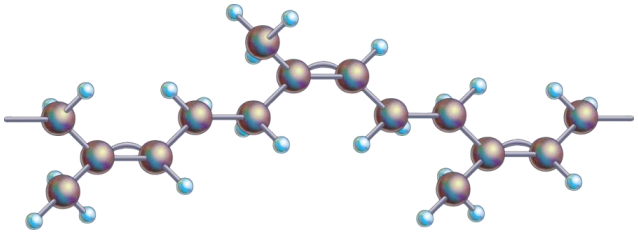
DAYTONA STATE COLLEGE

How Polymers Work



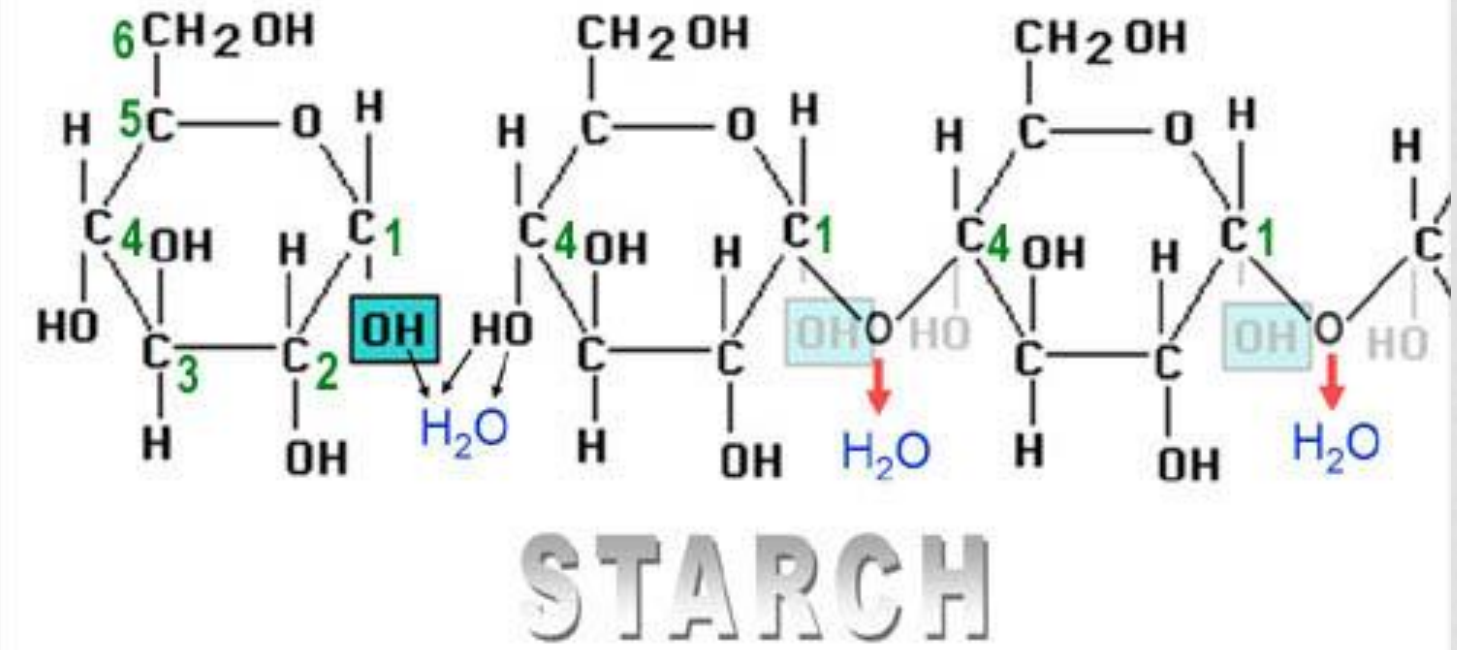
POLYMERS

POLYMERS

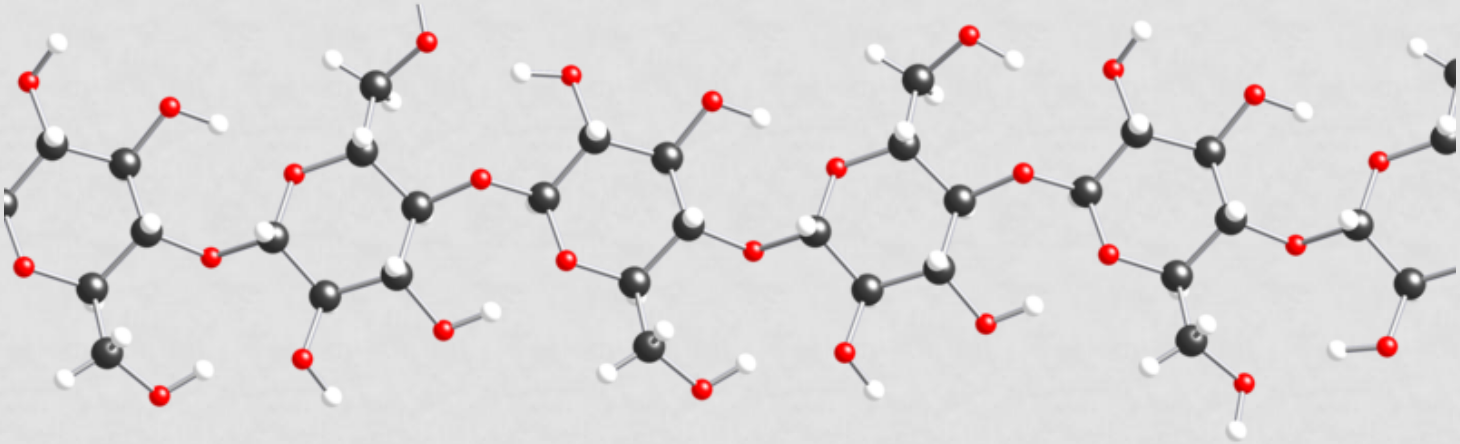
Polymers are

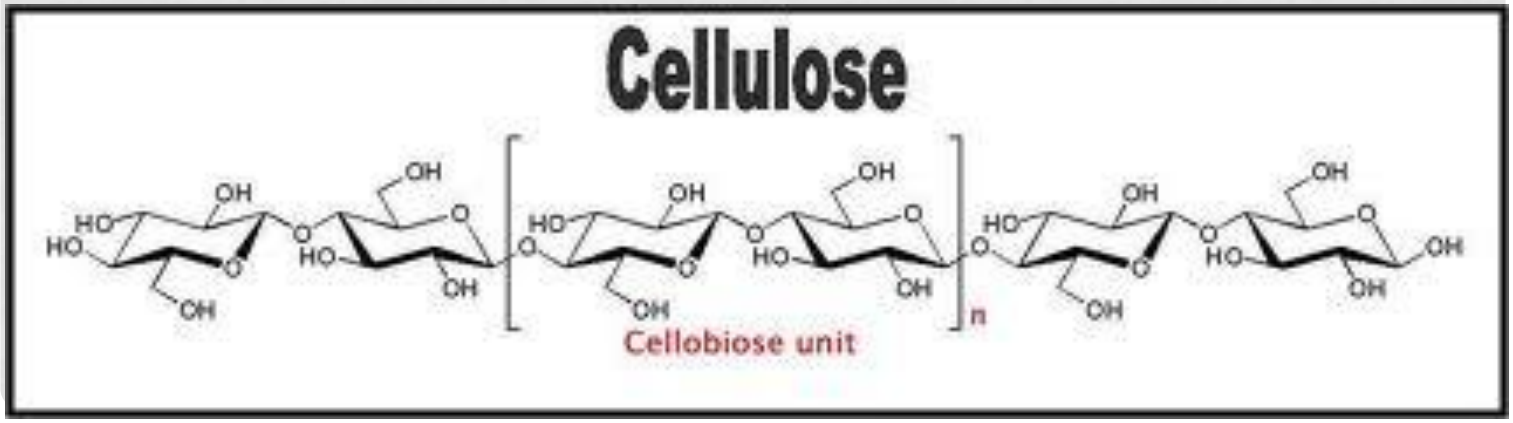
- large, long-chain molecules.
- found in nature, including cellulose in plants, starches in food, proteins, and DNA in the body.
- also synthetic such as polyethylene and polystyrene, Teflon, and nylon.
- have small repeating units called **monomers**.
- can be made from reaction of small alkenes.

