

# Implementing NGSS Science and Engineering Through Bioenergy



This project is supported by  
an AFRI Cap Grant no.  
2011-68005-30407 from the  
USDA National Institute of  
Food and Agriculture (NIFA).

**OSU**  
**Oregon State**  
UNIVERSITY  

---

**College of Education**

# Background

---



# Precision Agriculture



# Activity Procedure

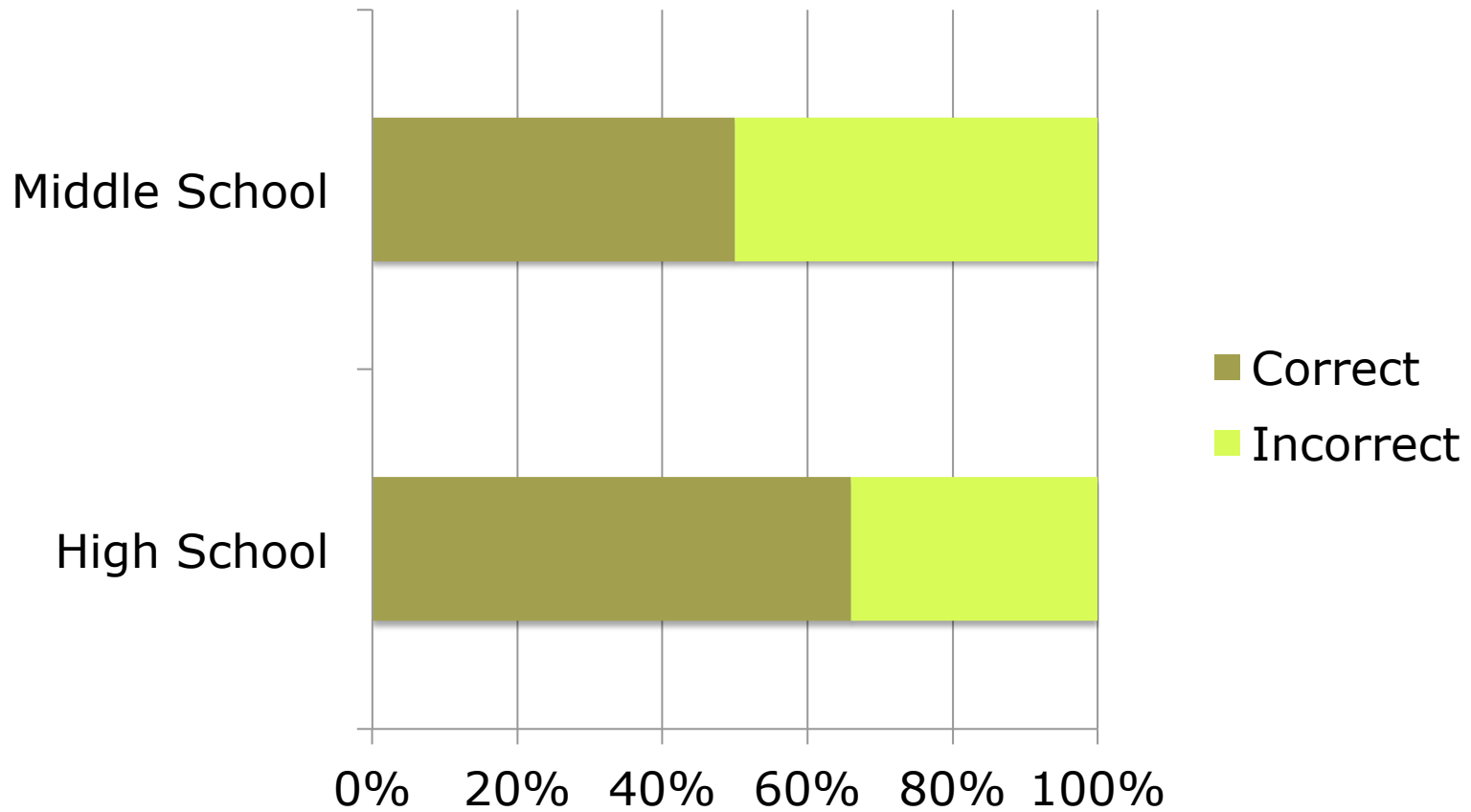
---

- Label 6 paper squares. Rub dry sample
- Label 6 cups (1-6)
  - Cup 1 – Cracker crumbs
  - Cup 2 – Marshmallows
  - Cup 3 – Peanut butter
  - Cup 4 – Apple sauce
  - Cup 5 – Corn kernel
  - Cup 6 – Biomass
- Test each cup with glucose strip
- Add two drops of iodine to each cup



