Pécs University Medical School
English Program

UNIVERSITAS QUINQUEECCLESIENSIS
13 67

a guide to ORGANIC CHEMISTRY 1ST SEMESTER

BRY.

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① ALKANES

A) THE sp^3 - HYBRIDIZED C - ATOM

- NORMAL CONFIGURATION : • $1s^2\ 2s^2\ 2p^2$
- HYBRIDIZED CONFIGURATION : • 4 <u>equivalent</u> sp^3
  • tetrahedral structure ($\alpha = 109,5°$)
  • saturated (<u>only</u> single bonds)

B) GENERAL FORMULA

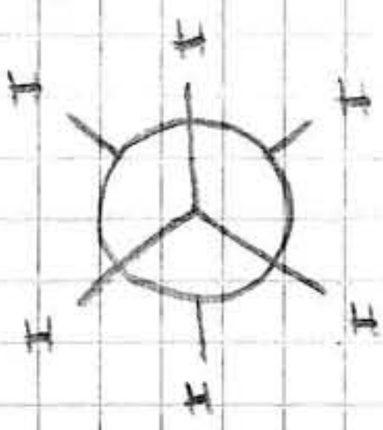
$C_nH_{(2n+2)}$

C) IUPAC NOMENCLATURE

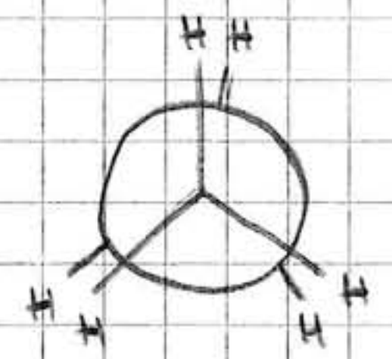
- ENDING : • -ane
- BASE CHAIN : • longest continuous carbon chain
- NUMBERING : • from the nearest branch-point
- SIDE-CHAINS : • alphabetic order

D) STRUCTURAL ISOMERISM

- STAGGERED CONFORMATION : • lowest potential energy (<u>most</u> stable)



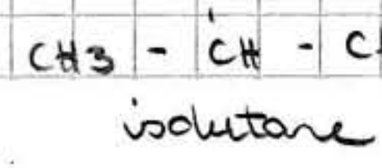
- ECLIPSED CONFORMATION : • highest potential energy



COMMENT TO SELF !
this is <u>not</u> structural isomerism, but CONFORMATIONAL ISOMERISM !

$CH_3 - CH_2 - CH_2 - CH_3$

n-butane



isobutane

E) PHYSICAL PROPERTIES

- non-polar
- lower boiling points (London forces only)
- insoluble in water
- methane - butane exists in gas form (4 first)

F) CHEMICAL PROPERTIES

- SUBSTITUTION : $R-H + Cl_2 \xrightarrow{cat} R-Cl + HCl$
  alkane halogen
  - catalysator : heat or light
  - free radical chain reaction
- OXIDATION : alkane + $O_2 \longrightarrow CO_2 + H_2O$ + heat
- PYROLYSIS : long alkane $\longrightarrow$ 2 shorter alkenes

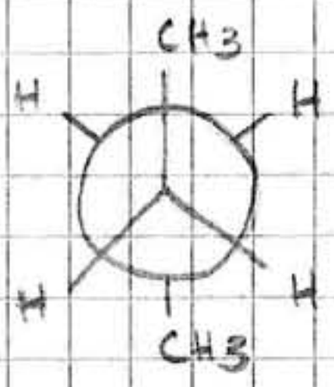
G) CONFORMATION OF ETHANE

C_2H_6, see D)

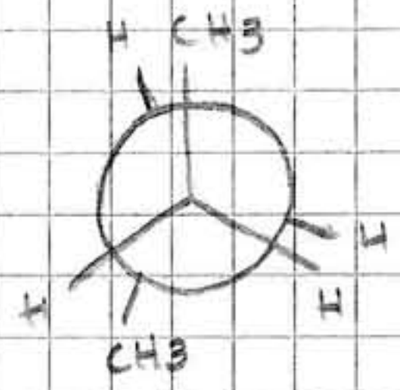
H) CONFORMATION OF n-BUTANE

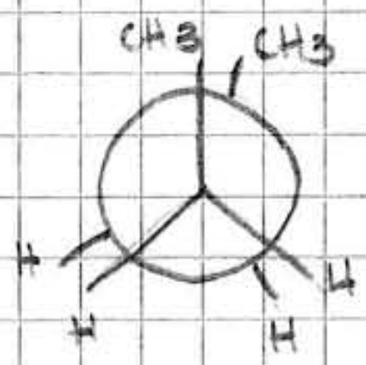
C_4H_{10}

- ANTI : most stable

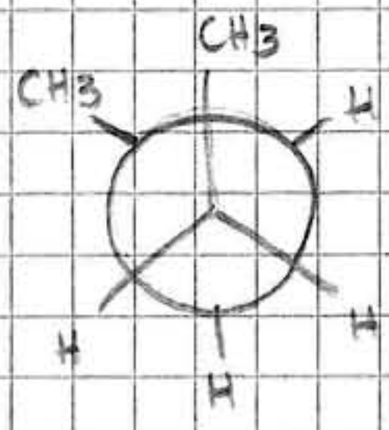


- ECLIPSED :





- GAUCHE :



② CYCLOALKANES

A) GENERAL FORMULA

- C_nH_{2n}
- saturated hydrocarbons
- no functional groups
- cyclo - prefix

B) PHYSICAL PROPERTIES

similar to corresponding alkanes

C) CHEMICAL PROPERTIES

similar to corresponding alkanes

- ADDITION : · instead of substitution

$$\triangle + Br_2 \rightarrow Br \cdot (CH_2)_3 - Br$$

D) CONFORMATION OF THE 3-, 4-, 5- AND 6-MEMBERED RINGS

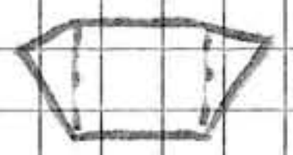
- CYCLOPROPANE : · planar

- CYCLOBUTANE : · puckered

- CYCLOPENTANE : · envelope
  - 4 atoms in 1 plane
  - 1 atom above

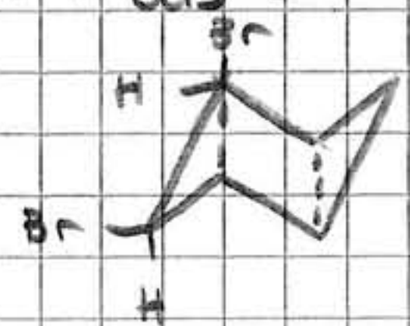
- CYCLOHEXANE : · chair
  - staggered

  - boat
    - eclipsed

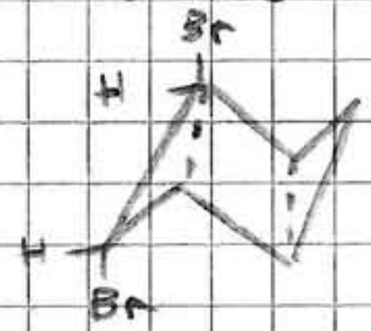


6) ISOMERISM OF STRUCTURED CYCLOALKANES

- STRUCTURAL
- STEREO : - cis -



- trans -



③ ALKENES AND ALKYNES

A) THE sp^2 - AND sp - HYBRIDIZED C-ATOM

- ALKENES :
  - 3 sp^2 and 1 p orbitals
  - the 3 sp^2 hybrid orbitals are in 1 plane
  - the p orbital is perpendicular to the sp^2 - plane
  - 2 p-orbitals form a π - bond
- ALKYNES :
  - 2 sp and 2 p orbitals
  - 2 sp orbitals (of different carbons) form a σ - bond
  - 4 p orbitals (of 2 different carbons) forms 2 π - bonds

B) GENERAL FORMULA

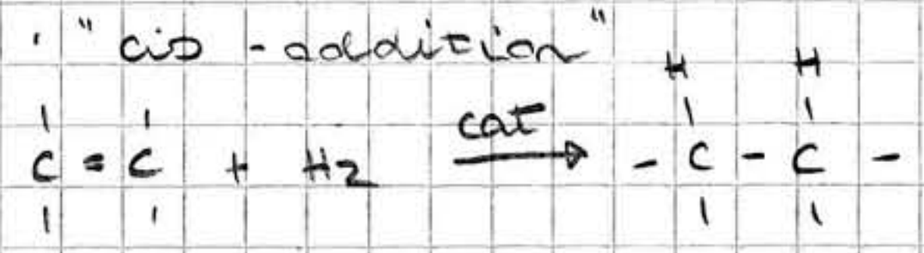
- ALKENES : C_nH_{2n}
- ALKYNES : $C_nH_{(2n-2)}$

