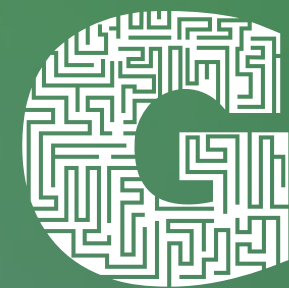


# Biodiesel



**GROW**  
**NEXT GEN**

# Soybean yield

A bushel of soybeans (60 pounds) yields about **11 pounds of soybean oil that can be converted to 1.5 gallons of biodiesel.**

Demand for domestic biodiesel is predicted to make up more than 25% of all soybean oil use in the U.S. by 2030.



# Biodiesel...

- lowers greenhouse gas emissions by as much as 86%
- is non-toxic, and biodegradable
- reduces particulates by 47%
- decreases hydrocarbon emissions by as much as 67%
- mitigates smog

# Many types of biofuel from plant oils

## Renewable diesel

- Produced through a thermochemical process
- Includes hydrotreating to stabilize the fuel at all temperatures
- Can be used in its pure form; more stable storage at low temperatures
- Derived entirely from biological sources (corn, soy and other vegetable oils, animal fats, and waste grease)
- Allows for blending and combustion in any diesel engine
- Lower production volumes than biodiesel


## Sustainable aviation fuel (SAF)

- Biofuel used to power aircraft
- Similar properties to conventional jet fuel
- Smaller carbon footprint
- Can reduce life cycle GHG emissions dramatically compared to conventional jet fuel
- Made from dry biomass and oil seeds

## Biodiesel

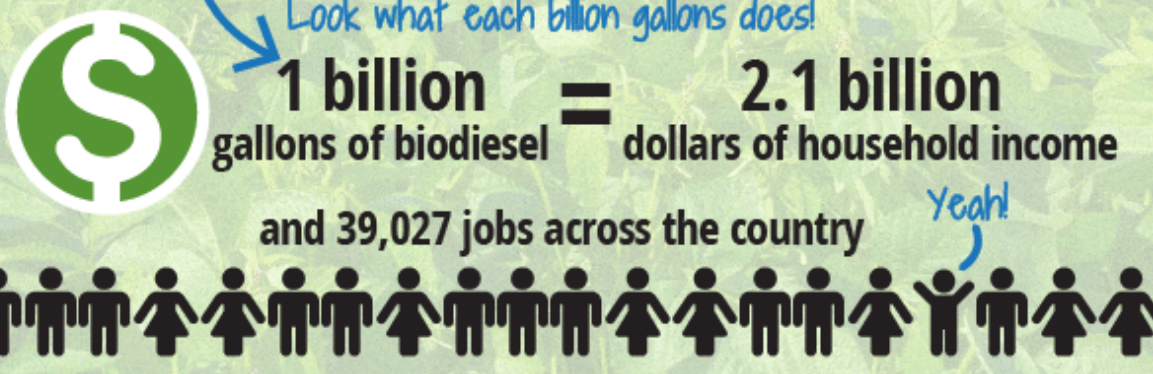
- Produced using the chemical process, transesterification
- Oil and methanol, with a catalyst
- End product is a combination of biodiesel diesel, unreactive methanol, base, glycerin, and soap
- Industrial biodiesel (primarily from soybean oil) follows a refinery process

**Production**  
 Currently there are about 200 biodiesel plants across the U.S.  
 Our country has registered capacity to produce some **3 billion gallons of fuel.**