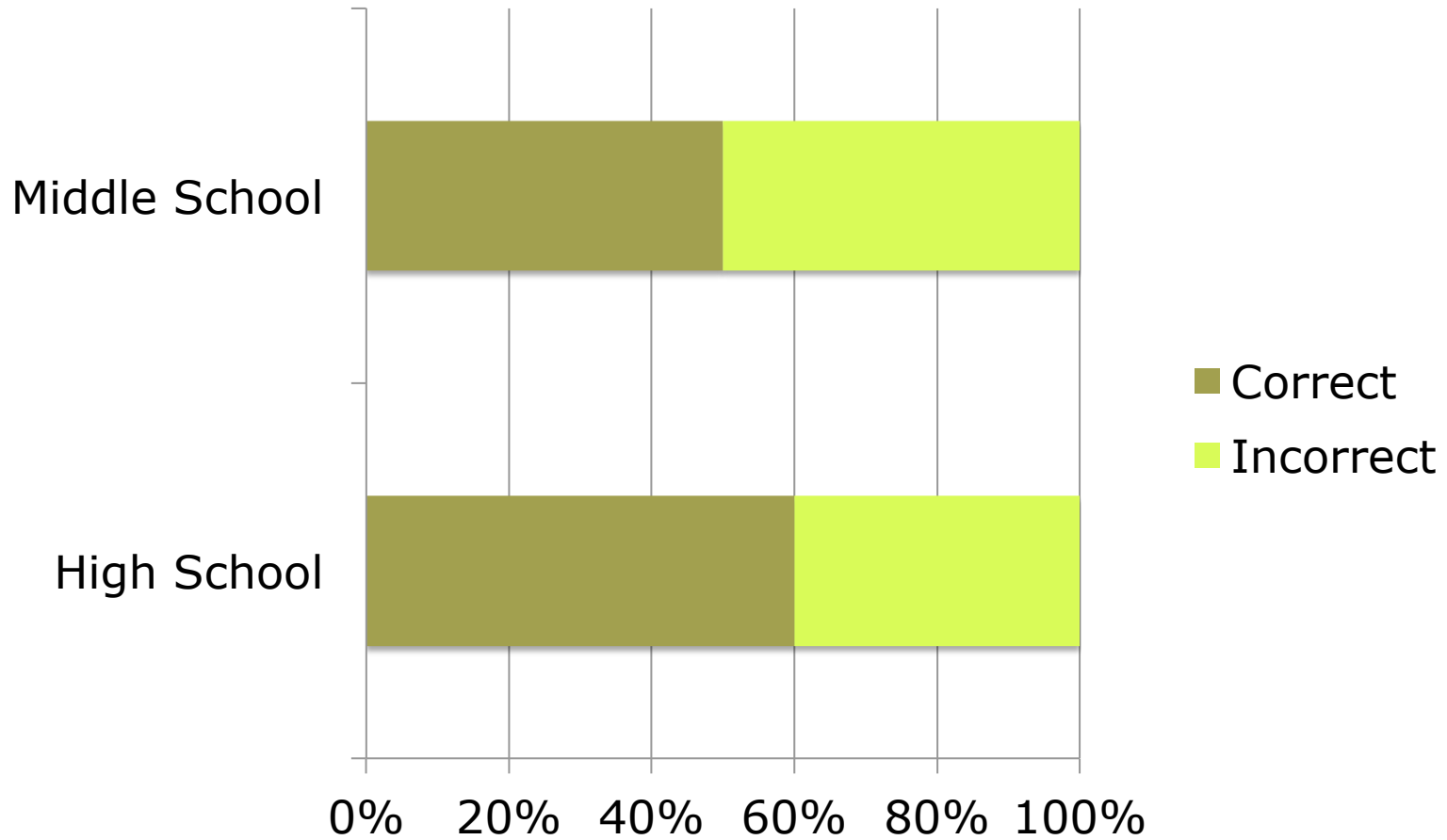
# What does the term 'renewable energy' mean to K12 Students?

