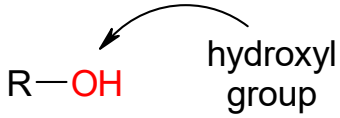
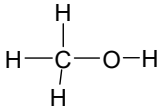
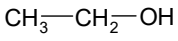
ALCOHOLS



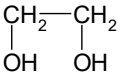


methanol
(methyl alcohol)

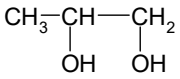


ethanol
(ethyl alcohol)

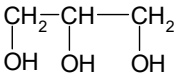
2-propanol
(isopropyl alcohol)



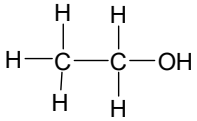
1,2-ethanediol
(ethylene glycol)



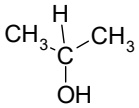
1,2-propanediol
(propylene glycol)



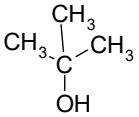
1,2,3-propanetriol
(glycerol)



primary alcohol



secondary alcohol

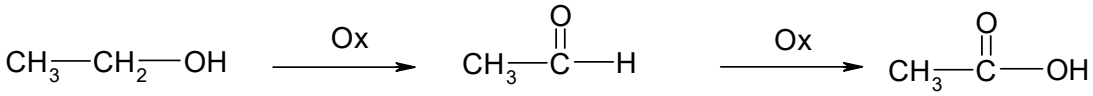


tertiary alcohol

Combustion

$C_2H_5OH + 3\ O_2 \rightarrow 2\ CO_2 + 3\ H_2O$

Oxidation
primary alcohols → -aldehydes → carboxylic acids

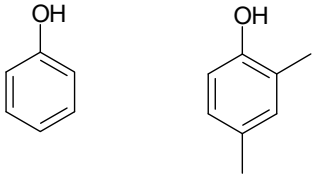


ethanol *acetaldehyde* *acetic acid*

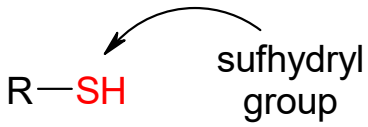
Secondary alcohols → ketones

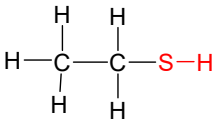
PHENOLS

Phenols --- ArOH
weak acids



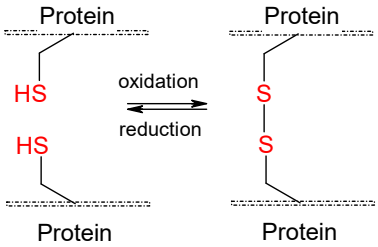
THIOLS



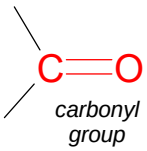


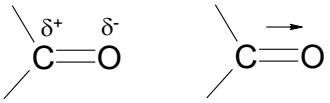
ethanthiol (ethyl mercaptan)

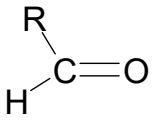
Oxidation: thiols → disulfides



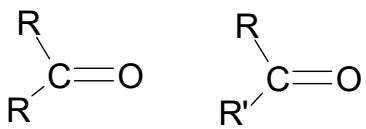
ALDEHYDES AND KETONES





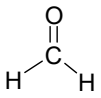


Aldehyde

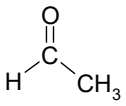


Ketones

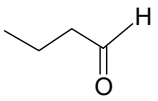
Aldehydes: examples



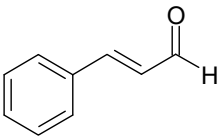
methanal (formaldehyde)



ethanal (acetaldehyde)

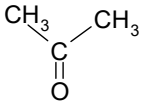


butanal

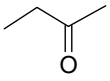


cinnamaldehyde

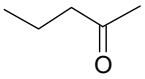
Ketones: examples



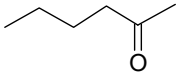
propanone (acetone)



