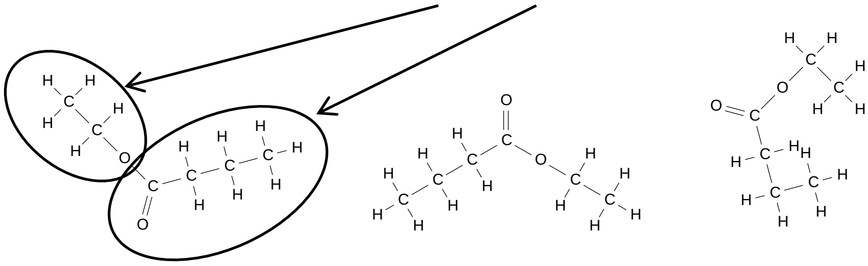
# TOP FIVE ORGANIC THINGS TO KNOW

*(It's hard to choose just 5 areas but these are all very important ones)*

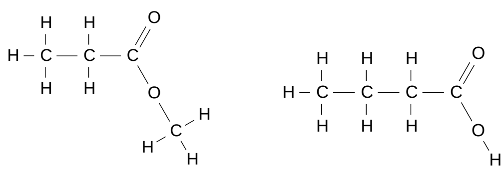
## Esters - know how to make, break and name an ester (and that esters are structural isomers with c.acids)

- Naming ___yl ______oate. "-yl part from alcohol ("in-line -O), -oate part from carboxylic acid (dangly =O")
- These 3 below are all identical – all are eth**yl** butan**oate**



- Two ways to make
  - Heat alcohol + c.acid + conc $H_2SO_4$ – conc. $H_2SO_4$ as a catalyst, and as a dehydrating agent
    - Lose the -OH of c.acid and -H of alcohol as water
  - Mix acid chloride + alcohol – *don't need heat or any conc. $H_2SO_4$*
    - Lose the -Cl of acid chloride and -H of alcohol as HCl(g)
- Preparation method (alc + c.acid); heat under reflux; add carbonate to neutralise acids, separate ester from impurities by distillation
- Breaking – reaction with $H_2O$ - hydrolysis (break where you make – i.e between O and C=O)
  - Acid hydrolysis: heat with dilute acid ($H^+/H_2O$, heat) – get alcohol + c. acid
  - Alkaline hydrolysis: heat with dilute NaOH, (NaOH(aq), heat) - get alcohol + sodium salt of the c. acid $RCOO^-Na^+$
- Something for nothing ☺ If you can make / break an ester you can also do / draw / explain
  - Formation of fats/oils from propan-1,2,3-triol & 3 fatty acids
  - Alkaline hydrolysis of fats/oils for form propan-1,2,3-triol & the sodium salts of fatty acids
  - Acid hydrolysis of fats/oils for form propan-1,2,3-triol & the fatty acids
  - Formation of polyesters from HO-X-OH & HOOC-Y-COOH or HO-X-OH & ClOC-Y-COCl
  - Hydrolysis of polyesters under acidic or alkaline conditions

- Isomerism e.g. $C_4H_8O_2$ could be an ester or a carboxylic acid (although they would be easy to distinguish by their reactions and physical properties)



**Alcohols, their reactions and how to distinguish between them**

**Reaction - Oxidation**

Use orange coloured $H^+/Cr_2O_7^{2-}$ (reduced to green $Cr^{3+}$) or purple coloured $H^+/MnO_4^-$(reduced to colourless $Mn^{2+}$)

- Primary alc → aldehyde (-CHO) → c.acid (-COOH)
- Secondary alc →ketone → X (not further oxidised)
- Tertiaty alc → X (not further oxidised)

Because the aldehyde is "on its way" to becoming oxidised to a c.acid….

- If you want to prepare the aldehyde you have to *distill it off as soon as it is made* or it will be fully oxidised to the c.acid.
- Aldehydes can be oxidised futher (unlike ketones) and so this allows them to be distinguished from ketones by using oxidising agents like:
  - Tollens / Silver mirror test. $Ag^+/NH_3$, heat. Result – silver mirror $Ag^+ + e^- \rightarrow Ag$
  - Benedicts / Fehlings solution. $Cu^{2+}$, heat. Result – orange ppt of $Cu_2O$ $Cu^{2+} + e^- \rightarrow Cu^+$
  - $H^+/Cr_2O_7^{2-}$, heat. Result – orange to green colour change $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$
  - In all 3 above the aldehyde → c. acid

- Lucas reagent – to distinguish $1^o$, $2^o$ and $3^o$ alcohols
  Warm alcohol with Lucas reagent: anhydrous $ZnCl_2$/conc HCl, heat
  - Primary alc → no change (for a very, very long time)
  - Secondary alc →cloudy after about 10 mins
  - Tertiaty alc → cloudy almost immediately

  Cloudiness due to formation of insoluble haloalkane in substitution reaction, -OH off and -Cl on

**Reaction – Esterification**

- $R\text{-}OH + R'\text{-}COOH \rightleftharpoons R'COOR + H_2O$
- R-OH can be primary, secondary or tertiary

**Reaction – formation of haloalkane (a substitution reaction)**

- $R\text{-}OH + SOCl_2 \rightleftharpoons R\text{-}Cl + SO_2 + HCl$
- $SOCl_2$ will work for primary, secondary & tertiary (and therefore safer bet than $PCl_5$ or $PCl_3$ or conc HCl or conc HCl/$ZnCl_2$).

