

ethanol  
group



## **Bite of Science**

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The Andersons, Inc. is a diversified company serving customers across North America and in global markets, doing business in the grain, ethanol, plant nutrient, railcar leasing and repair, turf products production, and consumer retailing industries. The company has operations throughout the United States, in Puerto Rico, and has rail equipment leasing interests in Canada and Mexico.

The company was founded in 1947 by the Anderson family, and continues to be headquartered in northwest Ohio. The company became publicly traded on the NASDAQ in the mid-1990s.

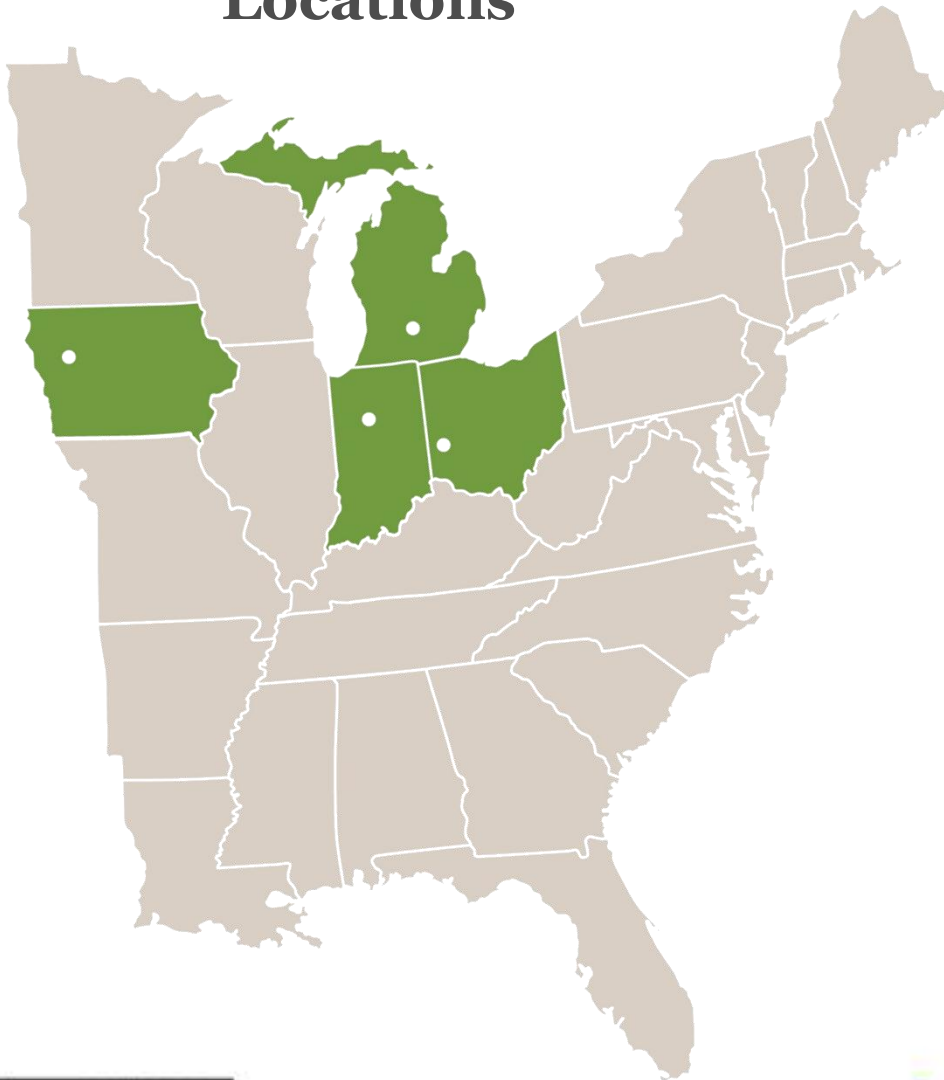


responsive rooted focused enduring

And

evolving diversified progressive resourceful

## Locations



## Services

- Facility operations
- Risk management
- Corn origination
- Ethanol and distiller dried grains (DDG) marketing