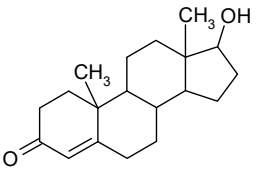
butanone



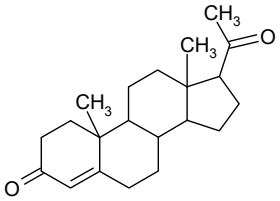
2-pentanone



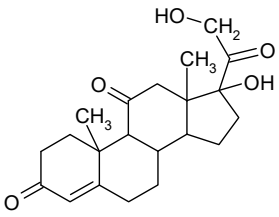
2-hexanone



Testosterone

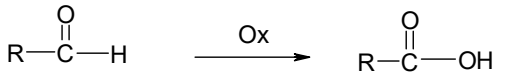


Progesterone



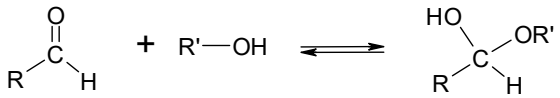
Cortisone

Oxidation:

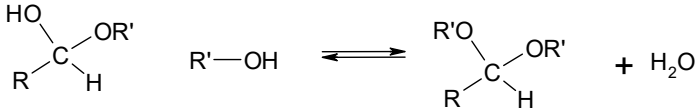


aldehyde *carboxylic acid*

Reactions with alcohols:



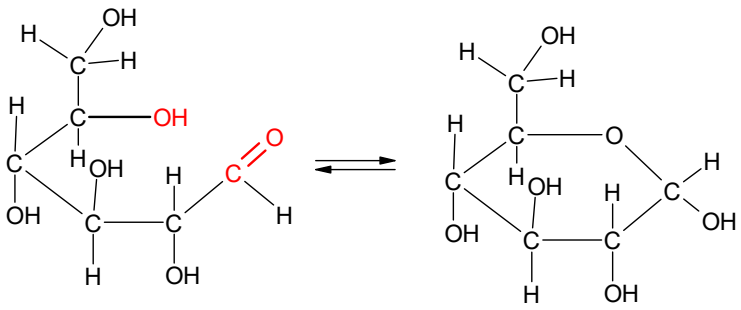
aldehyde *alcohol* *hemiacetal*



hemiacetal *alcohol* *acetal*

ketone *alcohol* *hemiacetal (hemiketal)*

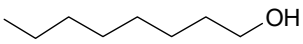
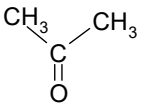
in carbohydrates:



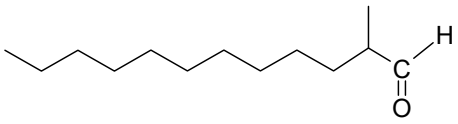
Tautomers

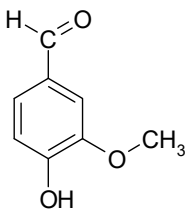
Keto-enol forms

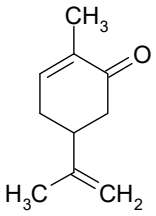
1) Which one of these compounds would you expect to be not soluble in water?

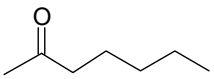
a)  b) CH_3OH c) 

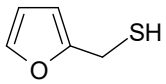
2) Identify the functional groups in each of the following compounds.

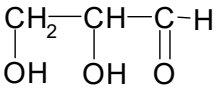




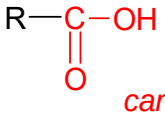






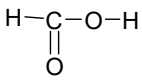


CARBOXYLIC ACIDS

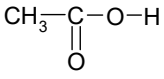


carboxyl group

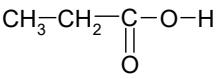
Carboxylic acids: examples



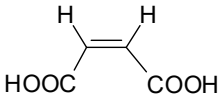
Methanoic acid (formic acid)



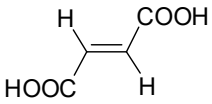
Ethanoic acid (acetic acid)



Propanoic acid (propionic acid)



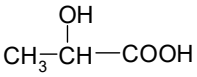
maleic acid (cis)