C) IUPAC NOMENCLATURE

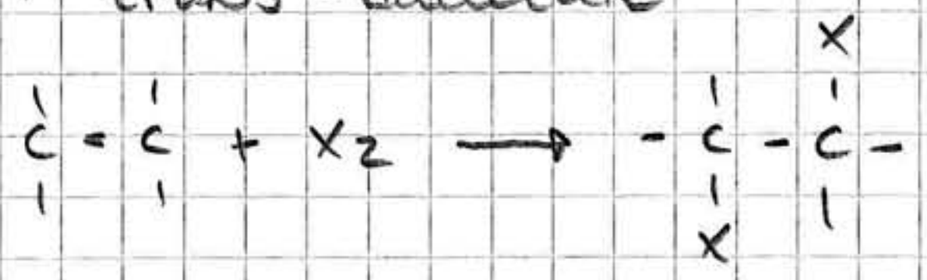
- ENDINGS :
  - alkenes, -ene
  - alkynes, -yne
- BASE CHAIN :
  - longest carbon chain containing the double / triple bond
- CONFIGURATION :
  - only alkenes
  - indication by cis - or trans - in front

D) CHEMICAL PROPERTIES OF ALKENES

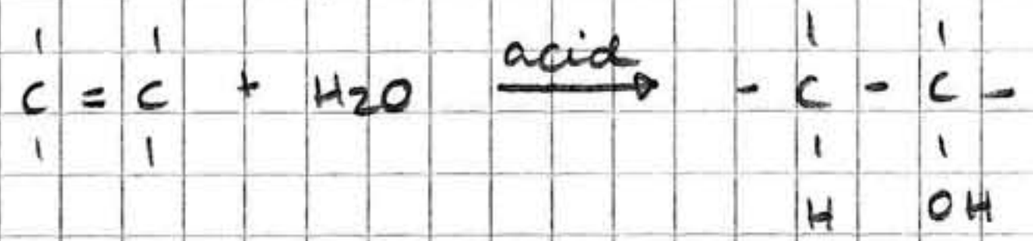
- HYDROGENATION :
  - "cis - addition"



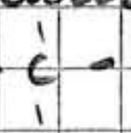
- HALOGENATION :
  - "trans - addition"



- HYDRATION :



· OXIDATION : alkene + oxidizing agent → glycols



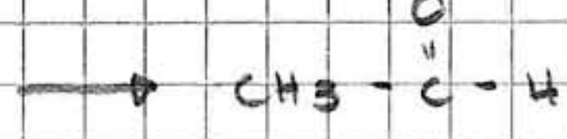
· POLYMERIZATION : alkene $\xrightarrow{cat}$ alkane polymer

E) CHEMICAL PROPERTIES OF ALKYNES

same reactions as alkenes, but twice as slow

· HYDRATION : $-C\equiv C- + H_2O \xrightarrow{Hg/acid} CH_2=CH-OH$

ethyne — vinyl alcohol



acetaldehyde

④ DIENES
2 double bonds are present

A) CLASSIFICATION
arrangement of double bonds

- ISOLATED : • double bonds separated by more than 2 single bonds
  • no interaction btw the double bonds
  • eg. $CH_2 = CH - CH_2 - CH = CH_2$
  1,4 pentadiene
- CUMULATED : • no separation btw double bonds
  • no interaction
  - eg. $CH_2 = C = CH_2$
  propadiene
- CONJUGATED : • double bonds separated by 1 single bond
  • positions of double bonds are not fixed (delocalized π-electrons)
  • very different chemical properties
  • eg $CH_2 = CH - CH = CH_2$
  1,3 butadiene

B) 1,2 - AND 1,4 - ADDITION
due to the delocalized e^- of conjugated dienes

- 1,2 - ADDITION : $CH_2 = CH - CH = CH_2 + Br_2 \rightarrow$

$CH_2(Br) - CH - CH = CH_2$

- 1,4 - ADDITION : $CH_2 = CH - CH = CH_2 + Br_2 \rightarrow$

$Br - CH_2 - CH = CH - CH_2 - Br$

• may be stereoisomers (cis/trans)

⑤ ALKYL HALIDES

: functional group : F, Cl, Br, I
: only synthetic

A) NAMES

halo- prefix

: ALKYL HALIDES
· ARYL HALIDES
· VINYL HALIDES

B) PREPARATION

· HALOGENATION : $RH \xrightarrow{X_2} RX$

· FROM ALCOHOL : $R\text{-}OH \xrightarrow{-X} R\text{-}X$

· ADDITION OF HYDROGEN HALIDES : $\text{>C=C<} \xrightarrow{HX} \text{>C(H)-C(X)<}$

C) SUBSTITUTION (SN) REACTIONS

· ALCOHOL : $R\text{-}X + OH^- \longrightarrow R\text{-}OH$
· ETHER : $R\text{-}X + O\text{-}R' \longrightarrow R\text{-}O\text{-}R'$
· THIOL : $R\text{-}X + SH \longrightarrow R\text{-}SH$
· SULFIDE : $R\text{-}X + S\text{-}R' \longrightarrow R\text{-}S\text{-}R'$
· NITRILE (CYANIDE) : $R\text{-}X + C\equiv N \longrightarrow R\text{-}C\equiv N$
· HALIDE : $R\text{-}X + X' \longrightarrow R\text{-}X'$
· AMINE : $R\text{-}X + NH_3 \longrightarrow R\text{-}NH_2 + HX$
· GRIGNARD REAGENTS : $R\text{-}X + Mg \longrightarrow R\text{-}Mg\text{-}X$

D) ELIMINATION (E) REACTIONS

$$H\text{-}\text{>C(H)-C(X)<} \xrightarrow[OH^-]{\text{high } T} \text{>C=C<}$$

ⓑ ALCOHOLS

A) DEFINITION

- functional group : -OH
- naturally occuring

B) CLASSIFICATION

- ALCOHOL : - -OH is attached to a sp^3 hybridized C-atom
  - primary -, secondary- and tertiary alcohols (# of C-atoms connected to the parent C-atom)
- ENOLS : - -OH is attached to a sp^2 hybridized C-atom
- PHENOLS : - -OH is attached <u>directly</u> to an aromatic ring

C) NOMENCLATURE

-ol ending

D) PHYSICAL PROPERTIES

- higher boiling point (-OH forms H-bonds btw themselves)
- methanol - propanol is soluble in H_2O (3 first)

E) CHEMICAL PROPERTIES

- ACIDITY REACTION : $R-OH \rightleftharpoons R-O^- + H^+$
- DEHYDRATION : $H_2C-CH_2 \xrightarrow[H^+]{heat} H_2C=CH_2 + H_2O$

  (H, CH) — ethanol → ethene
- ETHER FORMATION : $R-OH + HO-R' \xrightarrow{H^+} R-O-R' + H_2O$
- ESTER FORMATION : $R-OH + HO-\underset{\underset{O}{\|}}{C}-R' \rightleftharpoons$

  alcohol + carboxylic acid

  $R-O-\underset{\underset{O}{\|}}{C}-R' + H_2O$

  ester

- OXIDATION : - primary alcohol → aldehyde → carboxylic acid
  - secondary alcohol → ketone
  - tertiary alcohol → ∅

F) ALCOHOLS OF PRACTICAL IMPORTANCE

- METHANOL : - toxic
  - causes blindness / death
- ETHANOL : - toxic
  - narcotic
- GLYCEROL : - used in cosmetics
- PHENOL : - toxic
  - disinfecting
- GLYCEROL TRINITRATE : - dynamite

⑦ ETHERS

A) DEFINITION

- 2 organic compounds connected by a single O-atom
- similar bond angle to H_2O

B) CLASSIFICATION

- ETHERS
- EPOXIDES (3 membered cyclic ether containing 1 O-atom)
- CYCLIC ETHERS

