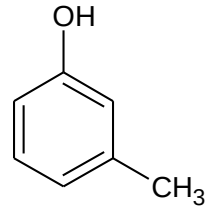




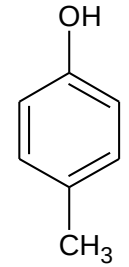
phenol



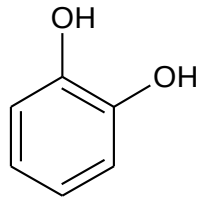
o-cresol
(2-methylphenol)



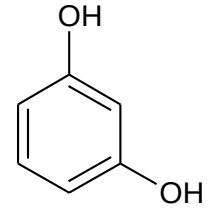
m-cresol
(3-methylphenol)



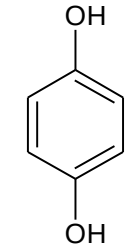
p-cresol
(4-methylphenol)



catechol
(2-hydroxyphenol)



resorcinol
(3-hydroxyphenol)

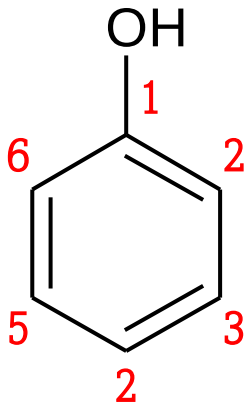


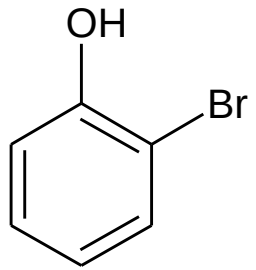
quinol
(4-hydroxyphenol)

การเรียกชื่อฟีนอล

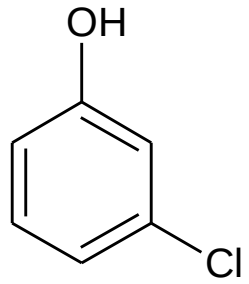
ชื่อระบบ IUPAC

นับคาร์บอนที่มีหมู่ไฮดรอกซิลต่ออยู่เป็นคาร์บอนตาแหน่งที่ 1 และตำแหน่งถัดมาเป็น 2 3 4 5 และ 6 ตามลำดับโดยการนับอาจนับตามหรือทวนเข็มนาฬิกาก็ได้ที่ให้ชื่อที่มีตัวเลขต่ำกว่า