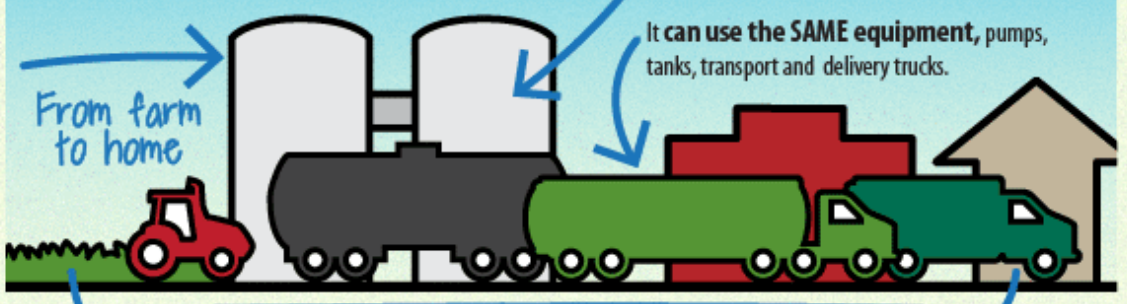
Look what each billion gallons does!

**1 billion gallons of biodiesel = 2.1 billion dollars of household income**  
 and 39,027 jobs across the country *Yeah!*




**The Infrastructure is in place**  
 Biodiesel can be stored anywhere that petroleum diesel and heating fuel is stored.  
 It can use the SAME equipment, pumps, tanks, transport and delivery trucks.

*From farm to home*



**Patriotic**  
 Home-grown and produced – provides U.S. jobs and supports the U.S. economy


Every gallon of U.S. biodiesel we use reduces the amount of oil we need to import from hostile countries.  
*Over 4.7 billion gal (201-2015)*



**Efficient**  
**Improved Performance** → *Available today!*  
 Equipment runs better = less maintenance, prolonging equipment life of vehicles and heating systems.


*Equipment is Good To Go!*

**Biodiesel is a HIGH performance fuel!**  
 Bioheat® is available now – Requires no equipment retrofitting or modifications  
 U.S. automakers and engine manufacturers stand behind biodiesel with support for biodiesel blends across all diesel applications.




**But wait, there's more...**

**Biodiesel 101: What Is It, Why Is It Important?**  
 Demanding standards define the most diverse fuel on the planet, which is produced with no waste material



**Biodiesel 103: Environmental Benefits**  
 Biodiesel is non-toxic and biodegradable  
 100% biodiesel is less toxic than table salt and biodegrades as fast as sugar



*See these infographics*

When you know the facts, the biggest question about bioheating oil should be:  
**"How can everyone use it?"**

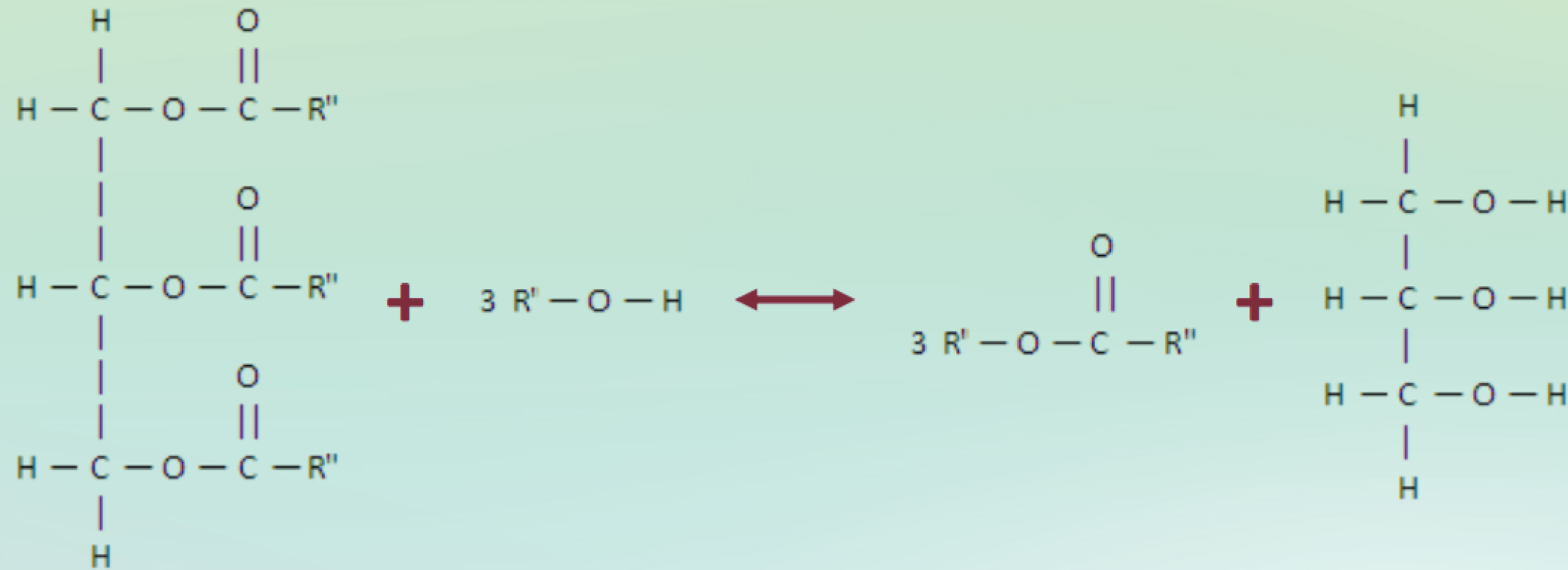
# US Department of Energy strategic plan