C) NOMENCLATURE

R-yl R'-yl ether

D) PHYSICAL PROPERTIES

- non-polar
- good solvent (O-atom makes H-bonds with other substances
- low melting/boiling point (very inflamable)

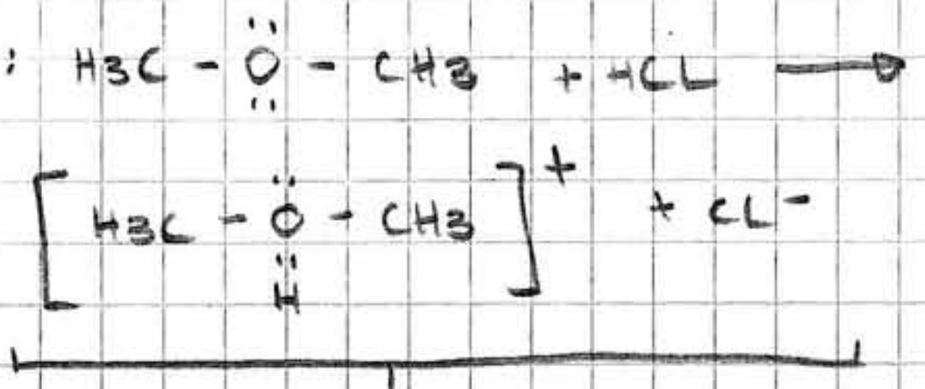
E) CHEMICAL PROPERTIES

I) PREPARATION

- FROM ALKYL HALIDES
- FROM ALCOHOLS

II) REACTIONS

- OXONIUM SALT FORMATION



- CLEAVAGE BY HYDROGEN HALIDES : $R-O-R' \xrightarrow{HX} RX + R'OH \xrightarrow{HX} RX$
- PEROXIDE FORMATION : $R-O-R' + O_2 \xrightarrow{h\nu} R-O-O-R'$

F) ETHERS OF PRACTICAL IMPORTANCE

- DIETHYL ETHER : anesthetic

⑧ ORGANIC SULPHUR COMPOUNDS

A) THIOLS

- FUNCTIONAL GROUP : -SH (sulfhydryl)
- GENERAL FORMULA : · R-SH
  · Ar-SH (thio phenol)

B) THIOETHERS

- FUNCTIONAL GROUP : -S- (sulfide)
- GENERAL FORMULA : · R-S-R'
  · Ar-S-Ar'
  · R-S-Ar

C) DEFINITION

the functional group contains S

D) NAMING

- ENDING : -thiol

E) PHYSICAL PROPERTIES

- volatile (weak H-bonds)
- unpleasant smell

F) CHEMICAL PROPERTIES

I) PREPARATION

- THIOLS FROM ALKYL HALIDES : $R-X + KSH \longrightarrow R-SH + KX$
- THIOETHERS FROM ALKYL HALIDES : $2\,R-X + K_2S \longrightarrow R-S-R + 2KX$

II) REACTIONS

- FORMATION OF DISULFIDE BRIDGE : $2\,R-SH \underset{red}{\overset{ox}{\rightleftharpoons}} R-S-S-R$
- OXIDATION OF THIOLETHERS : $R-\overset{\overset{..}{}}{\underset{..}{S}}-R' \xrightarrow{ox} R-\underset{\underset{O}{\|}}{S}-R'$

sulfoxide

$\xrightarrow{ox} R-\underset{\underset{O}{\|}}{\overset{\overset{O}{\|}}{S}}-R'$

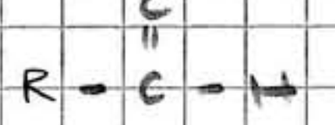
sulfone

9) THIO COMPOUNDS OF PRACTICAL IMPORTANCE

- disulfide bridges in biomolecules
- Na-salts of long-chain sulphonic acids are <u>great</u> detergents

⑨ ALDEHYDES

A) STRUCTURE OF THE CARBONYL GROUP



B) NAMING

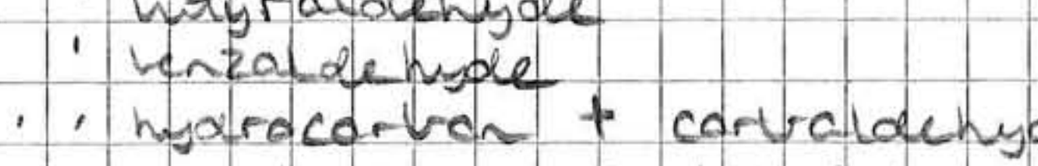
- ENDING : -al
- TRIVIAL NAMES : formaldehyde, butyraldehyde, benzaldehyde
- CYCLIC ALDEHYDES : hydrocarbon + carbaldehyde, eg. benzene carbaldehyde

C) CHEMICAL PROPERTIES

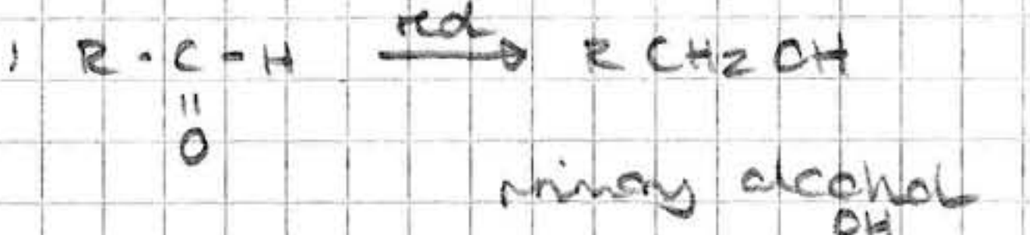
I) PREPARATION

- OXIDATION OF PRIMARY ALCOHOLS

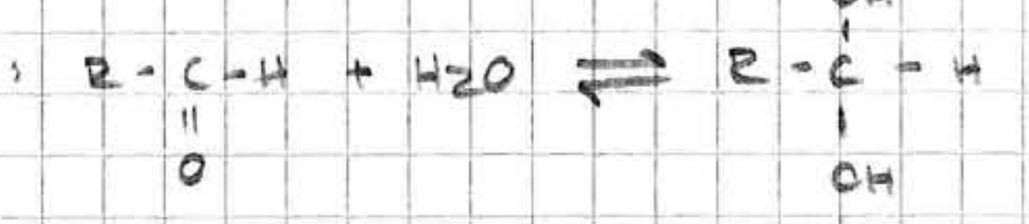
II) REACTIONS

- OXIDATION : 

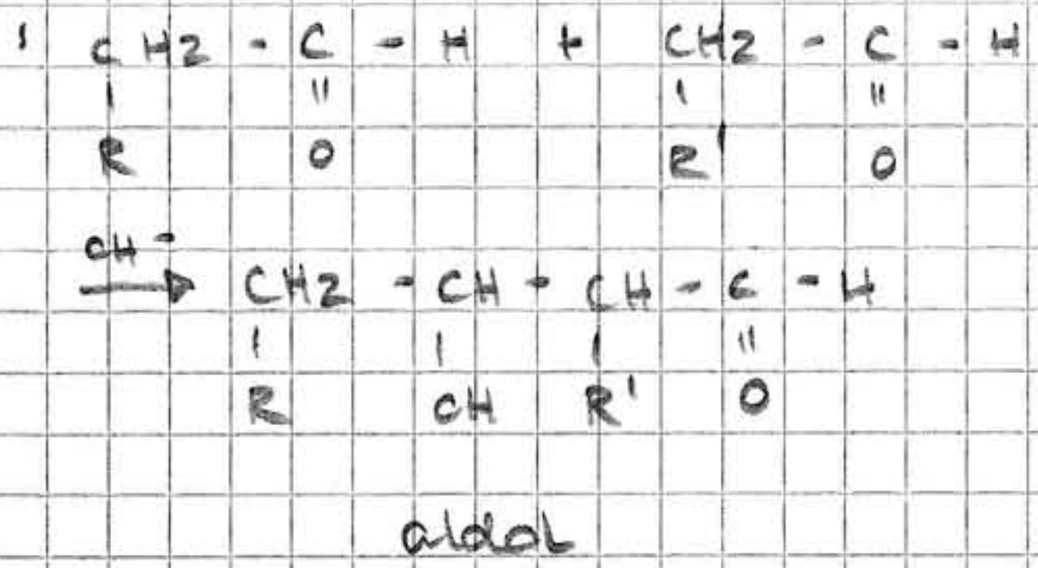
carboxylic acid

- REDUCTION : 

primary alcohol

- ADDITION : 

aldehyde hydrate

- CONDENSATION : 