STARCH

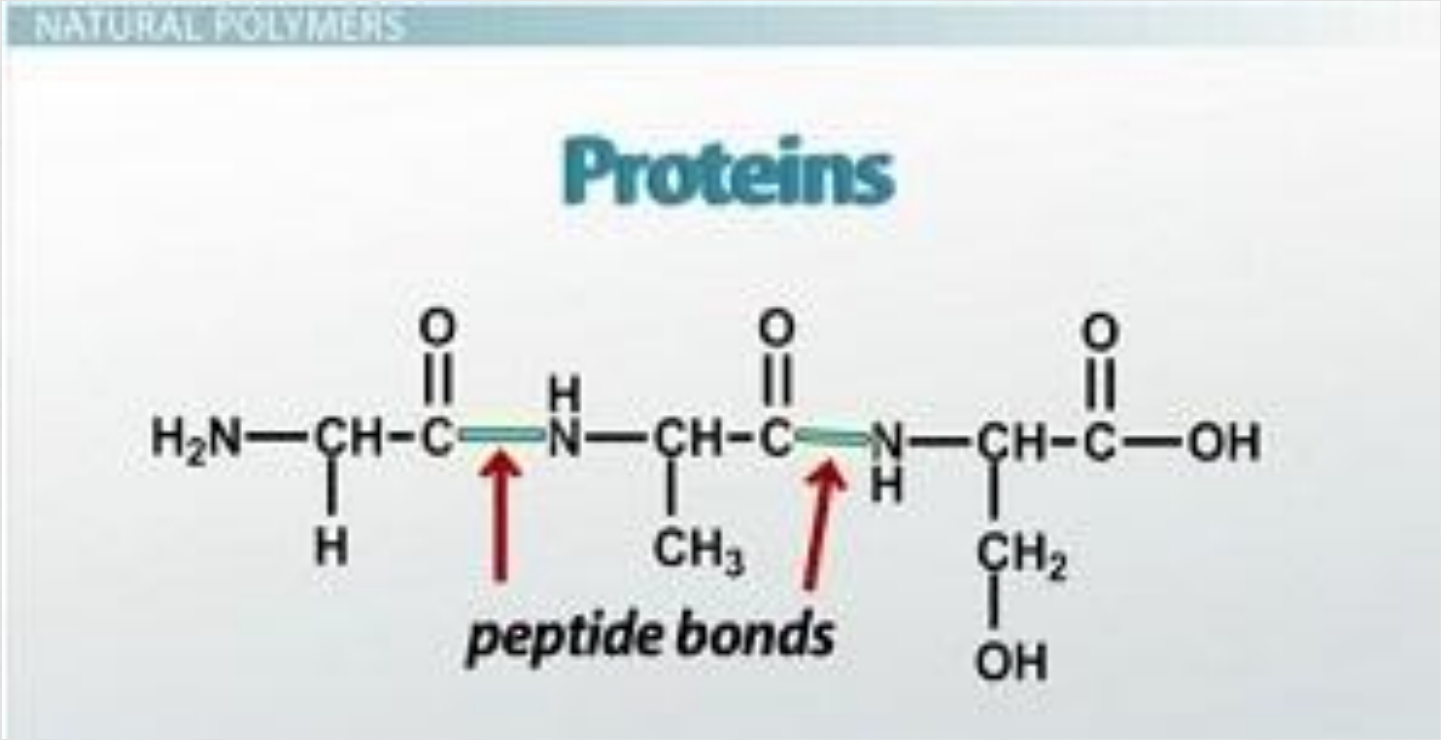


CELLULOSE

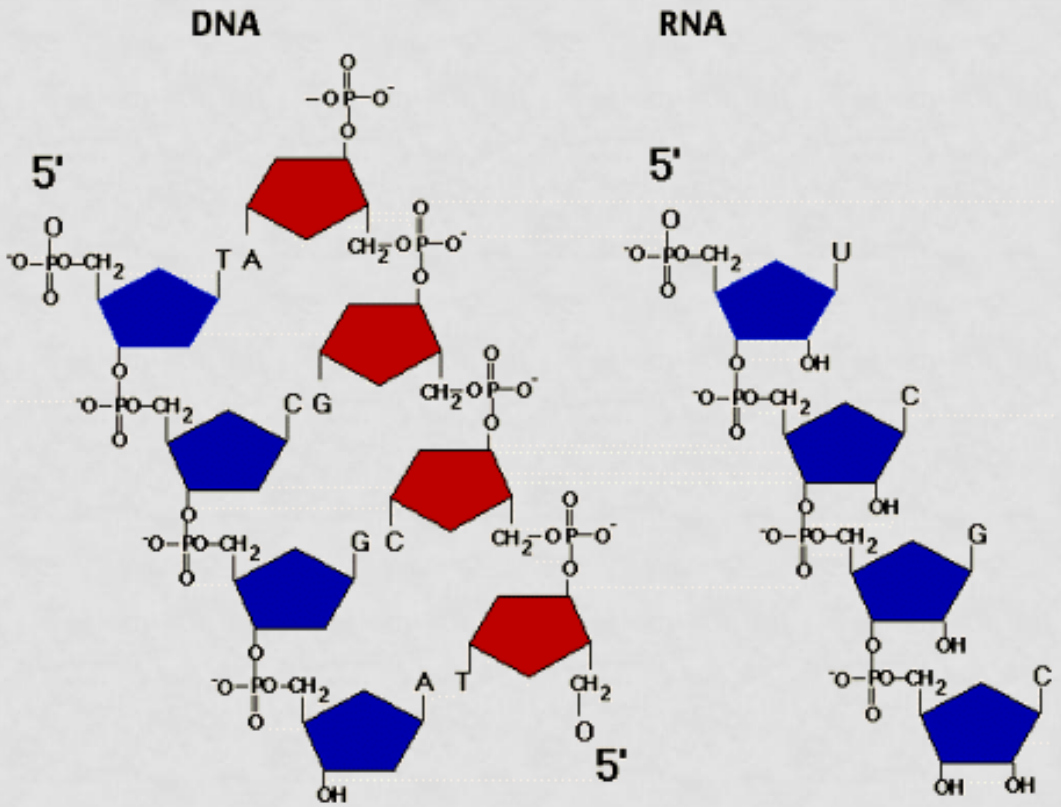




PROTEINS



DNA & RNA



COMMON SYNTHETIC POLYMERS

Polyethylene

Vinyl chloride

Polypropylene

Polytetrafluoroethylene (Teflon)

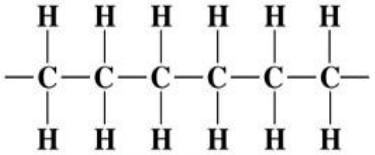
Polydichloroethylene (Saran)

Polystyrene

COMMON SYNTHETIC POLYMERS

$CH_2=CH_2$

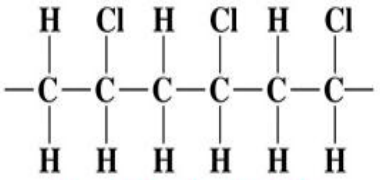
Ethene (ethylene)



