

WELCOME TO

POLYMER

PLANET



Level Two: Polymers Up Close and Personal

- On this level every section is stocked with information on a specific polymer.





Types of Polymers

- ❖ This is sort of an introductory page for a more in depth look at polymers.

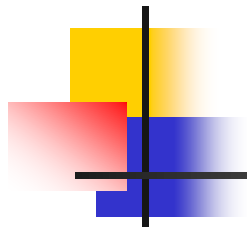




1- Linear Polymer:

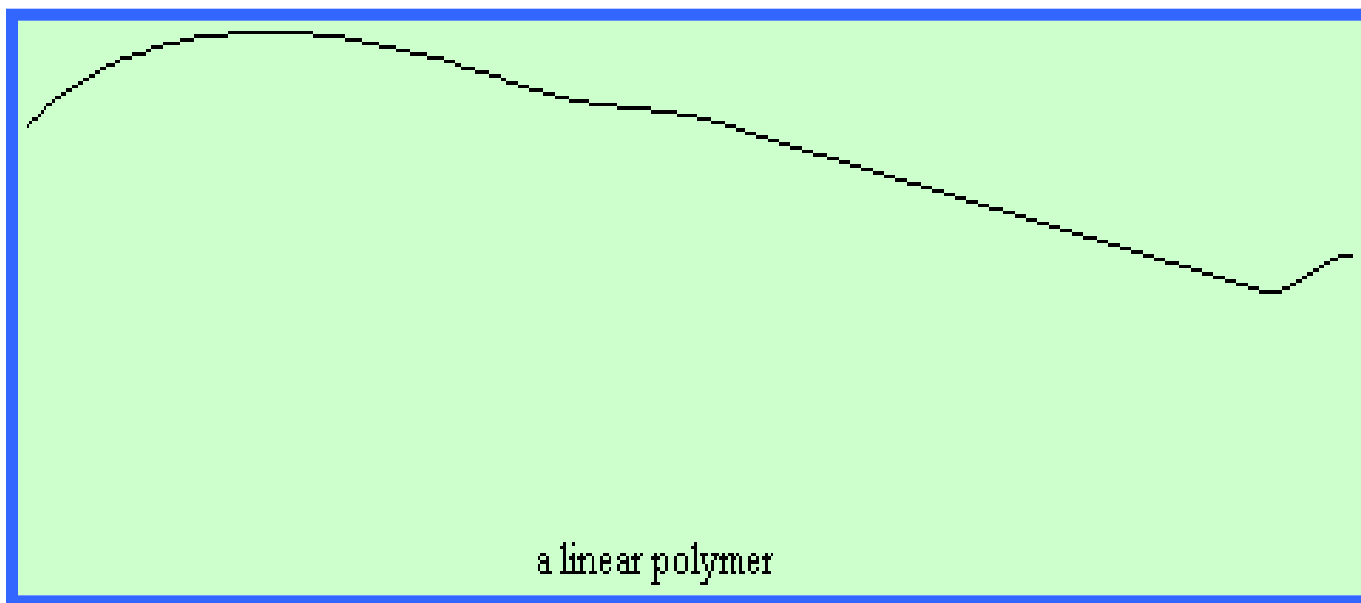
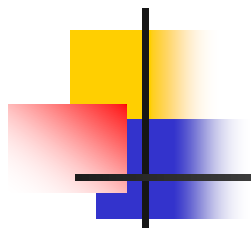
- ❖ Most of the time when we talk of polymers we're talking about molecules with molecular weights of hundreds of thousands, or even millions.

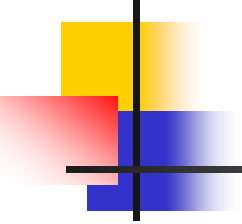




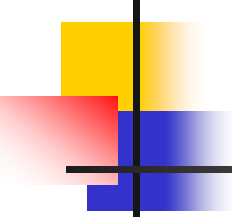
a linear polymer made of "A" atoms



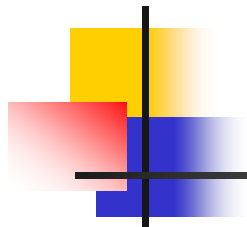


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- ❖ We're also usually talking about linear polymers.
 - ❖ A linear polymer is a polymer molecule in which the atoms are more or less arranged in a long chain.



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- This chain is called the *backbone*.
 - Normally, some of these atoms in the chain will have small chains of atoms attached to them.

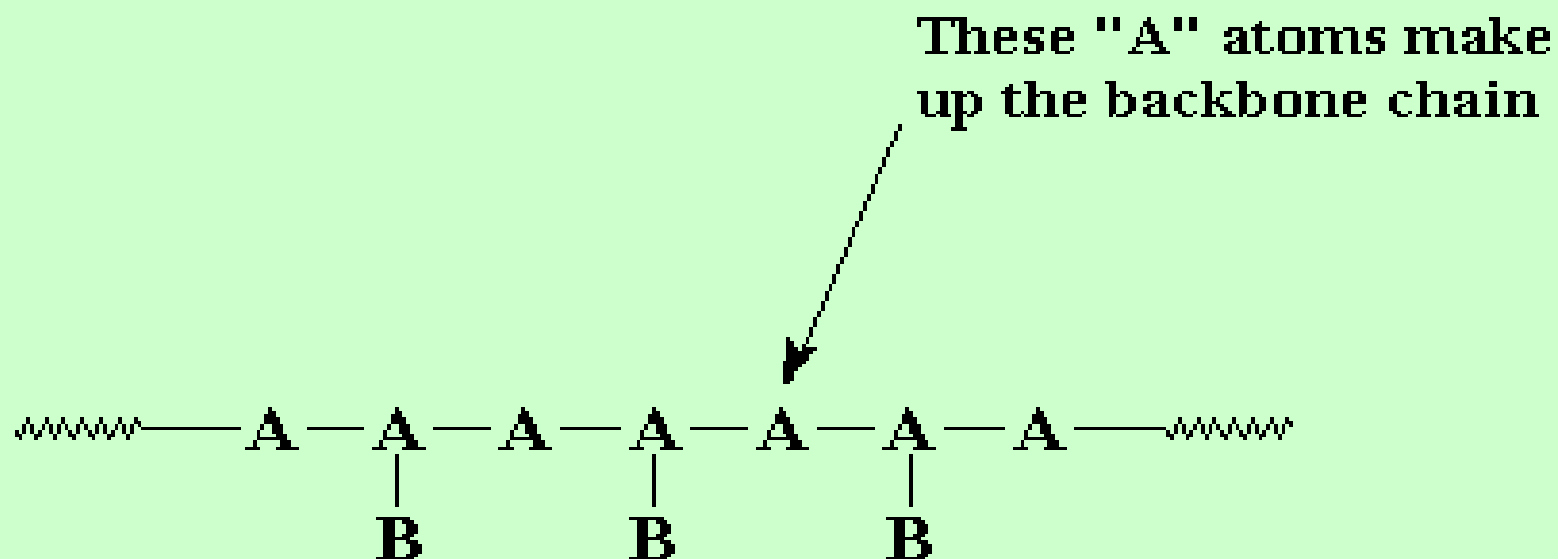




➤ These small chains are called *pendant groups*.

➤ The chains of pendant groups are much smaller than the backbone chain.





