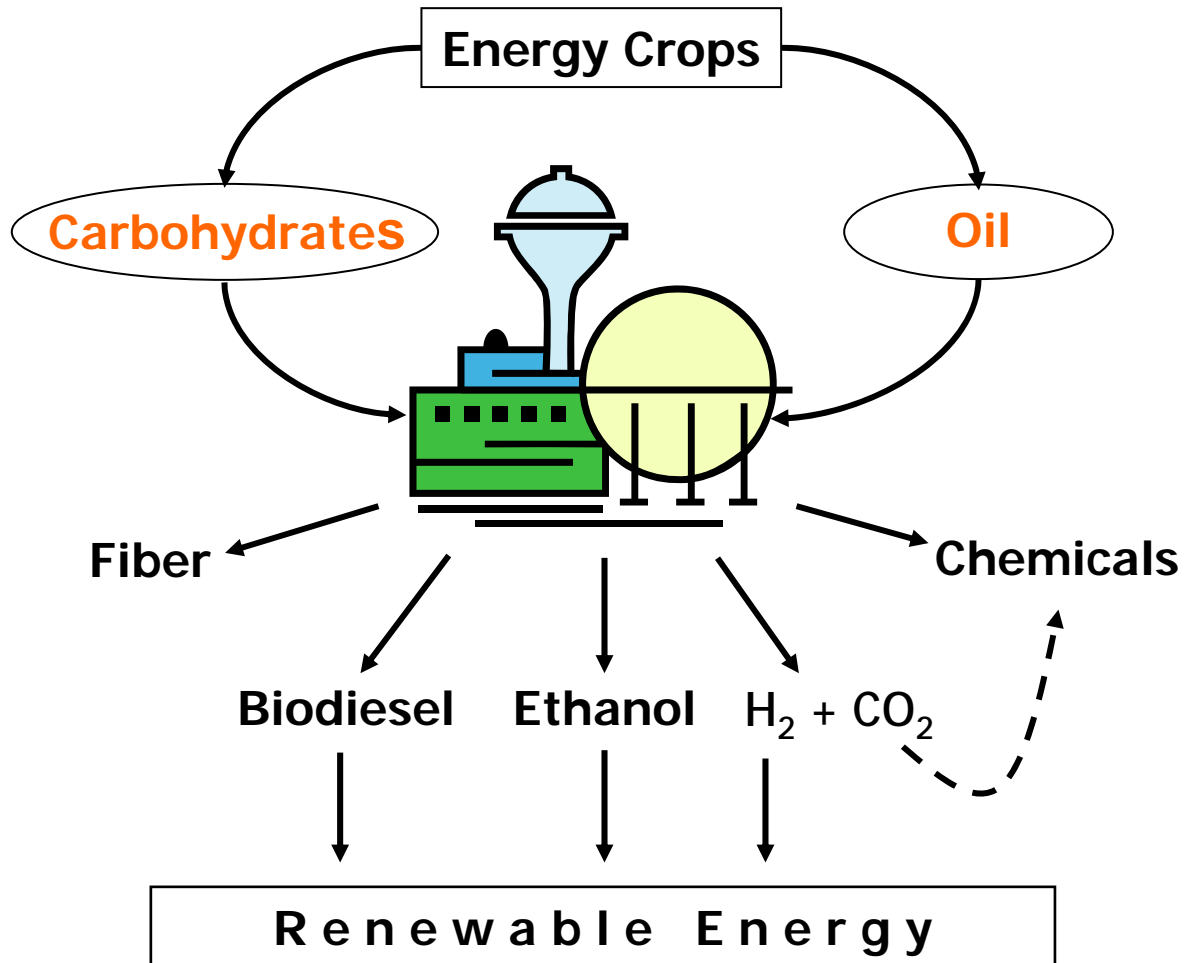


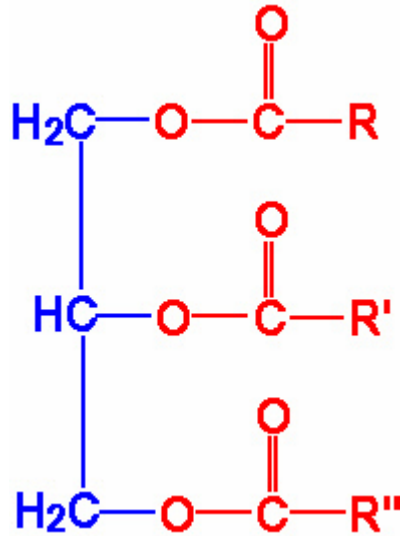
# Prospecting Renewable Fuels In North Dakota