Polyethylene

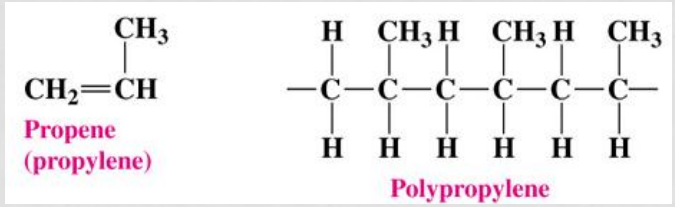
$CH_2=CH$ (Cl)

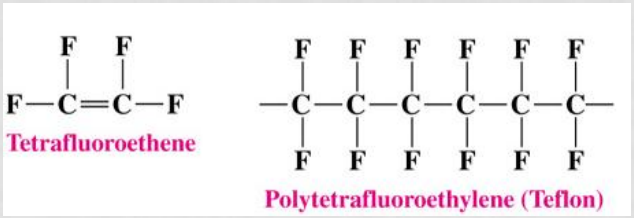
Chloroethene
(vinyl chloride)



Polyvinyl chloride (PVC)

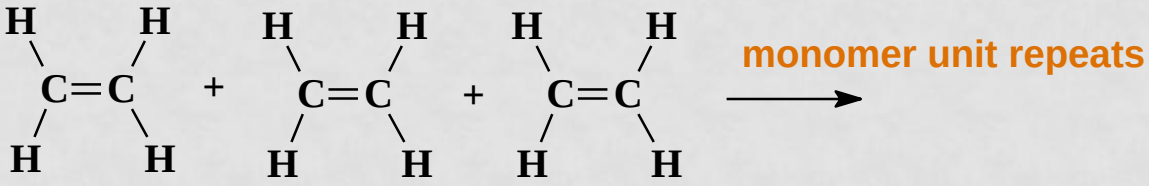
COMMON SYNTHETIC POLYMERS



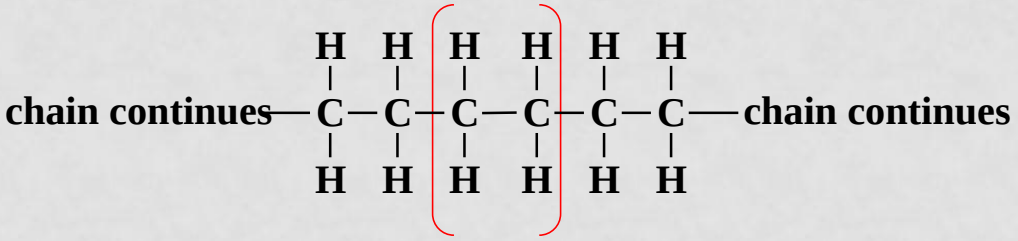


POLYMERIZATION

In polymerization, small repeating units called **monomers** join to form a long chain polymer.

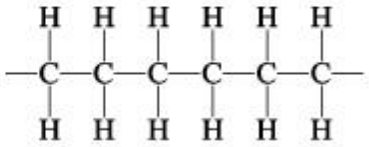
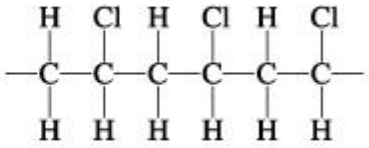
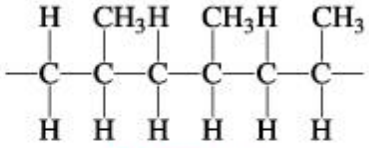