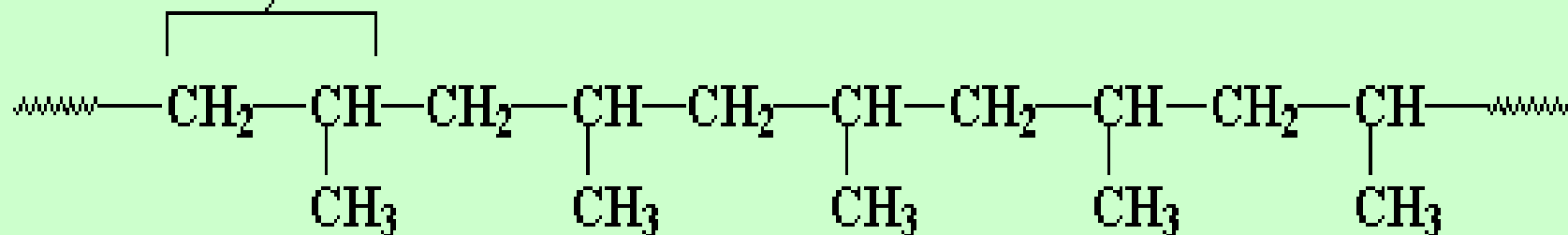
The "B" atoms are pendant groups



❖ This little recurring structure is called the *repeat structure* or the *repeat unit*.

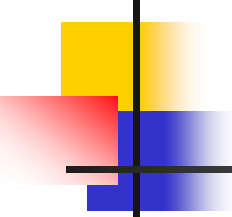


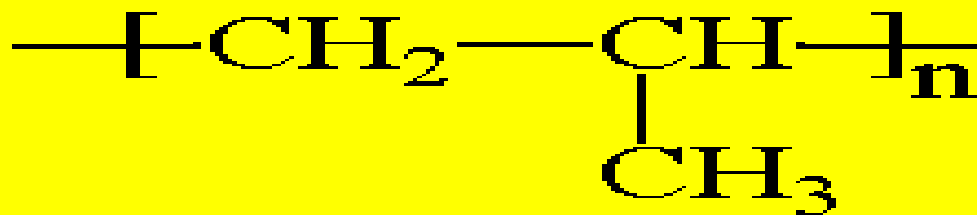
This pattern repeats itself over and over again



Polypropylene



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- To make things simple, we usually only draw one unit of the repeat structure, like this:

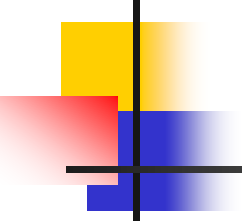




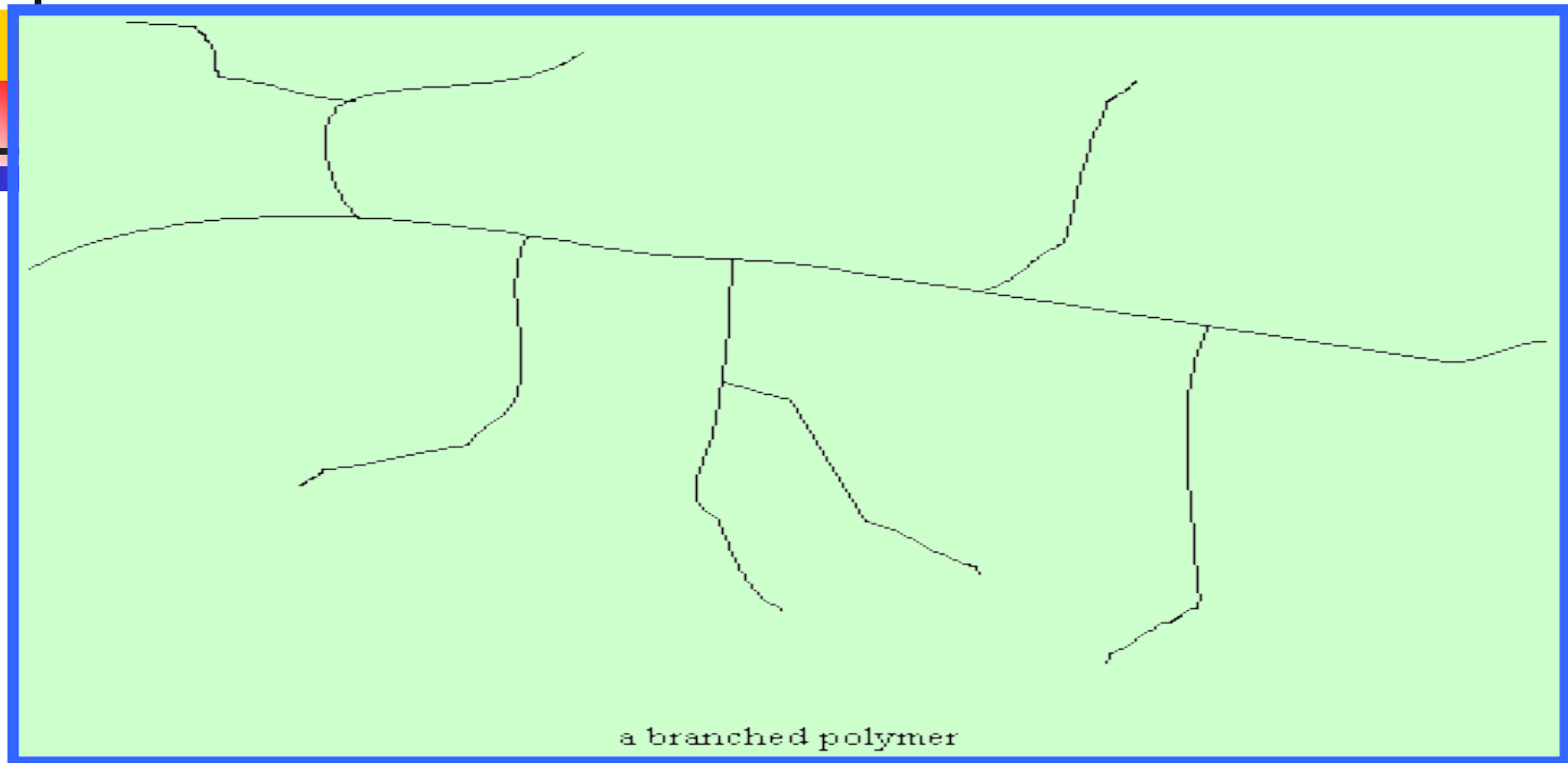
2- Branched Polymer:

- ❖ Not all polymers are linear in this way.
- ❖ Sometimes there are chains attached to the backbone chain which are comparable in length to that backbone chain.



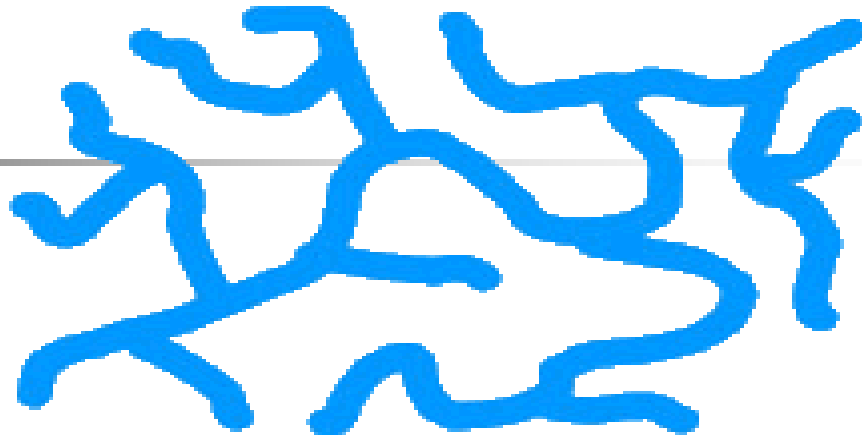
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- ❖ This is called a *branched polymer*.
 - ❖ Some polymers, like polyethylene, can be made in linear or branched versions.







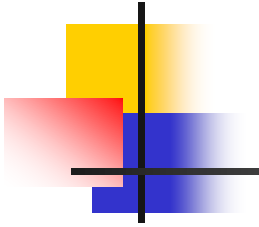
Branch Out!



A **BRANCHED** polymer chain has extra beginnings (branches!) along the chain and so it has lots of ends.

No matter where you start, you can't trace the entire polymer without backtracking.

