Student Name: _____
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# Polymers

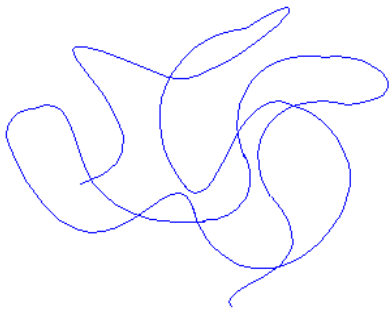
Polymer is a Greek word that means "many parts" (poly = many, meros = parts). The simplest definition of a polymer is something made of many units. Think of a polymer as a chain (imagine a long chain of paperclips). Super absorbent polymers encompass a number of polymers all having the basic ability to absorb massive quantities of water. They soak up water using the process of osmosis (water molecules pass through a barrier from one side to the other). When water comes in contact with the polymer, it moves from outside the polymer to the inside and causes it to swell. The polymer chains have an elastic quality, but they can stretch only so far and hold just so much water.

Four commonly used super absorbent polymers include sodium polyacrylate, polyacrylamide crystals, polyacrylamide plant spikes, and Gro-Creatures. While each polymer may have a somewhat different mechanism used to achieve the super-absorbing phenomenon and the rates of absorption can differ, they all effectively absorb water. All are essentially hydrophilic (water loving) non-toxic polymers that can absorb several hundred times their weight in water but cannot dissolve because of their three-dimensional polymeric network structure. They are fascinating materials and very versatile because of their unique solubility and transport properties. The liquid-like properties result from the fact that the polymer is composed almost entirely of water. However, the polymer also exhibits solid-like properties due to the network formed by the reaction. Composed of potassium, carbon, and nitrogen, these polymers are currently being used in many areas such as pharmaceuticals, food packaging, paper production, the horticultural industry, and oil drilling. Everyday examples include gelatin, disposable diapers, contact lenses, and even gravy.

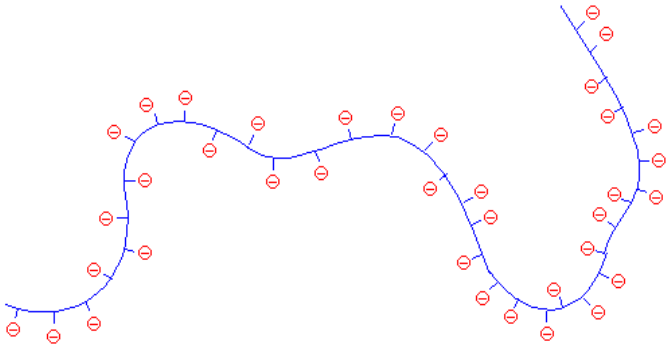
***Sodium Polyacrylate: The Super Slurper***

Sodium polyacrylate is nicknamed the "super slurper" because of its ability to absorb as much as 400-800 times its mass in water. These polymers were originally developed by The Department of Agriculture from hydrolyzed starch and polyacrylonitrile, but today a much more absorbent, totally synthetic polymer has been developed. The powder we find in today's disposable diapers is made from a reaction between sodium salts and polyacrylic acid to form sodium polyacrylate. Polymerization produces a linear molecule that has a very high molecular weight, usually greater than one million molecular units.

Scientists accidentally created a variation of the diaper polymer, called Insta-snow, that was far more fluffy when it absorbed water and created a substance that looked like real snow! This faux snow is so realistic that it is used on movie sets and indoor snowboarding parks. Insta-snow also soaks up water using the process of osmosis.



A polymer molecule tangled in a random coil.



A polyelectrolyte expands because it's like charges repel each other

Add a little water and your Insta-Snow expands to 100 times its original size. Let the students feel the insta-snow and acknowledge how cool it feels. This cooling effect is caused by water evaporating off the polymer. If you allow the insta-snow to dry to the point where all of the water has completely evaporated, the original amount of insta-snow

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should be recovered. This proves that the reaction is a physical rather than a chemical reaction.

Insta-Snow is similar to the super-absorbent polymers found in diapers. When water is added to a diaper, the polymer quickly turns into a gel-like solid. Insta-snow, on the other hand, becomes very fluffy when water is added. Both polymers look and feel the same before water is added; however, Insta-snow has much higher degree of "cross-linking" between the long chains of molecules. Cross-linking gives Insta-snow slightly different properties than the type of sodium polyacrylate found in diapers. This tightly cross-linked network rapidly unfolds when it comes in contact with water, which accounts for its greater ability to swell up into a fluffy material.