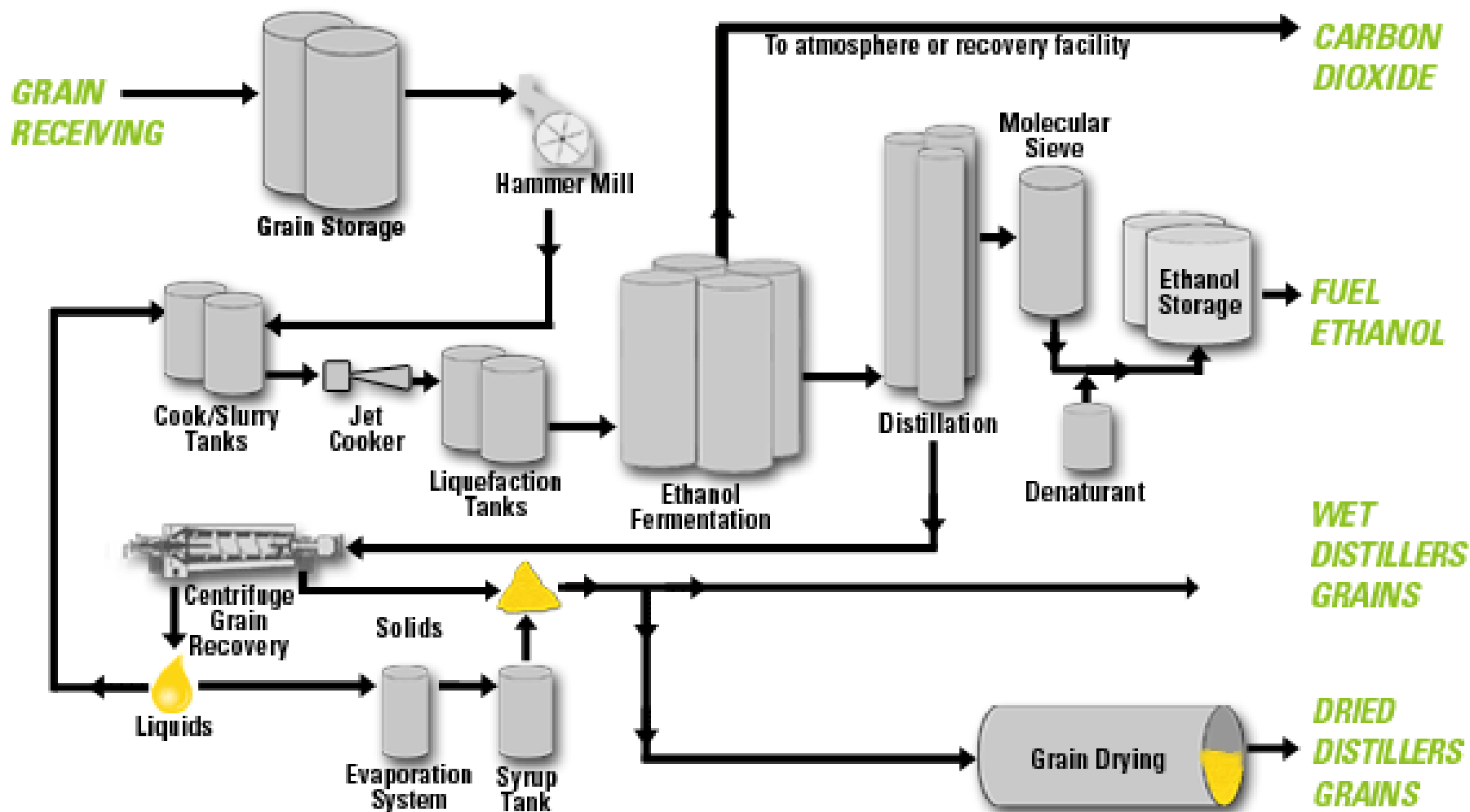
## Facilities

Significant investor and manager of four facilities in Michigan, Indiana, Ohio and Iowa, collectively capable of producing about 350 million gallons annually