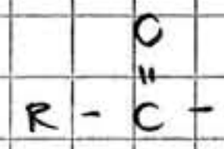
aldol

D) TAUTOMERISM

rearrangement of a H^+ ion over a double bond

(10) ALIPHATIC KETONES

A) STRUCTURE OF THE CARBONYL GROUP



B) NAMING

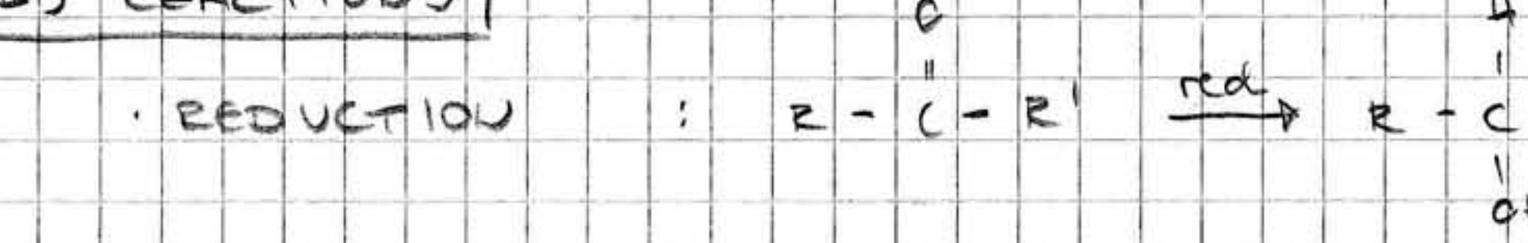
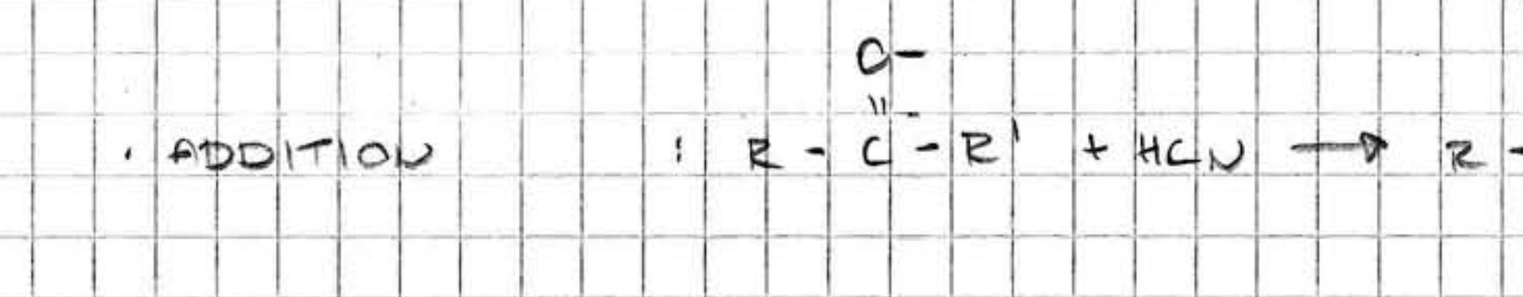
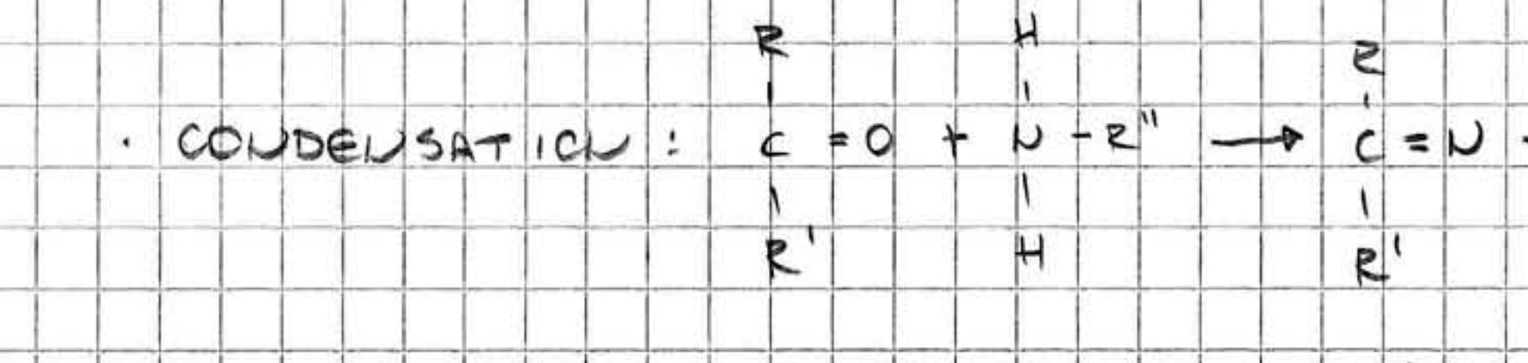
- RADICOFUNCTIONAL NAME : • simple ketones
  • organic groups + ketone
  • eg. ethyl methyl ketone
- SUBSTITUTIVE NAME : - one ending

C) CHEMICAL PROPERTIES

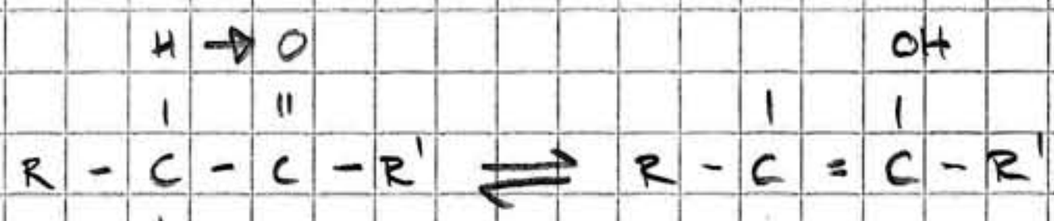
I) PREPARATION

- OXIDATION OF SECONDARY ALCOHOLS

II) REACTIONS

- REDUCTION : 
  secondary alcohol
- ADDITION : 
  cyanohydrine
- CONDENSATION : 
  schiff base

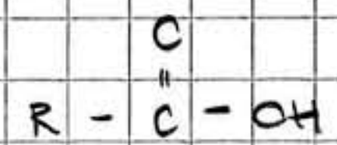
D) TAUTOMERISM



keto enol

(11) ALIPHATIC MONOCARBOXYLIC ACIDS

A) STRUCTURE OF THE CARBOXYL GROUP



B) NAME

- ENDING : - oic acid

C) CLASSIFICATION

- ORGANIC :
  - aliphatic
    - saturated
    - unsaturated
  - aromatic
  - substituted
- ACIDIC :
  - monocarboxylic acid
  - dicarboxylic acid
  - polycarboxylic acid