Dieter Hermsmeier

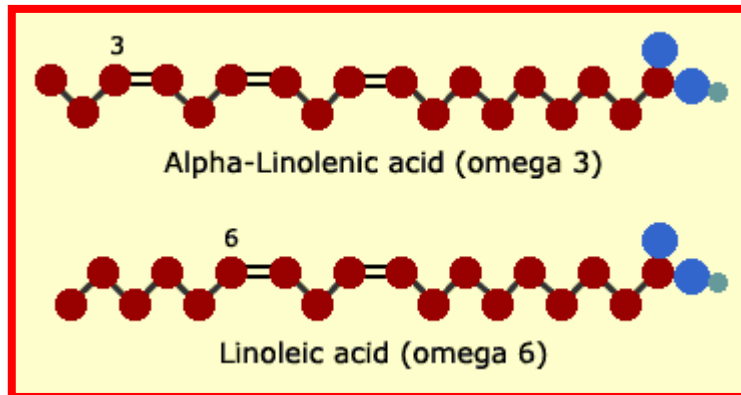
# BioRefinery Concept



# SEED OILS

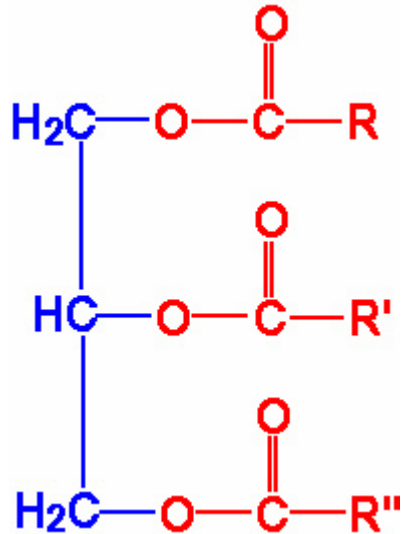


**Triacylglycerides** are composed of a **glycerol backbone** to which 3 **fatty acids** are esterified.



Two examples of fatty acids found in canola oil

# Producing BioDiesel by Transesterification



Triacylglycerides



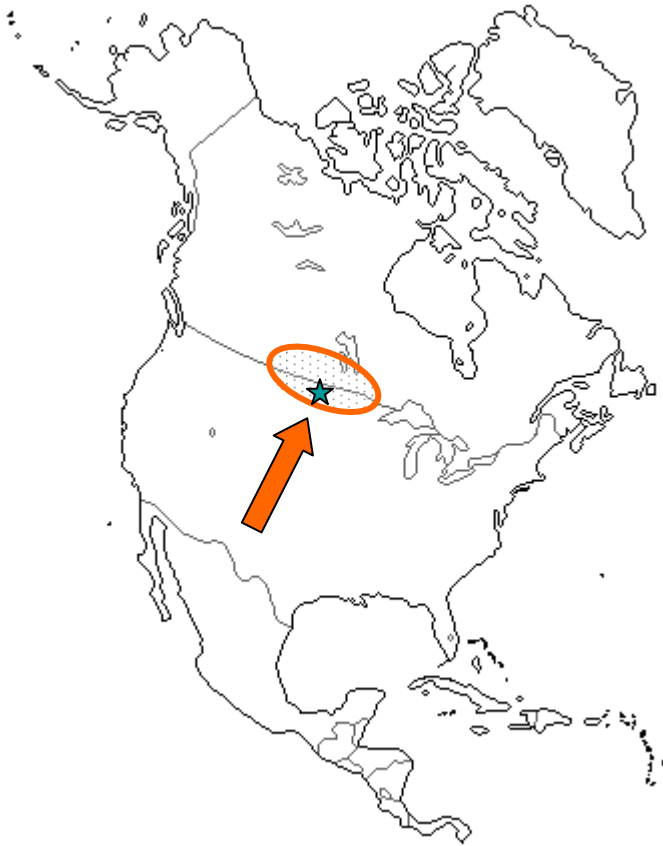
Glycerin

[ Trihydric Alcohol ]

Fatty Acid Esters

BioDiesel

# CANOLA



- North Dakota is located at the southern margin of the world's largest canola growing area.
- North Dakota produces more than 95% of the U.S. canola crop
  - ~ 1.3 billion lbs production
  - ~ \$ 140 million value

# CANOLA at the NCREC

- Research efforts at the NCREC are conducted in support of the **NDSU Center of Excellence for Agbiotechnology: Oilseed Development**
- The goal is to develop locally adapted, high-yielding canola varieties to sustain the local biodiesel industry.