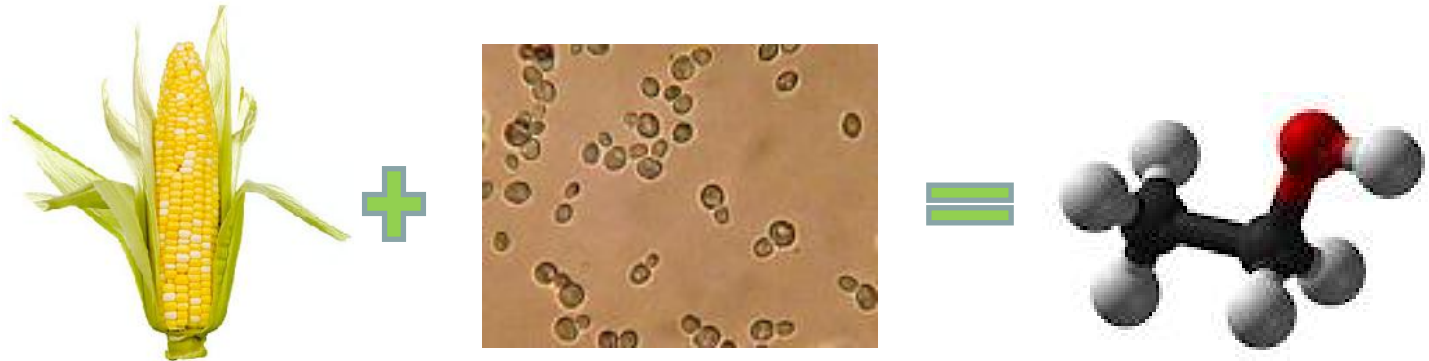
# Ethanol Production

## The Dry Mill Process

Mouse over diagram for more information.



## Interdisciplinary



- Food Production
- Chemistry
- Biology
- Soap Manufacture
- Explosive Manufacture

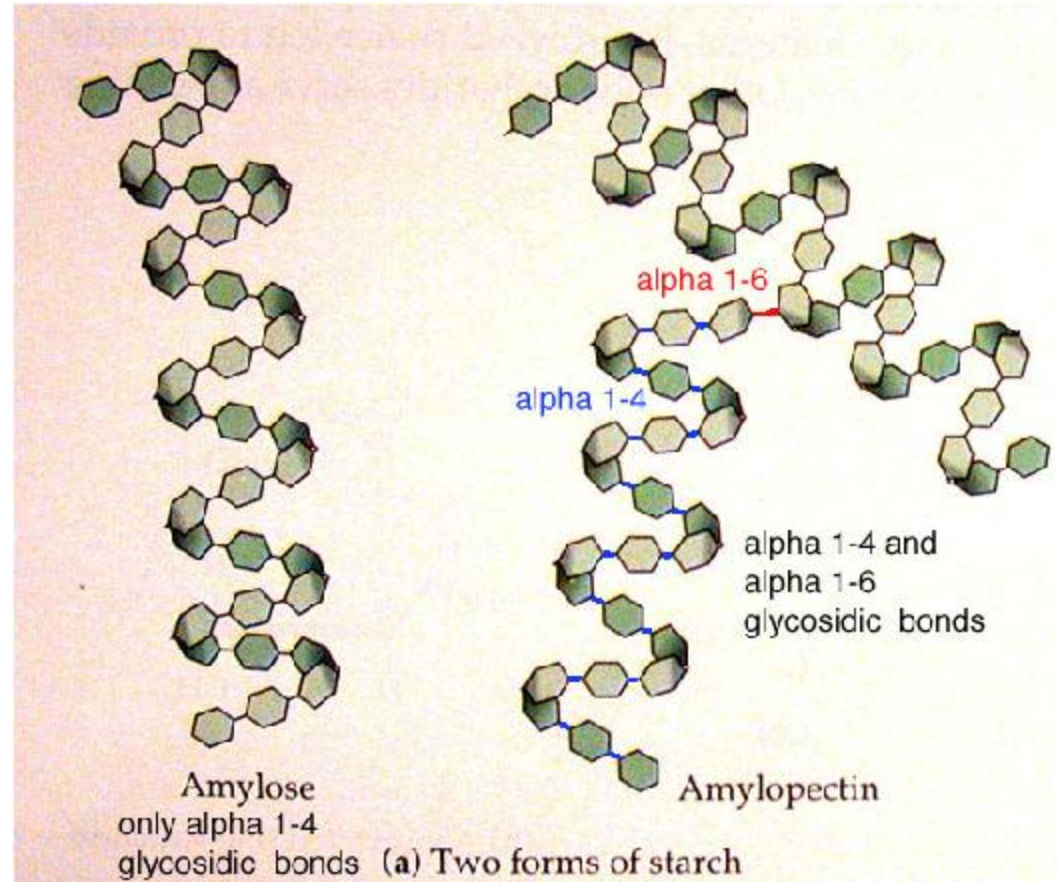


## Starch



## Dextrin

- Grind the corn
- Hydrolyze the starch
  - Heat
  - Water
  - Makes Gravy, need to break down starch fast
- Alpha-Amylase
  - Cleaves alpha 1-4 and alpha 1-6 bonds found in Amylose and Amylopectin the two forms of starch present in corn.
  - Reduces the length of dextrin chains
  - The “Axe”