D) PHYSICAL PROPERTIES

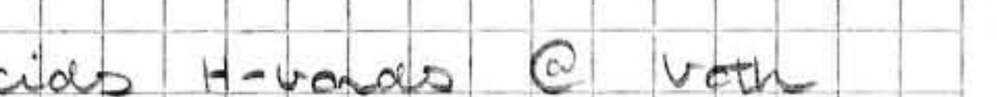
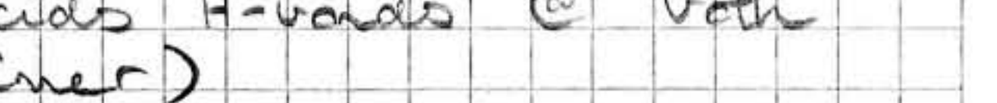
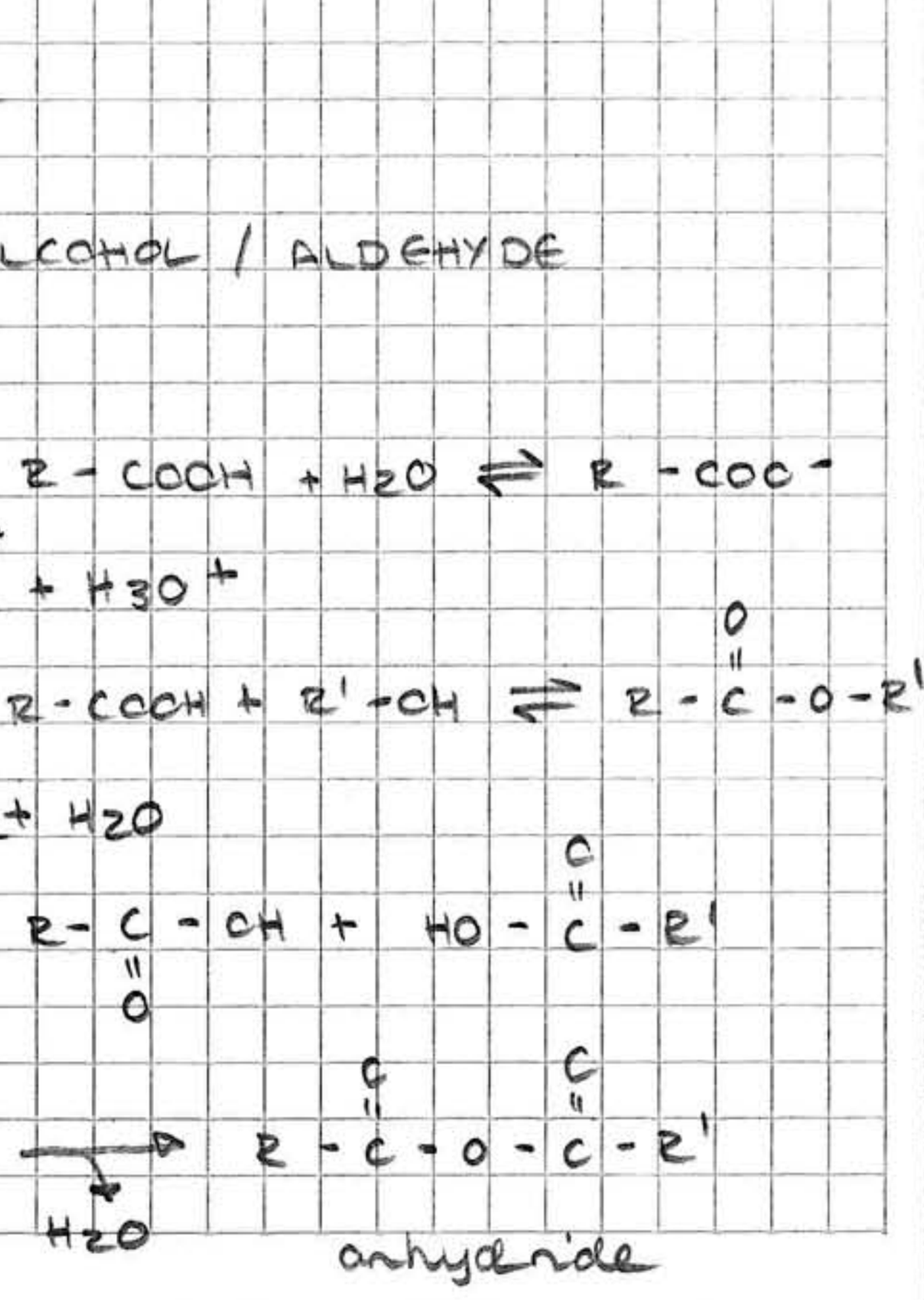
- liquids
- high boiling point (2 acids H-bonds @ both -OH and =O → acid dimer)
- first 4 acids are water soluble

E) CHEMICAL PROPERTIES

I) PREPARATION

- OXIDATION OF PRIMARY ALCOHOL / ALDEHYDE

II) REACTIONS

- SALT FORMATION : 
- ESTER FORMATION : 
- ANHYDRIDE FORMATION : 
  anhydride

F) MONOCARBOXYLIC ACIDS OF BIOCHEMICAL IMPORTANCE

· ACETIC ACID	: in vinegar
· BUTYRIC ACID	: in rancid butter
· GLUTARIC ACID	: regulation of physiological pH
· LACTIC ACID	: sour milk
· SALICYCLIC ACID	: preparation of aspirin (acetyl-salicyclate)

2003 © BR/

(12) FUNCTIONAL DERIVATIVES OF CARBOXYLIC ACIDS

A) ACYL GROUPS

- SALTS : $R-\overset{O}{\overset{\|}{C}}-O^- Na^+$
- ACYL HALIDES : $R-\overset{O}{\overset{\|}{C}}-X$
- ACID ANHYDRIDE : $R-\overset{O}{\overset{\|}{C}}-O-\overset{O}{\overset{\|}{C}}-R'$
- ESTERS : $R-\overset{O}{\overset{\|}{C}}-O-R'$
- AMIDES : $R-\overset{O}{\overset{\|}{C}}-NH_2$
- NITRILES (CYANIDES) : $R-C\equiv N$

B) CHEMICAL PROPERTIES

I) PREPARATION

- ACYL HALIDES :

$$R-\overset{O}{\overset{\|}{C}}-O-OH + PCl_5 \rightarrow R-\overset{O}{\overset{\|}{C}}-Cl + HCl + POCl_3$$

- ACID ANHYDRIDE :

$$R-\overset{O}{\overset{\|}{C}}-Cl + R'-\overset{O}{\overset{\|}{C}}-O\,Na$$

acyl halide + salt

$$\rightarrow R-\overset{O}{\overset{\|}{C}}-O-\overset{O}{\overset{\|}{C}}-R' + NaCl$$

acid anhydride

- ESTERS :

$$R-\overset{O}{\overset{\|}{C}}-OH + HO-R' \overset{H^+}{\rightleftharpoons} R-\overset{O}{\overset{\|}{C}}-O-R' + H_2O$$

- AMIDES : $R-\overset{O}{\overset{\|}{C}}-OH + NH_3 \rightarrow R-\overset{C}{\overset{\|}{C}}-O^- NH_4^+$

$\xrightarrow{heat} R-\overset{C}{\overset{\|}{C}}-NH_2 + H_2O$

- NITRILES (CYANIDES) : $R-\overset{C}{\overset{\|}{C}}-NH_2 \xrightarrow{heat} R-C\equiv N + H_2O$

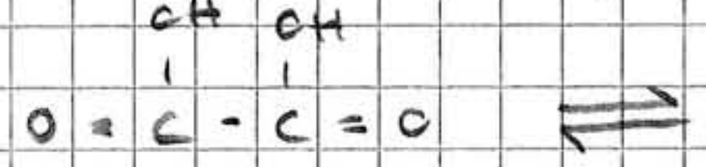
II) REACTIONS

- ACYL HALIDES : + $H_2O \rightarrow$ acid + HX
- ACID ANHYDRIDE : + $H_2O \rightarrow$ 2 acids
- ESTERS : + $H_2O \xrightarrow{heat}$ acid + alcohol
- AMIDES : + $H_2O \rightarrow$ acid + ammonia
- NITRILES : + $H_2O \rightarrow$ amide + $H_2O \rightarrow$ acid

(13) DICARBOXYLIC ACID

A) OXALIC ACID

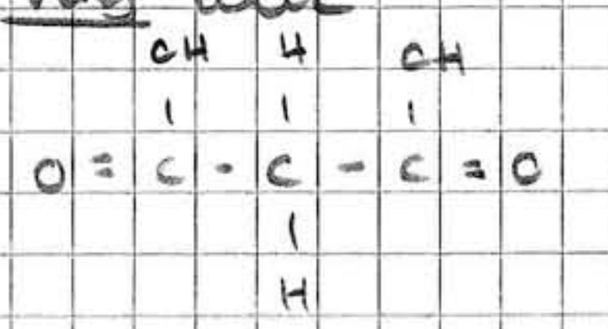
found in plants, very poisonous, inhibits (blood) coagulation



