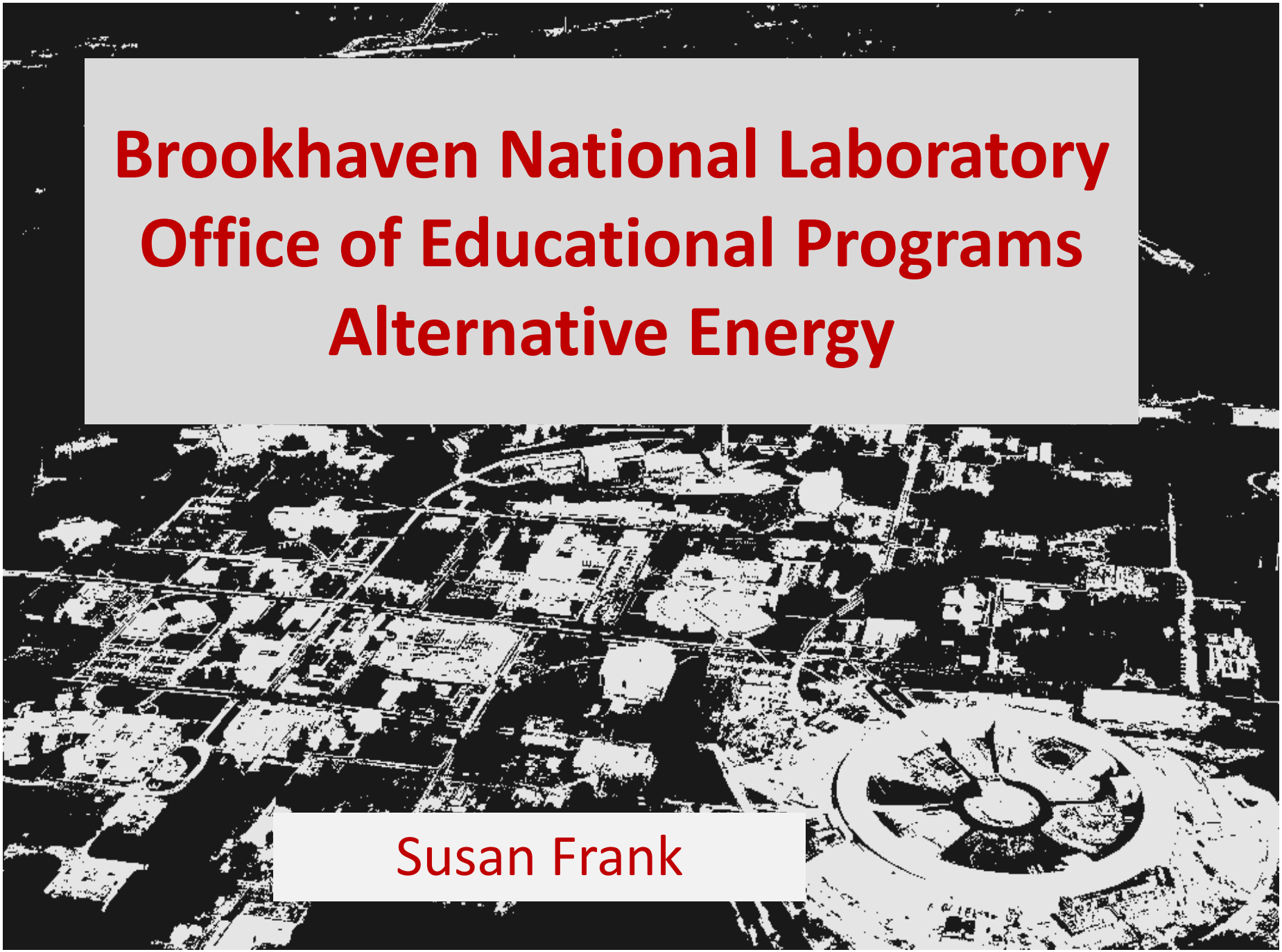
Brookhaven National Laboratory
Office of Educational Programs
Alternative Energy