## Maillard Reaction

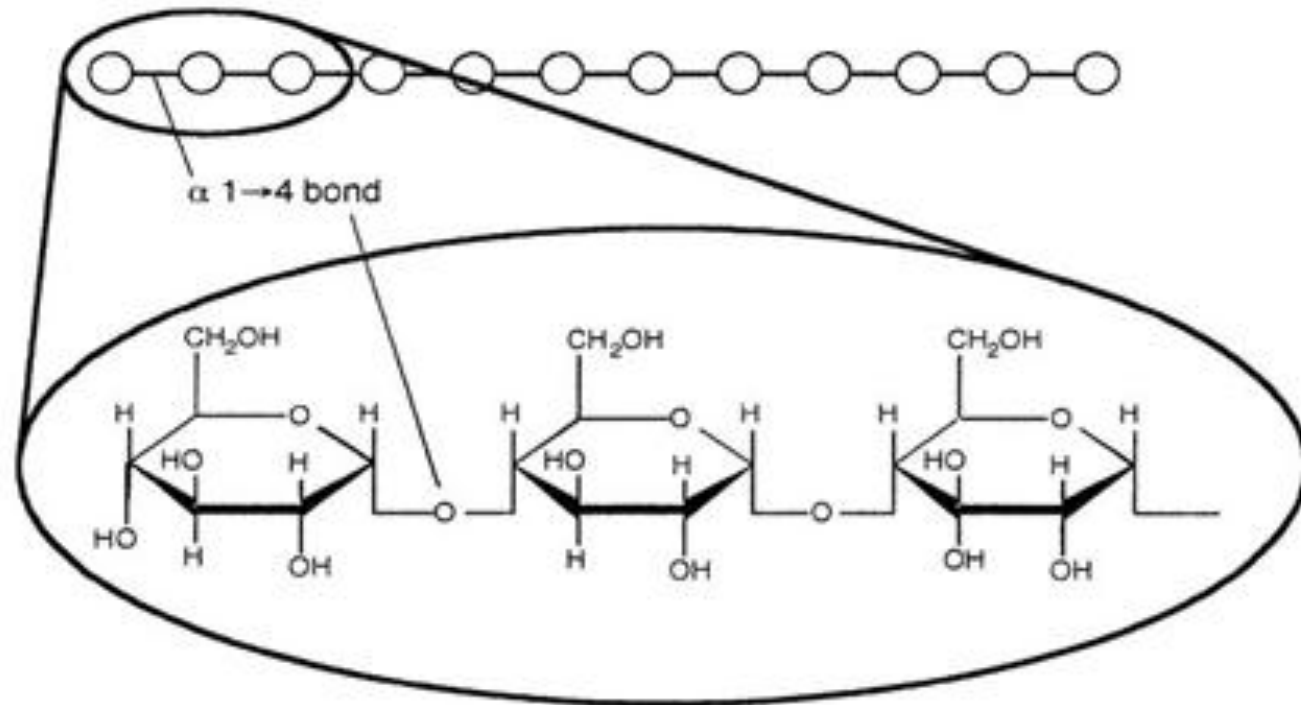
- Can occur in Jet cooker if simple sugars are exposed too quickly
- When heated the carbonyl group of a sugar reacts with amino group of an amino acid
- Responsible for browning in steak, onion, caramel, breads, etc
- Leads to reduced ethanol production efficiency and undesirable DDG color



- **ACTIVITY:** Submerge a sealed can of sweetened condensed milk in boiling water for 3 hours. Use as a dip for apple slices.