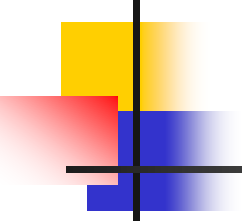




❖ 3- Cross- linked Polymer

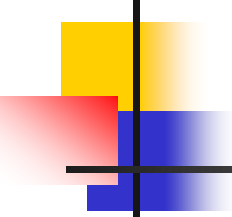
- ❖ When this happens, the sample is in fact one single molecule, a molecule large enough to pick up in your hands!



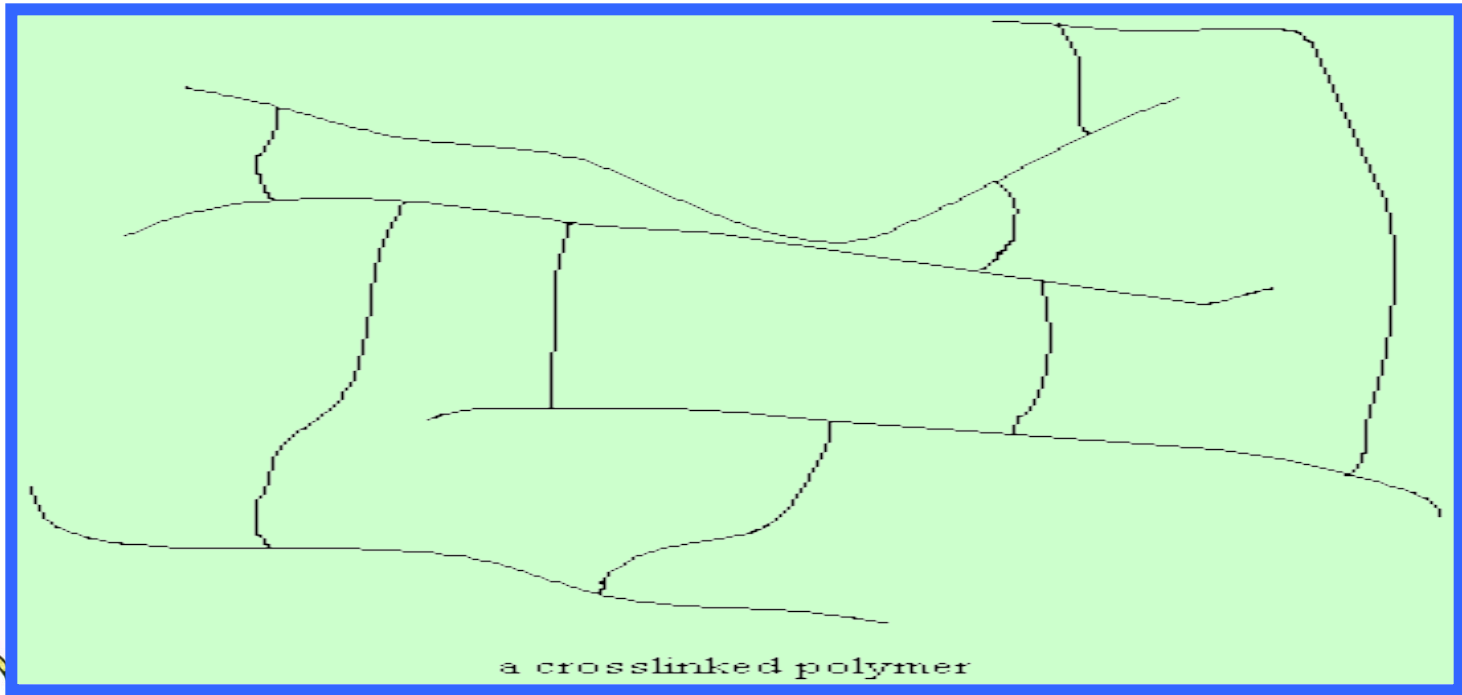
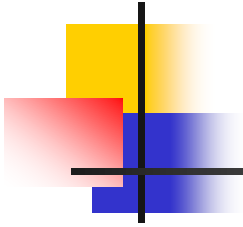


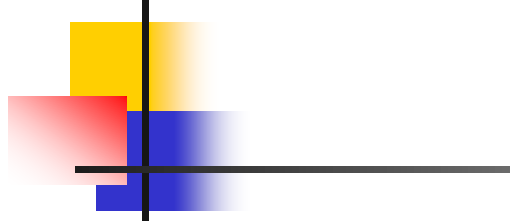
❖ Polymers like this are
called *crosslinked*
polymers.



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- ❖ Many types of *rubber*, such as polyisoprene and polybutadiene, are cross-linked.
 - ❖ A tire is actually one giant network molecule, a molecule so big it takes two hands to pick it up.





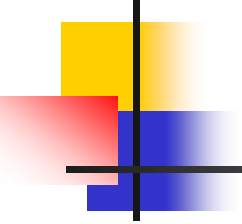




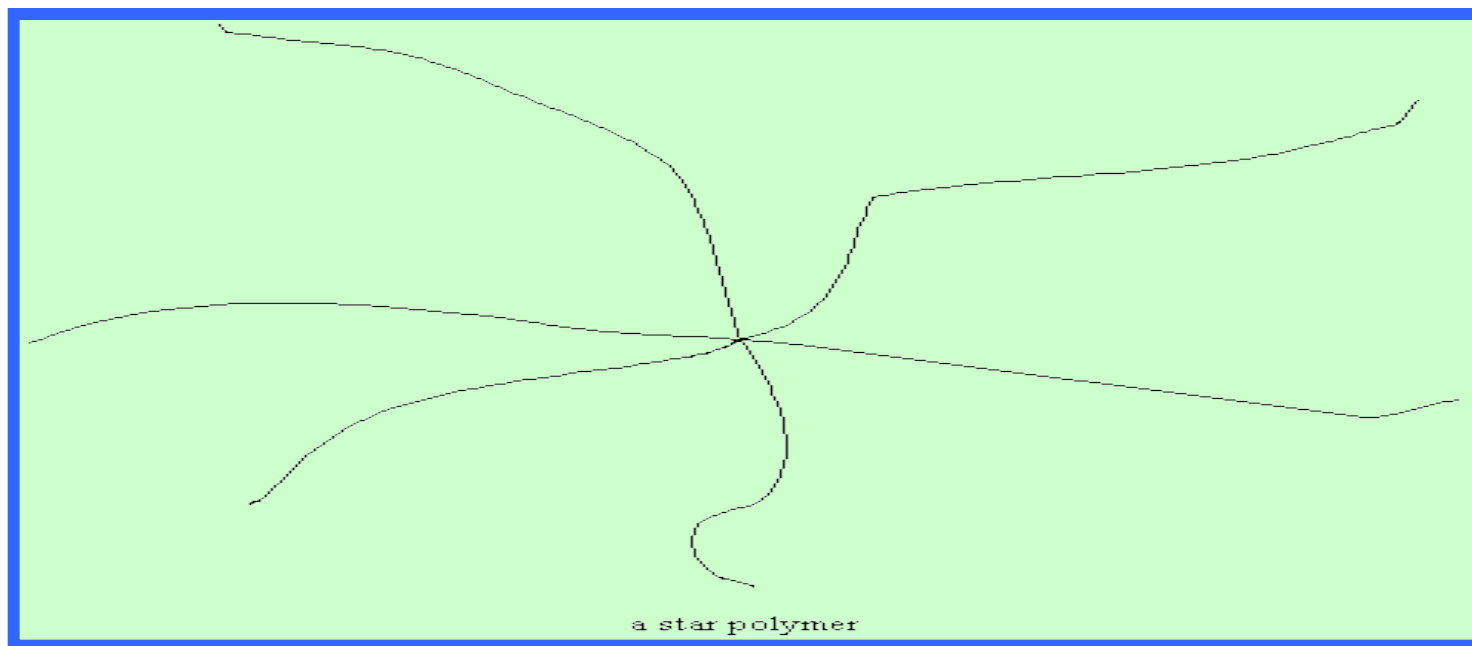
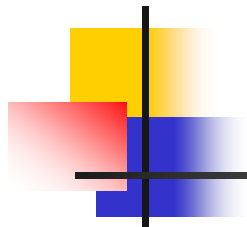
4- Star -Polymer

- Sometimes the ends of several polymer chains are joined together at a common centre.