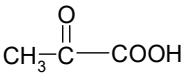
fumaric acid (trans)

configurational isomers, no free rotation around C=C

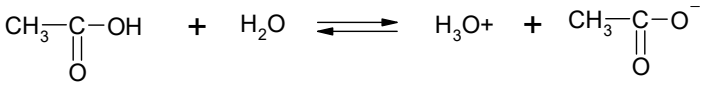
oxalic acid



lactic acid



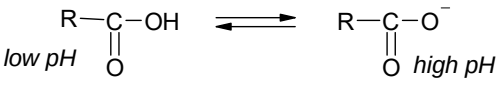
Pyruvic acid



acetic acid *acetate ion (-1 charge)*

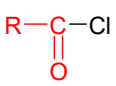
weak acids

acid	Ka	% ionization (0.1 M solution)	pKa
Formic	$1{,}8 \times 10^{-4}$	4.2%	3.75
Acetic	$1{,}8 \times 10^{-5}$	1.3%	4.75
Propionic	$1{,}3 \times 10^{-5}$	1.2%	4.89
Butyric	$1{,}5 \times 10^{-5}$	1.2%	4.82
valeric	$1{,}5 \times 10^{-5}$	1.2%	4.82
caproic	$1{,}4 \times 10^{-5}$	1.2%	4.85

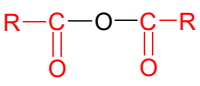


low pH *high pH*

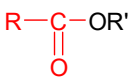
carboxylic acid derivatives:



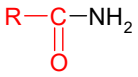
acyl chlorides



anhydrides



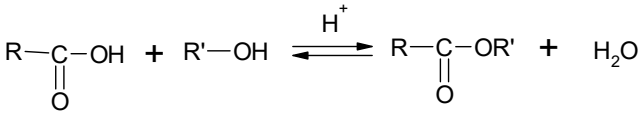
esters



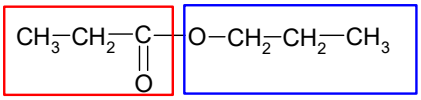
amides

RCO- ⇒ *acyl group*

esters

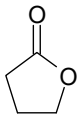


carb. acid *alcohol* *ester*

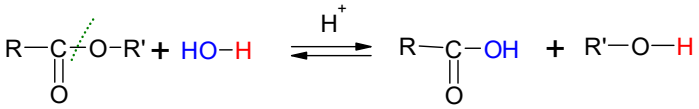


$CH_3COOC_2H_5$

ethyl acetate



lactone (cyclic ester)

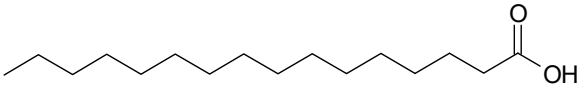


Hydrolysis

ester *carb. acid* *alcohol*

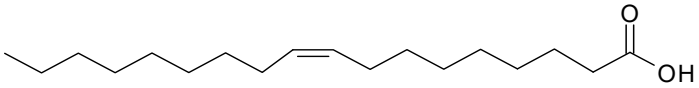
Fatty acids and esters

saturated fatty acid



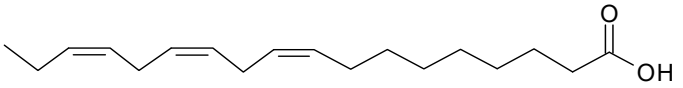
palmitic acid (C16) *$CH_3(CH_2)_{14}COOH$*

monounsaturated



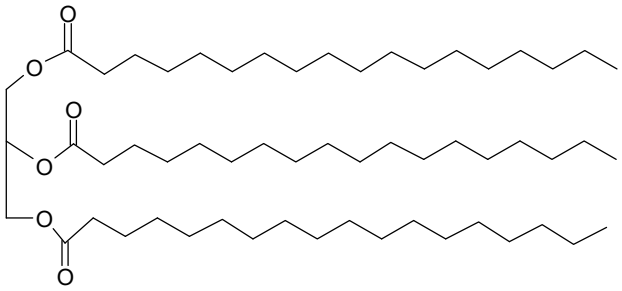
oleic acid (cis-9-octadecenoic acid) *CH_3-$(CH_2)_7$-CH=CH-$(CH_2)_7$-COOH*