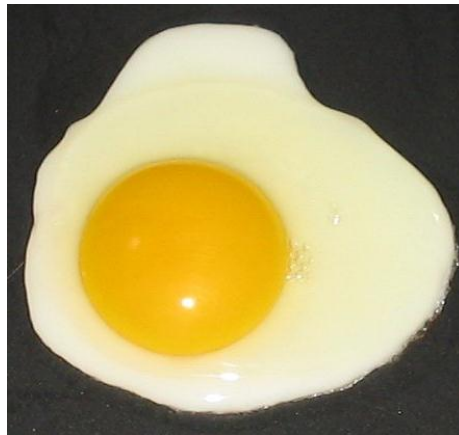
- Dextrin chains break down into glucose
- Too Slow
- Gluco-Amylase
  - Acts like Pacman breaking off one glucose molecule at a time.
  - The “Scalpel”





## Alpha-Amylase and Gluco-Amylase

- Naturally occurring enzymes
- Proteins produced by microorganisms
- Act a catalysts in the conversion of starch to glucose
- Each has functional pH and temperature ranges
  - Leaving the range causes irreversible denaturing

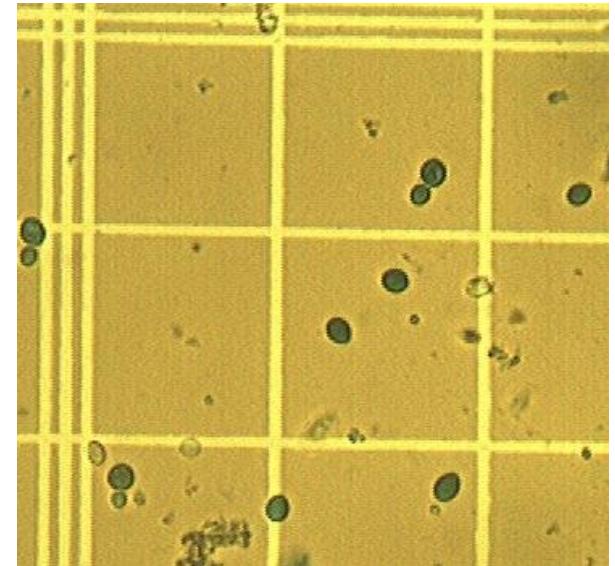




- Objective 1: Keep the yeast happy
  - Just enough food, thermal, osmotic and pH balance
- Objective 2: Keep the Bacteria miserable
  - Use slight differences in optimum growth conditions to help yeast out compete bacteria

Propagation: Aerobic process in which the primary metabolic product is more yeast cells (~7 hours)

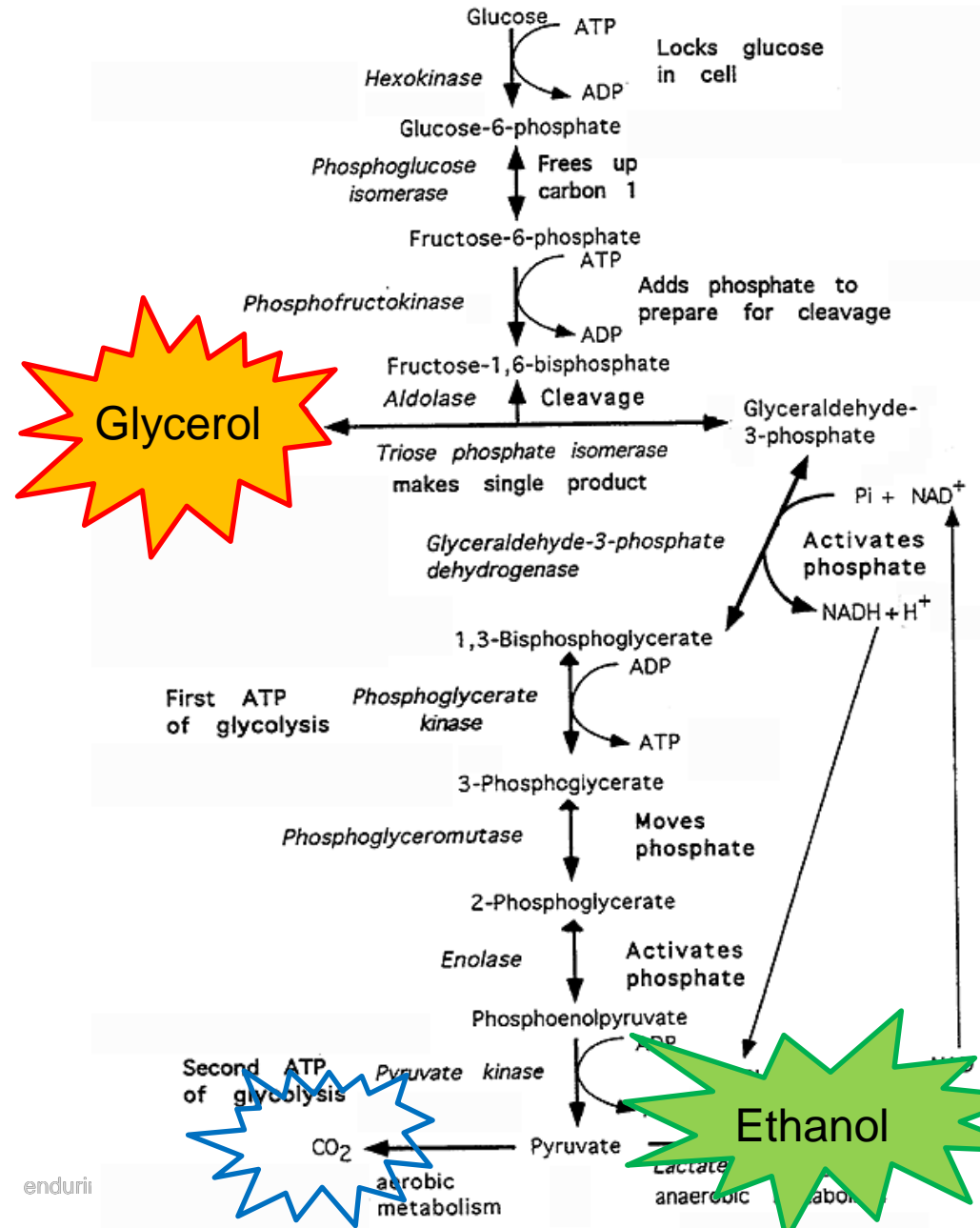
Fermentation: Anaerobic process in which the primary metabolic product is ethanol (~55 hours)