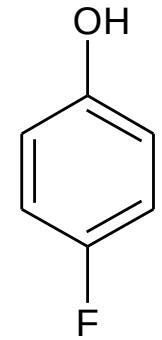




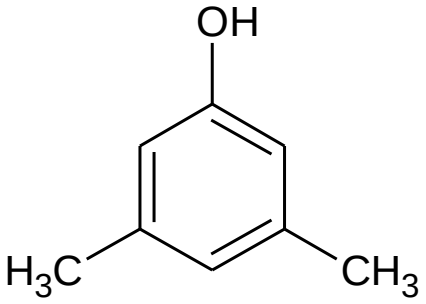
2-bromophenol



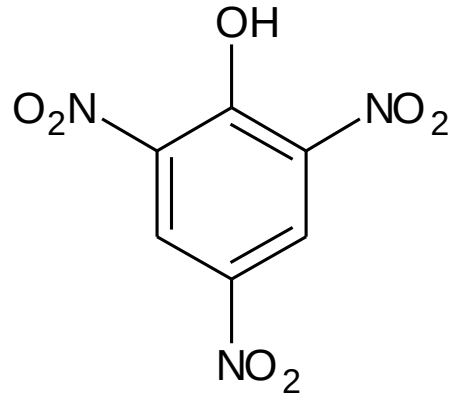
3-chlorophenol



4-fluorophenol



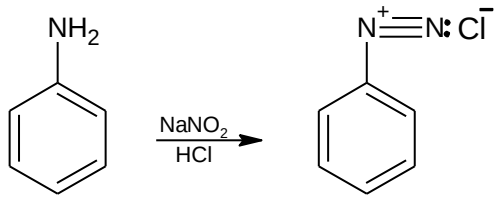
3,5-dimethylphenol



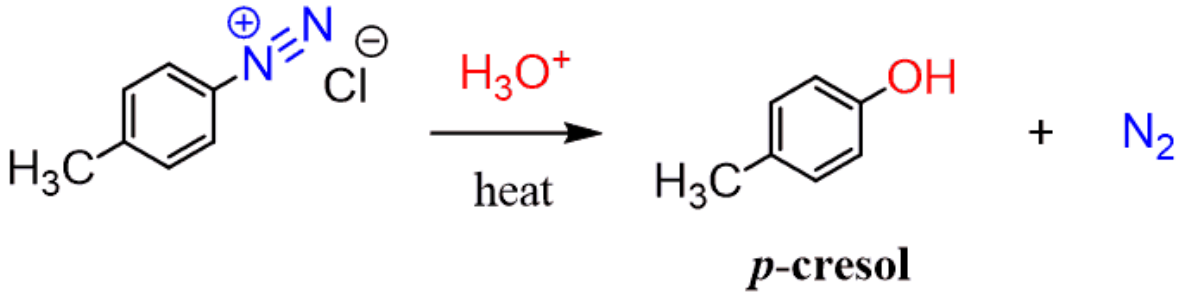
2,4,6-trinitrophenol

การเตรียมฟีนอล

- Hydrolysis of arenediazonium salts



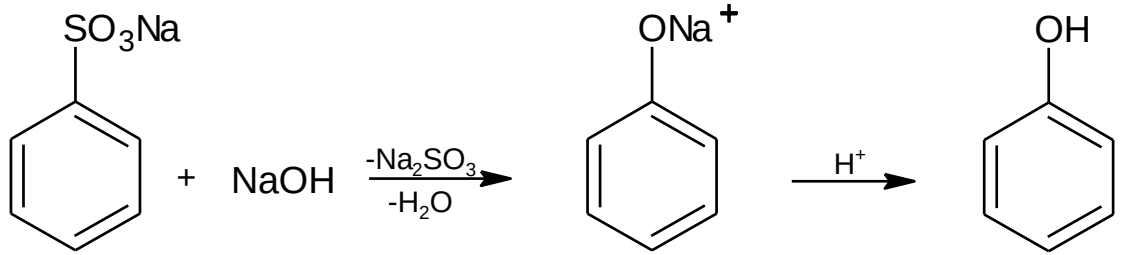
arenediazonium salts



p-cresol

- Alkali fusion of sulfonate

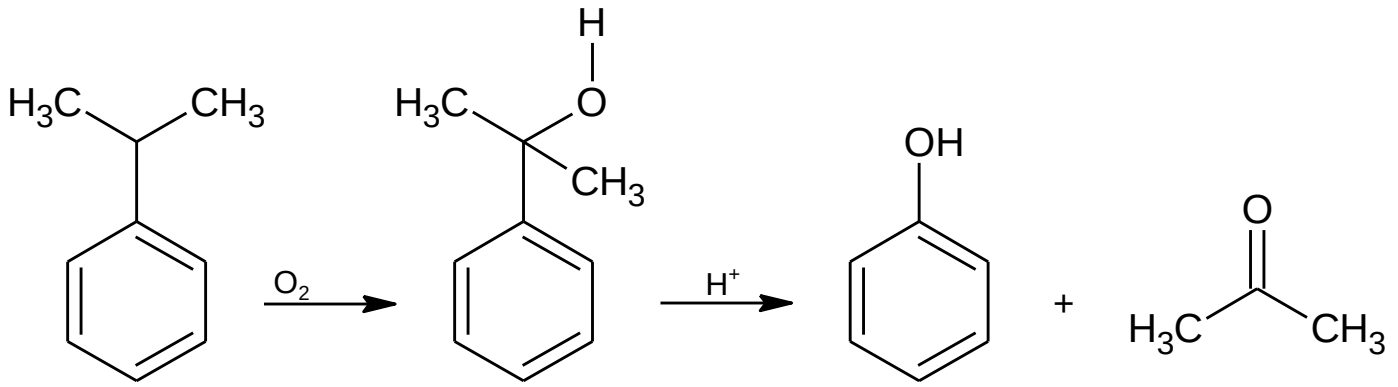
นำ sodium benzenesulfonate หลอม รวมกับ NaOH ที่อุณหภูมิสูง เกิด sodium phenoxide ซึ่ง ทำปฏิกิริยากับ กรด ได้ phenol