Ethylene monomers

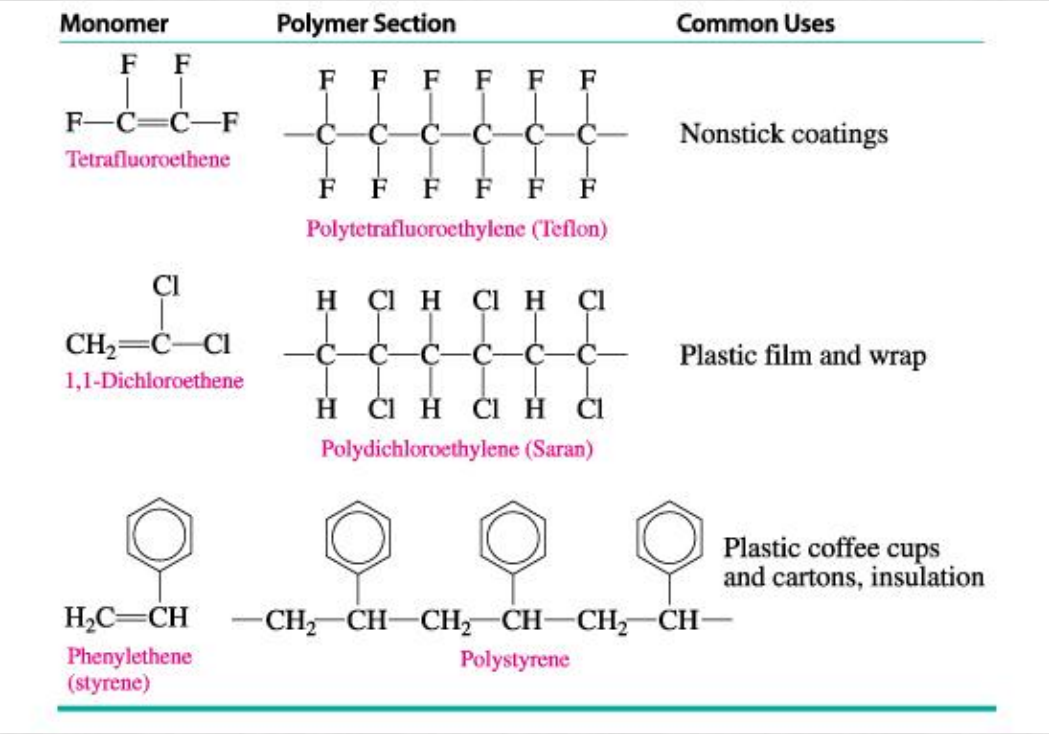


Polyethylene

POLYMERS FROM ADDITION REACTIONS

Monomer	Polymer Section	Common Uses
$CH_2{=}CH_2$ Ethene (ethylene)	 Polyethylene	Plastic bottles, film, insulation materials
$CH_2{=}CH(Cl)$ Chloroethene (vinyl chloride)	 Polyvinyl chloride (PVC)	Plastic pipes and tubing, garden hoses, garbage bags
$CH_2{=}CH(CH_3)$ Propene (propylene)	 Polypropylene	Ski and hiking clothing, carpets, artificial joints

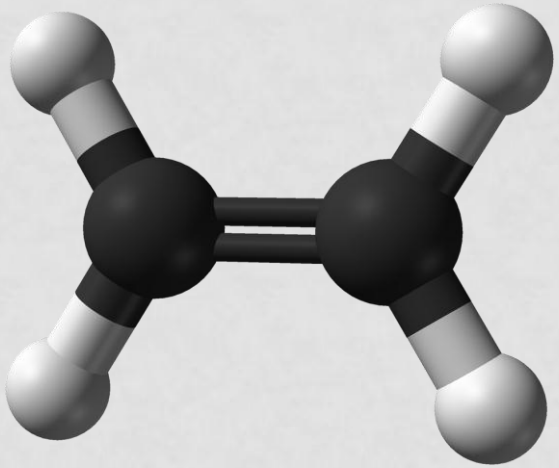
MORE MONOMERS AND POLYMERS



LEARNING CHECK

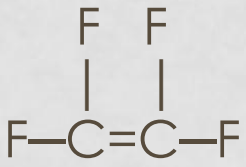
What is the starting monomer for polyethylene?

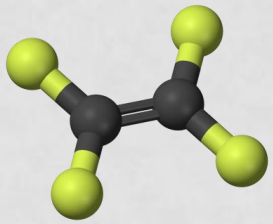
- Ethene (ethylene)
- $CH_2=CH_2$



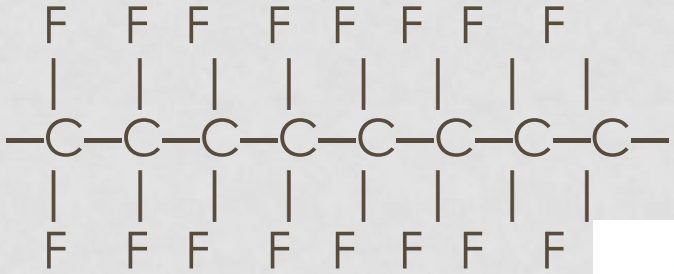
LEARNING CHECK

Name the monomer used to make Teflon and write a portion of a Teflon polymer using four monomers.