---



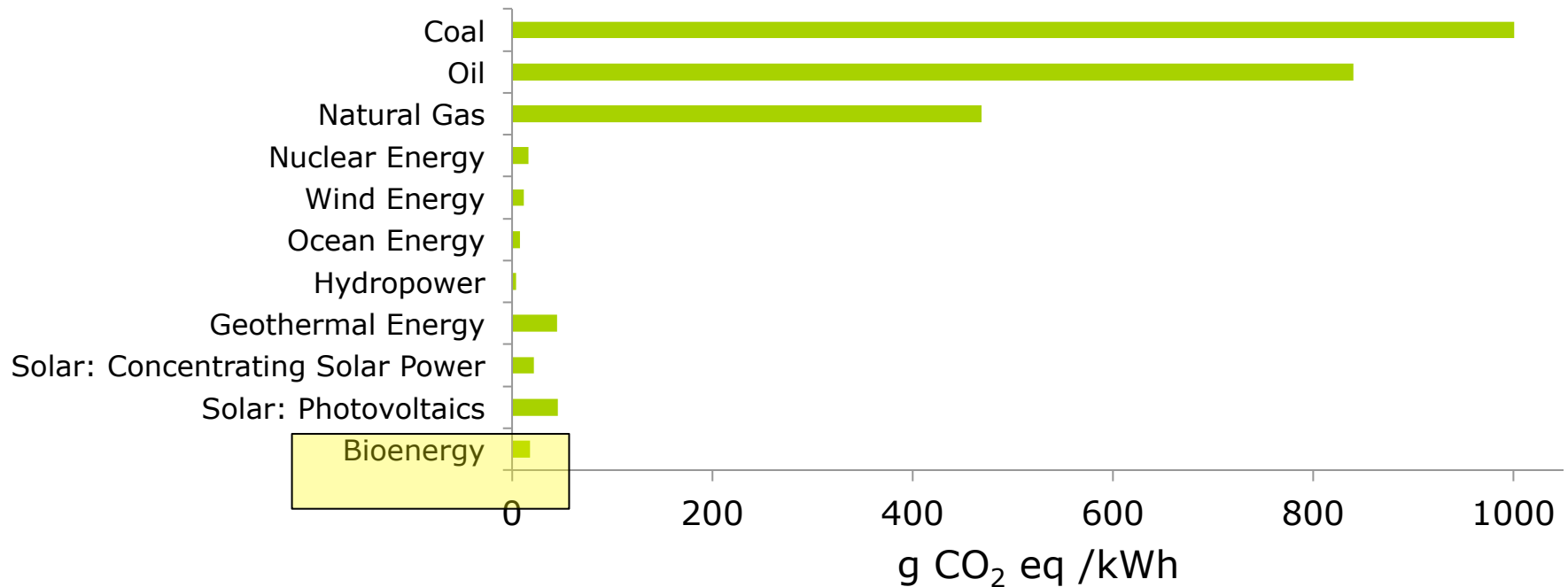
# Why can't we just switch to electric cars when we run out of fossil fuels?

---

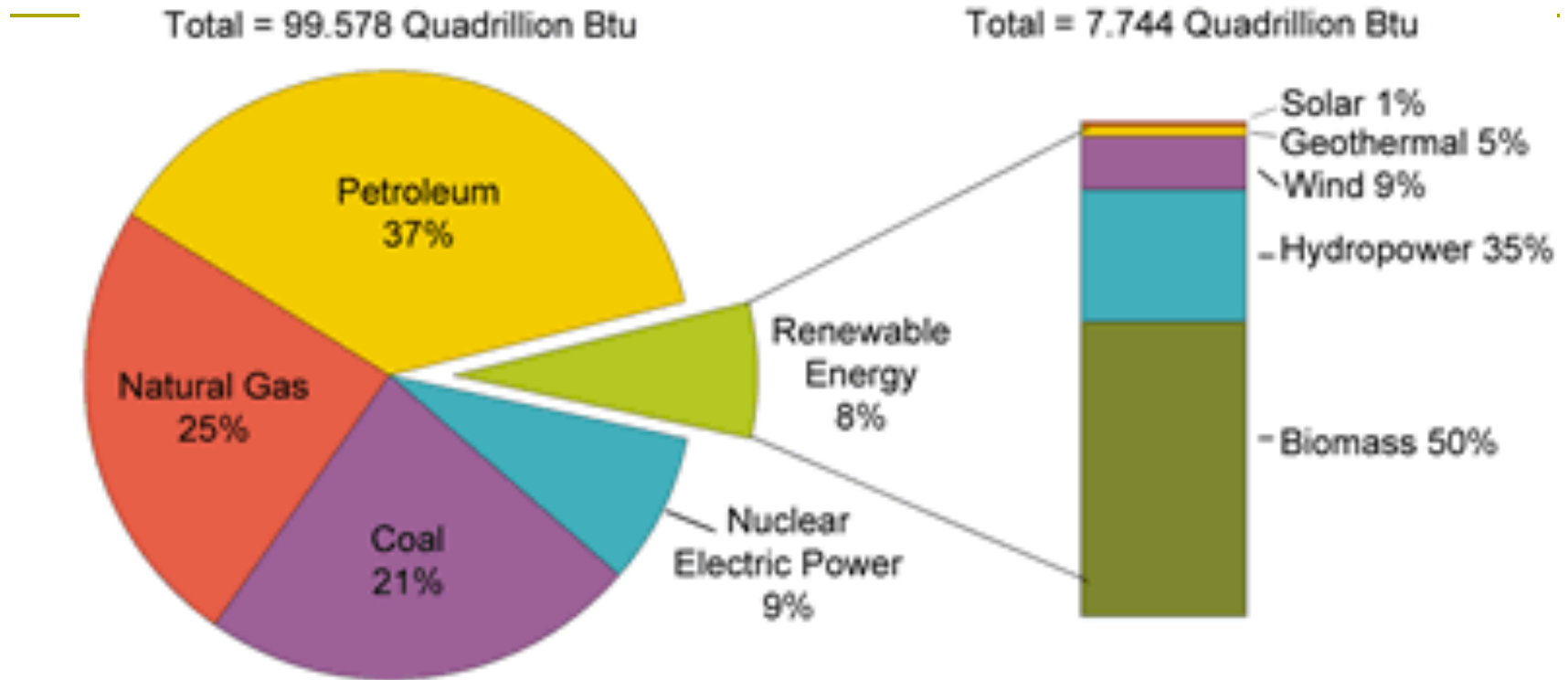


# Why Renewable Energy?

- Sustainable supply of energy
- Reduce CO<sub>2</sub> emission
- Stronger rural economy