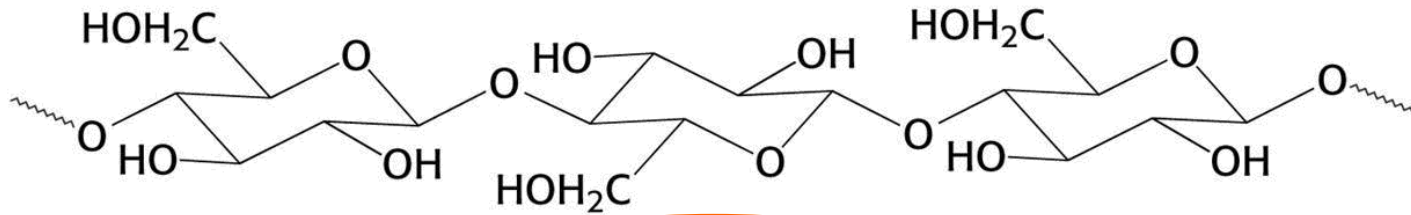


The NCREC is conducting canola research since 27 years.

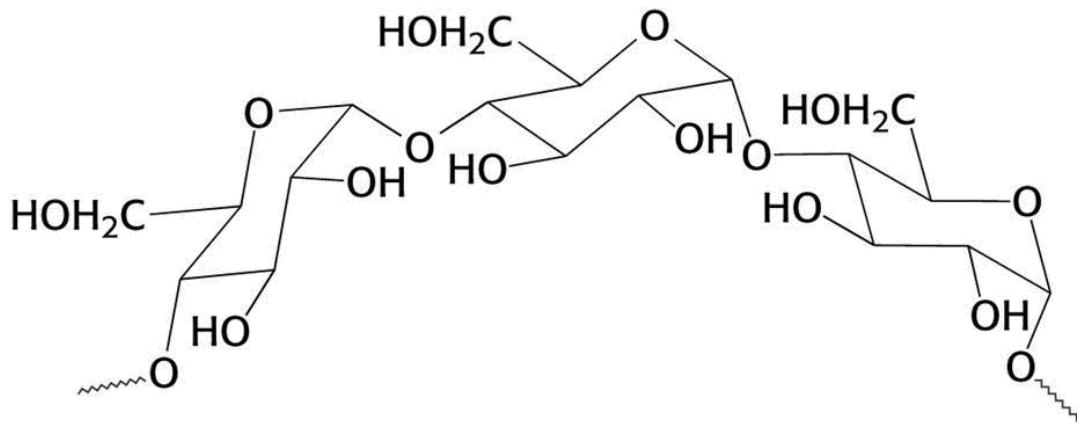
Currently several hundred canola lines and varieties are evaluated for important agronomic traits, like:

- Seed yield
- Oil content / composition
- Lodging and shattering
- Planting / harvesting time
- Applicability of straight combining
- Disease resistance
- Performance in crop rotations

# CARBOHYDRATES



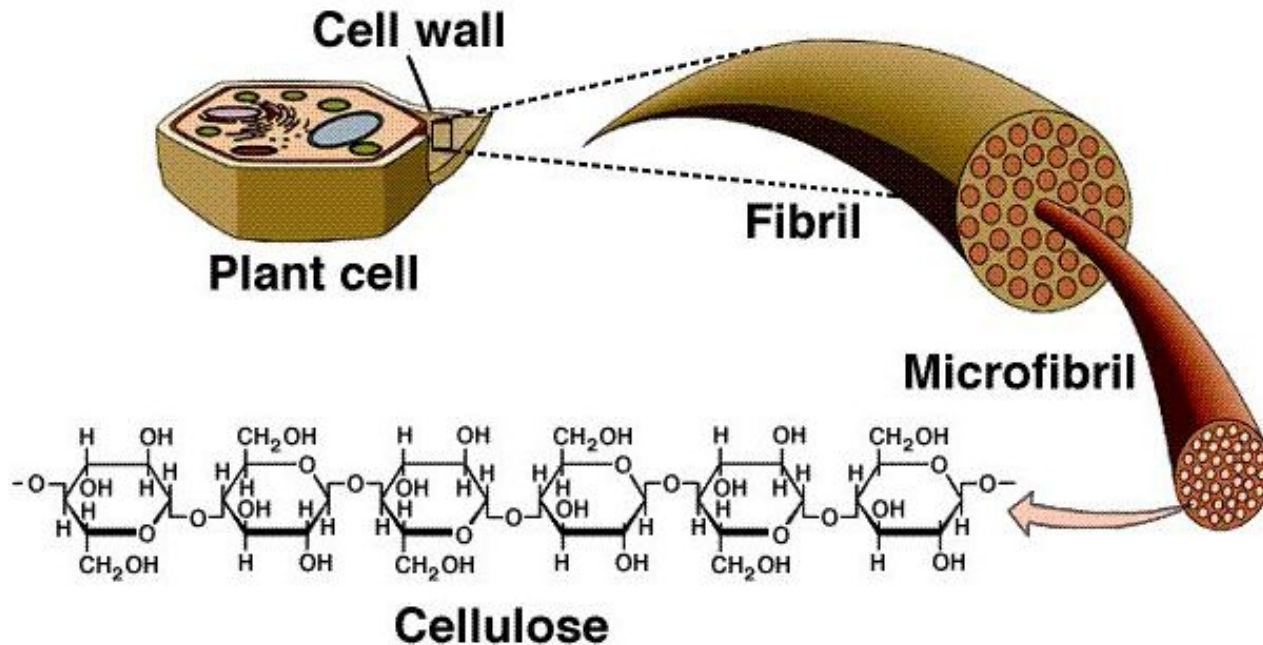
**Cellulose**  
( $\beta$ -1,4 linkages)



