



# ADDITION & CONDENSATION POLYMERS

	Addition polymers	Condensation polymers
what they are and how they are formed	long chain molecules made from joining together many shorter molecules (monomers) together to form a long chain molecule, with nothing else produced.	long chain molecules made from joining together many shorter molecules (monomers) together to form a long chain molecule, with some one small molecule also formed (e.g. water).
monomers	alkenes molecules with C=C bonds	dicarboxylic acids with diols dicarboxylic acids with diamines amino acids
examples	poly(ethene) PVC poly(propene)	polyesters (e.g. terylene) polyamides (e.g. nylon, Kevlar)
biodegradability	non-biodegradable (due to absence of polar bonds in the main chain (all bonds are C-C))	biodegradable (due to the presence of polar C-N or C-O bonds in the main chain)

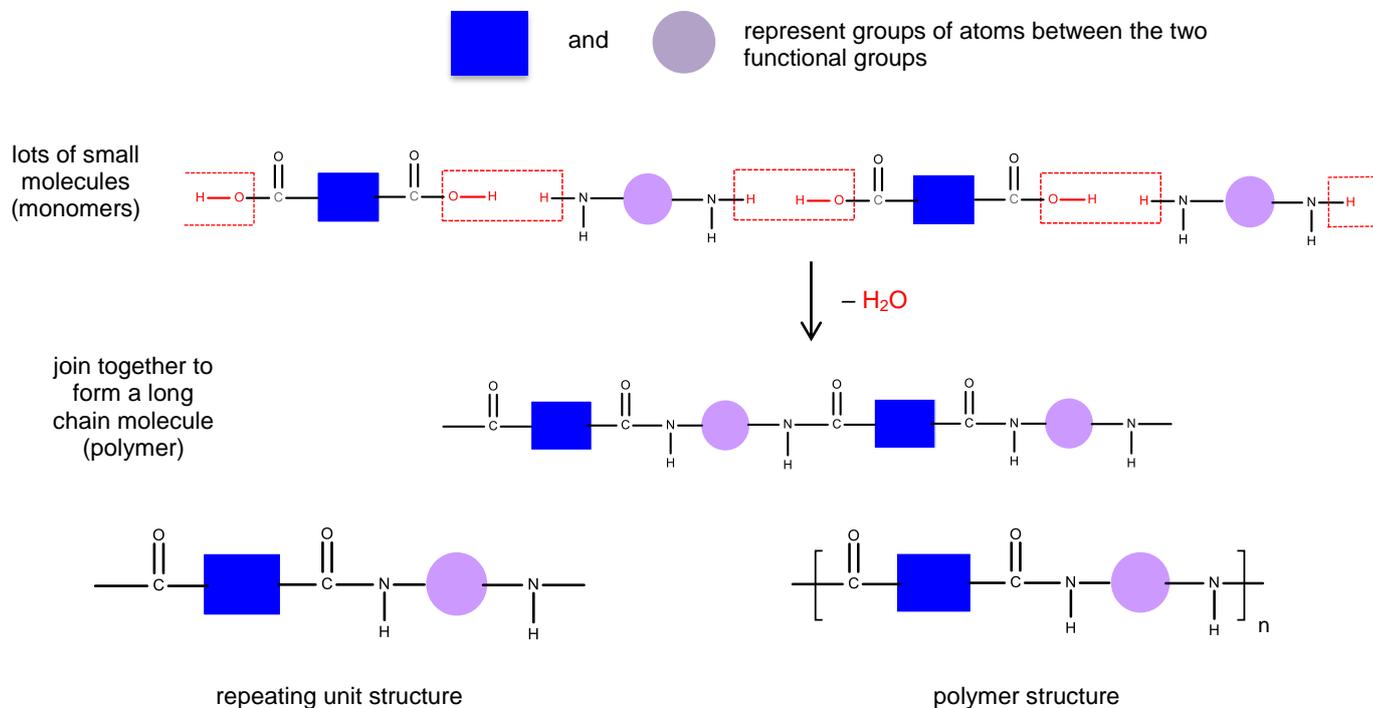
## ADDITION POLYMERS

Monomer		Polymer		
Name	Structure	Name	Structure	Repeating unit
chloroethene				
		poly(ethenol)		
dichloropropene				