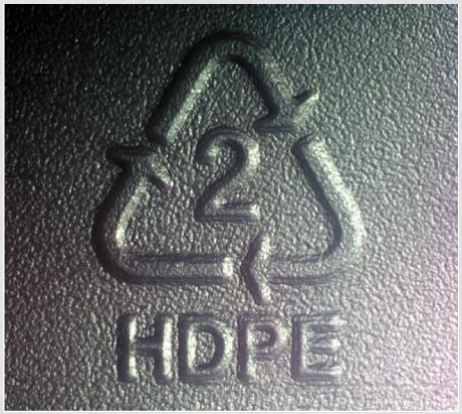
tetrafluoroethene



portion of Teflon

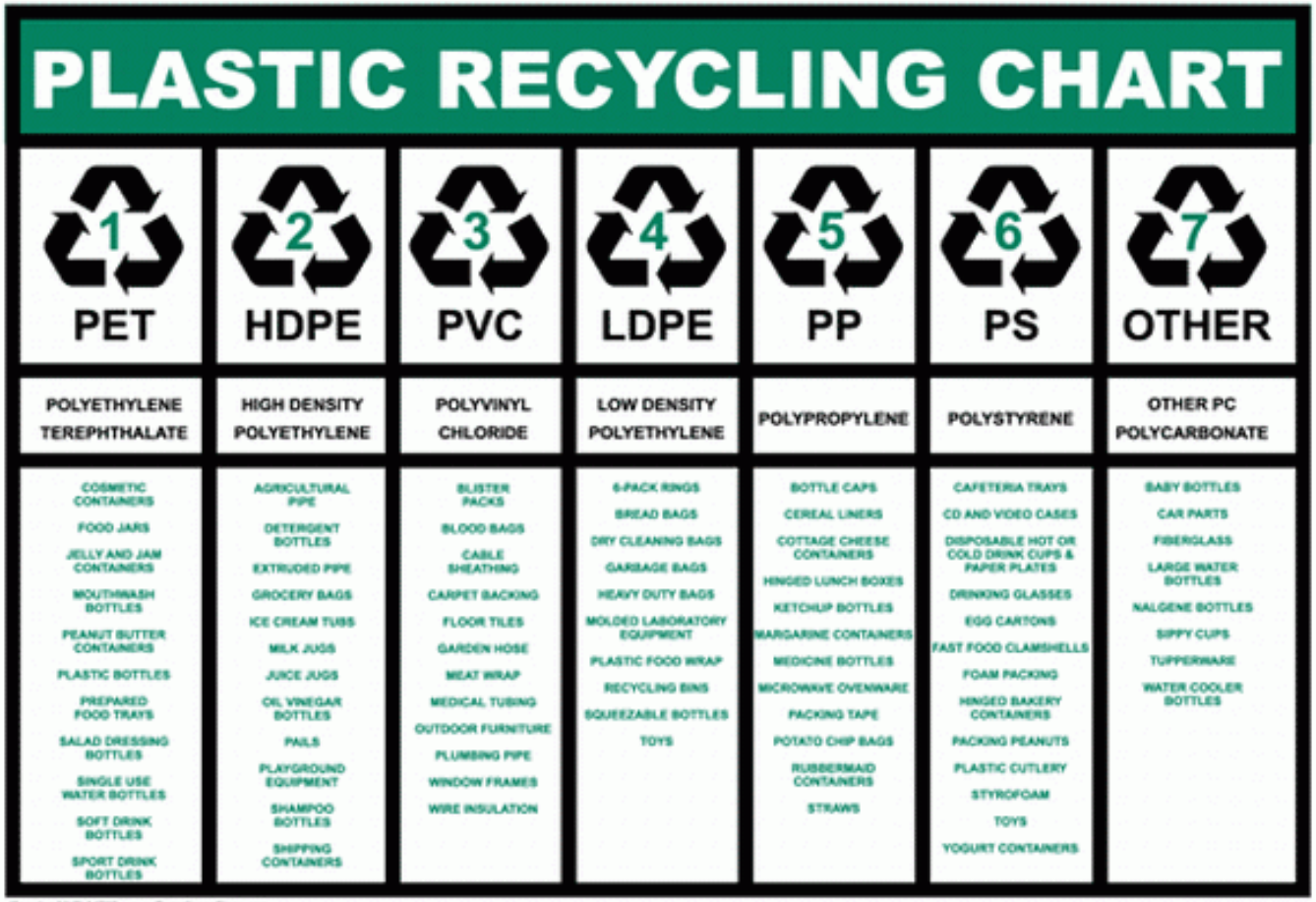
RECYCLING PLASTICS

Recycling is simplified by using codes on plastic items.



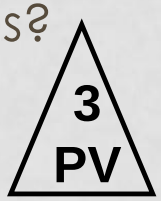
1 **PETE** Polyethyleneterephtalate
2 **HDPE** High-density polyethylene
3 **PVC or PV** Polyvinyl chloride
4 **LDPE** Low-density polyethylene
5 **PP** Polypropylene
6 **PS** Polystyrene

RECYCLING PLASTICS



LEARNING CHECK

What types of plastic are indicated by the following codes?

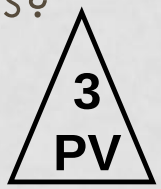
A. 

B. 

C. 

SOLUTION

What types of plastic are indicated by the following codes?

A. 

Polyvinyl chloride

B. 

Polypropylene

C. 