**Starch**  
( $\alpha$ -1,4 linkages)

# CELLULOSE

- Cellulose is the most abundant organic compound on earth
- Cellulose is encased in lignocellulose complexes
- Lignocellulose is recalcitrant to chemical and biological degradation



# Lignocellulose Processing

*TODAY*

*TOMORROW*

**Lignocellulose**

**Acid / Steam Pretreatment**

**Oxidative Degradation**  
(Fungal Peroxidases)

**Holocellulose**  
(Hemicellulose + Cellulose)

**Dilute Acid Hydrolysis**

**Hydrolysis** (Cellulases)

**Sugar**

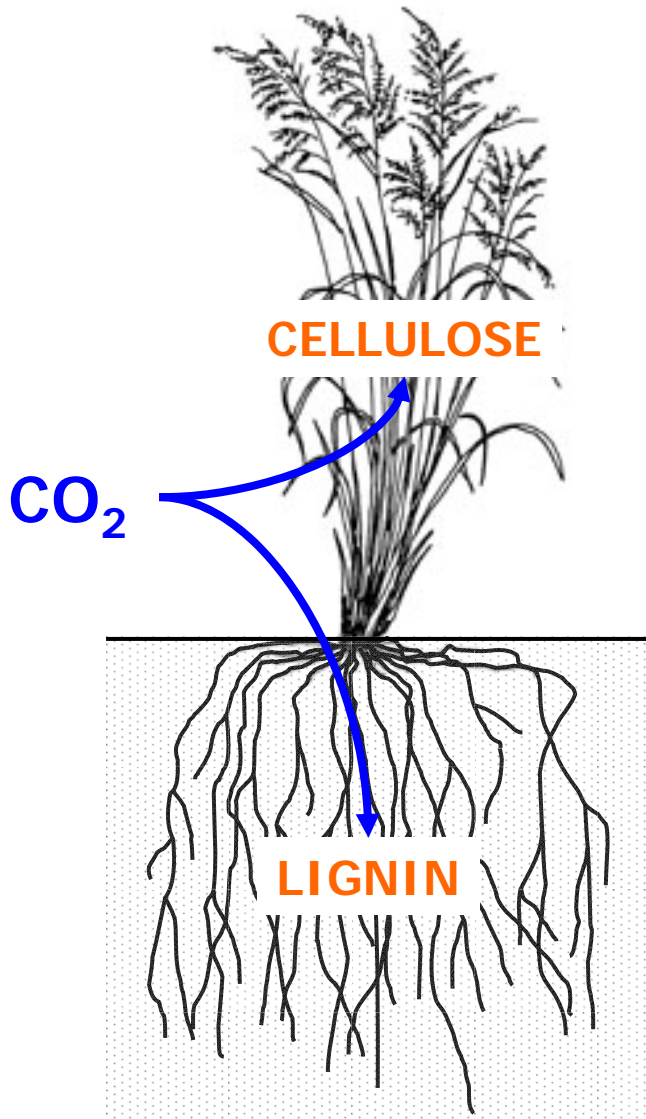
**Fermentation**

**Fermentation**

**Ethanol**

RED = Physical-Chemical  
GREEN = Biological

# SWITCHGRASS



- Switchgrass (*Panicum virgatum*) is a native warm season prairie grass.
- The perennial grass efficiently sequesters more than 50% of its carbon in the large root system which can reach 20 feet deep for water.
- Switchgrass varieties overproducing cellulose in above ground parts and sequestering carbon as lignin in roots would be superior energy crops.

# Herbaceous Biomass at the NCREC

A perennial herbaceous biomass study was planted in 2006 containing varieties of switchgrass, big bluestem, tall wheatgrass, intermediate wheatgrass, wildrye and CRP mix. A cycle of annual and biennial harvests begins in 2007.

Parameters of interest are:

- Appropriate grass species
- Harvest methods
- Maintenance practices
- Economics of production
- Impact on soil organic matter



The biomass study is a joint effort of:

North Dakota natural Resources Trust

NDSU Extension Services and Experiment Stations

USDA-ARS Northern Great Plains Research Laboratory

North Dakota Game and Fish Department

North Dakota Commerce Department

and others