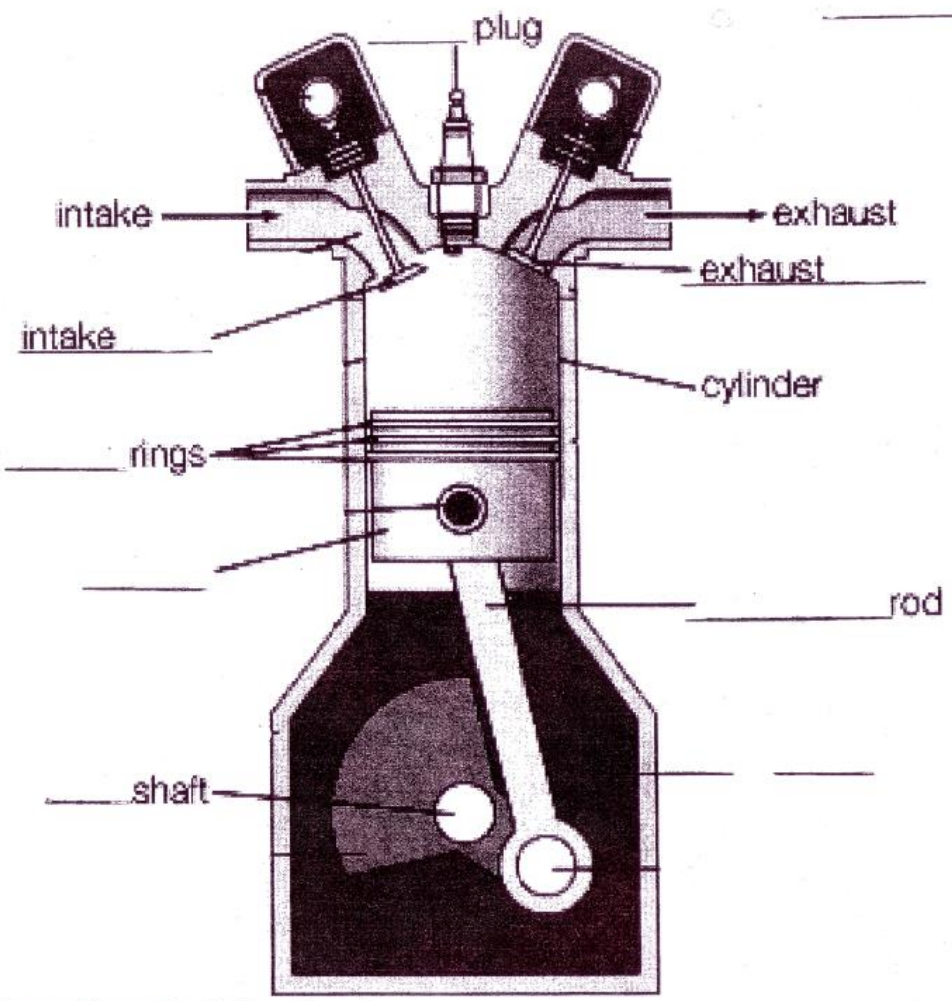


Susan Frank

Biofuels at BNL

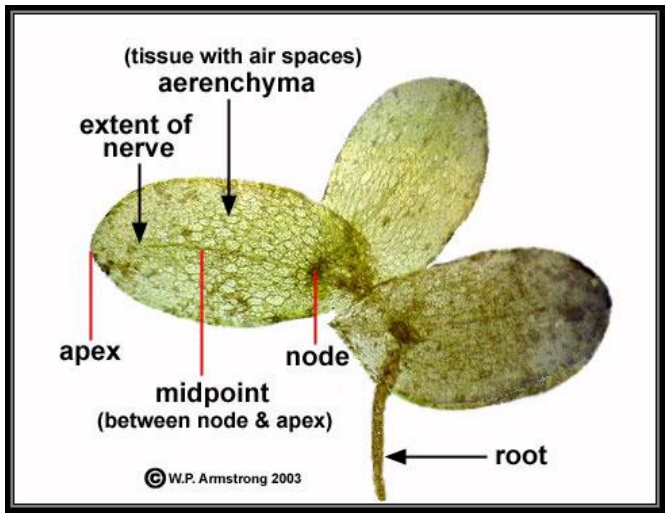
Biofuels

- http://www.nrel.gov/learning/re_biofuels.html



The Plant Sciences Group

Duckweed



- Belong to the Family *Lemnaceae.*
- Found in waste and still water environment.
- Reproduce by budding (very fast in 24 hrs.)
- Great source of protein for waterfowl and humans.
- Its fronds can make a lot more starch than corn.
- Efforts are ongoing to sequence its genome.

What will you make ethanol from?

- Corn
- Potato
- Paper
- Duck weed

Safety Equipment !

Day1: Breakdown of starch

1. Each pair gets two small beakers with chosen Biomass.
2. Label each beaker with:

    Biomass name

    Enzyme name

    Date

    Your initials

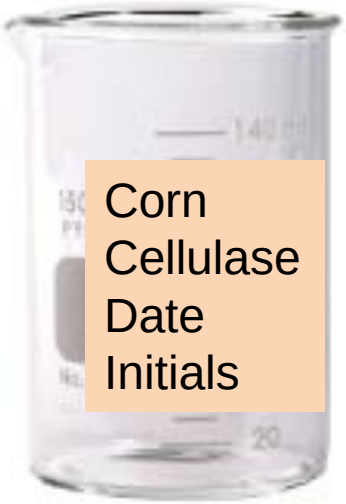
3. Add about ~0.05g of cellulose or amylase to two beakers each.

