Chemistry 1010

Plastics I

Introduction

In this lecture, we will answer the following questions:

What is a polymer?

What is a copolymer?

What are some natural polymers?

Can we make artificial polymers?

What are the two kinds of artificial polymers?

How are condensation polymers made?

What is a polymer?

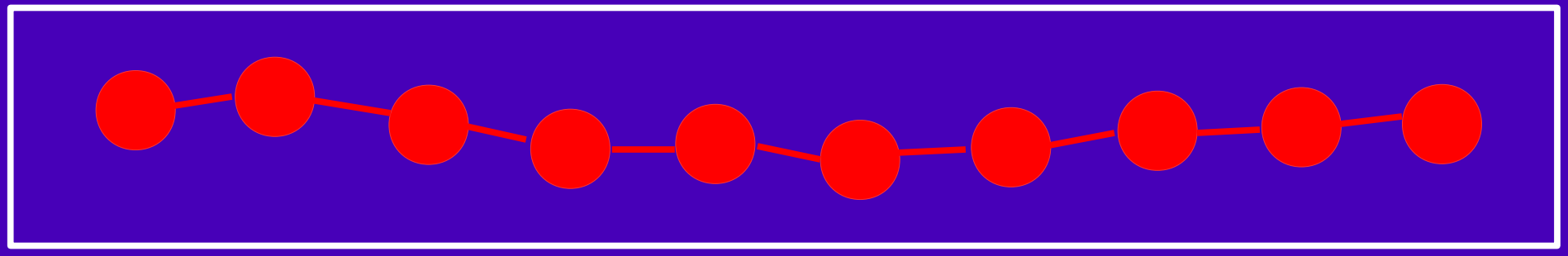
The final subject that we will talk about in this unit is polymers.

polymer = " *poly*" + "*meros*"

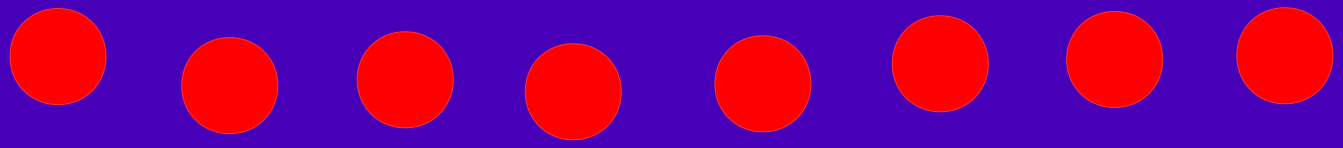
many

parts

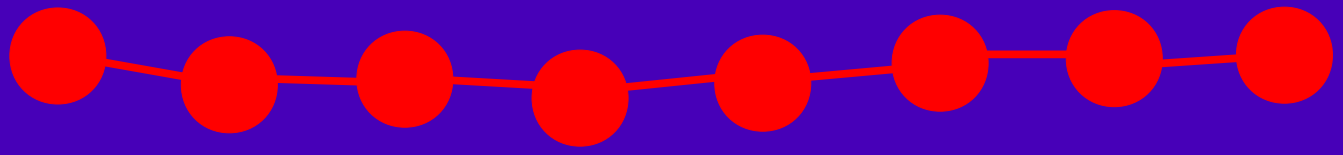
A polymer is a long molecule formed from joining short molecules together.



The small molecules that were joined together are called **monomers**.