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- ❖ Polymers like this are called *star polymers*.
 - ❖ They're used as additives in motor oil.



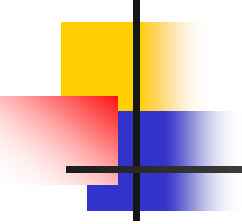




5- dendrimers

- ❖ Sometimes there is no backbone chain at all.

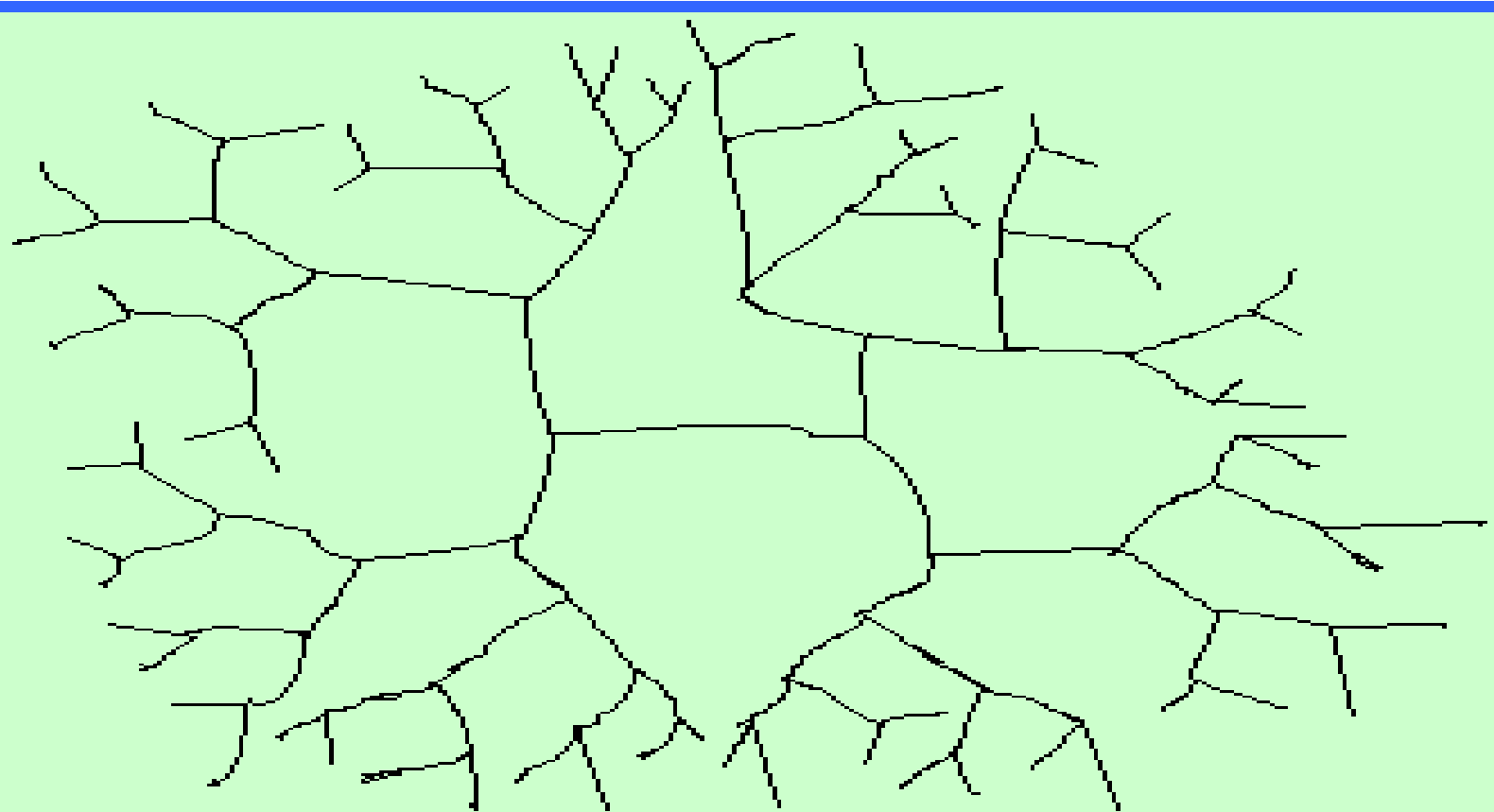


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- Sometimes a polymer is built in such a way that branches just keep growing out of branches and more branches grow out of those branches.



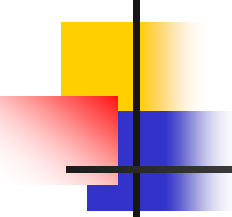
- 
- These are called *dendrimers* from the ancient Greek word for "tree."



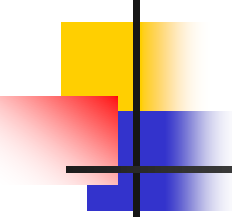


a dendrimer



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- ❖ **Drug delivery is one possibility.**
 - ❖ **One silicon-based dendrimer can trap oxygen molecules in its branches.**





❖ It is hoped that this can be someday used to make artificial blood.



- 
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- **In the more immediate future, dendrimers might end up in coatings and as catalysts.**



The Consequences of Being Big

????

- Let's get back to those simple linear polymers, now.