polyunsaturated

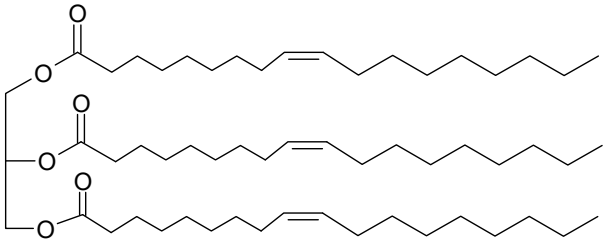


linolenic acid (cis,cis,cis-9,12-15-octadecadienoic acid)

triacylglycerols ester of fatty acids with glycerol: fats and oils

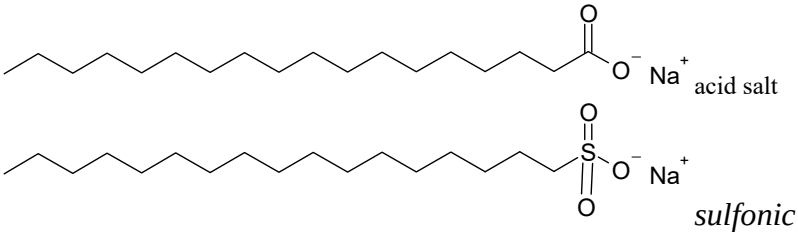


glyceryl tristearate

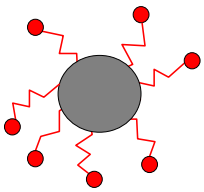


glyceryl trioleate

Soaps

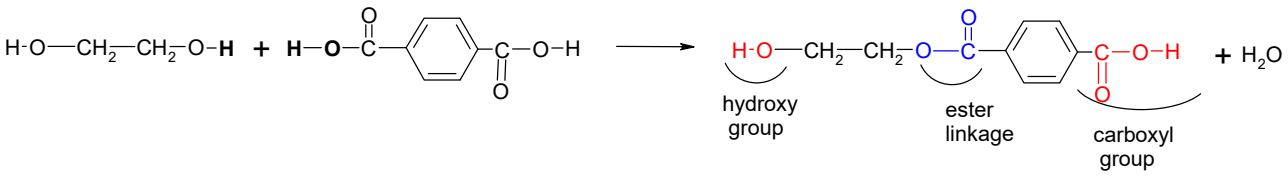


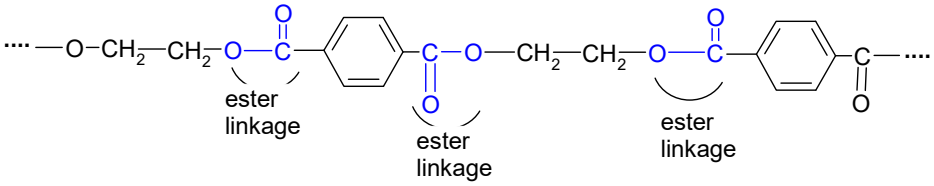
sulfonic group



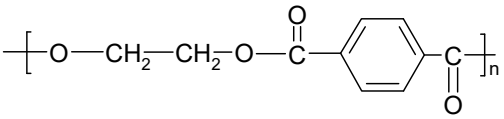
<u>*Polyesters*</u>

PET: terephthalic acid (a diacid) + ethylene glycol (a diol) *condensation polymer*



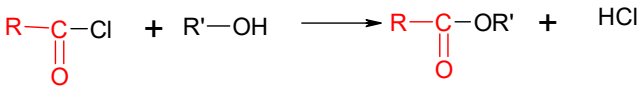


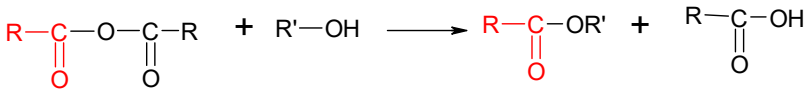
PET *poly(ethylene terephthalate)*



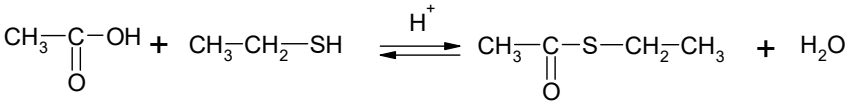
Lactic acid and PLA (polylactic acid)