**Reaction – dehydration to form alkenes C=C & $H_2O$ (an elimination reaction)**

- Heat, conc $H_2SO_4$
- If the alcohol is unsymmetrical, get 2 products (the poor get poorer)

## Haloalkanes

R-X where X is -F, -Cl, -Br, -I (but usually -Cl)

Can be primary, secondary or tertiary

**Reaction - Formation**

- from (any) alcohol using $SOCl_2$ (substitution)
  R-OH → R-Cl
- from alkenes using H-X (addition) e.g. HCl
  …but remember if alkene is unsymmetrical = 2 products (the rich get richer)

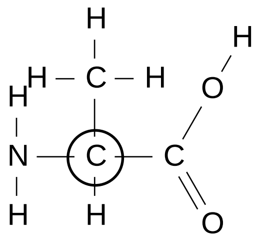
**Reactions – Elimination & Substitution with haloalkanes**

- Eliminate (with) the alcohol!!!!
  Warm with NaOH(**alc**) or KOH(**alc**); NaOH or KOH dissolved in ethanol
  R-X + NaOH(**alc**) → alkene + NaX + $H_2O$
  … but remember if haloalkane is unsymmetrical = 2 products (the poor get poorer)

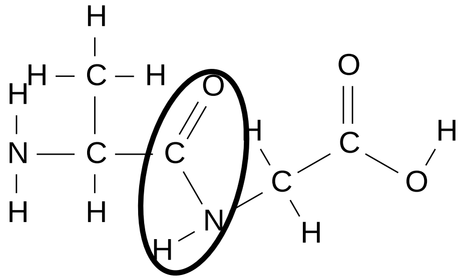
- Substitute (with) the water!!!!
  Uses NaOH(**aq**) or KOH(**aq**); NaOH or KOH dissolved in water
  R-X + NaOH(**aq**) → R-OH + NaX

**Amino acids**

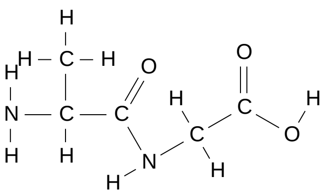
- Are building blocks of peptides & proteins
- Have a $-NH_2$ and a $-COOH$ group attached to the same C atom
- Can be chiral if the "middle C" has 2 different groups/atoms attached to it e.g.



- Join together in a condensation reaction, eliminating the small molecule $H_2O$, forming the "amide / peptide" link of -CONH-



- If you join 2 different amino acids you can make 2 different dipeptides



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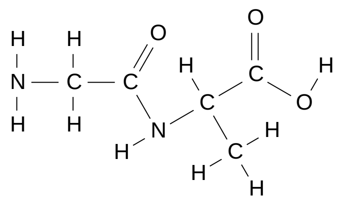
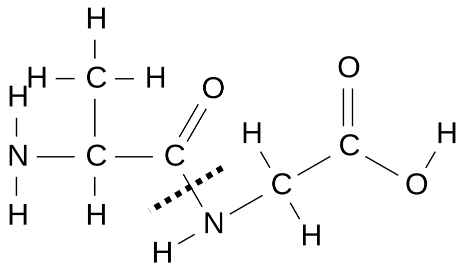


$NH_2$ end bonded to $-CH(CH_3)-$

$NH_2$ end bonded to $-CH_2-$

- And you break where you make…. in the reaction with dilute acids or alkalis (hydrolysis).



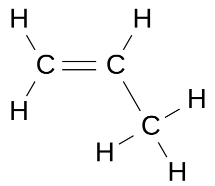
  - Under **acidic** conditions end up with a -COOH end and a $-NH_3^+$ end to the amino acids
  - Under **alkaline** conditions end up with a $-COO^-$ (or $-COO^-Na^+$) end and a $-NH_2$ end to the amino acids

**Addition reactions of alkenes**

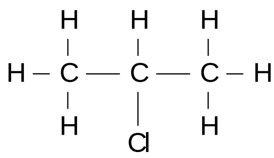
Addition of an unsymmetrical reagent, e.g. HCl or $H_2O$ to an unsymmetrical alkene; the rich get richer.

Addition of HCl to

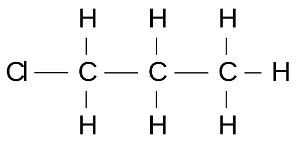
propene



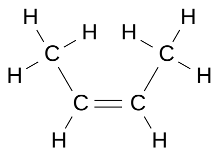
major product



minor product



Addition of HCl to cis and trans isomers of but-2-ene only forms ONE product because but-2-ene is symmetrical – and the product – a haloalkane has single C-C bonds which can freely rotate



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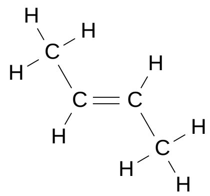
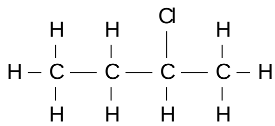
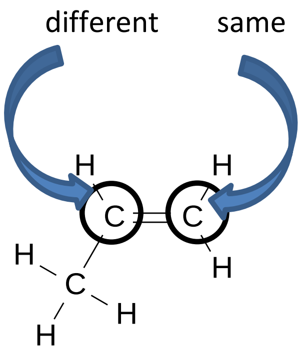


both give the same product

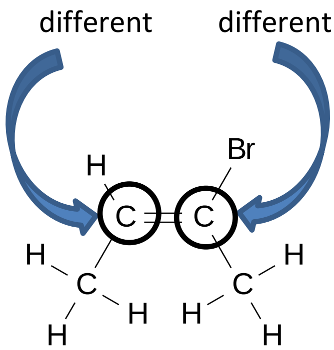


For geometrical isomers to exist you need:

- A C=C double bond, around which there is NO free rotation
- The groups/atoms on the C atom at **EACH END OF** the C=C double bond need to be different to each other.




no cis / trans




can exist as cis and trans

Addition of water to an alkene – hydration, an addition reaction.

Heat with dilute acid e.g. sulfuric acid. We normally write this as $H^+/H_2O$, heat