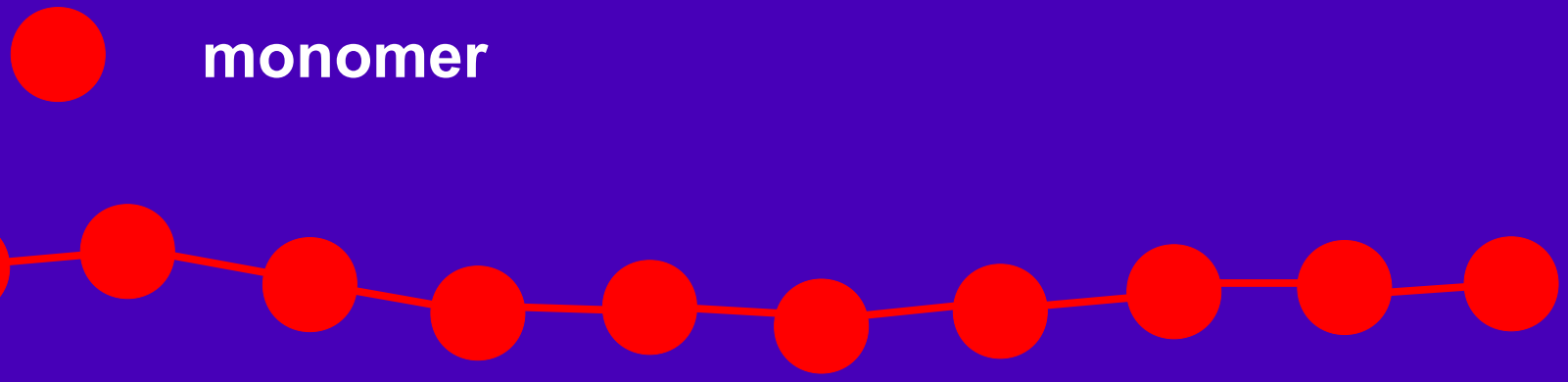
The process of joining monomers together to make a polymer is called **polymerization**.



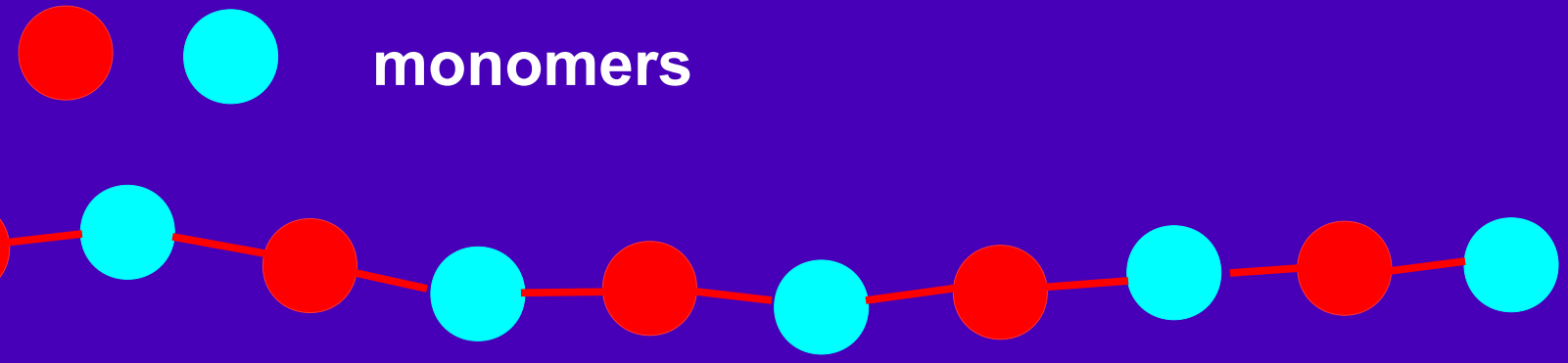
Polymers can be **thousands** of monomers long.

What is a copolymer?

Some polymers are made of only one kind of monomer.



Others are made by joining together two or more different monomers.



This kind of polymer is called a copolymer.

What are some natural polymers?

There are many natural polymers made by plants and animals.

chains of sugar molecules:

glucose – glucose – glucose – glucose – glucose

starch

cellulose

copolymer? no

chains of amino acids

valine - cysteine - alanine - leucine - tryptophan - glutamine

protein

muscle tissue

silk

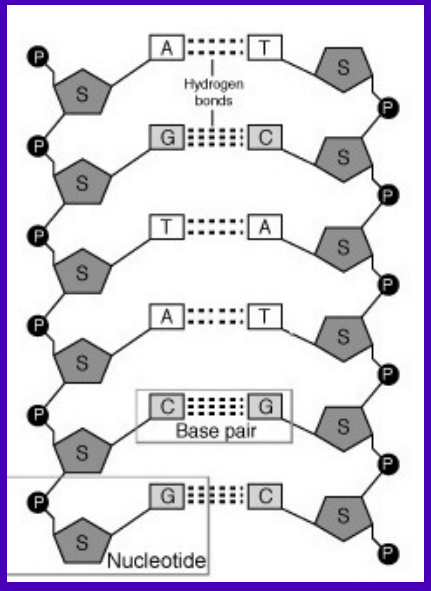
copolymer? yes!