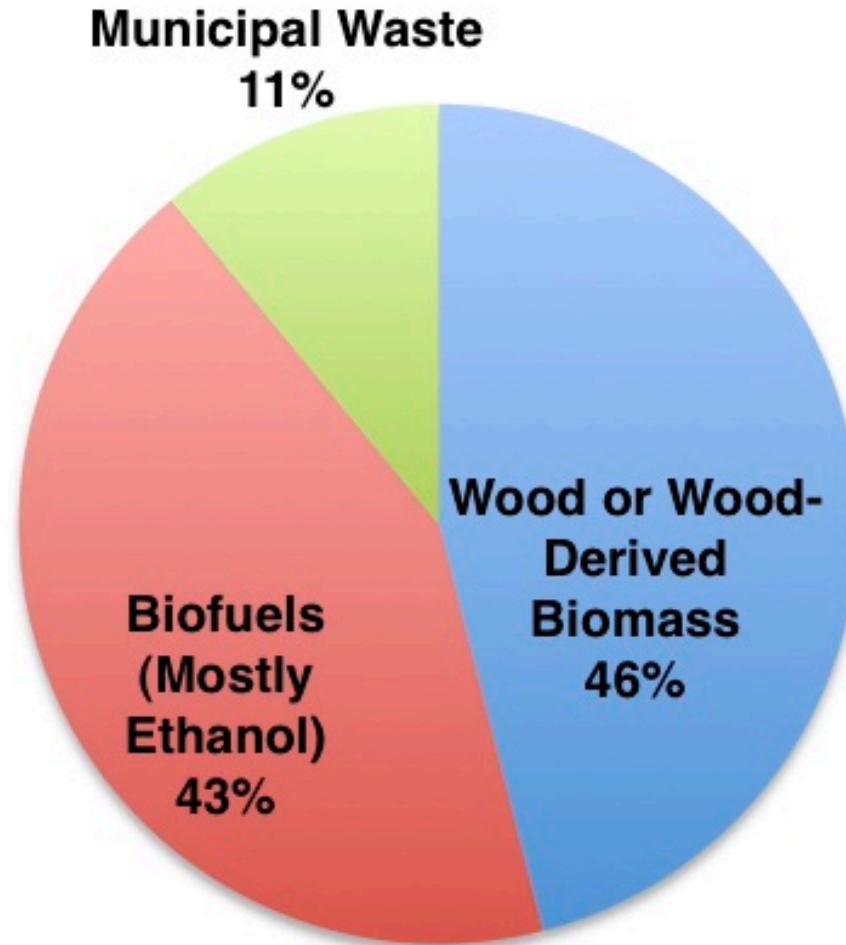


# Where does the US get its energy?



# Sources of Bioenergy?

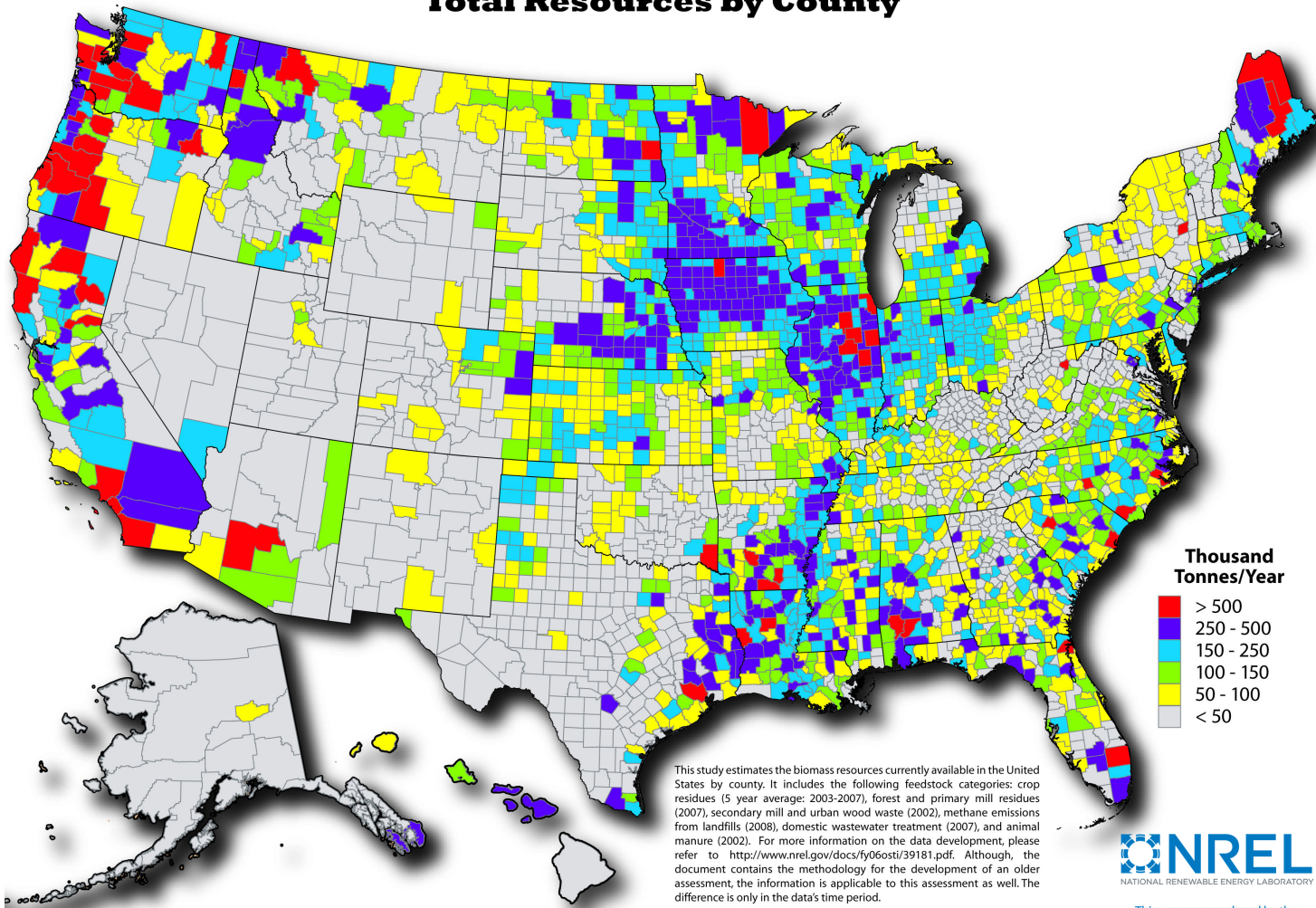
## — Sources of Biomass Energy 2010 —





# What part of the country has the best woody biomass?

## Biomass Resources of the United States Total Resources by County



# Is bioenergy practical?

---







# Mechanical Conversion

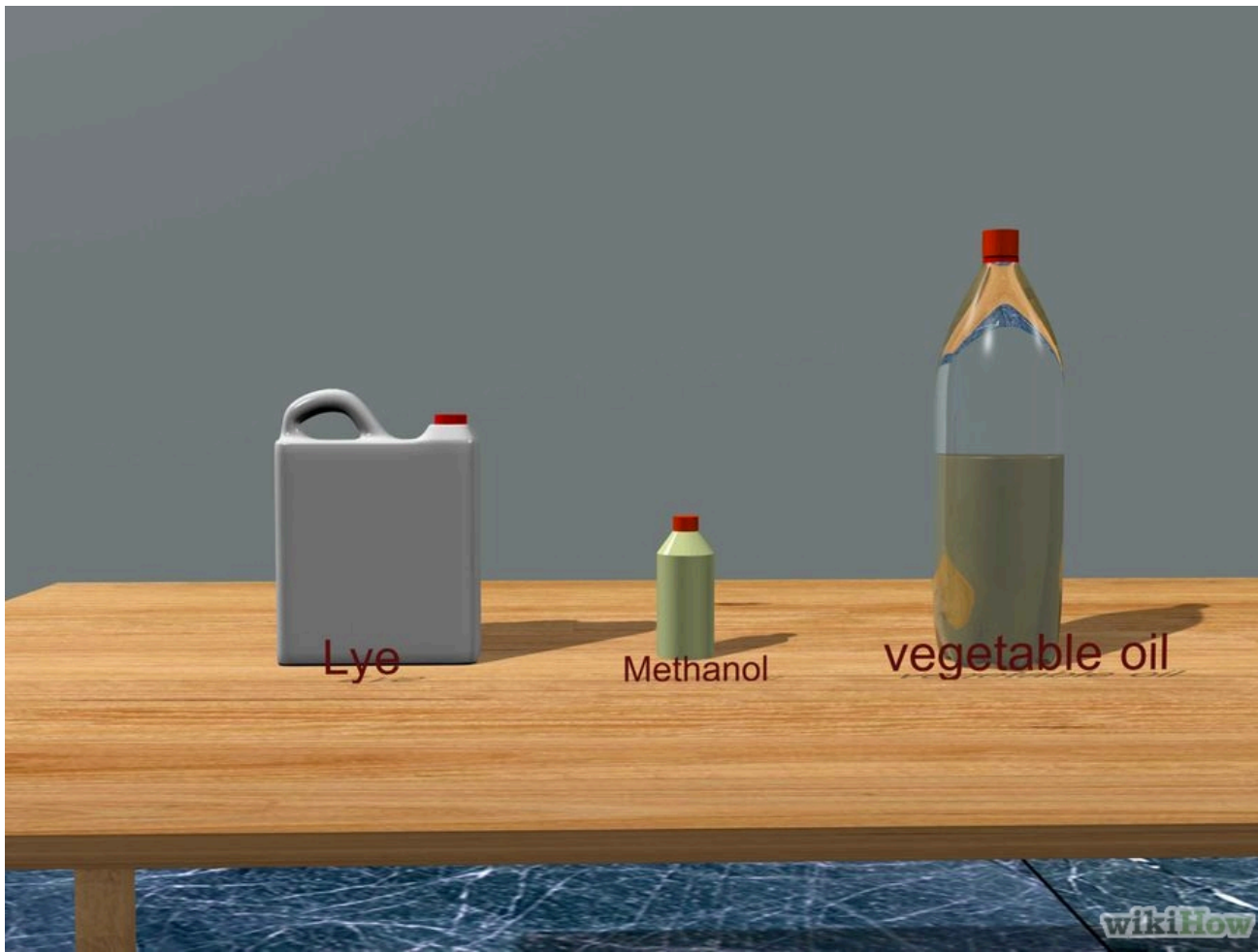




# Chemical Conversions

---

WikiHow: Making Pop Bottle Diesel