acyl transfer reaction

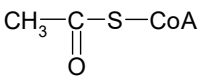




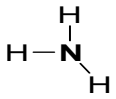
thioesters



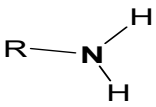
carb. acid *thiol* *thioester*

acetyl coenzyme A 

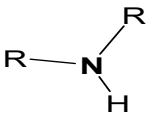
AMINES



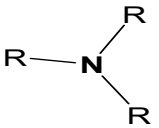
ammonia
NH_3



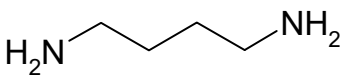
primary amine
CH_3NH_2
Methanamine



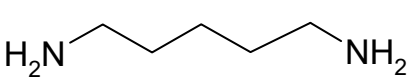
secondary amine
$CH_3(C_2H_5)NH$
ethylmethylamine



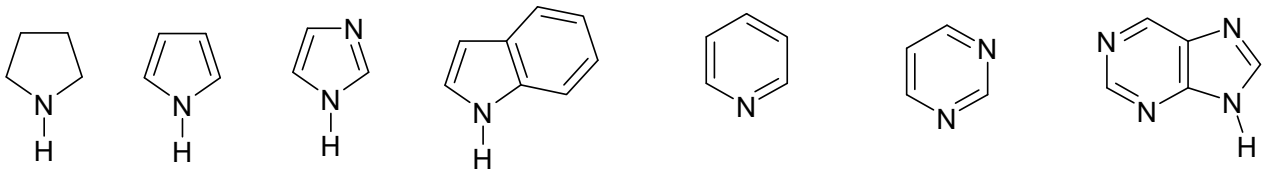
tertiary amine
$(C_2H_5)_3NH$
triethylamine



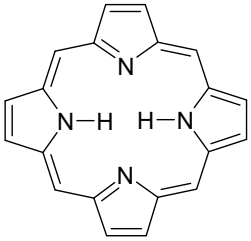
C4
1,4-butanediamine (Putrescine)



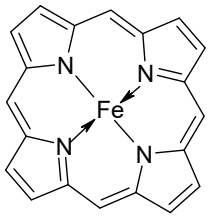
C5
1,5-pentanediamine (Cadaverine)



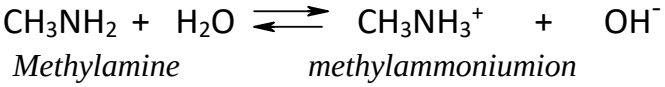
pyrrolidine *pyrrole* *imidazole* *indole* *pyridine* *pyrimidine* *purine*



Porphirine ring



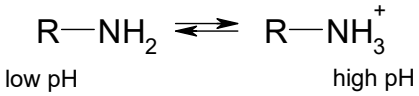
Heme, a component of hemoglobin-



Methylamine *methylammoniumion*

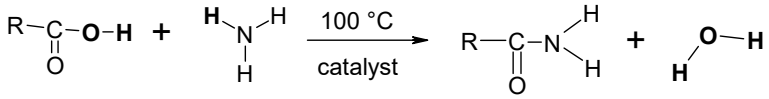
Weak bases

amine	pK_b	pKa (R_3NH^+)
Dimethylamine $(CH_3)_2NH$	3.3	10.7
Trimethylamine $(CH_3)_3N$	3.4	10.6
Methylamine CH_3NH_2	4.2	9.8
Ammonia NH_3	4.7	9.3
Aniline $PhNH_2$	9.4	4.6
Pyridine C_5H_5N	8.8	5.2

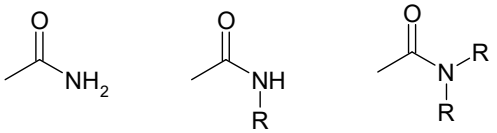


low pH high pH

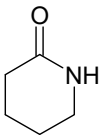
amides



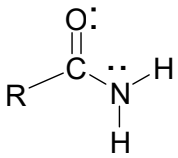
Carb. acid *ammonia* *amide*



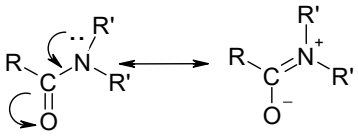
primary secondary tertiary



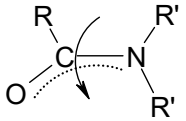
lactam (cyclic amide)