Vision 2040: A thriving and sustainable bioeconomy fueled by innovative technologies

Key opportunity:

- Biofuels and bioproducts offer a unique complement to other alternative energy technologies
- Bioenergy enhances energy security and provides U.S. economic benefits
- Bioenergy provides value for otherwise problematic waste streams
- Bioenergy can enhance the environment with purpose-grown feedstocks.

# How is biodiesel produced?



Vegetable Oil + Alcohol  $\rightleftharpoons$  Biodiesel + Glycerin

*R'' = fatty acid chain of the triglyceride (this will vary for each type of vegetable oil)*

*R' = in the case of methanol, this will be methyl group (CH<sub>3</sub>)*

Reagents		Catalyst		Products
Triglyceride (veggie oil) Alcohol (methanol)	→	KOH	→	Biodiesel (FAME) Glycerin

## Transesterification

FAME (Fatty Acid Methyl Ester)

# Day 1: Making the biodiesel

1. Under a fume hood, measure out 30 mL of methanol and add to glass jar, then seal jar quickly.
2. Weigh out 0.75 g of KOH (Potassium Hydroxide) and quickly add it to the jar of methanol. Seal jar immediately and shake to dissolve. Make sure to not leave the cap of of the KOH for too long because it is hygroscopic.
3. At the lab station, in a clean beaker, warm 75 mL of oil sample to 50 °C. Once oil is at 50 °C, add it to the jar of methanol/KOH solution.



4. Add magnetic stir bar to the jar, loosely place lid back on jar and place jar on stirring hot plate. Turn off heat. Set to stir on high for 15 minutes.
5. Remove the jar from the hot plate. Set aside or pour mixture into a labeled separatory funnel for 24 hours to allow for separation of the raw biodiesel and glycerin.
6. Repeat steps 1–5 with other oil sample. Make sure samples are properly labeled.



# Visual observations from day 1

(Be sure to describe all samples.)