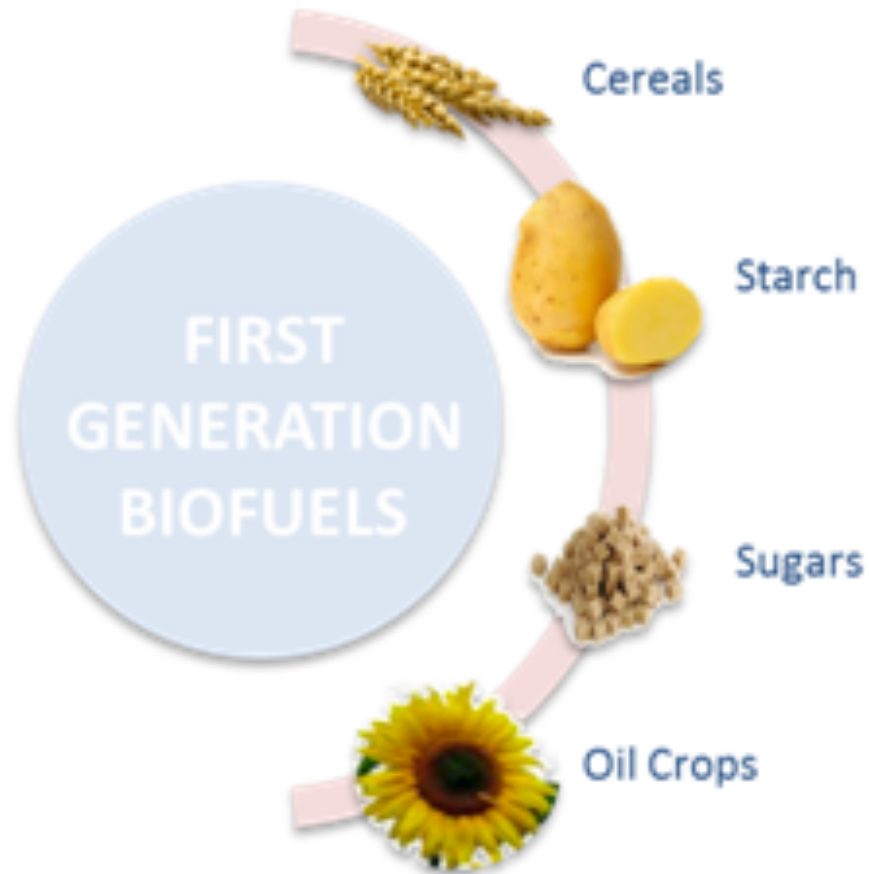


# What are Biological Conversion?



# First Generation biofuels

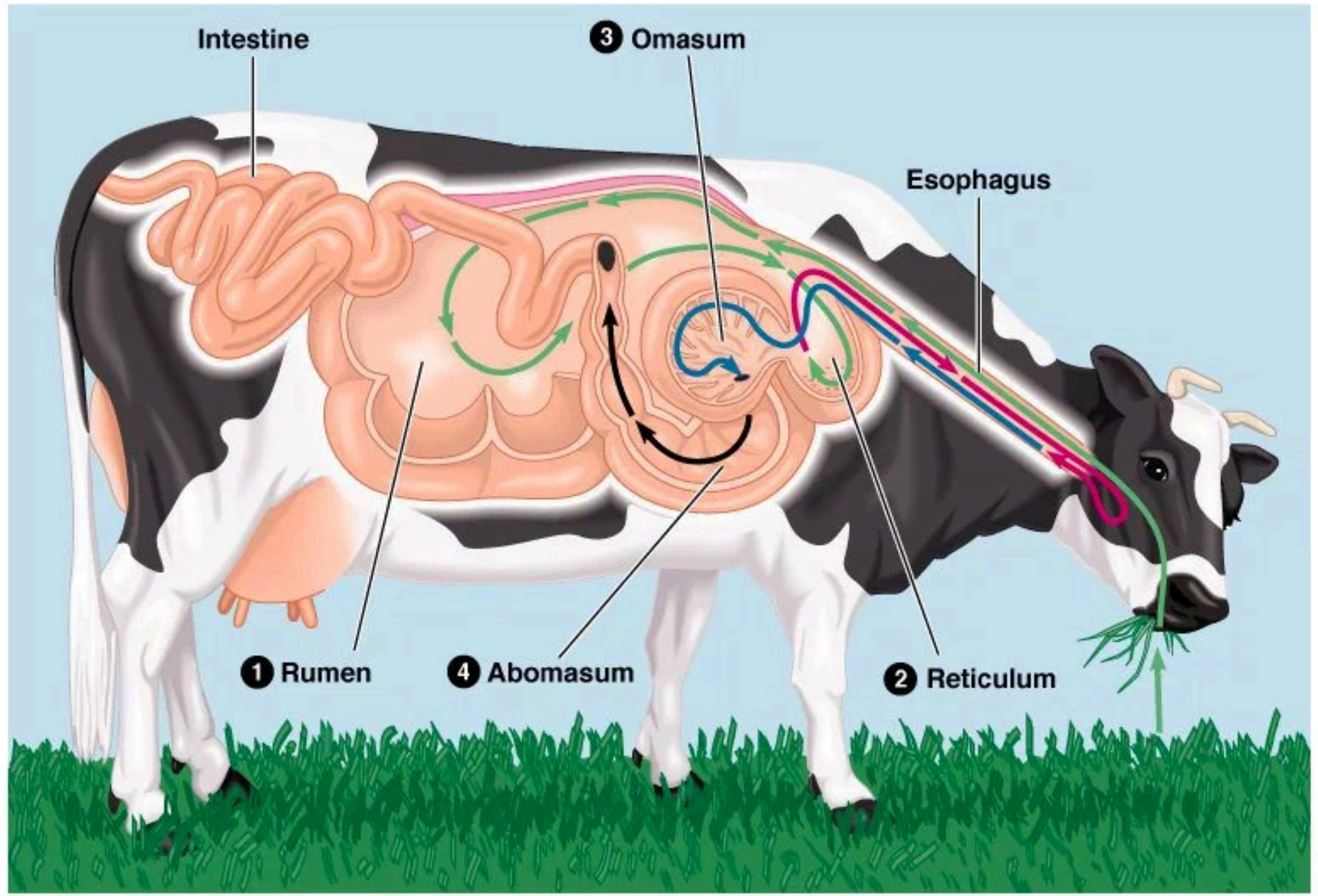
---



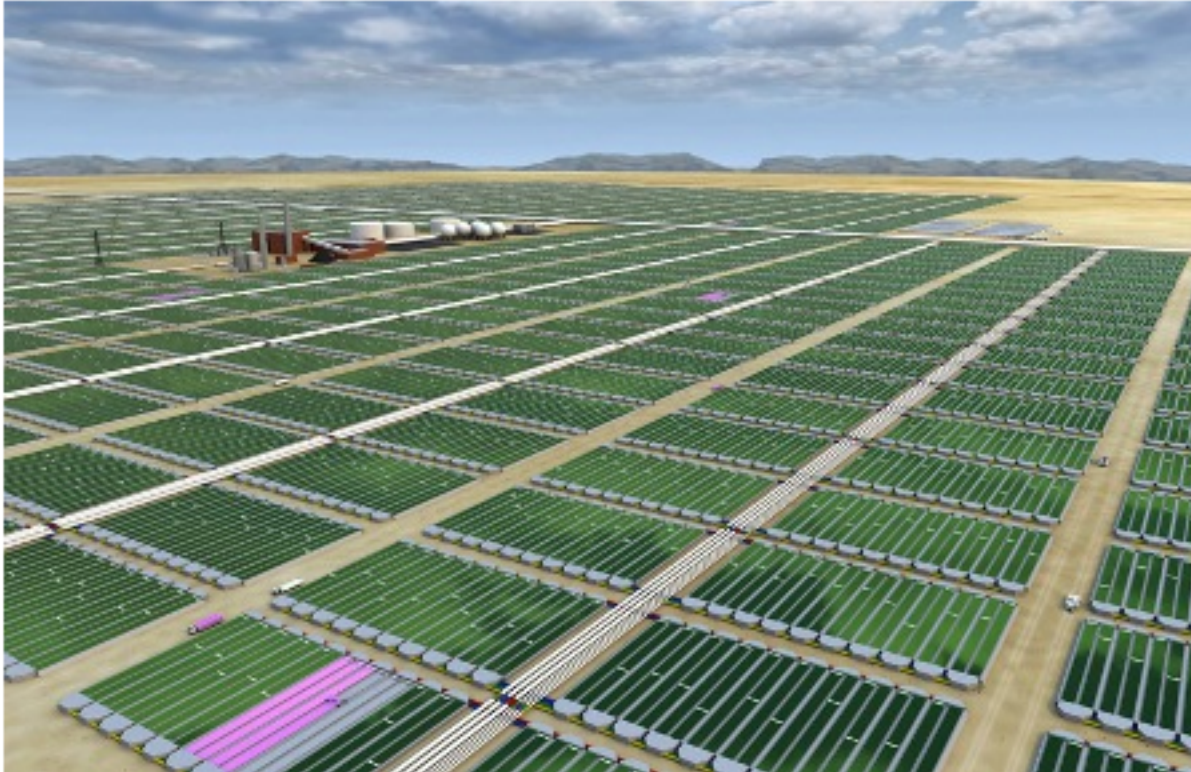
# Second Generation Biofuels







# Third Generation Biofuels



CLOSE X



# Green Crude

---



# Which Materials Will Yeast Digest?

---

- Cup 1 – Cracker crumbs
- Cup 2 – Marshmallows
- Cup 3 – Peanut butter
- Cup 4 – Apple sauce
- Cup 5 – Corn kernel
- Cup 6 – Biomass

