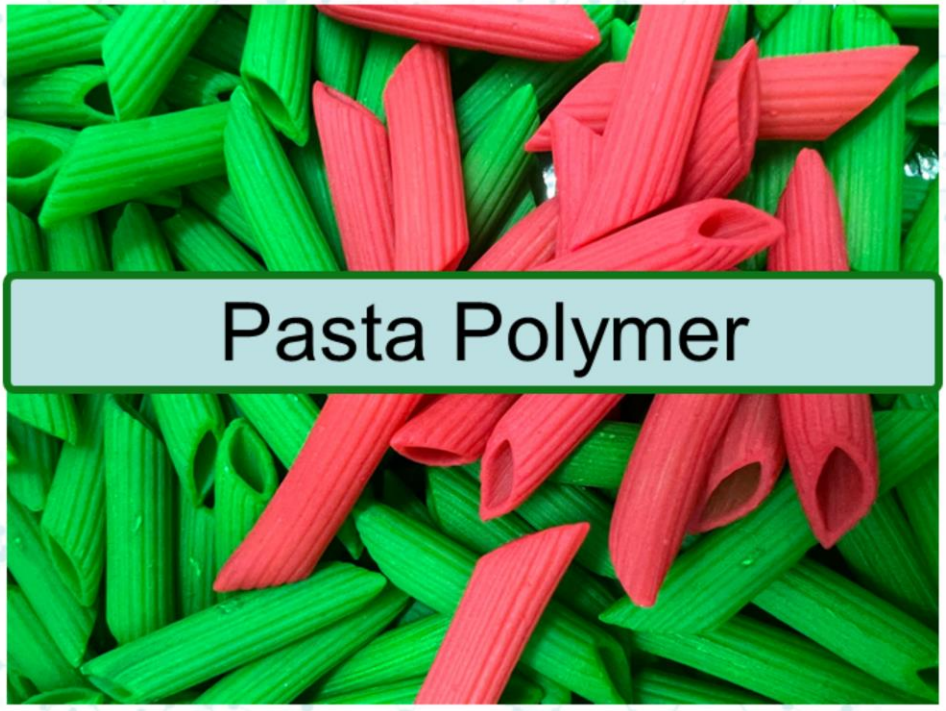
ARC TRAINING CENTRE FOR
GREEN CHEMISTRY
IN MANUFACTURING



Pasta Polymer

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What is Green chemistry?

Aims to use safe, sustainable, environmentally friendly, reusable and non-toxic materials.

Looks to change the practice of everyday chemistry through incorporation of the 12 principles of green chemistry.

Green Chemistry aims at changing the mindset and practices associated with everyday chemistry, to be safe, sustainable, environmentally friendly, re-used and non-toxic. The 12 principles of green chemistry were designed to help inform people about ways they can develop greener and safer chemical products or procedures. The 12 principles of green chemistry are shown on this slide - if there is time you can discuss with students which principles they remember from the biodegradable water bottle experiment.

Plastics

Plastics are all around us!

Some materials used to make plastics are:

- ✕ **not** sustainable
- ✕ **not** environmentally friendly
- ✕ **not** reusable
- ✕ toxic!

They can take centuries to breakdown in landfills and pollute our environment

Plastics are mainly made of non-biodegradable polymers.

Plastics are all around us. Conventional plastics are made from non-biodegradable materials that take centuries to break down in landfill and sometimes end up polluting our environment. Plastic in the ocean is one example of where conventional polymers have polluted our environment and dont breakdown. Most plastics are made up from polymers. Conventional polymers are are typically made up of several monomers - which when reacted result in a sturdy impenetrable final product; however, this means that it may take centuries to breakdown.

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How can we make plastics more sustainable?

..first, we need to understand the science!

So how can we make plastics more sustainable? If we understand the chemistry of polymers, we will have a better understanding on how we can develop greener, more biodegradable and environmentally friendly plastics. (like we did with the biodegradable water bottle practical experiment).

What is a polymer?