H bonding

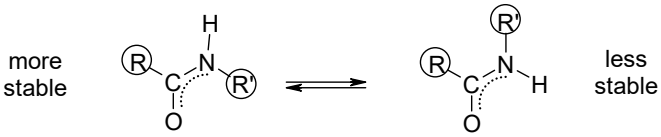


resonance

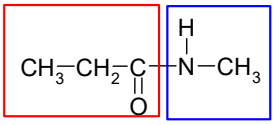


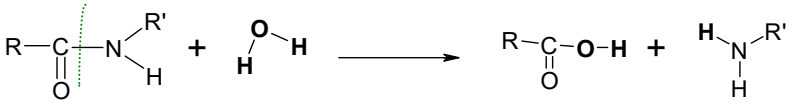
C-N rotation barrier
75 to 85 kJ / mol

rotation C-N bond restricted

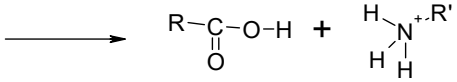


Hydrolysis

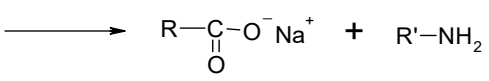




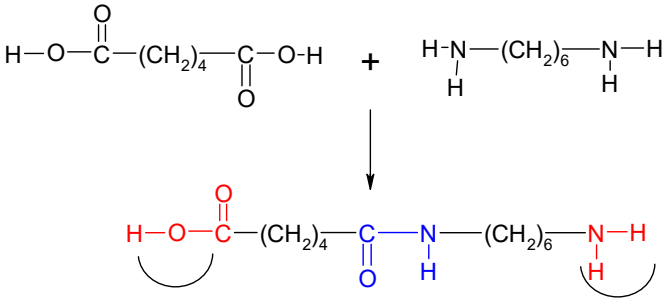
Acidic hydrolysis of amide

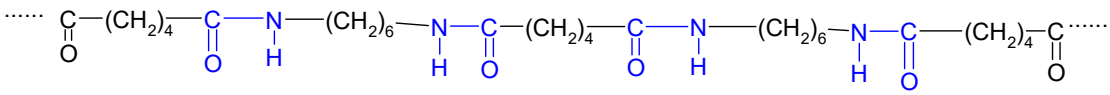


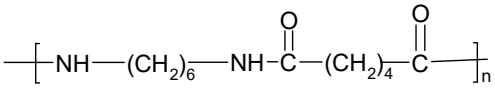
Basic hydrolysis of amide



polyiamides

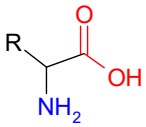






nylon 6,6 (polyamide)