sodium benzenesulfonate sodium phenoxide

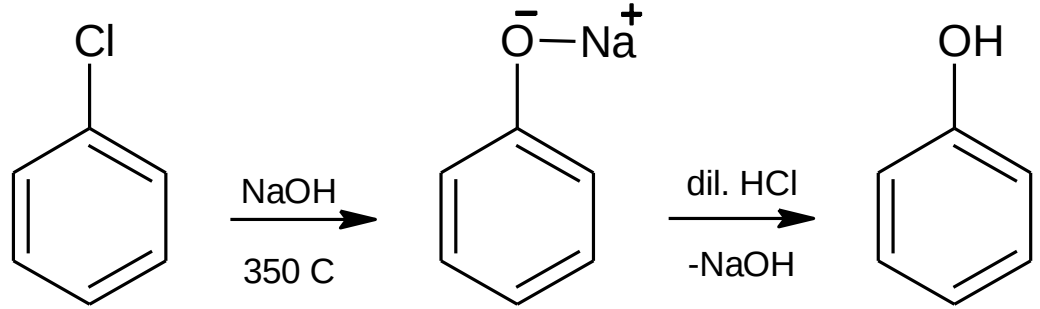
การเตรียมฟีนอล

- Oxidation of cumene



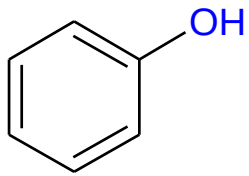
Cumene Cumene hydroperoxide phenol acetone

- Reaction of chlorobenzene

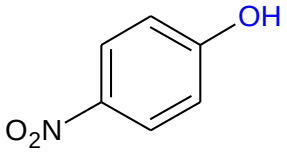


chlorobenzene phenoxide ion phenol

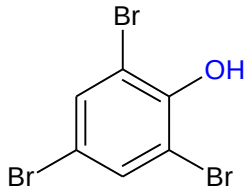
ปฏิกิริยาของฟีนอล



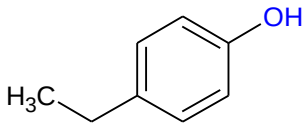
Nitration — HNO_3, CH_3COOH



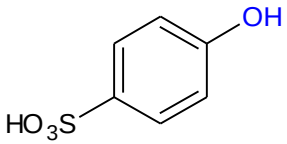
Halogenation — Br_2



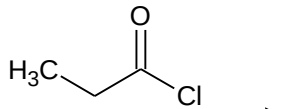
Friedel-Crafs alkylation — CH_3CH_2Cl, $AlCl_3$