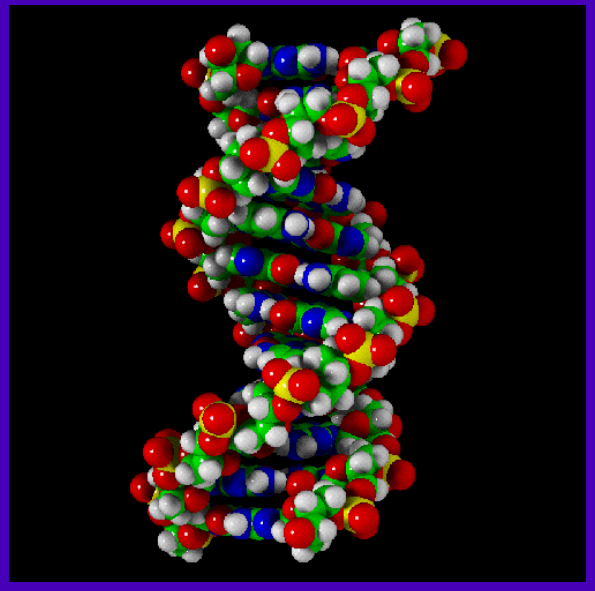
double chains of nucleotides

adenine – cytosine – thymine – adenine – guanine

thymine – guanine – adenine – thymine – cytosine

DNA





genetic material of all cells

copolymer? yes!

Can we make artificial polymers?

Chemists have learned to imitate nature to make artificial polymers.

We call materials made from these polymers plastics.














What makes plastic so useful? They are...















cheap

strong

water proof

lightweight

flexible

don't shatter

easy to manufacture

easy to color

doesn't conduct electricity

easy to control characteristics

What are the two kinds of artificial polymers?

There are two ways in which monomers can be combined to make polymers.

condensation polymers

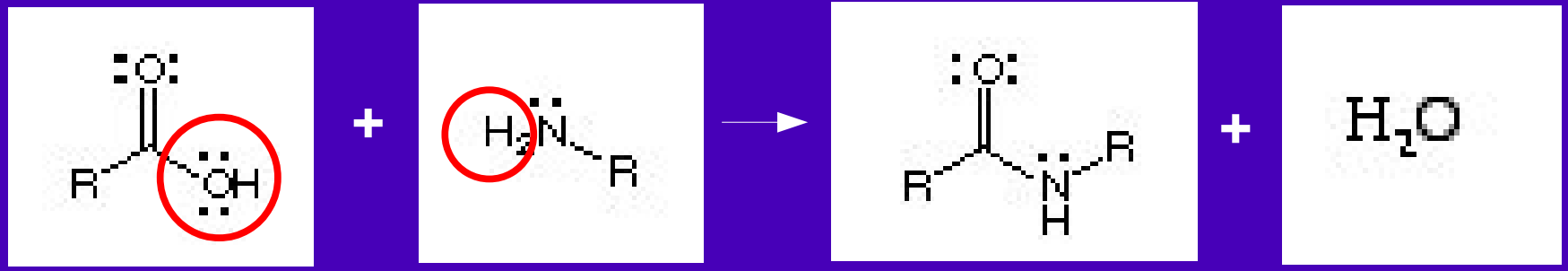
- two functional groups react and join together
- a water molecule is formed every time a linkage is made

addition polymers

- molecules containing C=C react to form a carbon chain
- no atoms are lost; all are present in the polymer

How are condensation polymers made?

When a carboxylic acid and an amine react, they form an amide and water.



carboxylic acid amine amide water

The OH is lost from the carboxylic acid, and one H is lost from the amine – they join together to make a water molecule.

The C from the carboxylic acid is joined to the N from the amine to make an amide.