4 . Three thing that make polymers are different

1. Chain entanglement
2. Summation of intermolecular forces
3. Time scale of motion



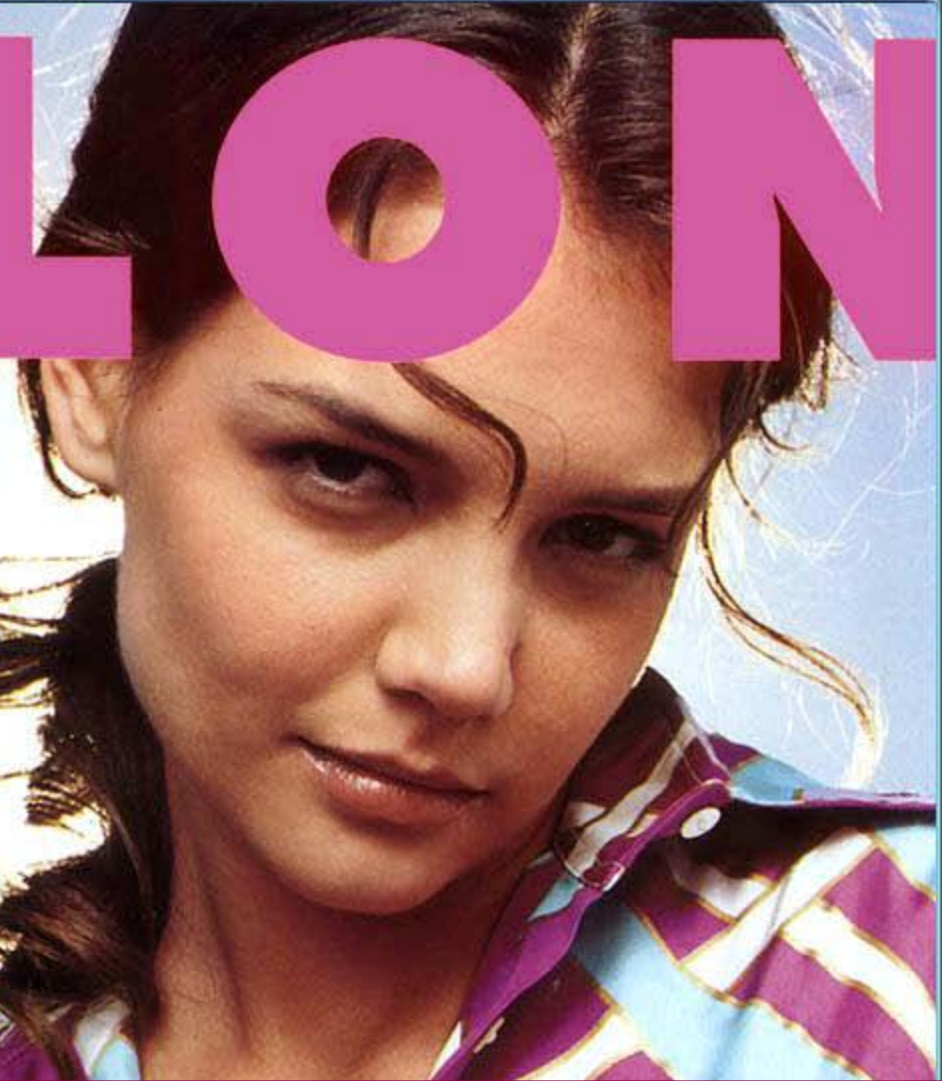


5. Polymer Synthesis

- **5.1. Condensation Polymerization (Step-growth Polymerization).**
- **5.2. Addition polymerization (Chain -growth Polymerization).**
- **5.3. Ring Opening Polymerization.**



NYLON



Nylon is used in clothes, shoes, jackets, belts, and accessories. It's not surprising a magazine is named after this polymer. Where did nylon get its name?

Nylon was discovered in 1935. The name nylon is derived from two cities where it was discovered namely New York (NY) and London (LON).

Two ingredients are mixed and a solid begins to form at the junction between the two layers of liquid.



Hot nylon spaghetti can be extracted.

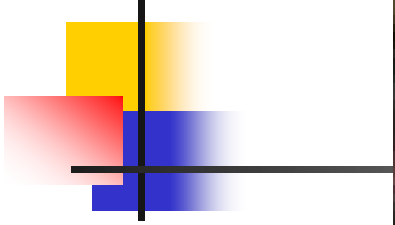


We say certain polymers are man-made, but the truth is they make themselves. Humans only have to get the ingredients near each other. The chemicals will assemble themselves.

Polymer Chemistry

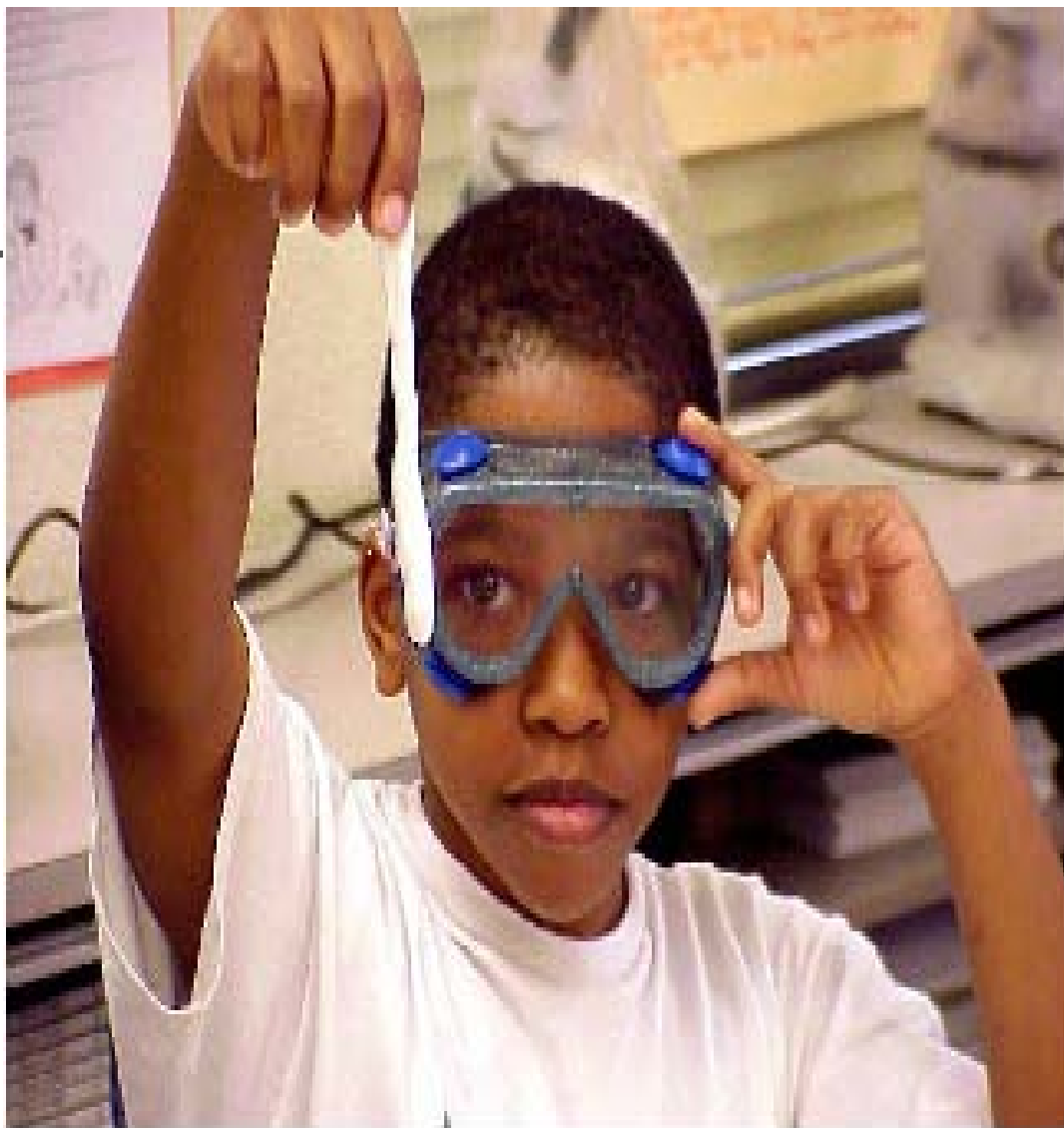
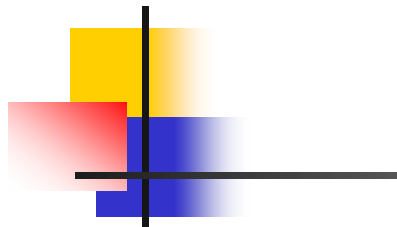


The students are handling the nylon string that was produced. Notice there's some kind of odor that is being noticed.