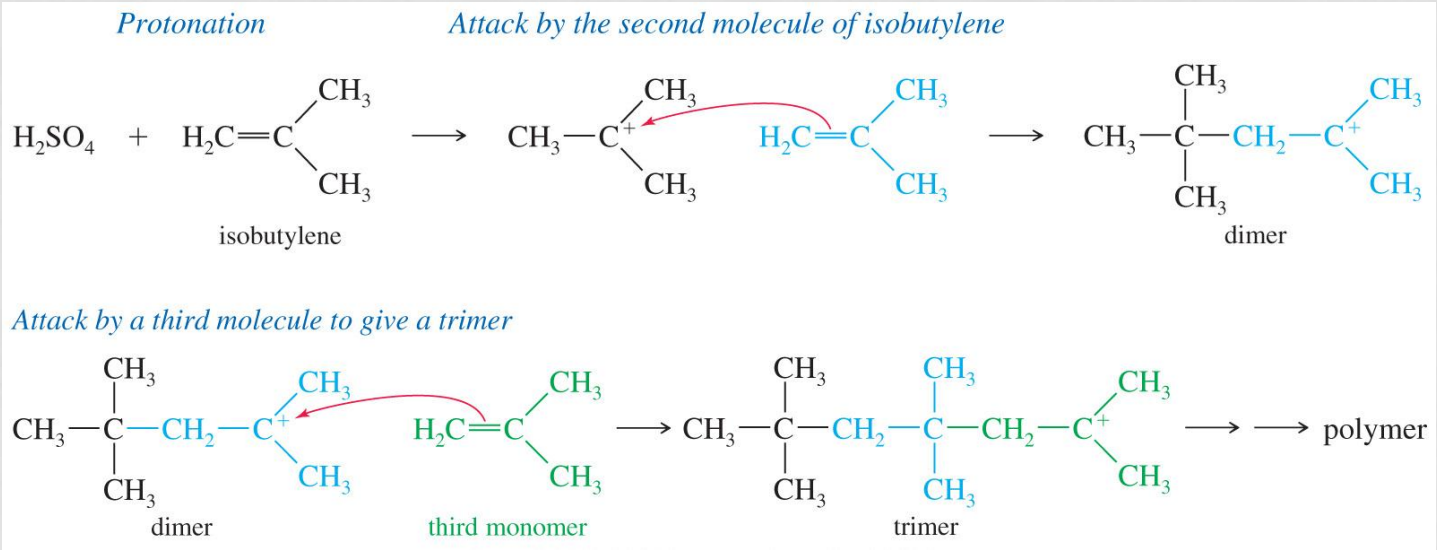
Polystyrene

.

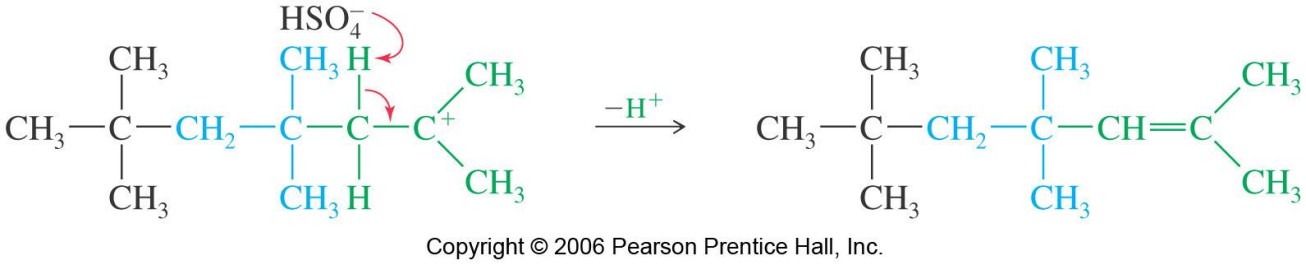
POLYMERIZATION

- An alkene (monomer) can add to another molecule like itself to form a chain (polymer).
- Three methods:
  - Cationic, a carbocation intermediate
  - Free radical
  - Anionic, a carbanion intermediate (rare)

CATIONIC POLYMERIZATION

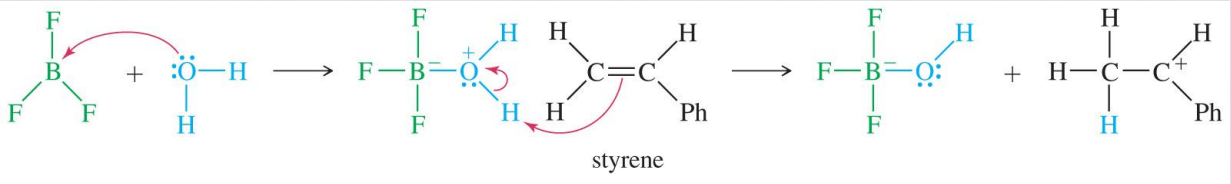


TERMINATION STEP OF CATIONIC POLYMERIZATION

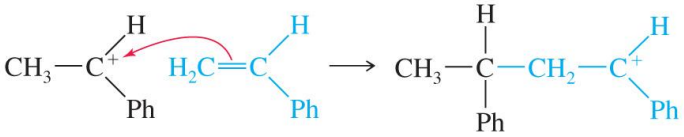


- The chain growth ends when a proton is abstracted by the weak base of the acid used to initiate the reaction.
- The loss of a hydrogen forms an alkene and ends the chain growth so this is a termination step.

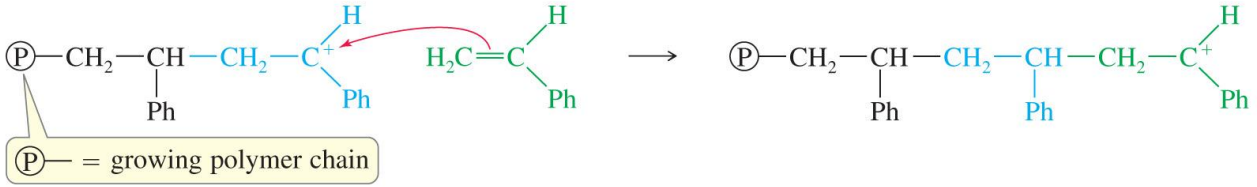
CATIONIC POLYMERIZATION USING BF_3 AS CATALYST