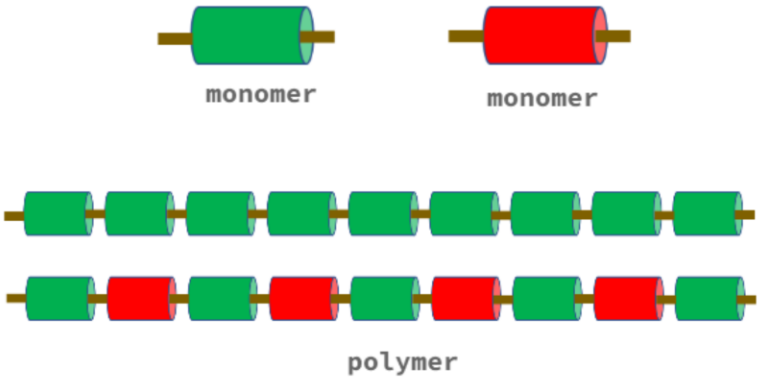
Polymers are large molecules made of connected monomers.Every monomer imparts specific properties to polymers. (heat resistance, water resistance, antimicrobial properties)

Definitions:

'mono'	one
'poly'	many
'mer'	unit

Monomer = one unit

Polymer = many units



A polymer is a large molecule made up of many smaller units or monomers.
The word polymer is made up of two short words..

1. 'Poly' which means 'many', and
2. 'Mer' which means 'part'

Polymers are actually long chains or molecules, made of connected monomers.
'Mono' means 'one', so monomers is 'one part'.

The repetition of the polymer is the basics for plastics.

Different types of polymers

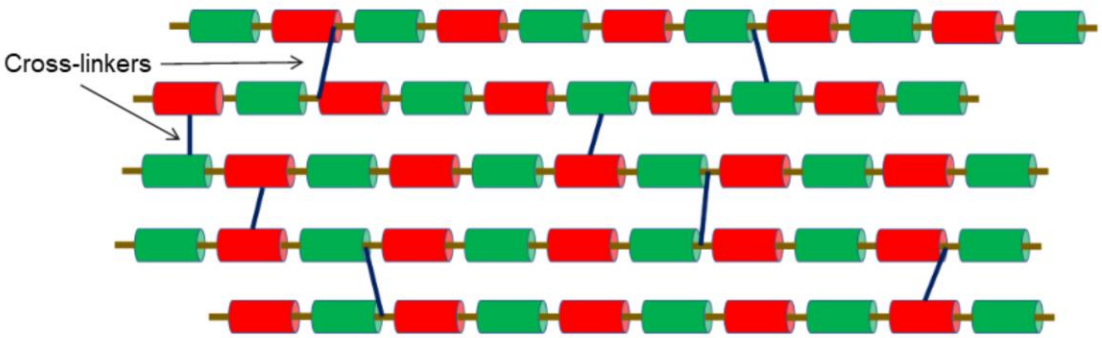
Homopolymer ('same' polymer): a polymer with only one kind of monomer

Alternating copolymer: a polymer with types different types of monomers that repeat

There are different ways you can arrange the monomers within a long polymer chain. If you have multiple monomers, you can create what is called an "alternating polymer", with alternating monomers alternates. This may vary the physical properties of the final polymer. You'll be making both of these types of polymer chains in class today.

Different types of polymers

We can join different polymers to make them more stable, rigid and stronger.



You can also join your polymer chains to create a cross-linked polymers. This stops the chains sliding past each other and creates a structure like a net which is usually much more rigid. Varying the kind of cross-linker will also change the properties of the final polymer.

Let's make our own PASTA Polymers!

Aim

- To make two different types of polymer using pasta and then join them together (cross-link them).