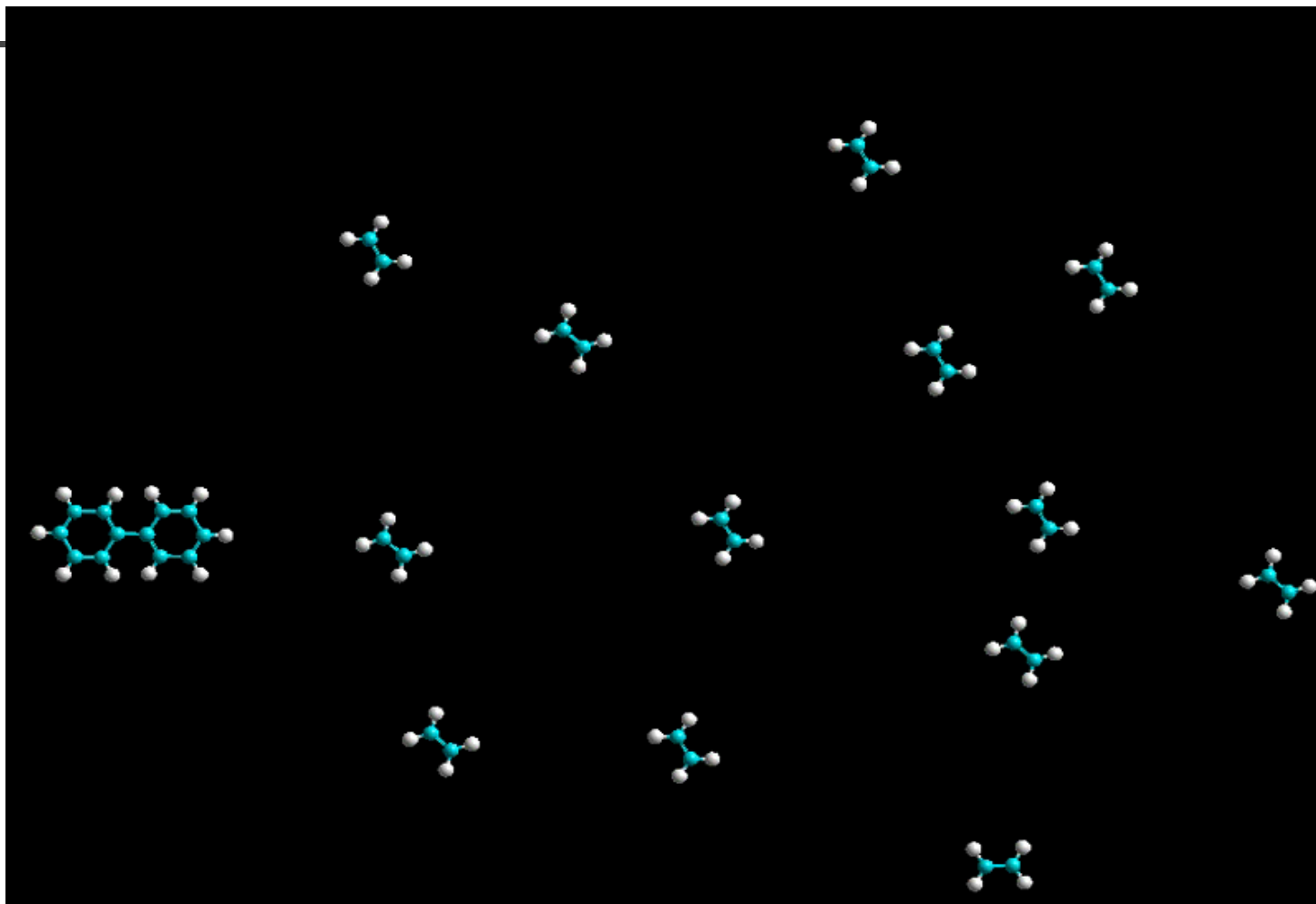


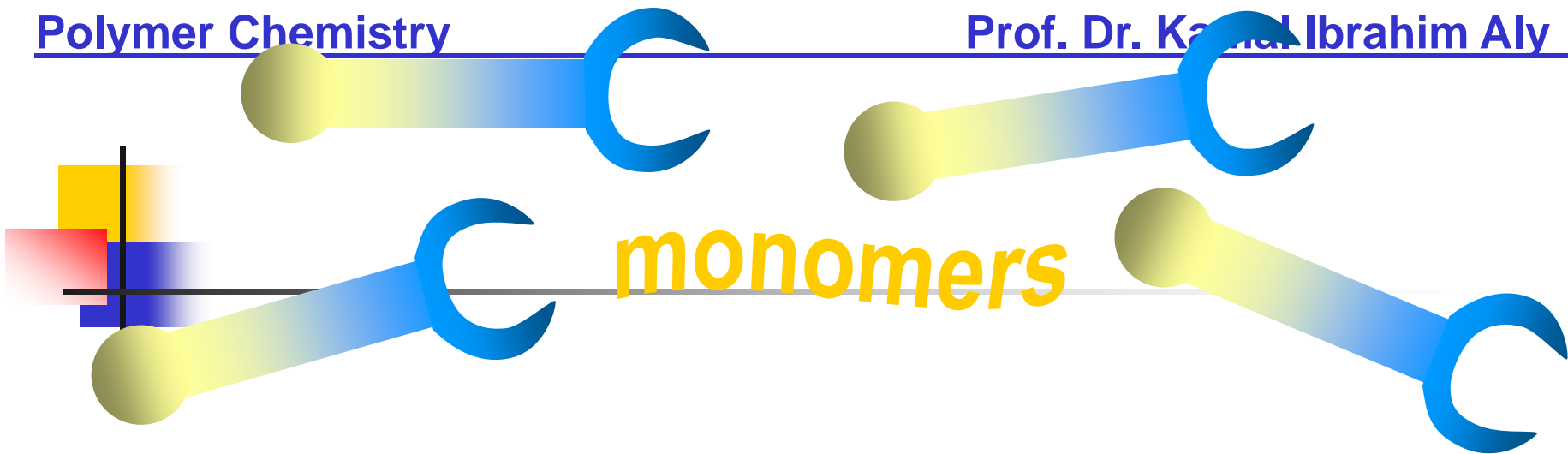
Science Scape and polymers



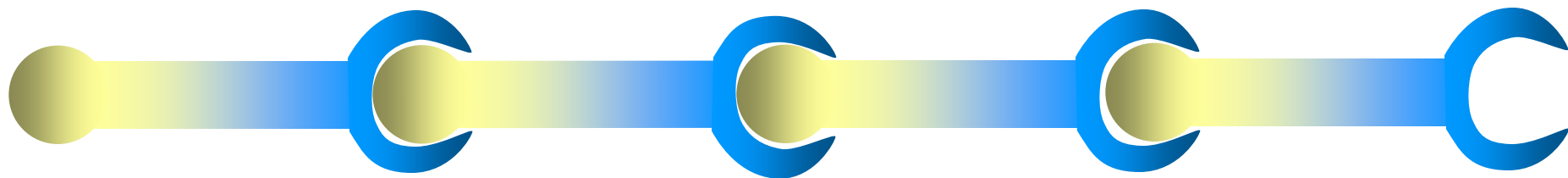


POLYMERIZATION

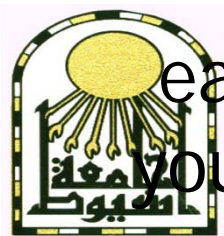


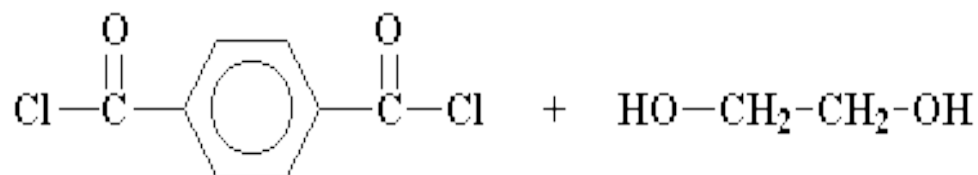


Polymer



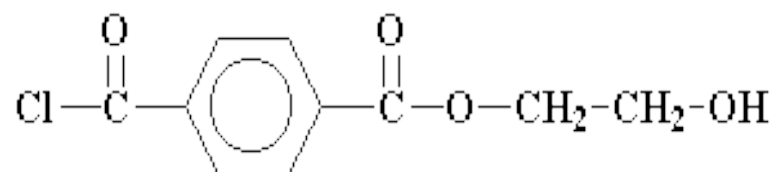
The word, **polymer**, implies that polymers are constructed from pieces (**monomers**) that can be easily connected into long chains (**polymer**). When you look at the above shapes, your mind should see that they could easily fit together.