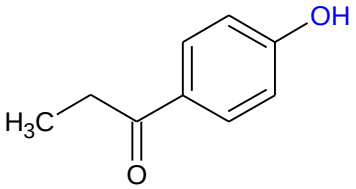


Sulfontion — H_2SO_4

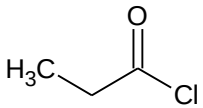


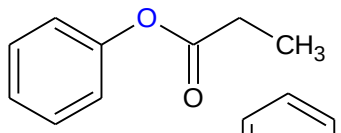
Friedel-Crafs acylation — $AlCl_3$



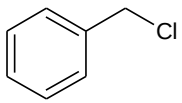


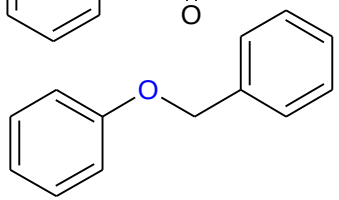
Ester formation by acid halide





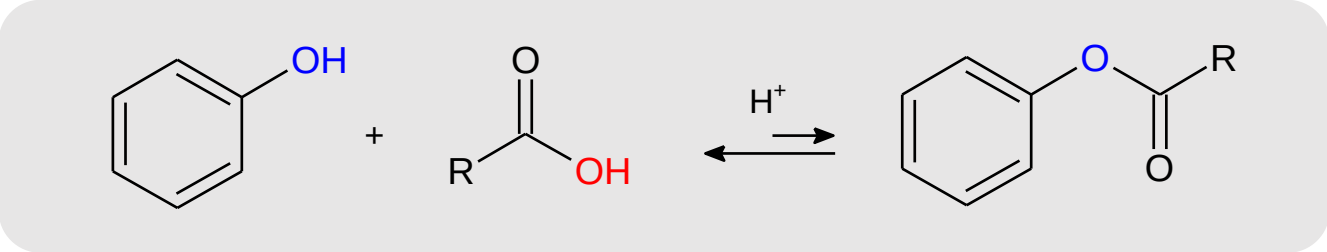
Ester formation (Williamson) — Na



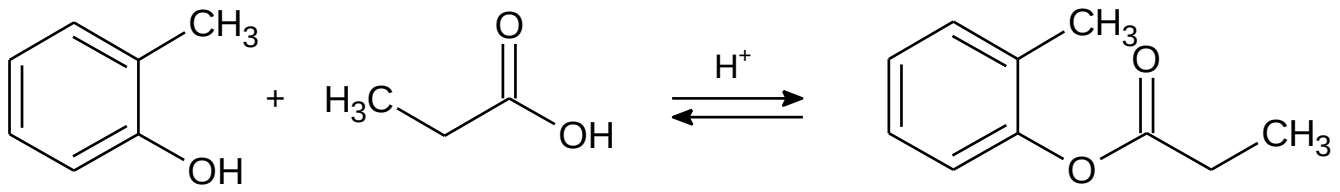


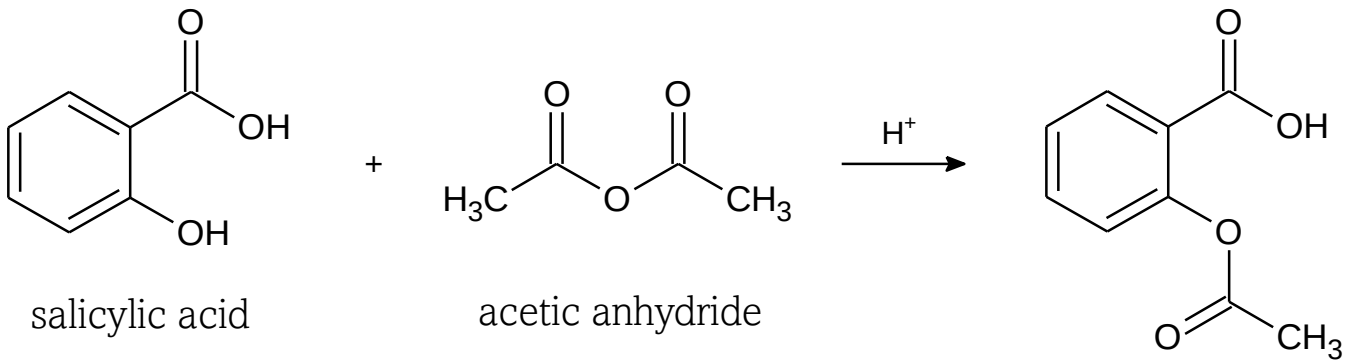
20°C to be ortho-
100°C to be para-

Ester formation (similar alcohol)