# Glycerol

- Produced by yeast to aid osmoregulation
- Reduces the efficiency of ethanol production
- Used in the manufacture of explosives
  - Learn what they do to improve efficiency and do the opposite

The Glycolysis Pathway:





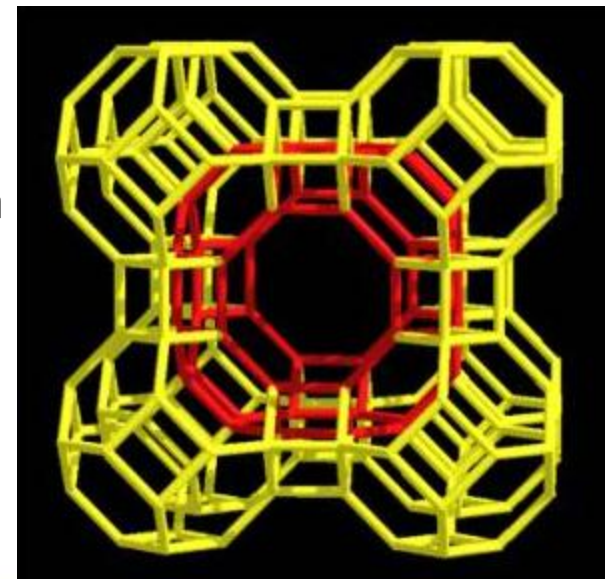
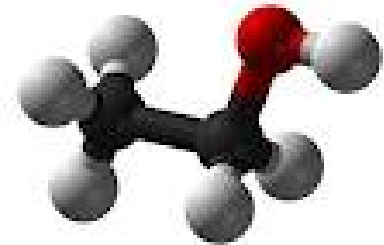
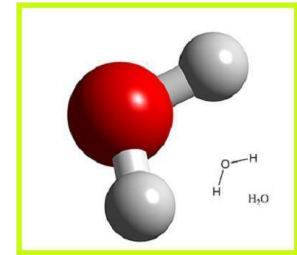
## The Science of Separation

- Distillation: Control the temperature and pressure of the system to vaporize alcohol in the beer
  - Maximize Efficiency: Get all of the alcohol and very little water.
- Centrifugation:
  - Solid wet cake separated from thin stillage
  - Non-oil separated from Oil
- Evaporation:
  - Used to condense the suspended solids in thin stillage into a product called syrup