terephthoyl chloride

ethylene glycol

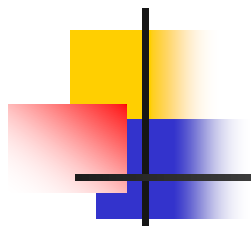


dimer

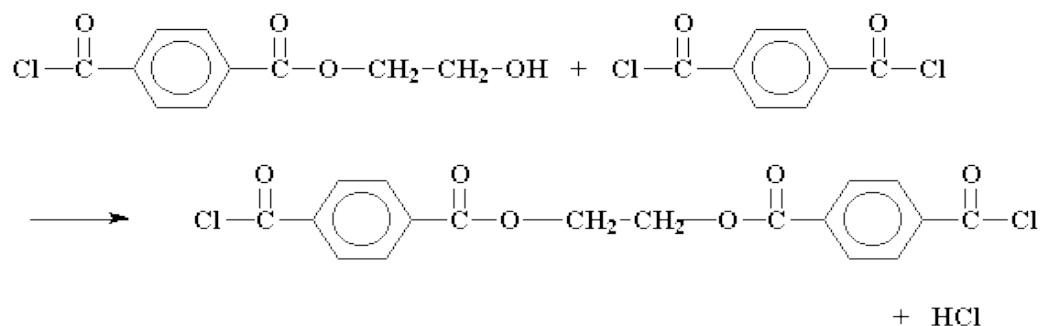


Terephthoyl chloride and ethylene glycol react to form an ester dimer



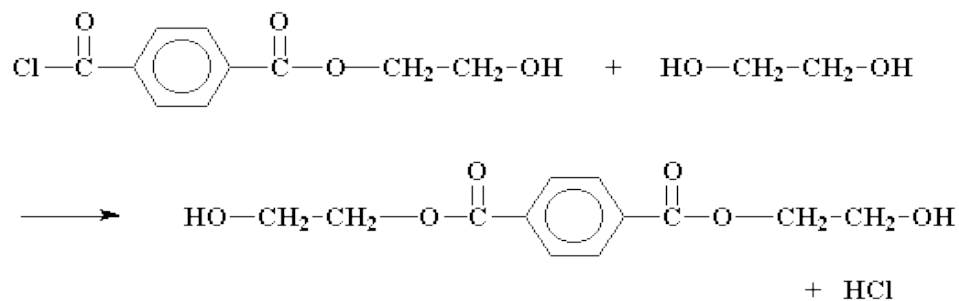


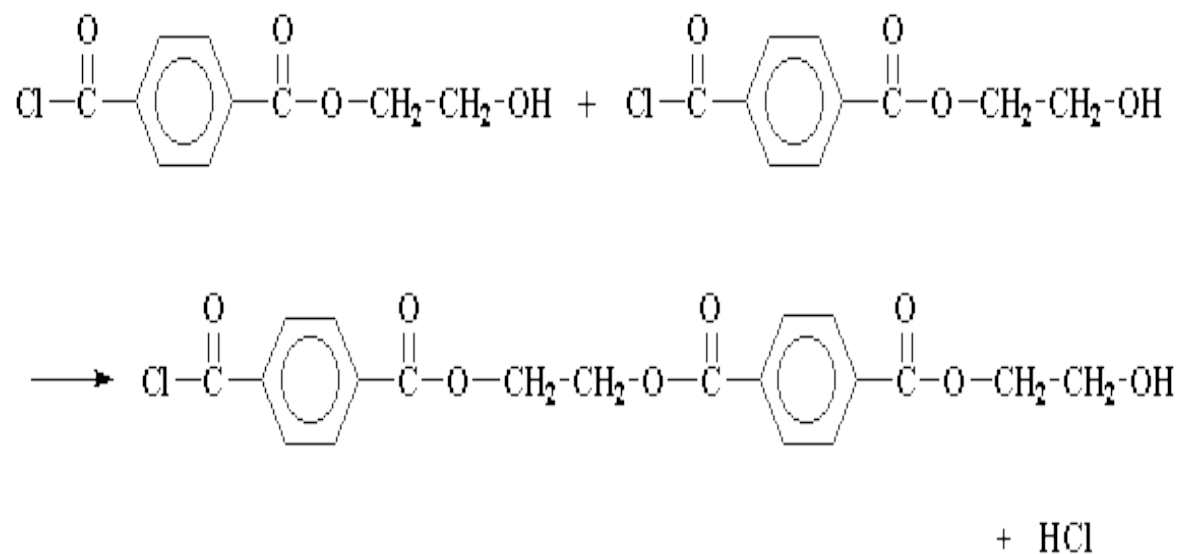
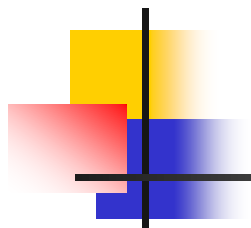
Our little dimer can react with a molecule of terephthoyl chloride...



Or...

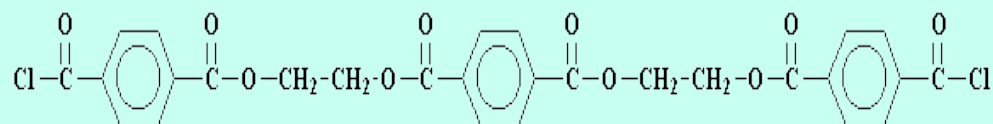
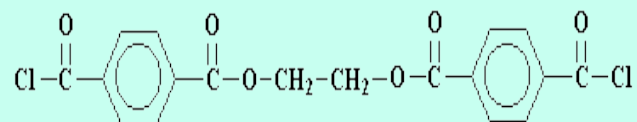
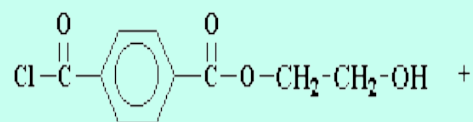
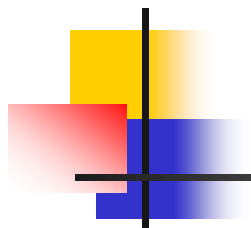
It can react with a molecule of ethylene glycol.





Two of our dimers are ganging up to form a tetramer.

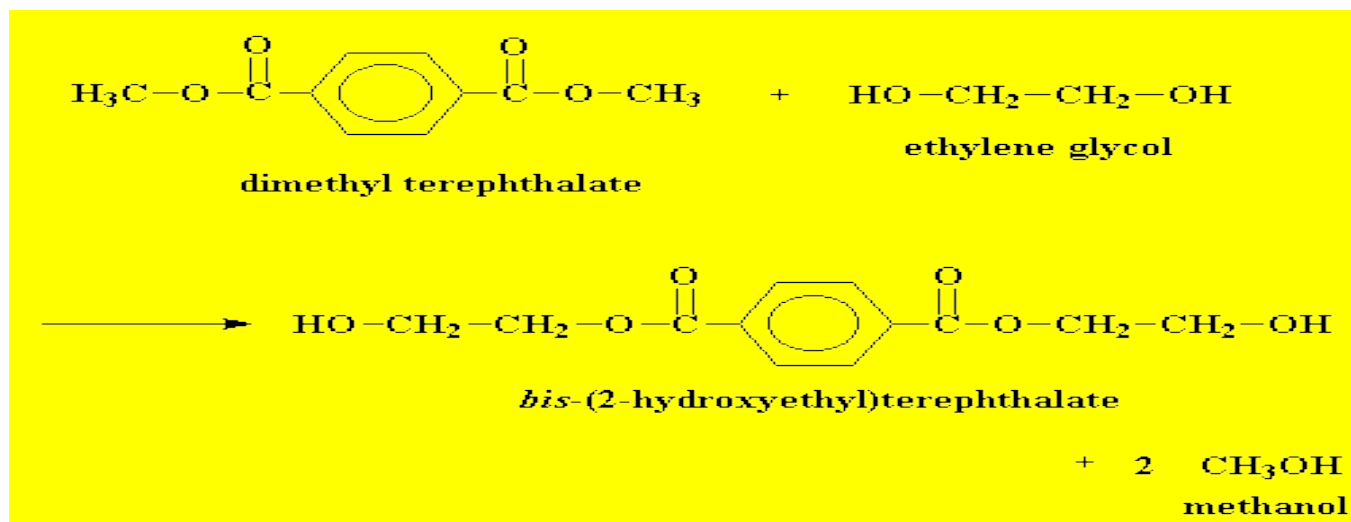
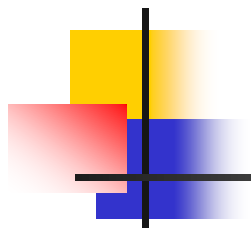