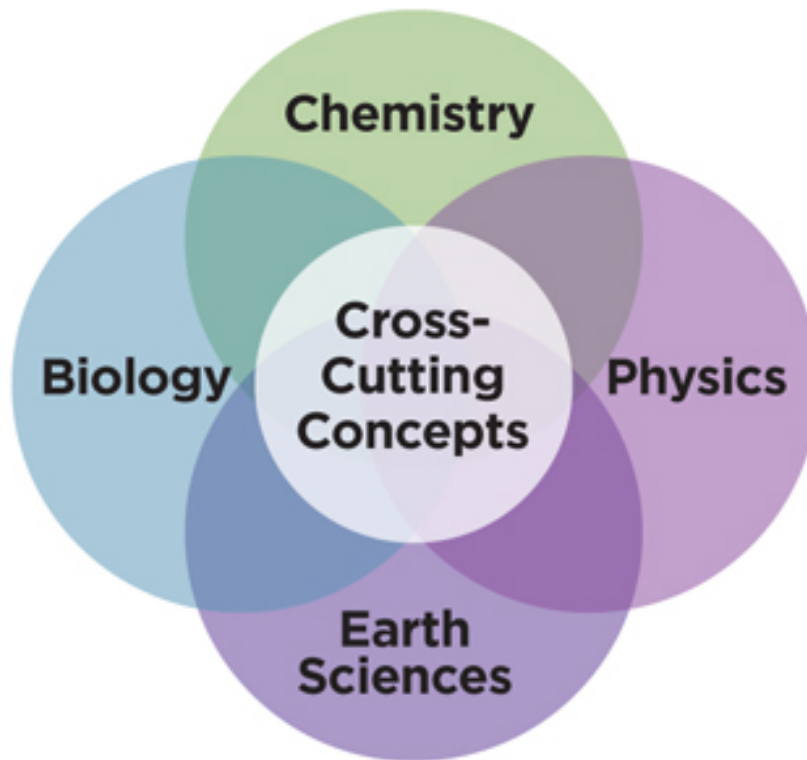
# Linking the Yeast Experiment to Bioenergy

---

- Is yeast plant, animal, or fungi?
  
- Middle School?
  - Sugar + Yeast →  
Alcohol + Carbon Dioxide
  
- High School?
  - $C_6H_{12}O_6 + \text{Zymase} \rightarrow$   
 $2 C_2H_5OH + 2 CO_2$

# K12 Bioenergy: What is a Crosscutting Concept?

---



Rather than siloing, the NGSS include cross-cutting concepts so students can understand how various science disciplines overlap and interact.

# NGSS: Cross-cutting Concepts

---