# CONDENSATION POLYMERS

## (a) Polyamides

When a carboxylic acid reacts with an amine, an amide is formed with water released as the molecules join together. If a dicarboxylic acid reacts with a diamine, a polymer called a **polyamide** is formed and water is released.



e.g. 1,6-diaminohexane and hexane-1,6-dioic acid to make **nylon 6,6**:

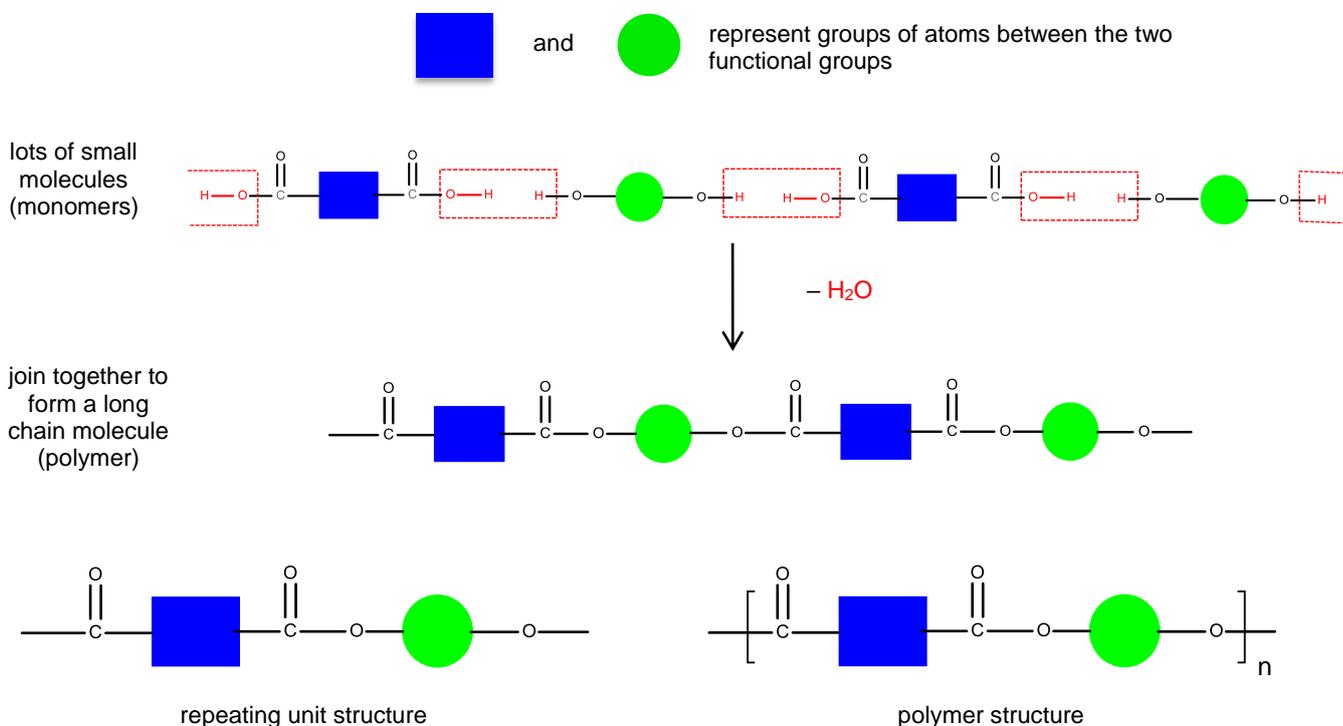
monomer 1	1,6-diaminohexane	$\text{H}_2\text{N}-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{NH}_2$
monomer 2	hexane-1,6-dioic acid	$\text{HO}-\overset{\text{O}}{\parallel}{\text{C}}-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2-\overset{\text{O}}{\parallel}{\text{C}}-\text{OH}$
polymer	repeating unit	$\text{---}\overset{\text{O}}{\parallel}{\text{C}}-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2-\overset{\text{O}}{\parallel}{\text{C}}-\text{HN}-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{NH}---$
	polymer structure	$\left[ \overset{\text{O}}{\parallel}{\text{C}}-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2-\overset{\text{O}}{\parallel}{\text{C}}-\text{HN}-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{NH} \right]_n$

Polyamides can also be formed by the polymerisation of amino acids as they contain a carboxylic acid group and an amine group. In a protein, different amino acids are joined together in a specific sequence. However, if a single amino acid is used (that may or may not be an  $\alpha$  amino acid) then a polymer with a common repeating unit is formed.