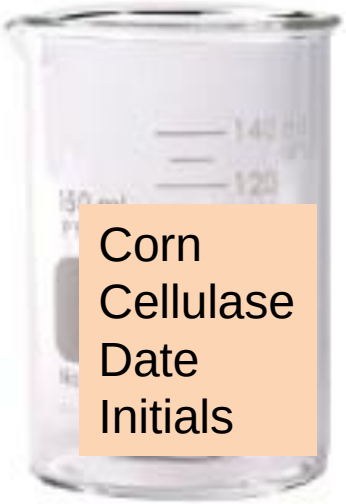
4. Cover each beaker with parafilm.

5. Incubate your beakers at room temperature for 24 hours.

Label each beaker.

OR



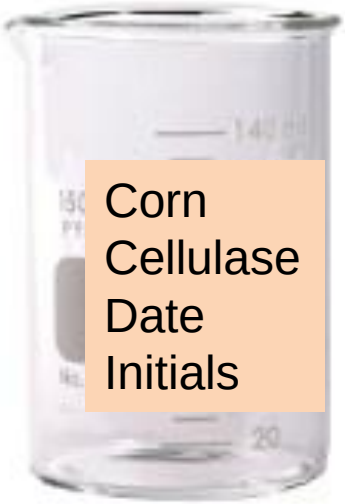


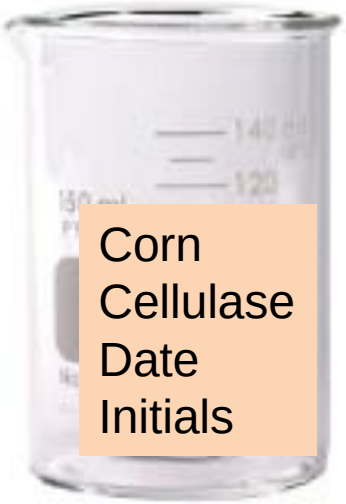
Gently mash biomass with water.

Strain biomass into beaker. Approximately 40 mL.

Pour approximately 20 mL of the biomass into each beaker.