weak nucleophile especially in acidic conditions

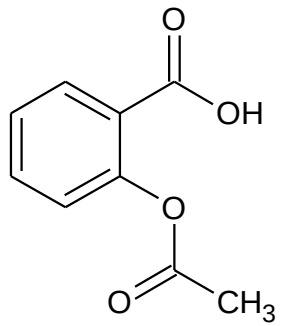




salicylic acid

acetic anhydride

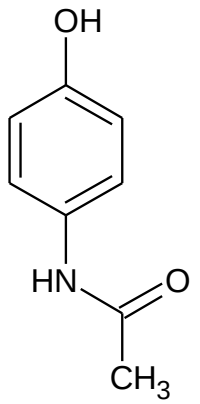
aspirin



aspirin

Analgesic
Anti-inflamtory
Ani-pyrretic
Anti-coagulant

Reye's syndrome not to be use by children with high fevers

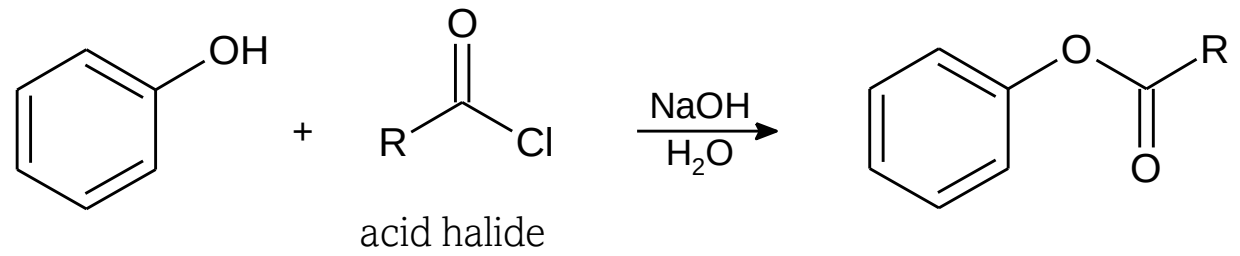


acetaminophen

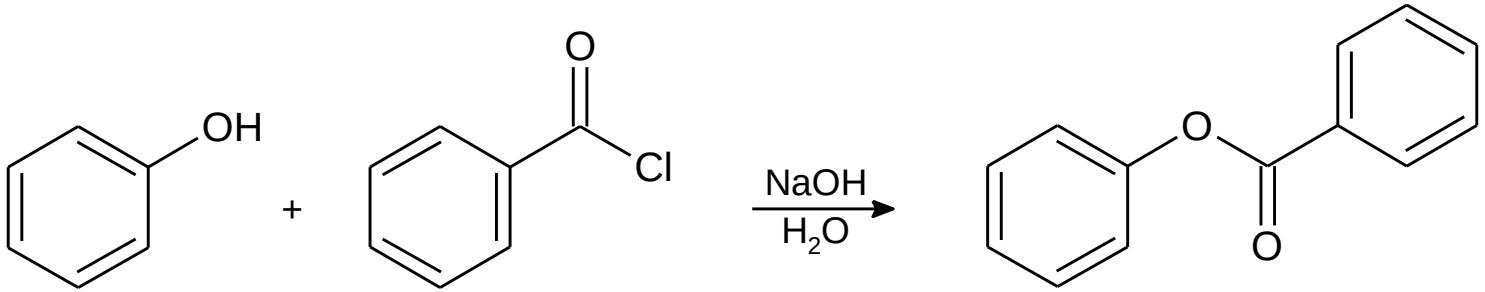
aspirin substitute
Tylenol

Kidney damage

Ester formation (Williamson Synthesis)



acid halide



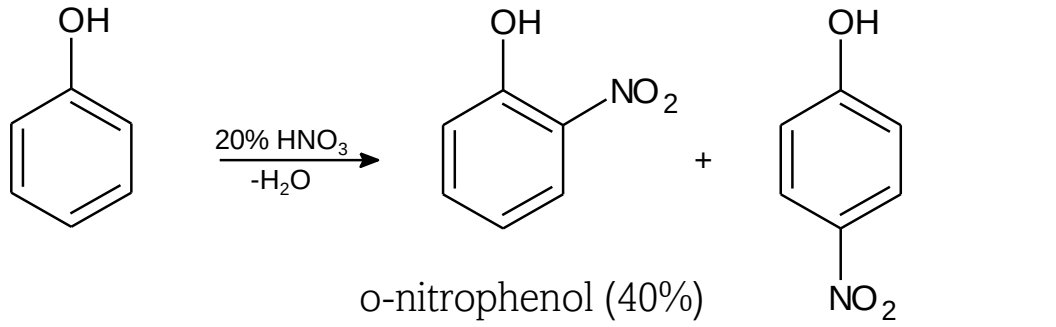
benzoyl halide

phenyl benzoate

Electrophilic Aromatic Substitution

- **Nitration**

  Conc. HNO_3 เกิด polynitration



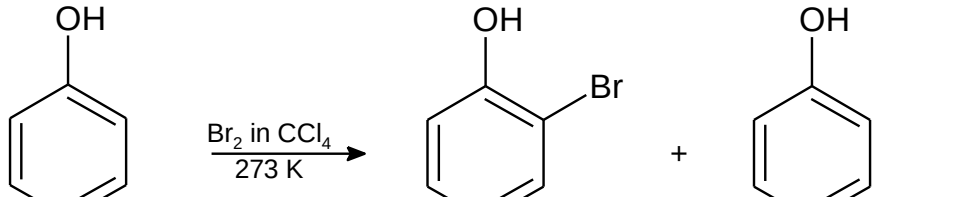
o-nitrophenol (40%)

p-nitrophenol (13%)