$$O=C(OH)-C(OH)=O \rightleftharpoons CO_2 + CO + H_2O$$

B) MALONIC ACID

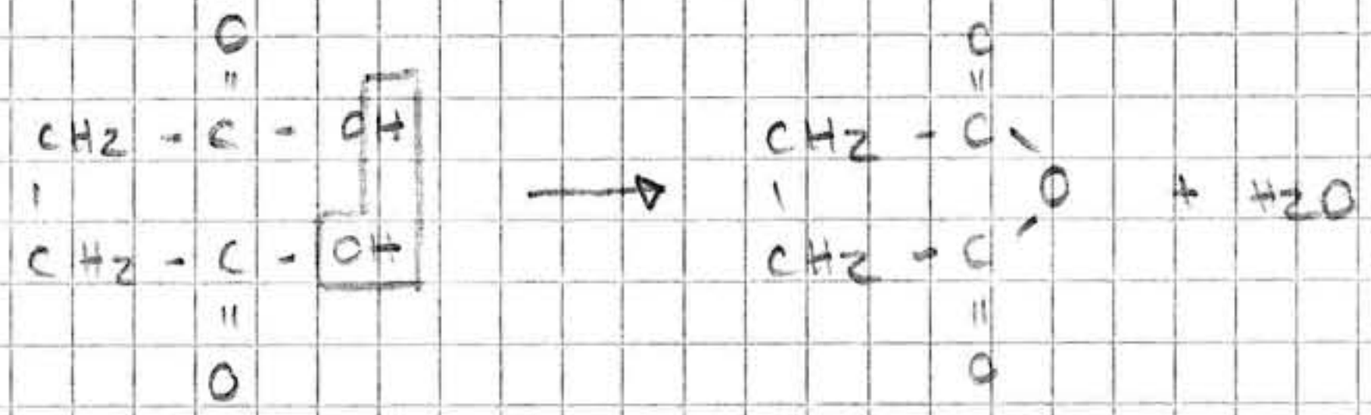
very toxic



$$O=C(OH)-CH_2-C(OH)=O \longrightarrow CH_3COOH + CO_2$$

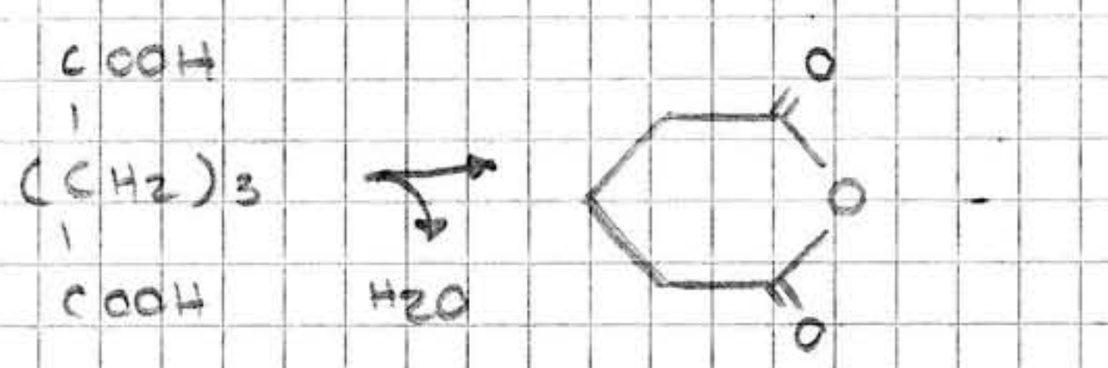
C) SUCCINIC ACID

intermediate in the tricarboxylic acid circle



$$CH_2(C(=O)OH)-CH_2-C(=O)OH \longrightarrow CH_2(C(=O)-O-C=O)-CH_2 + H_2O$$

D) GLUTARIC ACID



$$HOOC-(CH_2)_3-COOH \xrightarrow{-H_2O}$$

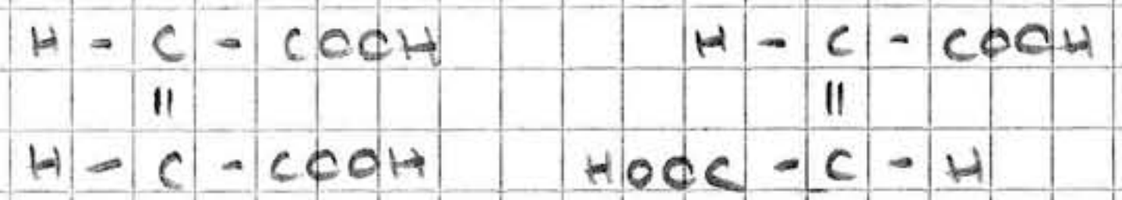
glutaric anhydride (inner anhydride)

E) ADIPIC ACID

found in beet juice

$$HOOC-(CH_2)_4-COOH$$

F) MALEIC AND FUMARIC ACID



maleic acid (cis)

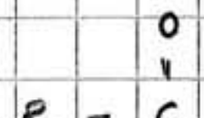
fumaric acid (trans)

a) INNER ANHYDRIDES

5-6 membered ring formed from a dicarboxylic acid (eg. glutaric anhydride)

(15) ESTERS

A) FUNCTIONAL GROUP



B) CLASSIFICATION

- FRUIT ESTERS
- TRIGLYCERIDES
- WAXES

C) NAMING

- ALCOHOL : - comes first
  - yl ending
- CARBOXYLIC ACID : - ate ending

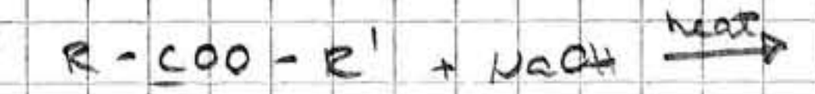
eg. ethyl acetate

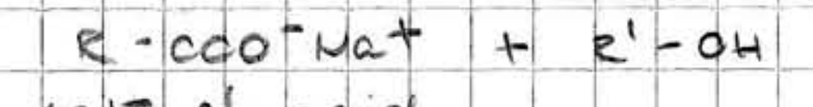
D) CHEMICAL PROPERTIES

I) PREPARATION

carboxylic acid + alcohol

II) REACTIONS

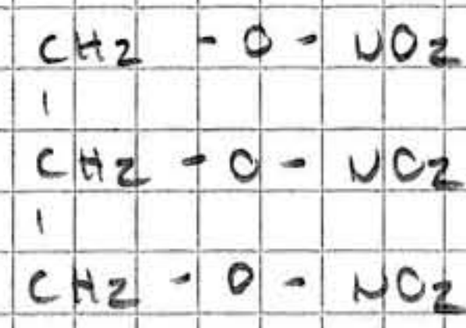
- SAPONIFICATION : 



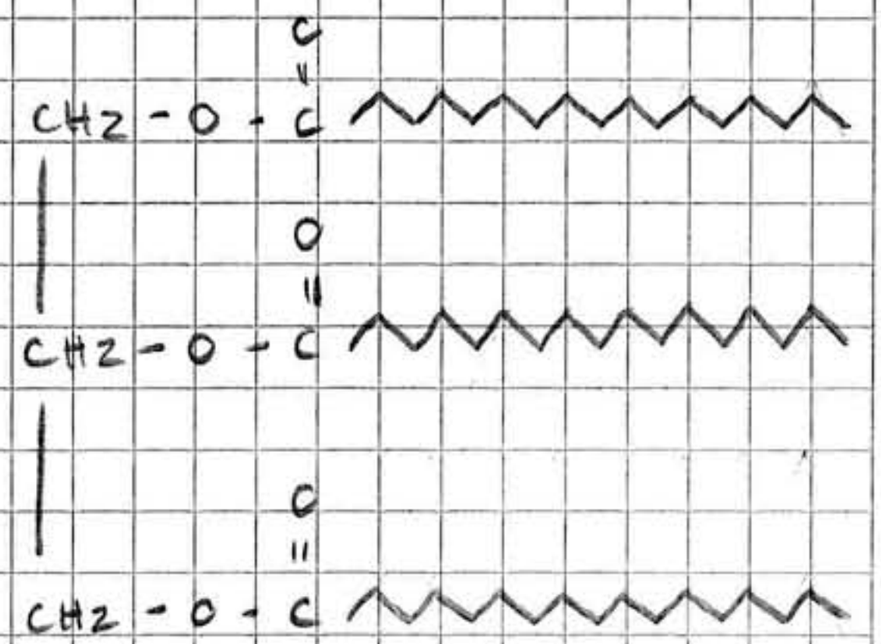
salt of acid

III) COMPOUNDS

- GLYCEROL TRINITRATE : - dynamite
  - vasodilator



· GLYCEROL ESTERS : · detergent (soap)



(16) ALIPHATIC AMINES

A) DEFINITION

compounds structurally derived from ammonia by replacing 1 or more H-atoms with hydrocarbon groups

