WHAT IS A POLYMER?
IT’S ALL GREEK

• Poly = many
• Meros = part
• Something (a substance) made of many parts
• Some questions
  – What kind of substance?
  – How many parts can there be?
  – How can the parts be arranged?
  – What kinds of parts can there be?
• Atom
  – The basic unit of matter, some 118 kinds are now known
  – Democritus: atoms are inert solids that interact with other atoms mechanically
  – The modern view is more complex
• Atoms can form bonds to one another
• Molecules: groups of two or more atoms that are held together by a covalent chemical bond
MORE PLAIN ENGLISH

• Covalent chemical bond: “an attraction between atoms that allow them to form molecules”

• Some examples of molecules
  – Hydrogen molecule $H_2$  \( H - H \)
  – Oxygen molecule $O_2$  \( O = O \)
  – Water molecule $H_2O$
  – Methane molecule $CH_4$
SOME QUESTIONS

• What kind of substance is a polymer?
  
  A substance composed of large molecules that are formed by connecting smaller molecular repeating units together with chemical bonds

• How many parts can there be?

• How can the parts be arranged?

• What kinds of parts can there be?
HOW LARGE A MOLECULE?

- Molecular weight: Ratio of the weight of a molecule to that of one hydrogen atom (not strictly true)
  - Typical non polymers less than 1000
  - Polymers 10,000-6 million

- Molecular size
How can the parts be arranged?

- Monomers: there are many kinds of monomers
- How many kinds in one polymer molecule?
  - Copolymers
    - A-B-A-B-A-B-
- How are the monomers arranged in the polymer molecules?
  - Linear polymers
  - Branched polymers
  - Ring polymers
  - Star polymers
  - Network polymers
  - .......
WHAT KIND OF PARTS?

• Polymer backbone: the kinds of chemical bonds that connect the monomers
  -CH₂-CH₂-  -CH₂-O-CH₂-  -NH-CH₂-C(=O)-
  -O-CH₂-C(=O)-  -O-Si(CH₃)₂-

• Some examples of monomers

\[
\begin{align*}
&\text{HO-Si(CH₃)₂-OH} \\
&\text{H₂C—CH₂} \\
&\text{H—C—C—O} \\
&\text{HO-C—COOH}
\end{align*}
\]
SO WHAT IS A POLYMER? IN PLAIN ENGLISH PLEASE

• A substance composed of very large molecules that have been formed by connecting small molecules through chemical bonds.
• The process used to make the connections is called polymerization.
WHAT IS A PLASTIC?

• Plastikos: capable of being molded or formed
• The term is most commonly applied to certain man-made polymeric substances
  – Thermoplastic polymers
  – Thermosetting polymers
• Most polymeric substances are not plastics
• Some polymers that are not plastics are used as coatings and adhesives
SOME NATURAL POLYMERS

• Polysaccharides (Greek again)
  – Cellulose
  – Chitin
  – Starches
• Poly amino acids: polypeptides and proteins
• Polynucleotides: DNA and RNA
• Polyphenolic alcohols: lignins
• Polyisoprenes: natural rubber
Cellulose

Peptide Bond

Hemoglobin
DNA Structures: A, B and Z
SOME SYNTHETIC POLYMERS

- Cellulose derivatives: guncotton, pyroxylin, collodion, celluloid, rayon
- Phenol formaldehyde resins: Baekelite
- Hydrocarbon backbones: polyethylenes, polypropylenes, polystyrenes, polyvinylchlorides, polymethylmethacrylates, polytetrafluorethylene
- Polyamides: Nylons, Nomex, Kevlar
VIDEO
SOME MORE SYNTHETIC POLYMERS

• Polyesters: Polyethyleneterephthalate, Polylactic acid, PolyBPAcarbonate
• Synthetic rubbers: SBRs, Chloroprene, Silicones
• And many many more.....
COULD WE LIVE WITHOUT POLYMERS?

NO!—Polymers make up the functioning parts of all life forms.
HOW CAN WE LIVE WITH SYNTHETIC POLYMERS?

By being sensible about the way we make, use, and dispose of them.