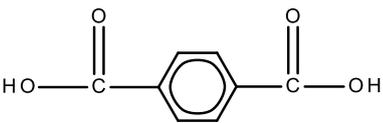
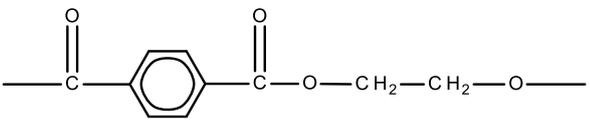
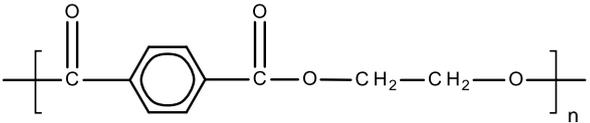
structure of monomer	repeating unit of polymer	structure of polymer
$\text{H}_2\text{N}-\underset{\text{H}}{\text{C}}-\overset{\text{O}}{\parallel}{\text{C}}-\text{OH}$	$\text{---HN}-\underset{\text{H}}{\text{C}}-\overset{\text{O}}{\parallel}{\text{C}}---$	$\left[ \text{HN}-\underset{\text{H}}{\text{C}}-\overset{\text{O}}{\parallel}{\text{C}} \right]_n$

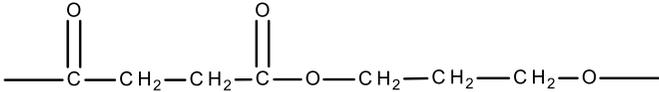
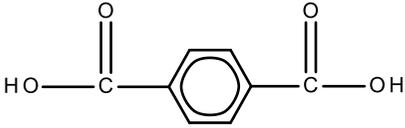
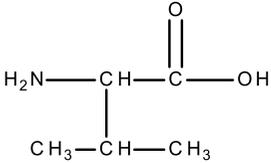
## (b) Polyesters

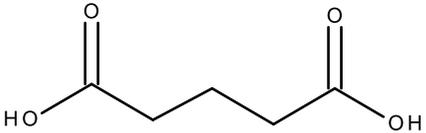
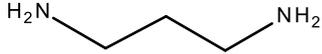
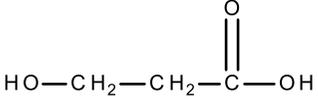
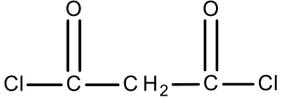
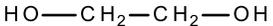
When a carboxylic acid reacts with an alcohol, an ester is formed with water released as the molecules join together. If a dicarboxylic acid reacts with a diol, a polymer called a **polyester** is formed and water is released.



e.g. ethane-1,2-diol + benzene-1,4-dicarboxylic acid to make **terylene**, also known as **PET**

monomer 1	ethane-1,2-diol	HO—CH <sub>2</sub> —CH <sub>2</sub> —OH
monomer 2	benzene-1,4-dicarboxylic acid	
polymer	repeating unit	
	polymer structure	

Monomer 1 (name & structure)	Monomer 2 (name & structure)	Polymer	
		repeating unit	 $\text{---C(=O)---CH}_2\text{---CH}_2\text{---C(=O)---O---CH}_2\text{---CH}_2\text{---CH}_2\text{---O---}$
		repeating unit	
	only one monomer	repeating unit	
pentane-1,5-dioic acid	ethane-1,2-diol	repeating unit	
		structure	

Monomer 1 (name & structure)	Monomer 2 (name & structure)	Polymer	
		repeating unit	
		structure	$\left[ \text{NH}-\text{CH}_2-\text{CH}_2-\text{CH}_2-\overset{\text{O}}{\parallel}{\text{C}} \right]_n$
		repeating unit	
		structure	
	<p style="text-align: center;">only one monomer</p>	repeating unit	
		structure	
		repeating unit	
		structure	