B) NAMING

- ENDING : - amine

C) CLASSIFICATION

- PRIMARY AMINES : $R-\underset{\underset{R'}{|}}{\overset{\overset{H}{|}}{N}}-H$
- SECONDARY AMINE : $R-\underset{\underset{R'}{|}}{\overset{\overset{R}{|}}{N}}-H$
- TERTIARY AMINE : $R-\underset{\underset{R''}{|}}{\overset{\overset{R'}{|}}{N}}-R''$

D) PHYSICAL PROPERTIES

- can form H-bonds (but less so than alcohols → lower boiling point)
- smaller amines (1-7 C) are soluble in water
- fish-like smell

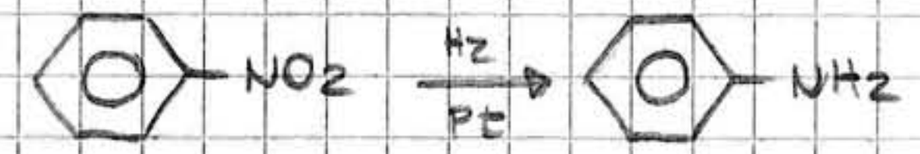
E) CHEMICAL PROPERTIES

I) PREPARATION

- SUBSTITUTION OF HALIDES : $CH_3CH_2X + NH_3 \longrightarrow$

  $CH_3CH_2-NH_3^+X^- \longrightarrow$

  $CH_2=CH_2-NH_2$

- REDUCTION : 

II) REACTIONS WITH NITROUS ACID

determination of primary -, secondary - or tertiary amines

- PRIMARY AMINES : $R-NH_2 + HNO_2 \longrightarrow R-OH + N_2\uparrow$
- SECONDARY AMINES : $R-\underset{\underset{R'}{|}}{NH} + HNO_2 \longrightarrow H_2O + \underset{R'}{\overset{R}{>}}N-N=O$ (nitrosamine)
- TERTIARY AMINES : $R-\underset{\underset{R''}{|}}{\overset{\overset{R'}{|}}{N}}-R'' + HNO_2 \longrightarrow \emptyset$

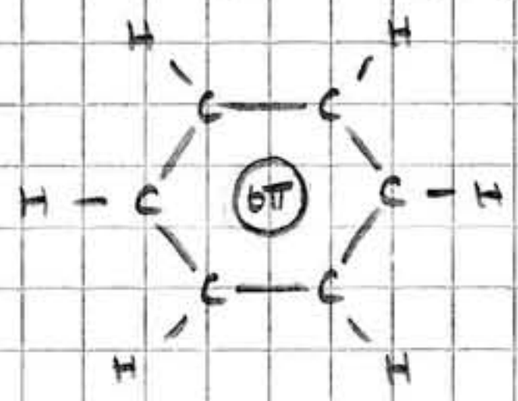
FD BIOLOGICAL IMPORTANCE OF AMINES, NEUROTRANSMITTERS

- ETHANOLAMINE & CHOLINE : · constituents of glycerophospholipids (in cell membranes)
- SPERMINE & SPERMIDINE : · essential in function of chromosome (DNA packaging)
- EXITATORY NEUROTRANSMITTERS : · acetylcholine
  · catecholamines
- INHIBITORY NEUROTRANSMITTERS : · δ-aminobutyric acid (GABA)
  · glycine
  · taurine

(17) AROMATIC HYDROCARBONS I

A) STRUCTURE OF BENZENE

· planar
· alternating bonds (btw single and double)



B) THE HÜCKEL'S RULE

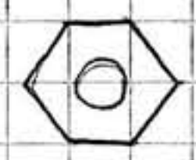
1) the molecule must be cyclic
2) each atom in the ring system must be in the sp^2- hybridized state
3) the ring system must be planar
4) there must be $(4n+2)\pi$ e^- in the ring system

C) AROMATIC CHARACTER

· unsaturated
· stable (low reactivity, undergoes substitution instead of addition)

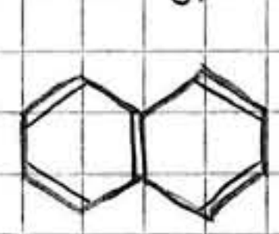
D) GROUPING

· BENZENOID : · alternating conjugated double bond system



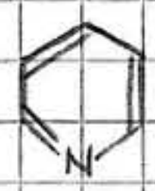
eg. benzene

· POLYCYCLIC : · 2 or more rings
· 2 types : · FUSED
· ISOLATED



eg. naphtalene

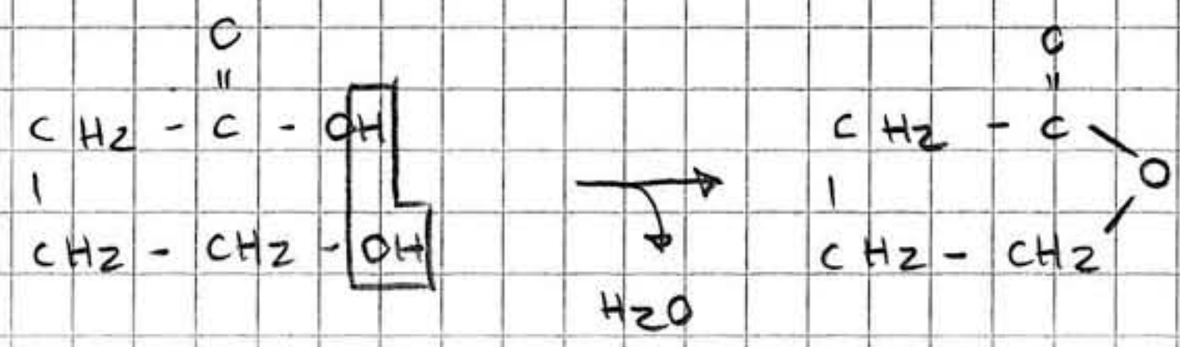
· HETEROCYCLIC · contains a non-carbon in the ring system



eg pyridine

(14) HYDROXY AND OXO CARBOXYLIC ACIDS

A) THE REACTIONS OF THE OH AND COOH GROUPS, LACTONES



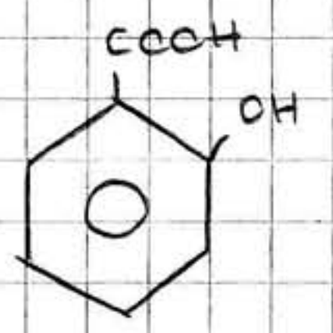
Lacton
(5 membered ring
w/ internal ester)

B) IMPORTANT HYDROXY CARBOXYLIC ACIDS

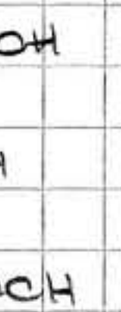
have both a carboxyl- and a hydroxy group

· LACTIC ACID : · important in metabolism

· SALICYLIC ACID : · flavour in candy
· preparation of aspirin



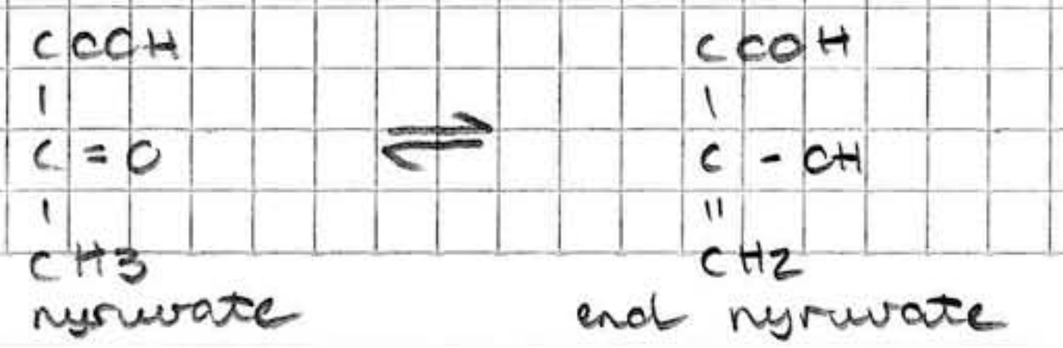
· CITRIC ACID : · in lemon juice
· flavour in candy
· in tricarboxylic acid circle



C) IMPORTANT OXO CARBOXYLIC ACIDS

have both a carboxyl- and a carbonyl group

· PYRUVIC ACID : · in glycolysis



keto pyruvate — enol pyruvate

E) NAMING

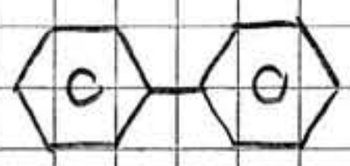
common names !