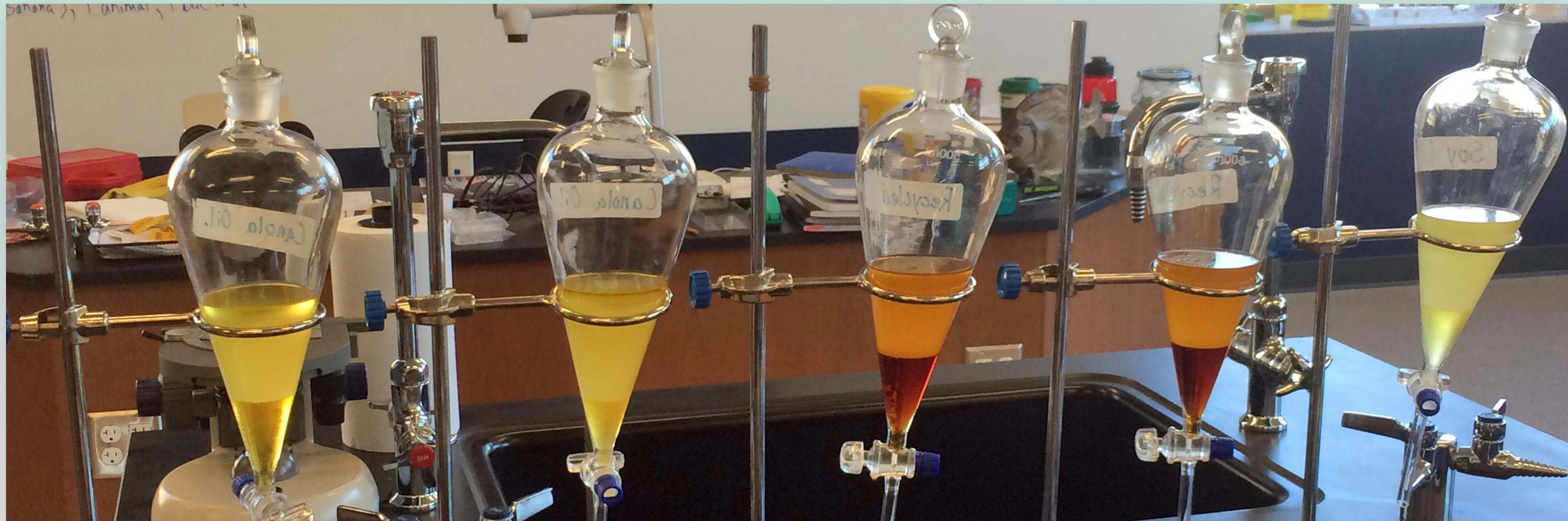
1. Immediately upon adding the methoxide, what was noticed about the vegetable oil? Was there any change in color in each sample?
2. What did the solution look like after it began stirring?
3. Once the mixture has rested for 24 hours in a separatory funnel, describe what visual observations noticed for each sample.