“What is added in this cross cutting discussion is recognition that an understanding of these core (Energy and matter flow) ideas can be informative in examining systems in life science, earth and space science, and engineering contexts.”

(NGSS Framework, 2011, p 96)



# Introducing Bioenergy

## First Generation Biofuels

Fermentation

## Second Generation Biofuel

Cellulosic Ethanol

## Third Generation Biofuels

Algae

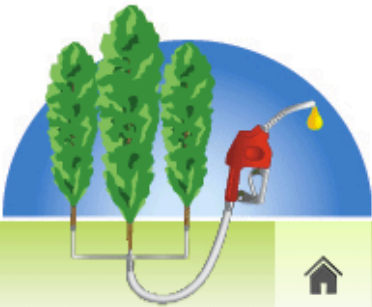
## Advanced Bioenergy

Microbial Fuel Cell


## Bio-products

Biodegradable plastics





# Advanced **Hardwood Biofuels** Northwest

[ABOUT](#)[PROJECTS](#)[AUDIENCES](#)[NEWS AND EVENTS](#)[RESOURCES](#)[COLLABORATORS](#)

## 5 RESEARCH AREAS

[AHB Feedstock](#)[AHB Conversion](#)[AHB Sustainability](#)[AHB Education](#)[AHB Extension](#)

# AHB

Advanced Hardwood Biofuels Northwest (AHB) is researching and developing ways to grow and convert hybrid poplars into bio-based chemicals and liquid biofuels.