Example: nylon is a condensation polymer joined by amides

invented in 1928

first used to make tooth brush bristles

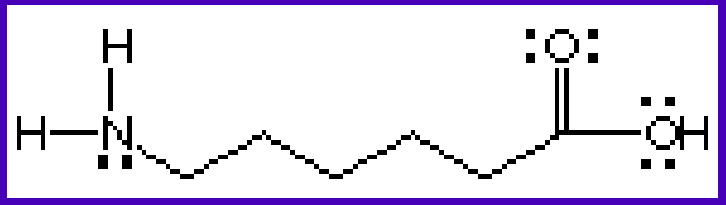
replaced silk stockings

rationed during World War II

used to make rope, tents, parachutes, guitar strings, and racquetball strings

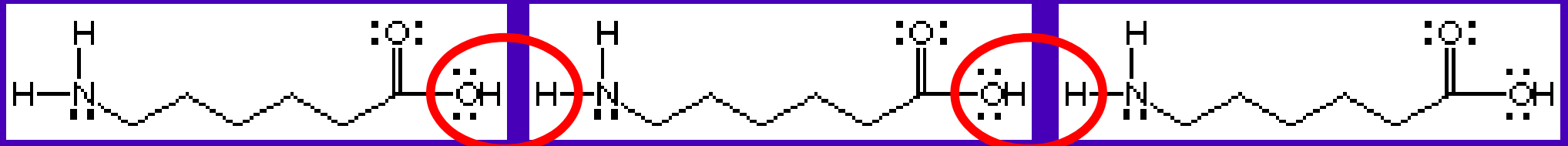
There are two ways to make nylon:

Nylon-6 is made from monomers which have a carboxylic acid one one end and an amine on the other.

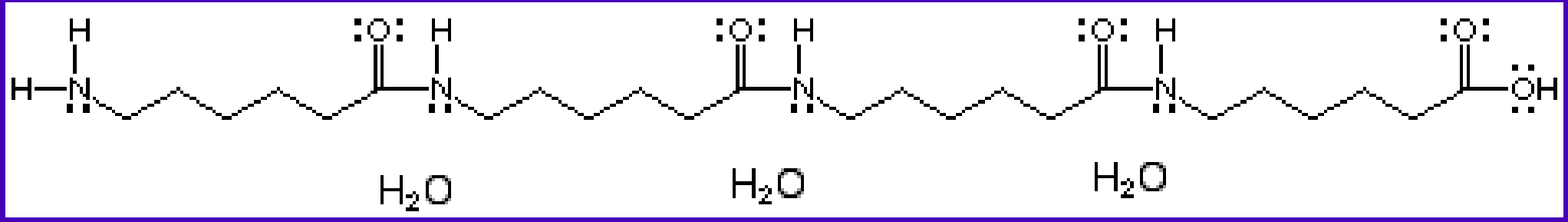


The polymer is made by joining them end to end.

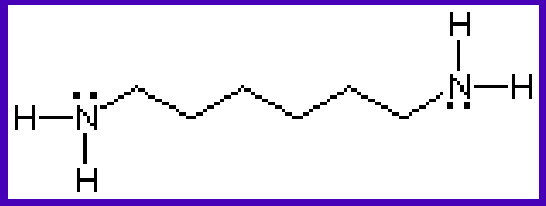
monomers:

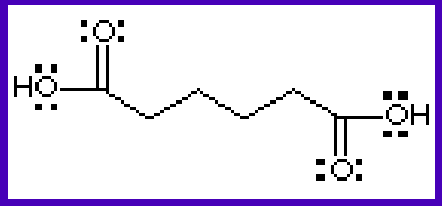


polymer:



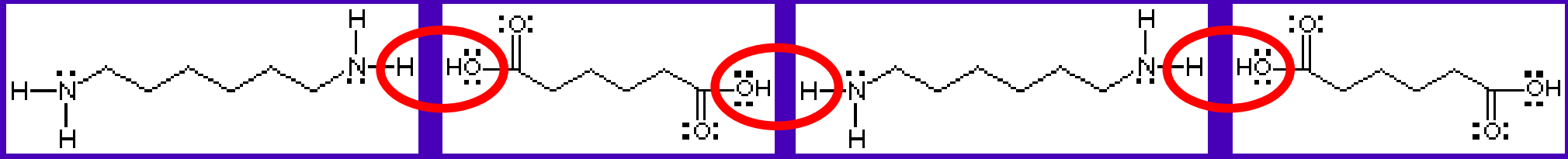
Nylon-66 is made from two monomers, one with carboxylic acids on both ends, and one with amines on both ends.