# Day 2: Data collection

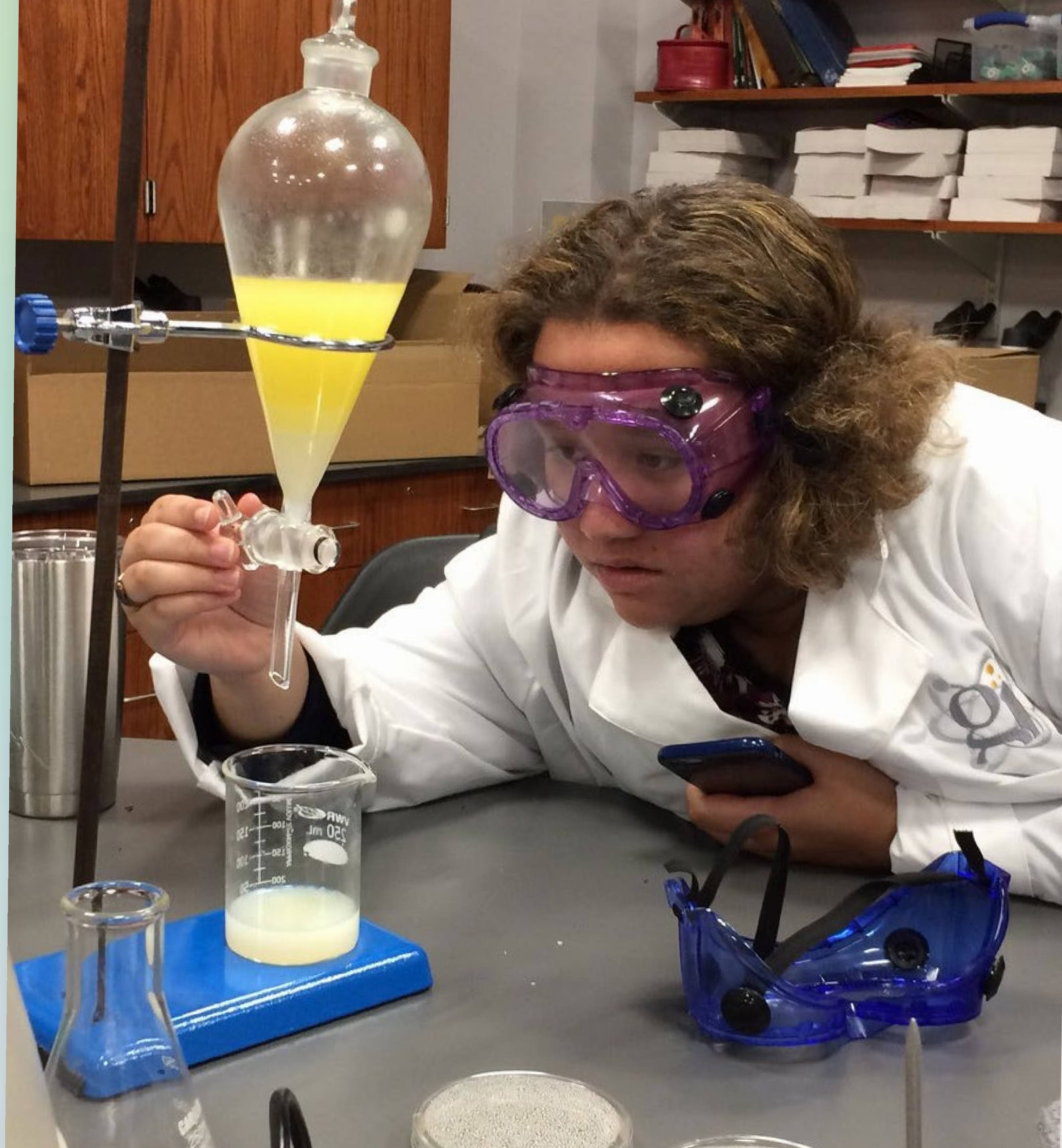
1. Now that biodiesel has rested for 24 hours in a separatory funnel, describe what you see for each sample.
2. Record the following characteristics of your biodiesel sample: *color, consistency, odor*.
3. Measure the quantity of biodiesel in a graduated cylinder and record the amount of in a data table.
4. Calculate the % yield of your biodiesel production using the following equation:  
**$$\% \text{ yield} = \text{volume biodiesel} / (\text{volume biodiesel} + \text{volume glycerin}) \times 100\%$$**

# Day 2: Initial removal of glycerin

1. Drain the glycerin from the biodiesel into your jar. Using a graduated cylinder, record the amount of glycerin retrieved from the samples.  
*(Note: Crude biodiesel contains impurities such as soap, incompletely transesterified glycerides, and methanol and must be cleaned/washed prior to use.)*



# Washing process



# Wash and dry biodiesel

1. Using a serological pipette, slowly add a total of 20 mL distilled water down the side of the jar or separatory funnel.
2. Gently rock the jar or separatory funnel to mix the water and wash the biodiesel. (*Do not shake*).
3. Let jar or funnel stand for 10 minutes for the mixture to separate into two layers.
4. Remove the bottom “soapy” layer by draining from the funnel or using a serological pipette into a waste container.
5. Repeat washing procedure steps 1–4 for a second washing.
6. Repeat washing procedure steps 1–4 twice for a second sample.
7. Using pH paper or probe, test the pH of the “soapy” layer collected from both washings and record in data table.

**Now we have biodiesel!**