- **Halogenation**

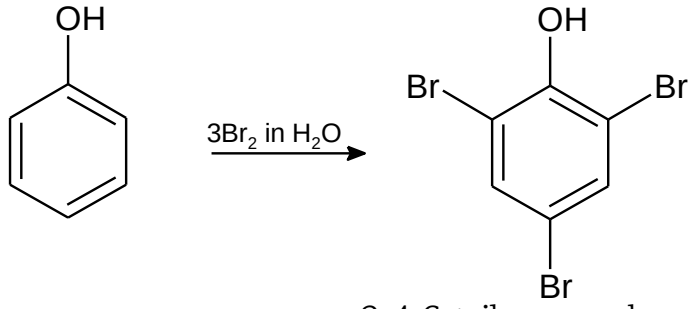
  หมู่แฮโลเจนแทนที่ H ที่ตำแหน่ง ortho และ para

  - Non-polar solvent เกิดตำแหน่ง ortho หรือ para
  - Polar solvent เกิด polyhalogenation



2-bromophenol

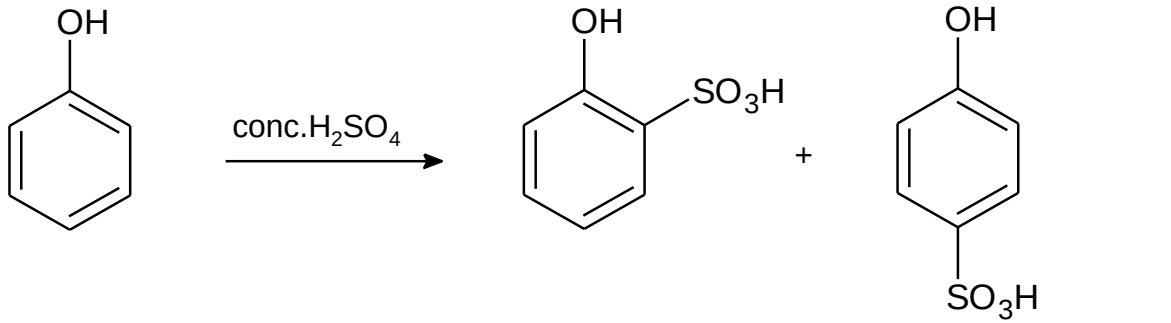
4-bromophenol



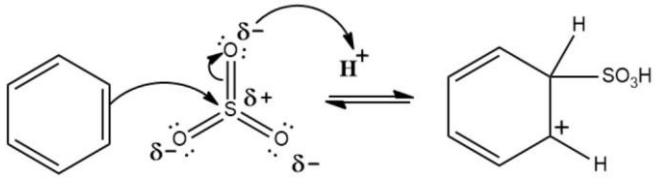
2,4,6-tribromophenol

Electrophilic Aromatic Substitution

- Sulfonation

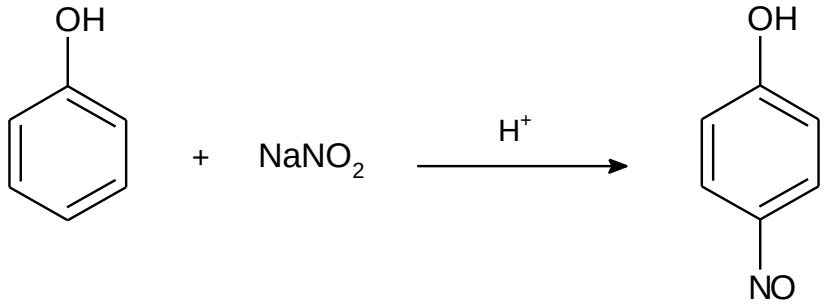


o-phenolsulfonic acid p-phenolsulfonic acid



20°C to be major of ortho-
100°C to be major of para-

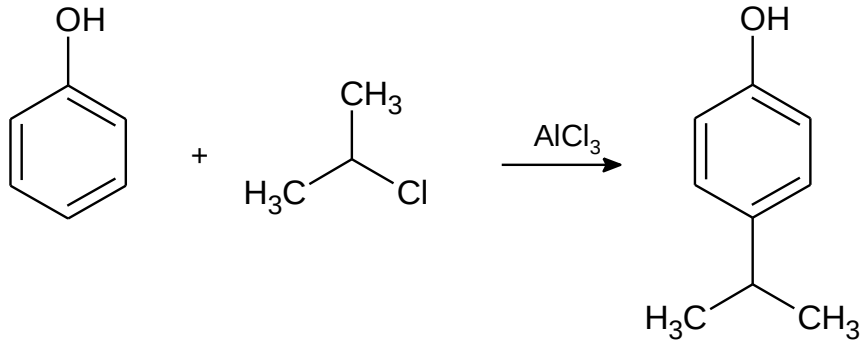
- Nitrosation



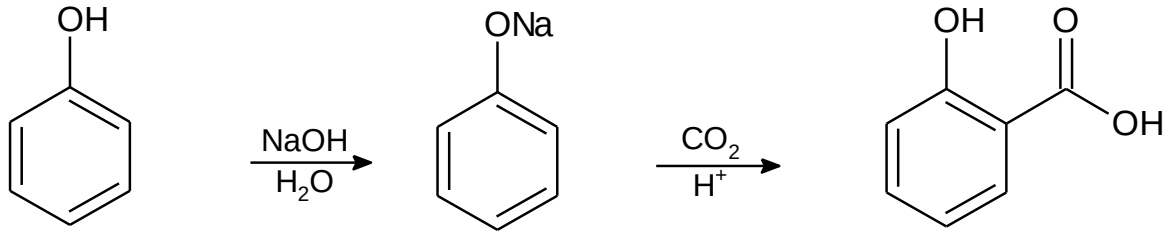
p-nitrosophenol

Electrophilic Aromatic Substitution

- Friedel-Crafts alkylation



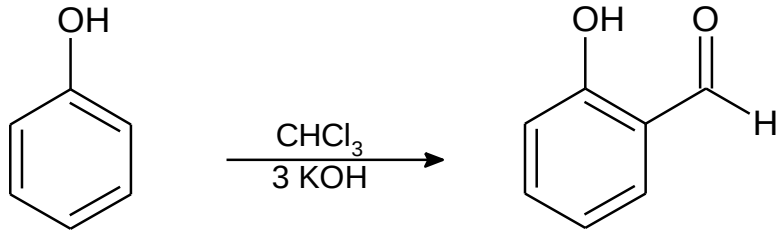
- Kolbe reaction (carbonation)



sodium phenoxide salicylic acid

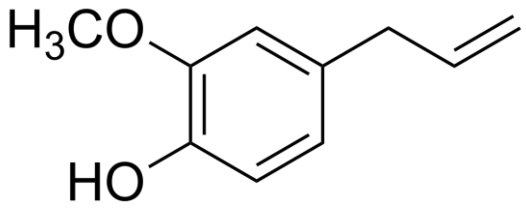
- Reimer-Tiemann reaction

ใช้เตรียม phenolic aldehyde

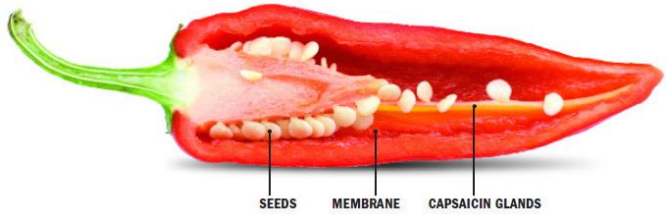


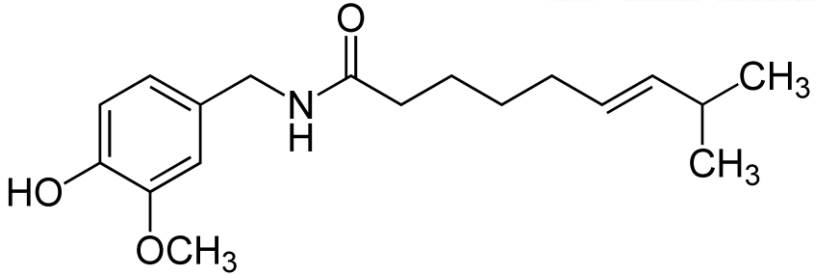
Hydroxybenzaldehyde (Salicylaldehyde)