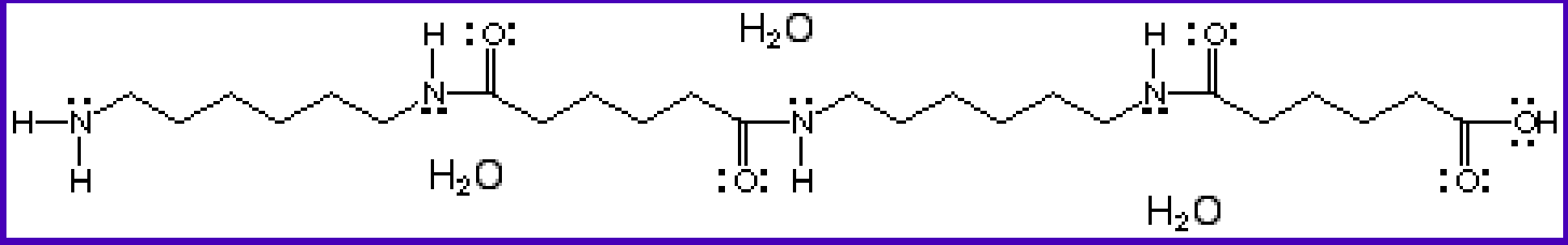


These monomers are joined together by alternating them.

monomers:



polymer:

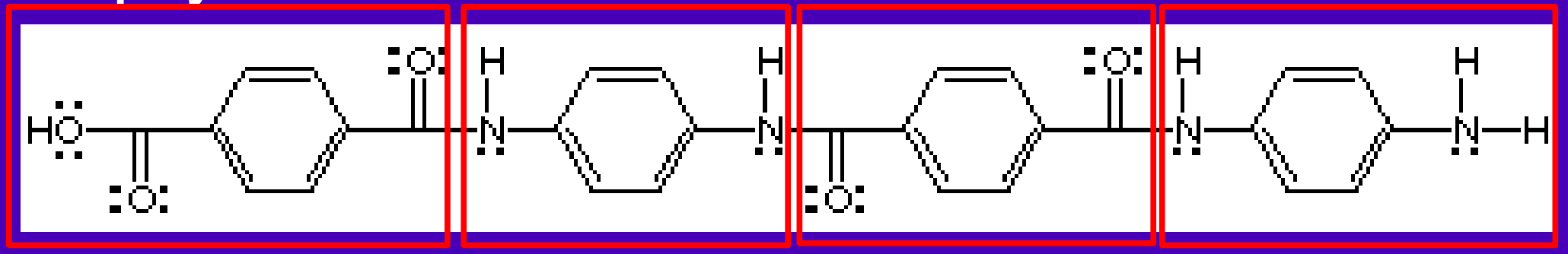


Example: kevlar

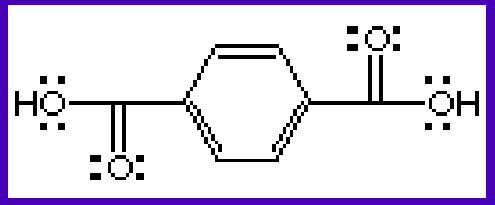
Kevlar was invented in 1966. It can be used to make bullet-proof vests and helmets, as well as light-weight sports gear.

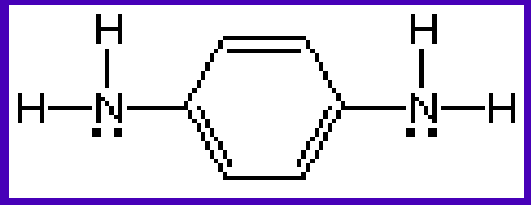
Kevlar also uses amide linkages, but with different monomers.

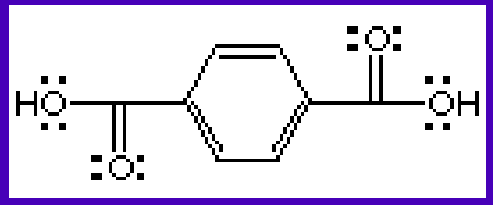
polymer:

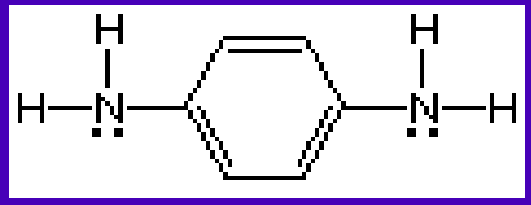


monomers:

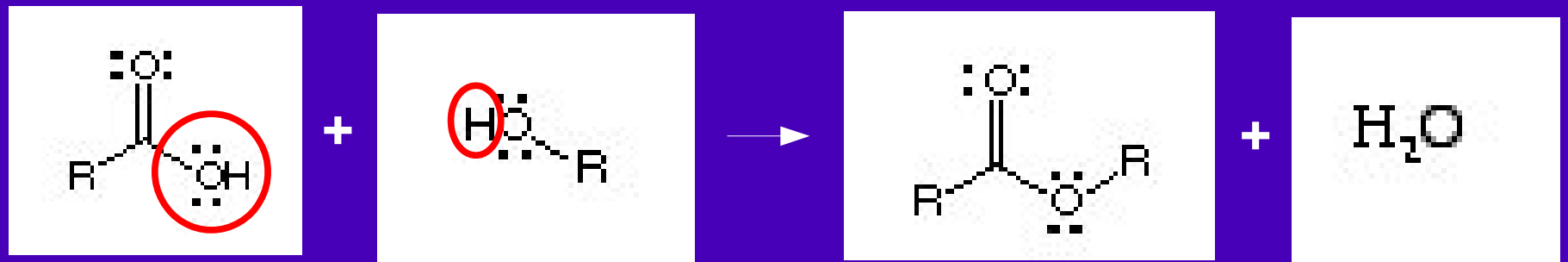








Polymers can also be made using alcohols in place of amines.



carboxylic acid + alcohol → ester + water

The OH from the carboxylic acid and the H from the alcohol join to form a water molecule.

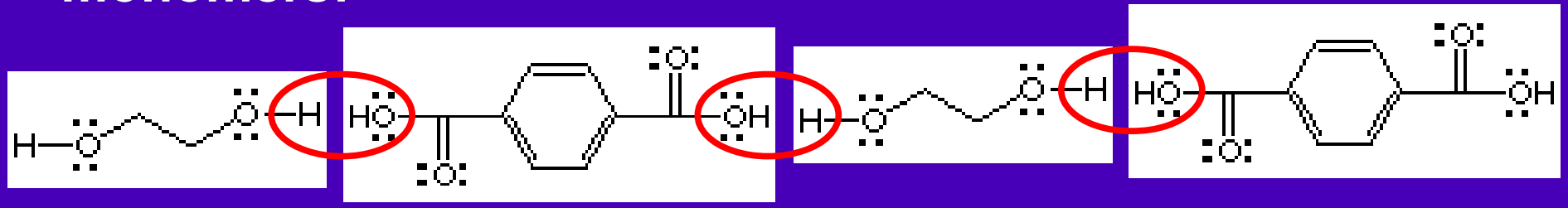
The C from the carboxylic acid and the O from the alcohol join to form an ester.

What would you call a polymer made from joining lots of esters together?

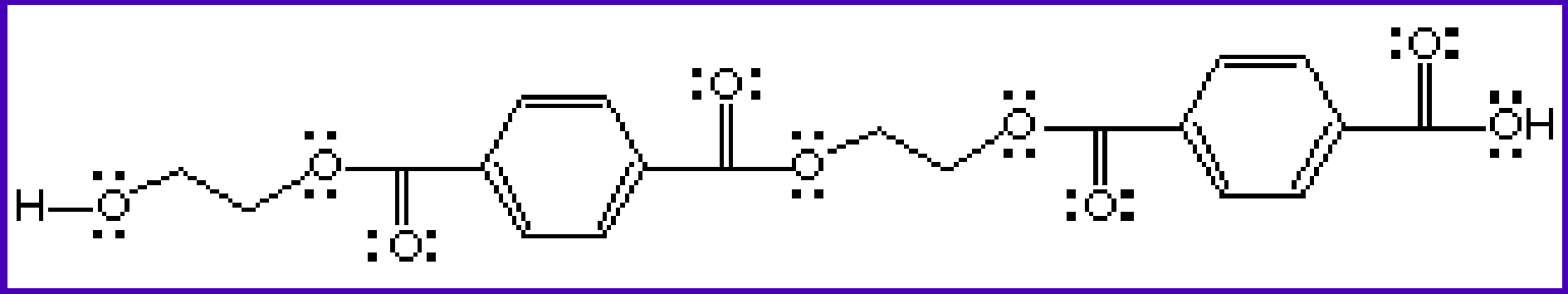
polyester

The material we call “polyester” is made from the two monomers shown below.

monomers:



polymer:



Polyester is used to make cloth fibers, as well as Mylar tape used in video cassette tapes.