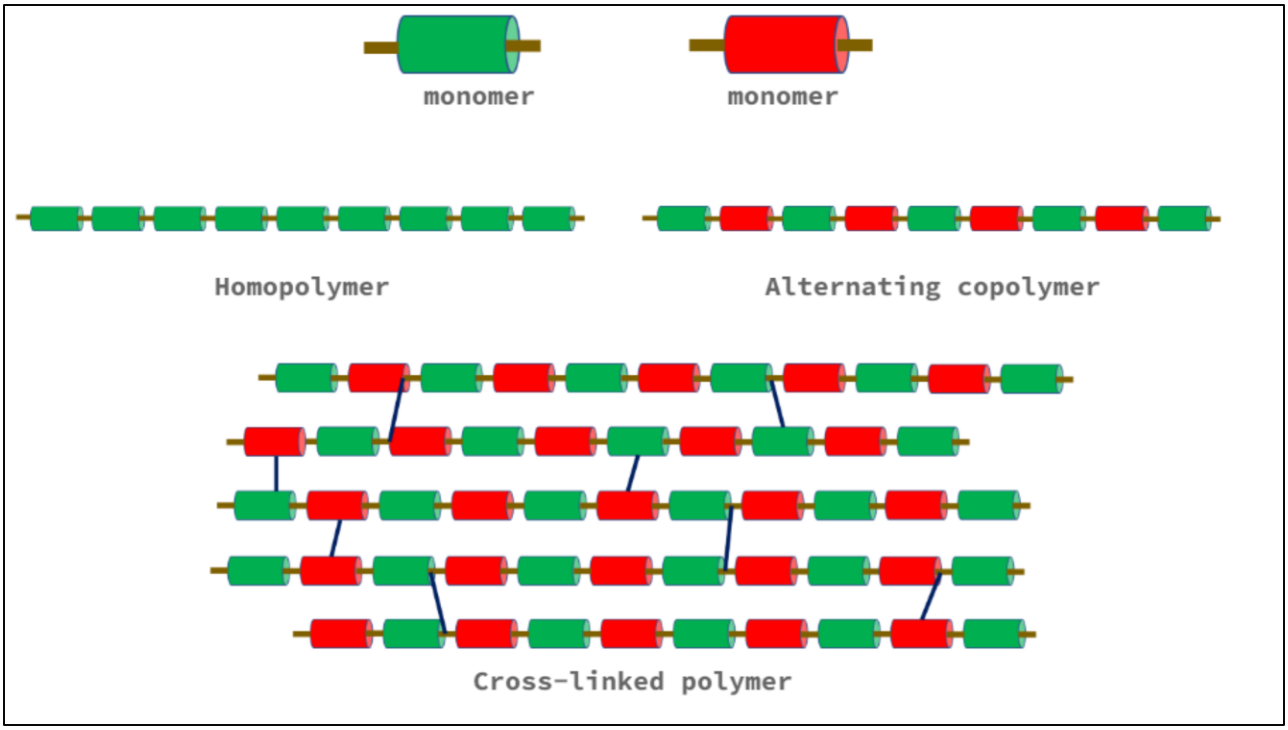
Material

- Green and red pasta (2 different monomer units)
- Small paper clips (cross-linker 1)
- Black twine (cross-linker 2)

Let's make our own Pasta Polymers!

Method

1. Collect all materials - refer to the worksheet
2. In your group create 4 **homopolymer** chains using the green pasta - thread the monomers onto the twine and tie a large knot in the end of the twine. Each chain should contain ~10 pasta.
4. In your group create 4 **alternating copolymer** chains using the green and red pasta. Each chain should contain ~10 pasta.
5. Once you have created your polymer chains, try joining them using the paperclips. Observe your cross-linked polymer chain. Take note of the way it moves.
6. Remove the paper clips, and join your polymer chains with the black twine pieces. Observe the difference in your cross-linked chain compared to previously.


monomer
monomer
Homopolymer
Alternating copolymer
Cross-linked polymer

When are polymers biodegradable?

- When polymers can be broken down into individual monomer units and further break them down into natural elements in a short span of time, then they are biodegradable.
- Biodegradable polymers can be synthetic, natural or a combination of both.
- Natural biodegradable polymers- silk, keratin, cellulose, even our DNA!
- Synthetic biodegradable polymers- some types of polyester, poly(lactic acid).

Extra information if needed.

What are green polymers?

- Green polymers are polymers made using sustainable methods.
- Green chemistry focusses of either replacing a synthetic polymer with a natural counterpart and if that is not possible, reducing the effect on environment while synthesizing them.
- The green nature of polymers can be improved by using biodegradable crosslinkers that join the polymer strands.
- While all biodegradable polymers can be considered green polymers(if they are made in a sustainable way), not all green polymers may be biodegradable.