F) ISOMERISM

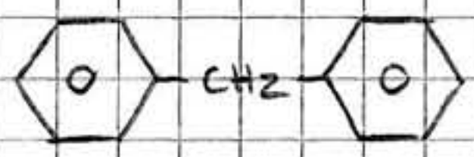
- ORTHO : 1,2
- META : 1,3
- PARA : 1,4

G) ISOLATED POLYCYCLIC AROMATICS

- DIPHENYL :



- DIPHENYL METHANE :



H) FUSED POLYCYCLIC AROMATICS

- NAPHTHALENE

(18) AROMATIC COMPOUNDS I

A) PHYSICAL PROPERTIES OF AROMATIC HYDROCARBONS

higher melting- and boiling point (stronger van der Waals forces acting on larger surfaces)

B) REACTIONS OF BENZENE

electrophilic aromatic substitution

- HALOGENATION : $Ar-H + X_2 \longrightarrow Ar-X + HX$
- NITRATION : $Ar-H + HNO_3 \longrightarrow Ar-NO_2 + H_2O$

C) ORIENTATION OF ELECTROPHILIC AROMATIC SUBSTITUTION

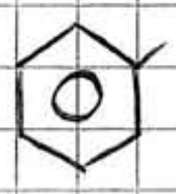
- KÖRNER I SYSTEM : · ortho- and para position
  · functional groups consisting of only single bonds (-R, -X, -OH, $-NH_2$)

- KÖRNER II SYSTEM : · meta position
  · functional groups consisting of both double and single bonds ($-NO_2$, -COOH, $-C\equiv N$)

(19) PHENOLS, QUINONES AND ENOLS

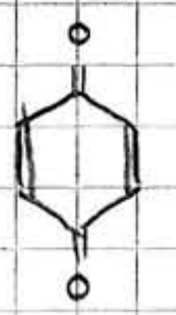
A) CLASSIFICATION OF UNSATURATED OH - COMPOUNDS

· PHENOLS : · -OH linked directly to aromatic ring



eg. phenol

· QUINONES : · oxidized phenols



eg. quinone

· ENOLS : · -OH linked to sp^2 - hybridized C - atom

$H_2C = CH - OH$

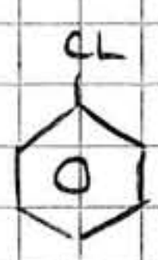
eg. vinyl alcohol

B) PHYSICAL PROPERTIES OF PHENOLS AND QUINONES

· much higher boiling points (-OH forms H - bonds between each other)
· insoluble
· quinones are colored (conjugated double bonds)

C) CHEMICAL PROPERTIES OF PHENOLS AND QUINONES

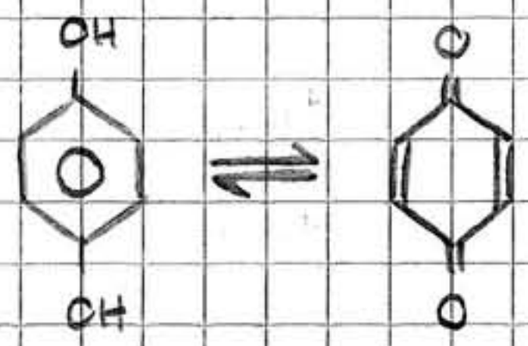
I) PREPARATION

· PHENOLS :  + NaOH →  + NaCl

chlorobenzene phenol

· substitution (from aryl halides)

· QUINONES : · oxidation



hydroquinone quinone
(phenol)

II) REACTIONS

- ELECTROPHILIC AROMATIC SUBSTITUTION
- OXIDATION

DD IMPORTANT PHENOLS AND QUINONES

- PHENOLS : · disinfectants
  · poisonous (fatal)
- QUINONES : · oxidants (reducing agents)
  · coenzyme Q (in mitochondria)

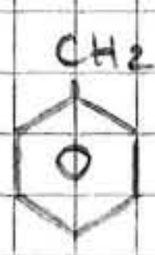
(20) AROMATIC OKO COMPOUNDS AND AROMATIC CARBOXYLIC ACIDS

A) BENZALDEHYDE REACTIONS

Most of aldehydes and of aromatic compounds

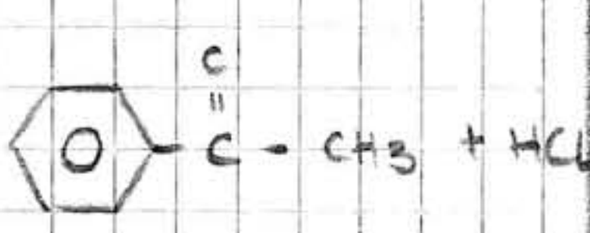
· CANIZZARO'S REACTION : 2  + OH^- →

benzaldehyde

 + 

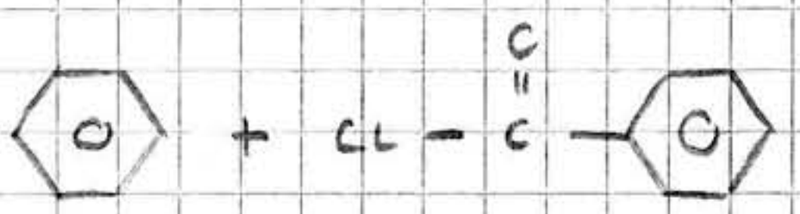
benzyl alcohol (red.) benzoic acid (ox.)

B) ACETOPHENONE REACTIONS

 +  + 1/2 H_2 →  + HCl

acetyl chloride acetophenone

C) BENZOPHENONE REACTIONS

 + 1/2 H_2 →  + HCl

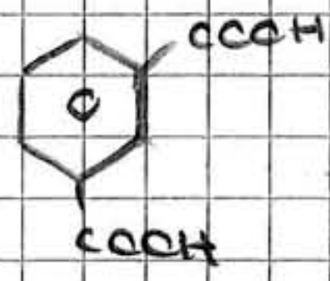
benzyl chloride benzophenone

D) BENZOIC ACID, IT'S CHEMICAL PROPERTIES AND DERIVATIVES

· white crystalline substance
· insoluble in water
· its sodium salt is water soluble (sodium benzoate)
· food preservative (sodium benzoate)

6) AROMATIC DICARBOXYLIC ACIDS

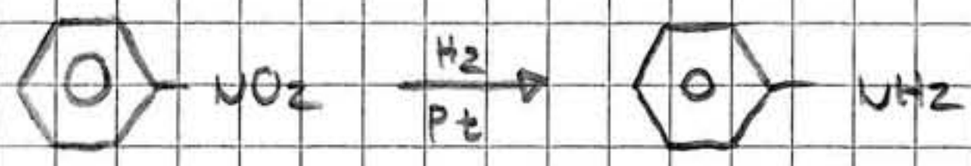
stronger than monocarboxylic acids (duh!)



(21) AROMATIC AMINES

A) CHEMICAL PROPERTIES OF ANILINE

- REDUCTION : see aliphatic amines

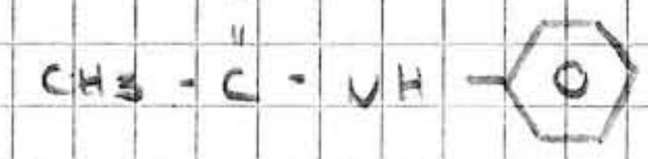


B) AZO COUPLING

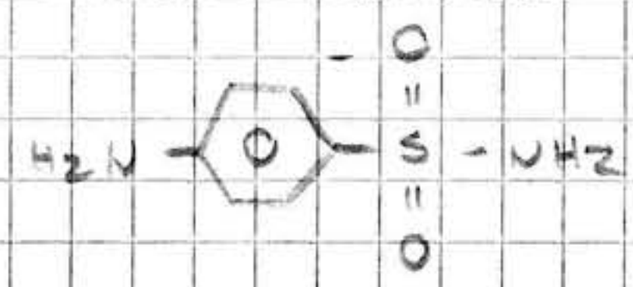
coupling of 2 aromatic amines by $-N=N-$
(→ colored substances)

C) ANILINE DERIVATIVES

- ACETANILIDE : antipyretic
  : toxic



- SULPHONAMIDES : antibacterial



- PAS : antituberculostic