

Cornell Notes

Name

Date

Topic

Class/
Subject

Blank area for notes on the left side of the page.

Lined area for notes on the right side of the page.

Blank area at the bottom of the page for a summary or conclusion.

Polymers in everyday things – contact lenses

1. Suggest why people may wish to wear contact lenses instead of glasses.

.....
.....

2. Suggest why some people who wear glasses do not wish to wear contact lenses.

.....
.....

3. Write down two properties of glass that made it suitable for use in the contact lenses made before 1950.

.....
.....

4. Suggest why research scientists looked for alternative materials to glass for use in contact lenses.

.....
.....

5. Why could polymers not be used in contact lenses before 1930?

.....
.....

6. Explain the meaning of the word 'transparent'.

.....
.....

7. Suggest why the ideal material for a contact lens should:

a. Have a low density

.....
.....

b. Be unreactive

.....
.....

c. Be easy to manufacture.

.....
.....

16. Each of the three types of polymer used in contact lenses has advantages and disadvantages. Copy and complete the table below to summarise these strengths and weaknesses. Give as many points as you can for each kind of lens.

	Advantages	Disadvantages
Soft lenses (polyacrylamide)		
Hard lenses (PMMA)		
Rigid gas-permeable lenses		

17. Continued research into materials by chemists and materials scientists is important. Name two other areas, in addition to contact lenses, where this is important.

.....
.....

Polymers in everyday things – contact lenses

(Background information)

Polymers are a part of everyday life and examples can be found almost anywhere. Many people think of polymers simply as plastics used for packaging, in household objects and for making fibres, but this is just the tip of the iceberg.

Polymers are used in all sorts of applications you might not have thought much about before, for example in modern contact lenses.

What is a contact lens?

A contact lens is a prescription medical device manufactured from high-grade plastic polymers. The contact lens rests on the front surface of the eye (the cornea) and works just like eyeglasses – it bends light rays so that images are properly focused on the retina (at the back of the eye).

Contact lenses can be worn by people with eye disorders as an alternative to glasses.

The history of contact lenses

The first contact lenses were made from glass shells filled with jelly. Early contact lenses were uncomfortable and often very unhealthy for the eye. Until 1930 there was no alternative to using glass for making contact lenses – no other suitable material was available.

In the 1930s suitable polymers were discovered and by 1950 the first polymer contact lenses were being made.

Research into new types of polymers has now provided three types of material that can be used to make different kinds of contact lenses. These are called hard (created in the early 1960s), soft (created in the early 1970s) and gas-permeable (created in the late 1970s) lenses.

What properties are desirable in polymers for contact lenses?

Polymers are the most suitable materials available now for contact lenses to be made from.

The properties of an ideal polymer for contact lenses include:

- Transparent
- Some flexibility
- Low density
- Tough
- Unreactive to chemicals on the eye surface
- Easy to manufacture
- Made from a raw material that is available in abundance
- Easy to mould
- Refractive index suitable for bending light rays
- Hydrophilic ('water-loving')
- Lets oxygen gas pass through to the eye surface
- Produces lenses that are easy to insert, remove, clean and store.

Scientists first developed materials that had some of these properties. Continual research work produced polymers that were more and more suited to the application.

What polymers are used to make contact lenses?

The first polymer contact lenses became commonly available in the early 1960s and were made from a polymer called polymethylmethacrylate (PMMA). Lenses made of PMMA are called hard lenses.

PMMA is still used in Plexiglas® and Lucite®, as well as for things like aquariums and ice hockey pucks/barriers.

PMMA lenses are hard, rigid and not very comfortable; it sometimes takes users many weeks to get used to them. The lenses do not allow oxygen to pass directly to the cornea, which can be damaging to the eye. Users have to put a wetting solution in their eyes before putting the lenses on. Hard lenses are not very popular anymore, even though they give good clarity of vision and are very durable – they can last for years.

The first soft contact lenses were introduced in 1971. These were made from a polymer called polyacrylamide. This polymer is different from PMMA because it contains nitrogen atoms in its structure (PMMA does not contain nitrogen). Polyacrylamide is similar to the polymers used to make acrylic fibres for fabrics. When the polyacrylamide chains are cross-linked, the material absorbs water. Substances such as this are called hydrophilic ('water-loving').

This property makes polyacrylamide a useful material for producing contact lenses. Between 38% and 79% of a soft contact lens is water. This water keeps the lens soft and flexible. However, the high water content also makes the lens more fragile and reduces clarity of vision.

Soft lenses are cheaper than hard lenses and this has added to their popularity. In fact, some soft lenses can be used for one day and then discarded.

In 1978, the first rigid gas-permeable lenses (also known as RGPs) became available. These lenses were made from a combination of PMMA, silicones and fluoropolymers. This combination allows oxygen to pass directly through the lens to the eye, which makes the lens more comfortable for the wearer. It may only take three hours to get used to wearing this kind of lens. The rigidity of RGPs can also make vision clearer than with soft lenses. RGPs are better suited to correcting myopia and for bifocal needs than the other kinds of lenses. The disadvantages of RGPs include their high cost and some inflexibility in the lens.