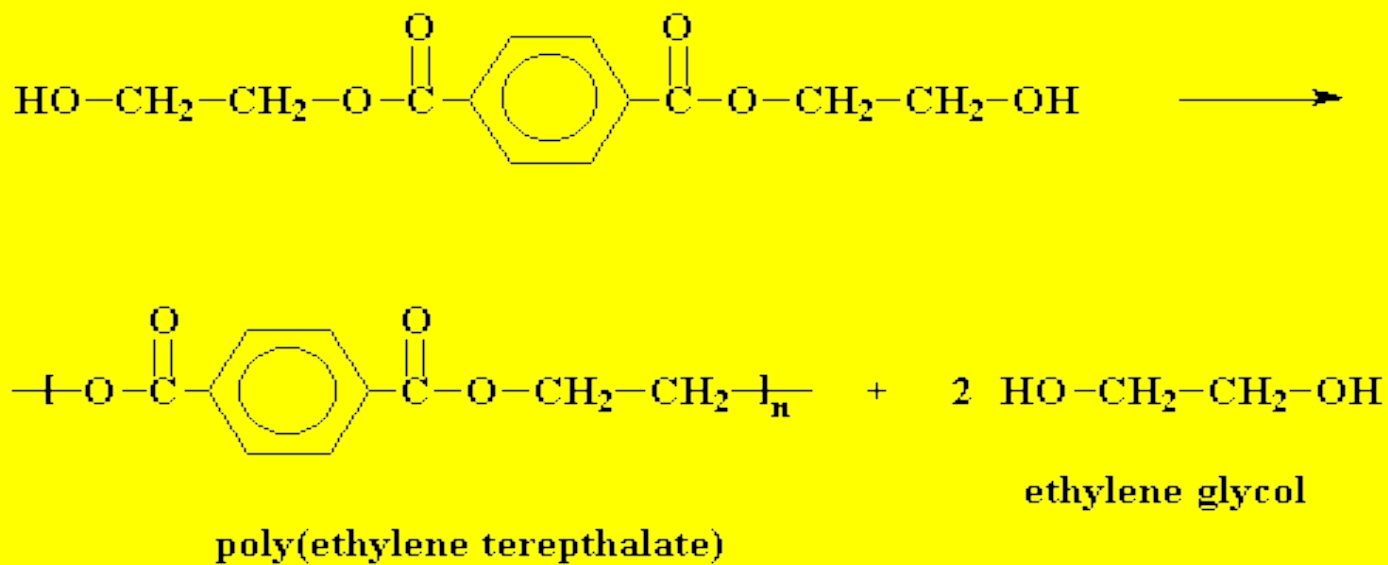


Merger Mania!

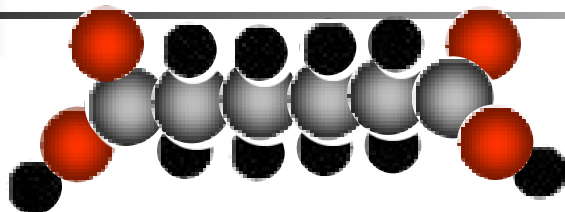
The dimer joins the trimer to form a pentamer. Will the madness never stop?



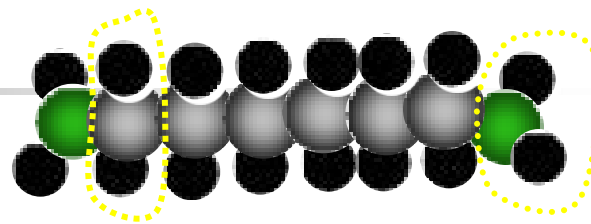




Tetramethylene
dicarboxylic acid
(adipic acid)



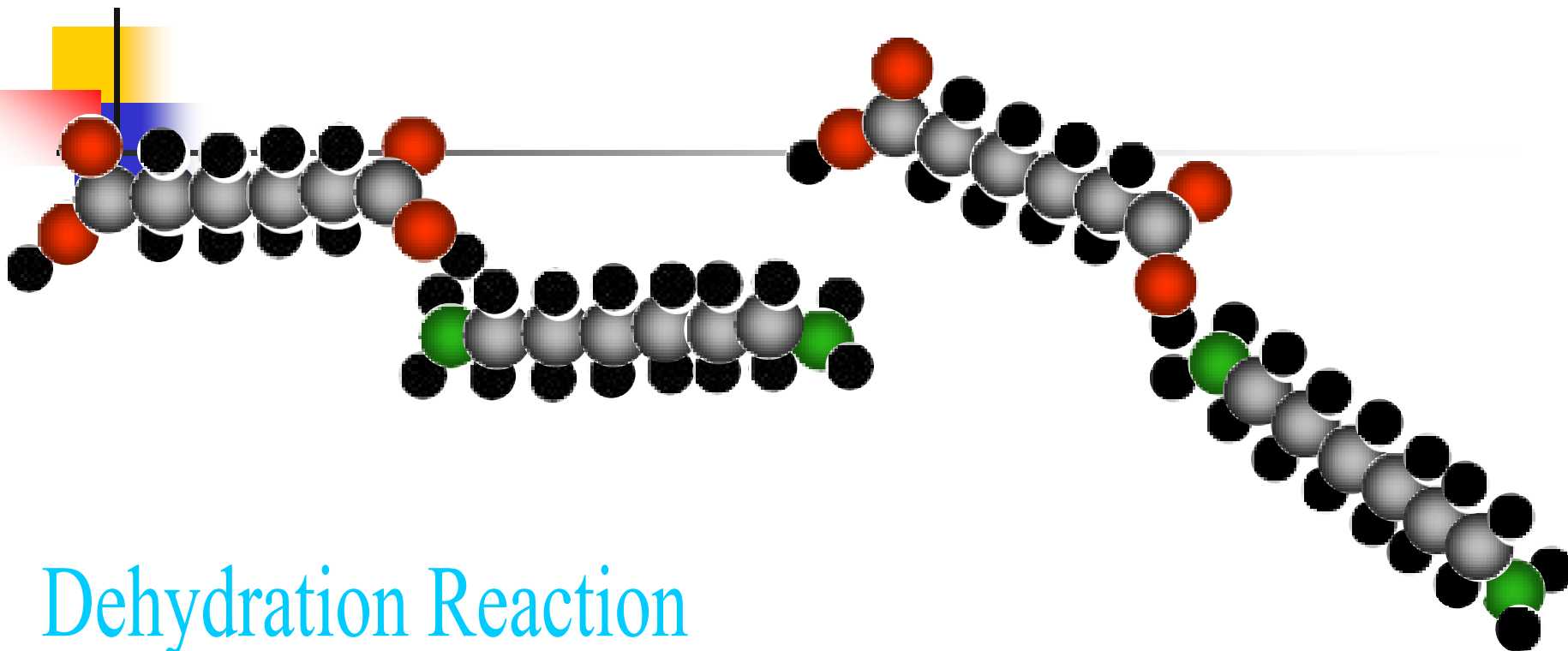
Hexamethylene diamine



methylene x 6 (hexa) amine x 2 (di)

Nylon is actually a “copolymer” because it is made from two monomers. When these two monomers are in the same beaker, they combine and give off a molecule of water. This is called a “dehydration” reaction because we are taking away (*de*) water (*hydra*). (regarding odor: amines smell like fish or worse. Adipic acid is odorless)





Polyesters, PET



© Brooks/Cole, Cengage Learning



**Jackets made from recycled
PET soda bottles**



**Soda bottles,
mylar film.**

Polyester is a
another
copolymer. It
is made from
equal amounts
of two different
monomers.
Polyester is
used to make
bottles and
fabrics.



POLYMERS ARE EVERYWHERE