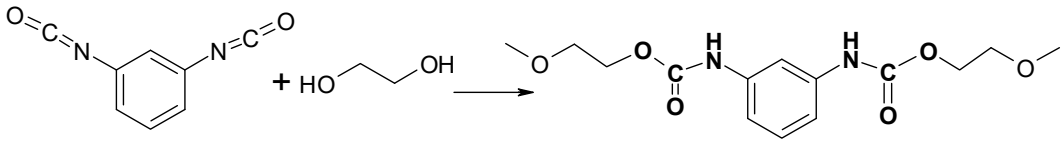
Aminoacids: two functional groups



natural polymers: proteins

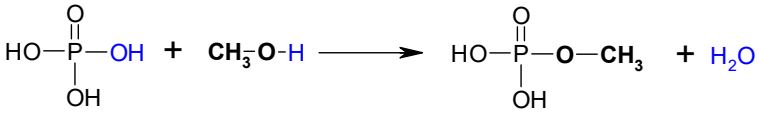
ISOCYANATES

R-N=C=O

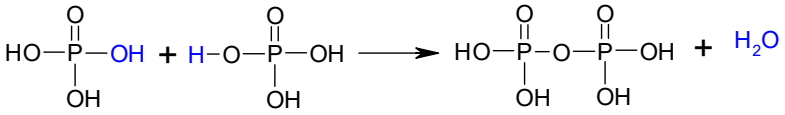


benzene diisocyanate *ethylene glycol* *polyurethane*

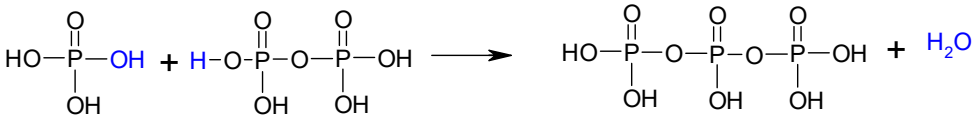
ORGANIC PHOSPHATES

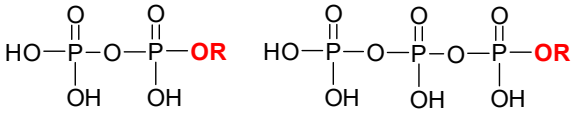


phosphoric acid *methyl ester of phosphoric acid*

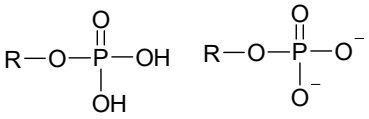


phosphoric acid phosphoric acid diphosphoric acid ($H_4P_2O_7$)

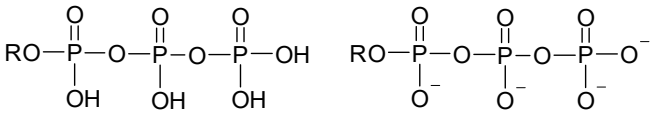




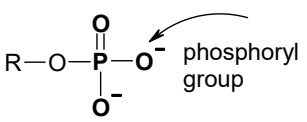
Diphosphate monoester and triphosphate monoester

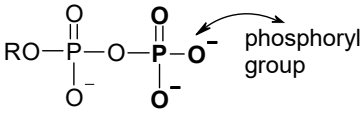


Neutral form and ionic form

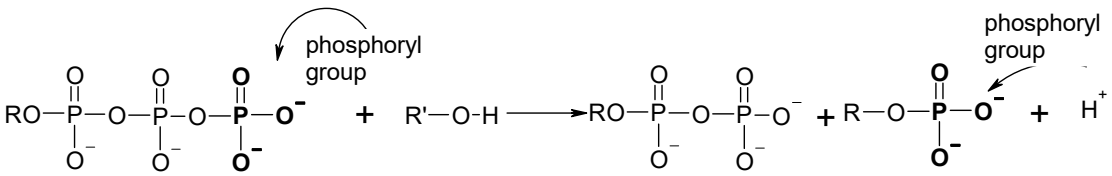


Neutral form and ionic form

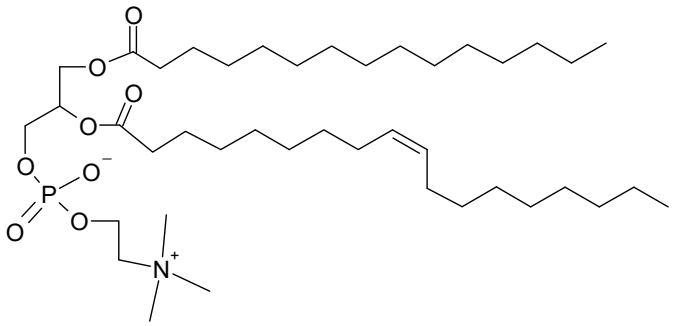




PO_3^{2-}

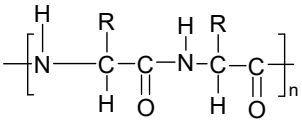


lecitines

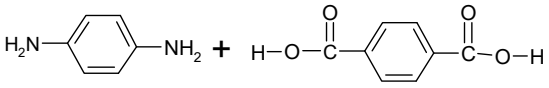


1) 4-PHB -[-O-CH_2-CH_2-CH_2-CO-]$_n$- is a biodegradable polymer. Write the molecular formula of the monomer.

2) Write the molecular formula of the monomer.



3) Which class of polymer can be obtained from the reaction of these two monomer?



4) Identify the functional groups in each of the following compounds