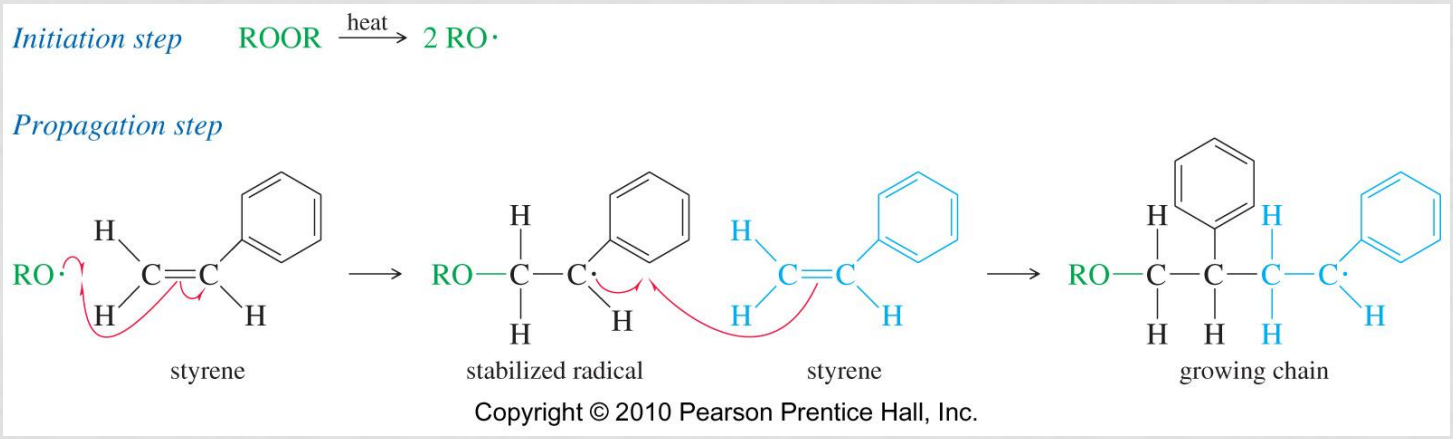
First chain-lengthening step



After many steps the polymerization continues



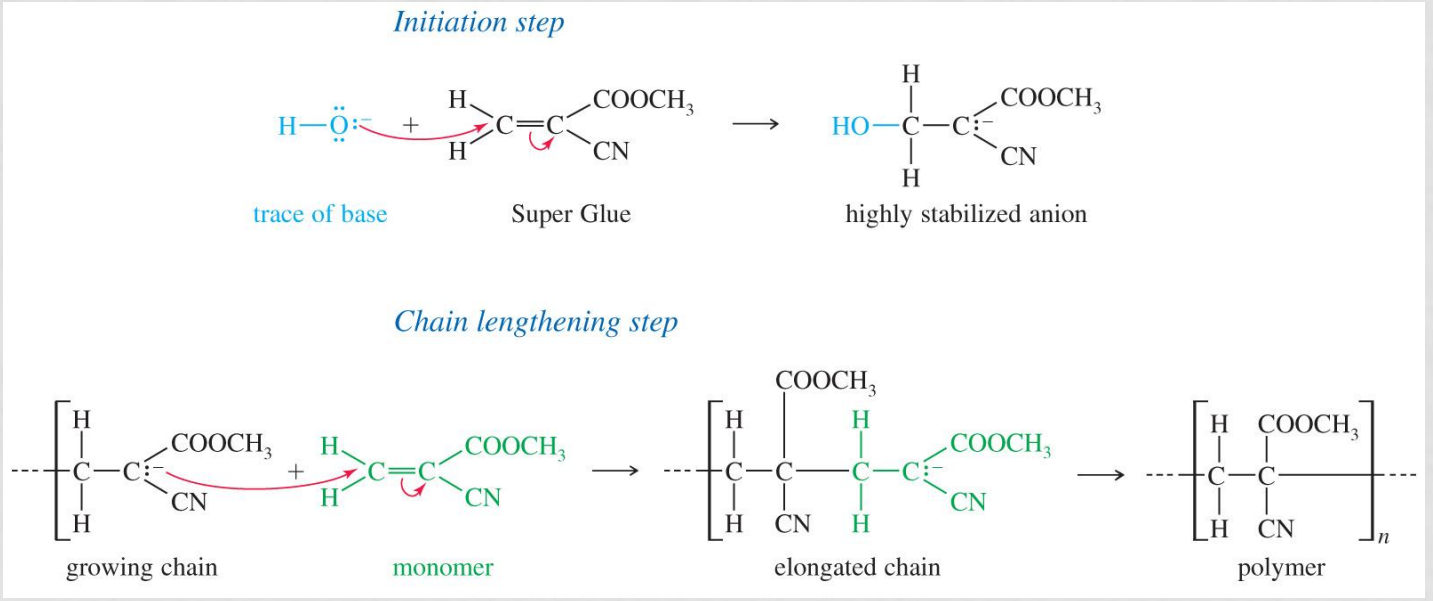
RADICAL POLYMERIZATION



- In the presence of an initiator such as peroxide, free-radical polymerization occurs.

ANIONIC POLYMERIZATION

- For an alkene to gain electrons, strong electron-withdrawing groups such as nitro, cyano, or carbonyl must be attached to the carbons in the double bond.



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Questions

Compiled from various sources by

D. Leonard (Learning Specialist)

The Academic Support Center @ Daytona State College

http://www.daytonastate.edu/asc/ascsciencehandouts.html