The future of contact lenses

Polymers are now starting to buy contact lenses for fun, choosing coloured or designer contact lenses. As contact lenses become more popular, the companies that make them will be able to spend more money on research into the different types of materials that could be used to make better or cheaper lenses in the future.

Halloween **Slime** lab



How does it work?

The mixture of Elmer's Glue with Borax and water produces a putty-like material called a polymer. In simplest terms, a polymer is a long chain of molecules. You can use the example of cooking spaghetti to better understand why this polymer behaves in the way it does. When a pile of freshly cooked spaghetti comes out of the hot water and into the bowl, the strands flow like a liquid from the pan to the bowl. This is because the spaghetti strands are slippery and slide over one another. After awhile, the water drains off of the pasta and the strands start to stick together. The spaghetti takes on a rubbery texture. Wait a little while longer for all of the water to evaporate and the pile of spaghetti turns into a solid mass -- drop it on the floor and watch it bounce.

Many natural and synthetic polymers behave in a similar manner. Polymers are made out of long strands of molecules like spaghetti. If the long molecules slide past each other easily, then the substance acts like a liquid because the molecules flow. If the molecules stick together at a few places along the strand, then the substance behaves like a rubbery solid called an elastomer. Borax is the compound that is responsible for hooking the glue's molecules together to form the putty-like material. There are several different methods for making this putty-like material. Some recipes call for liquid starch instead of Borax soap. Either way, when you make this homemade Silly Putty you are learning about some of the properties of polymers.

Elmer's Slime is very easy to make, but it's not exactly what you'll find at the toy store. So, what's the "real" slime secret? It's an ingredient called polyvinyl alcohol (PVA). The cross-linking agent is still Borax, but the resulting slime is longer lasting, more transparent... it's the real deal.

What are polymers?

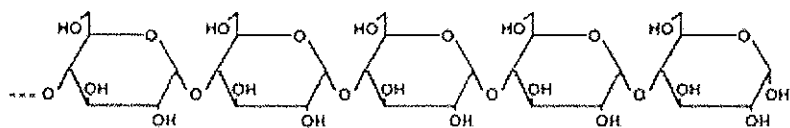
Polymers are molecules which consist of a long, repeating chain of smaller units called *monomers*. Polymers have the highest molecular weight among any molecules, and may consist of billions of atoms. Human DNA is a polymer with over 20 billion constituent atoms. Proteins, or the polymers of amino acids, and many other molecules that make up life are polymers. Polymers are the largest and most diverse class of known molecules. They even include plastics.

Monomers are molecules typically about 4-10 atoms in size, reactive in that they bond readily to other monomers in a process called *polymerization*. Polymers and their polymerization processes are so diverse that a variety of different systems exist to classify them. One major type of polymerization is *condensation polymerization*, where reacting molecules release water as a byproduct. This is the means by which all proteins are formed.

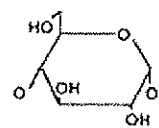
Polymers are not always straight chains of regular repeating monomers; sometimes they consist of chains of varying length, or even chains that branch in multiple directions. Residual monomers are often found together with the polymers they create, giving the polymers additional properties. To coax monomers to link together

in certain configurations requires a variety of catalysts--secondary molecules which speed up reaction times. Catalysts are the basis of most synthetic polymer production.

Examples of a polymer and it's monomer:



Starch



Glucose

Other examples of polymers:

PTFE- polytetrafluoroethylene - teflon

PE- poly ethylene - clear plastics

PS- Polystyrene- Styrofoam

High Density Poly(ethylene)- bullet proof vests



Instructions:

1. Thoroughly mix $\frac{1}{4}$ cup of water and $\frac{1}{4}$ cup of white glue ("Elmer's School Glue") in your ziplock bag.
2. Add a few drops of food coloring to the water/glue mixture, again mixing thoroughly. This will be your "**Glue Solution**".
3. In a cup, mix $\frac{1}{4}$ cup of water and $\frac{1}{4}$ teaspoon of "Borax". The objective is to make a saturated Borax solution that is, one in which the Borax will not continue to dissolve after mixing. This will be your "**Borax Solution**".
4. Now you are ready to slimify. Get ready to pour a **small** amount of Borax Solution into your Glue Solution, being prepared to mix the two very rapidly with spoon.
5. For very **firm** slime, add a **large** amount of Borax Solution to your Glue Solution. For **drippy** slime, add a **small** amount of Borax Solution to the Glue Solution and mix very rapidly and thoroughly.



Answer the question on a separate sheet of paper.

Slime Lab Questions:

1. Slime is made of two components. Name the components and their functions.
2. What's the difference between monomers and polymers?
3. What are polymers?