## Separation (Cont.)

- Molecular Sieve Dehydration:  
Uses a crystalline lattice to trap molecules of a specific size
  - Vapor consisting of ~95% Ethanol and ~5% water
  - System is pressurized
  - The smaller water molecules are forced into and retained in the lattice structure
  - Ethanol bypasses the lattice
  - Vapor exiting ~99% Ethanol and ~1% water

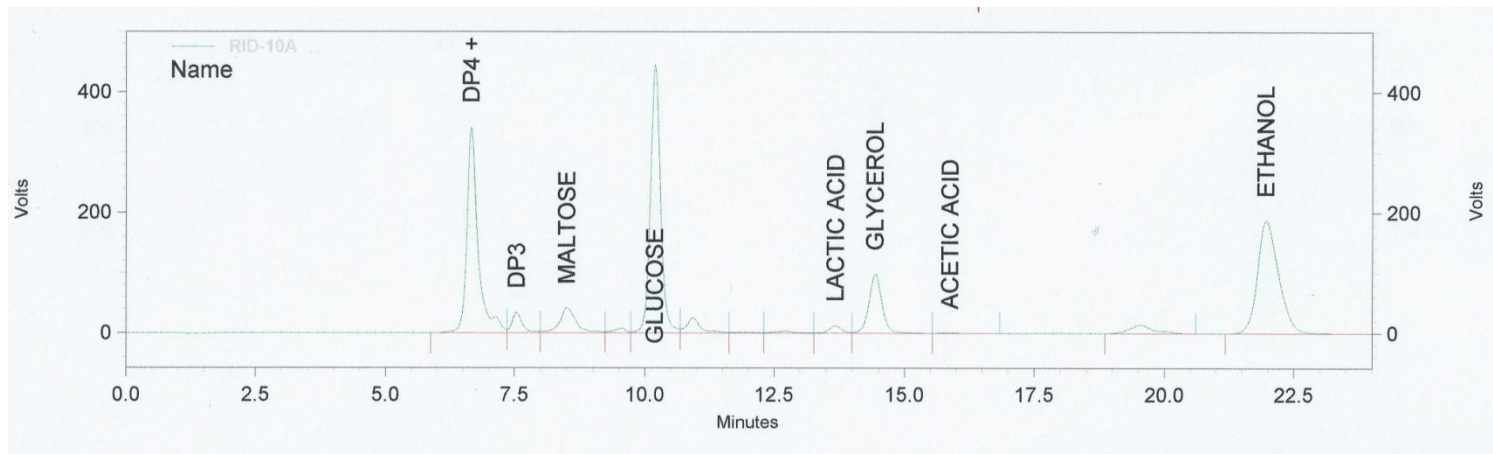


## Activity!

- Please take a cup, a marker and coffee filter strip from the table.
- Place a small amount of water in the cup
- Using the marker make a dot about one inch from the end of the strip. (About the size of a button)
- Suspend the strip dot end down in the water, making sure you don't submerge the dot.
- Hang the top of the strip over the edge of the cup and bend it so that it stays in place.

# Separation (Cont.)

- Chromatography: Method used for separating and quantifying analytes present in a solution
  - Mobile phase “pushes” analytes
  - Stationary phase offers resistance to movement
  - Analytes sorted by size and degree of interaction





Chromatography: Like dogs in an agility course, size is not the only factor



## Activity: Chromatography

Stationary Phase: Coffee filter

Mobile Phase: Water

Analyte: Marker pigment (can also use leaf pigment)

Many variations available online.

“Cheap” markers may contain more pigments.



Beer

Distillation

Whole Stillage

Low Proof Alcohol

Molecular Sieve Dehydration

Wet Cake

Thin Stillage

High Proof Alcohol \$

Water 

Centrifugation

Oil \$

Aqueous Portion

Centrifugation

DDG \$

Syrup

Water 

Evaporation

Chromatography

## Saponification

- The process of turning fatty acids into soap
- Biodiesel Manufacturers focus on unsaponifiable content of their feedstock as the key indicator of potential biodiesel yield.
- Primary quality control concern for corn oil
- We do a bench top saponification to determine the percent unsaponifiable matter present in our product.
- Our test is “destructive” in that we do not intend the leftover to be used as soap.
- **Activity:** Soapmaking in chemistry class



How can we serve you?