Natural phenol occurring

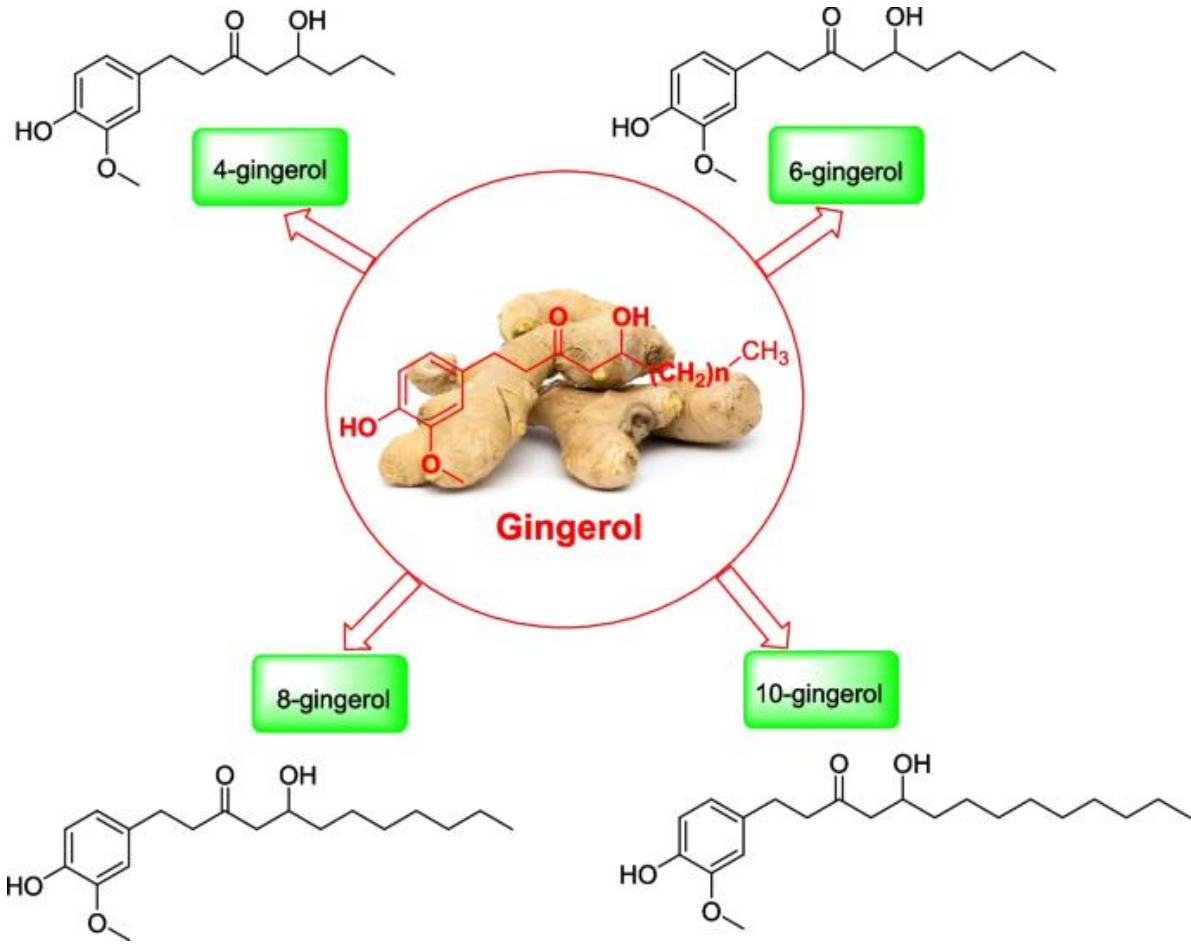


ยูจินอล (eugenol)
พบในกานพลู ใบกระเพรา



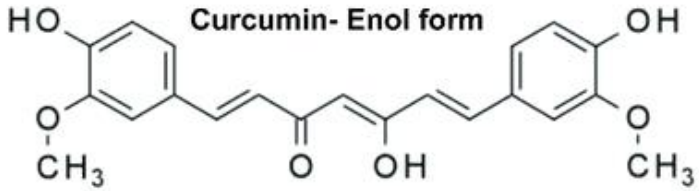


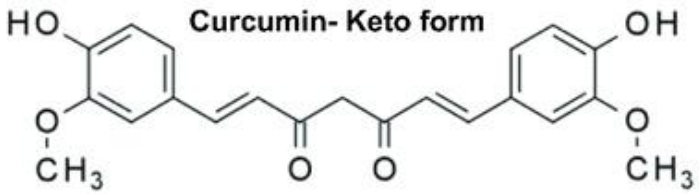
แคปไซซิน (capsaicin) ในพริก



จินเจอรอล (gingerol) พบใน ขิง

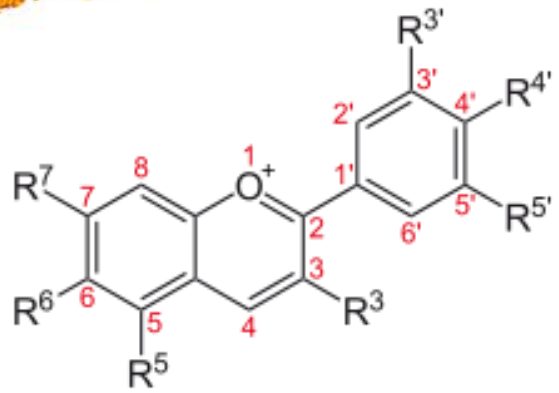
Natural phenol occurring





เคอคิวมิน (Curcumin) ในขมิ้น

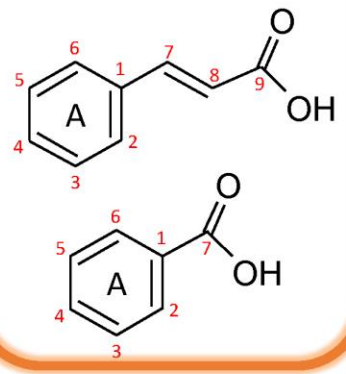
แคทีชิน (catechin) ในชา



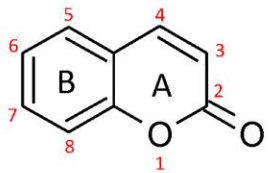
แอนโทไซยานิน (anthocyanin) ในพืชสีม่วง

PLANT POLYPHENOLS

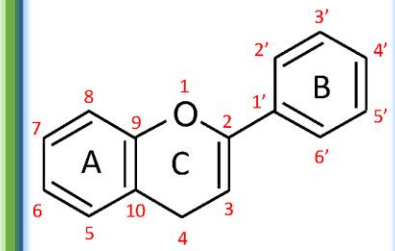
PHENOLIC ACIDS



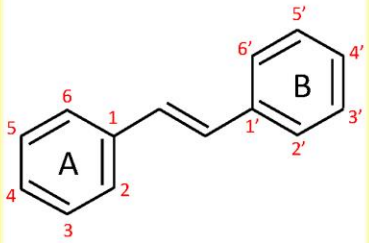
COUMARINS



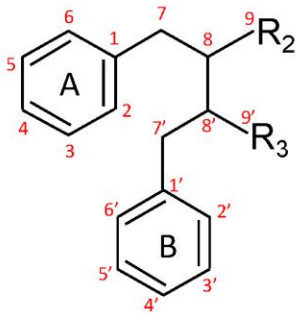
FLAVONOIDS



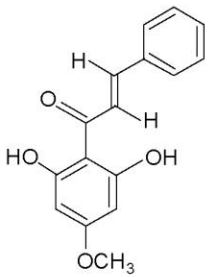
STILBENES



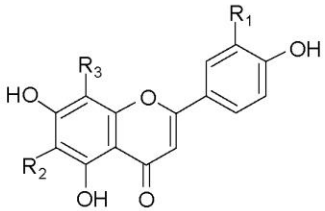
LIGNANS



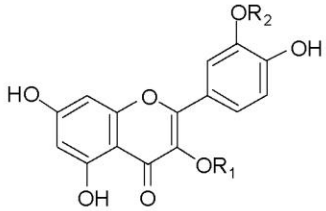
CHALCONES



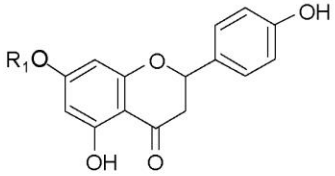
FLAVONES



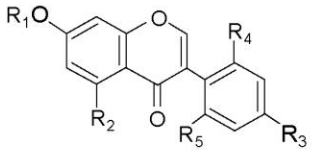
FLAVONOLS



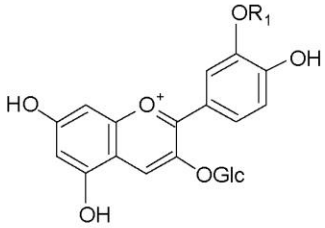
FLAVANONES



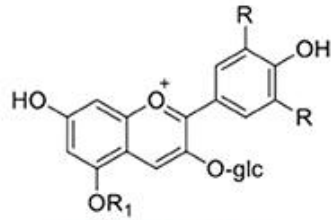
ISOFLAVONOIDS



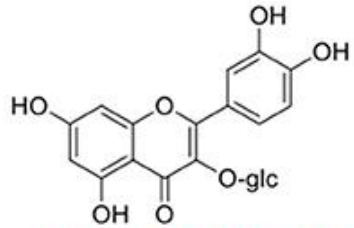
ANTHOCYANINS



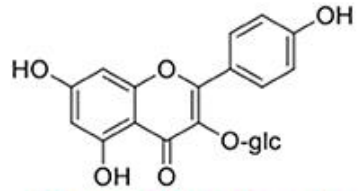
Onion byproducts



Anthocyanins

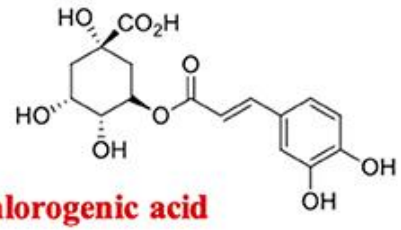


Quercetin glycosides



Kaempferol glycosides

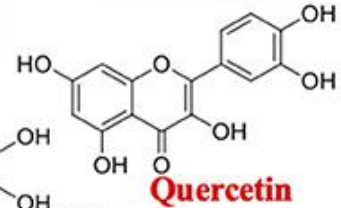
Carrot and potato byproducts



Chlorogenic acid

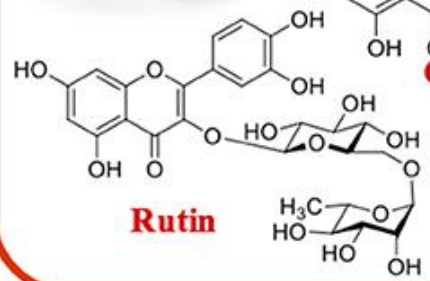
- ✓ Antiviral
- ✓ Antimutagenic
- ✓ Anti-inflammatory
- ✓ Cardioprotective
- ✓ Antiobesity
- ✓ Wound healing

Tomato byproducts

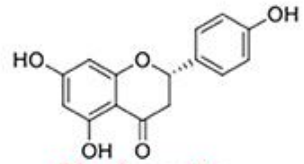


Quercetin

Kaempferol



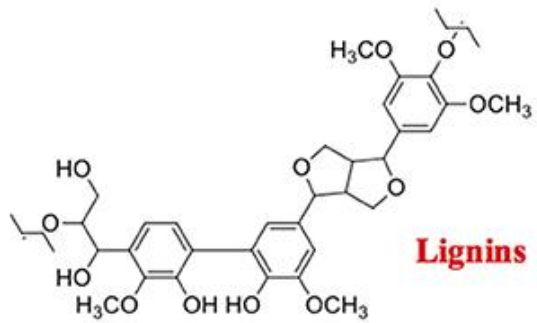
Rutin



Naringenin

Lignocellulosic byproducts

- ✓ Antioxidant
- ✓ Antimicrobial agent



Lignins

#กิจกรรม work@class

แบ่งกลุ่มทำกิจกรรม 6.1

มอบหมายโจทย์ให้แต่ละกลุ่ม
ระดมสมองแก้ไขโดยวิธีการ
ร่วมแสดงความคิดเห็น

ให้แต่ละกลุ่มนำเสนอ วิธีการแก้ไขโจทย์ปัญหา

1) หลักการสำคัญหรือหลักพื้นฐานที่ถูกต้อง

2) วิธีการคำนวณค่าที่ถูกต้อง

3) วิธีอธิบายเชิงพฤติกรรม (วิธีปฏิบัติ) ที่ถูกต้อง

โดยให้กลุ่มอื่น ๆ รับฟัง และซักถามในข้อที่สงสัย