OR





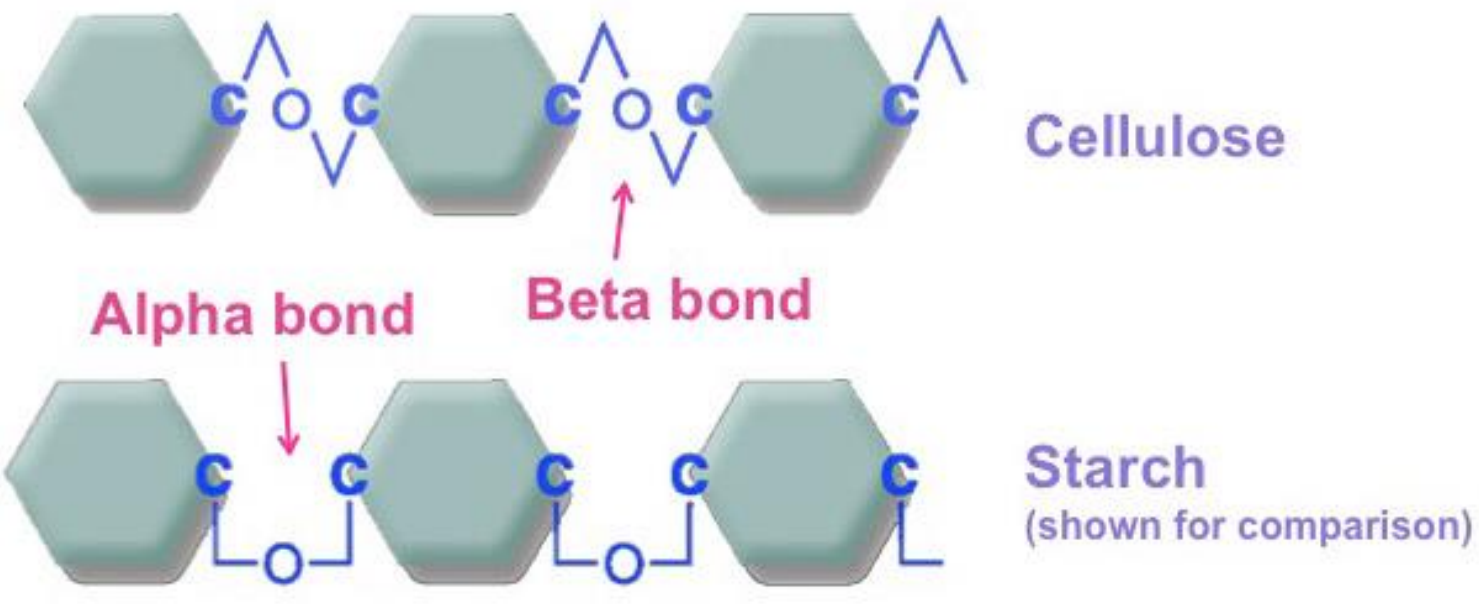
Test for Starch

- Test for starch using iodine.

Test for starch.

	Starch	No Starch
Corn		
Potato		
Paper		
Duck weed		

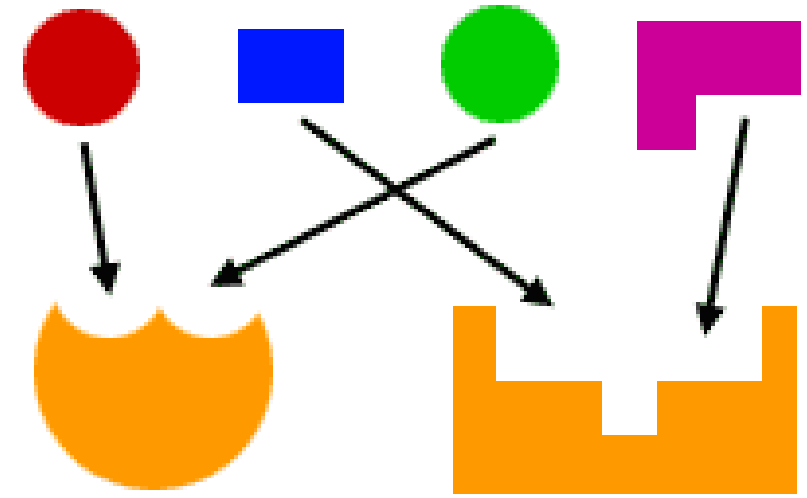
Two types of sugar are found in plants



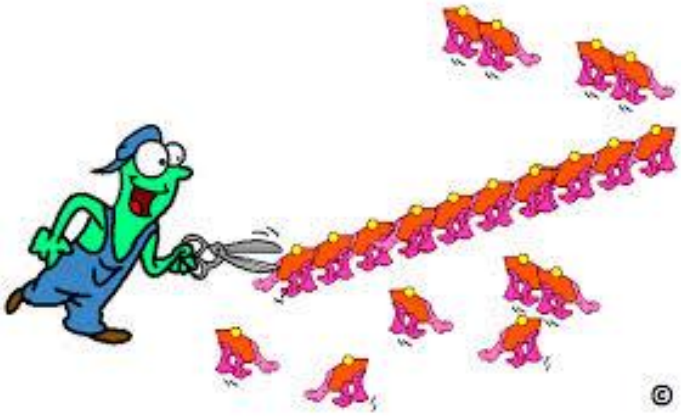
- Cellulose and starch are many molecules of glucose.
- The bonds that form the starch and cellulose are different.

How do we break the bonds ?

Artist's rendition of the Magic Enzyme Fairy

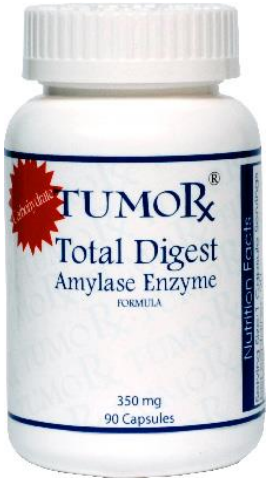


ENZYMES ARE VERY SPECIFIC
AND ONLY WORK WITH
CERTAIN SUBSTRATES



Enzymes

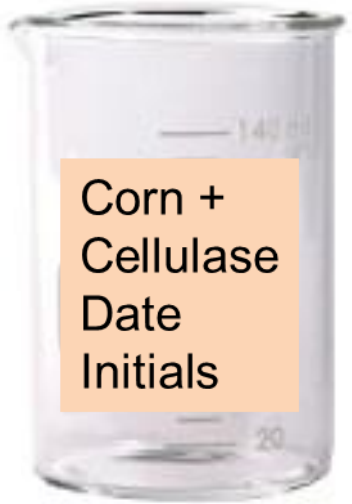
- Amylase to break down starch



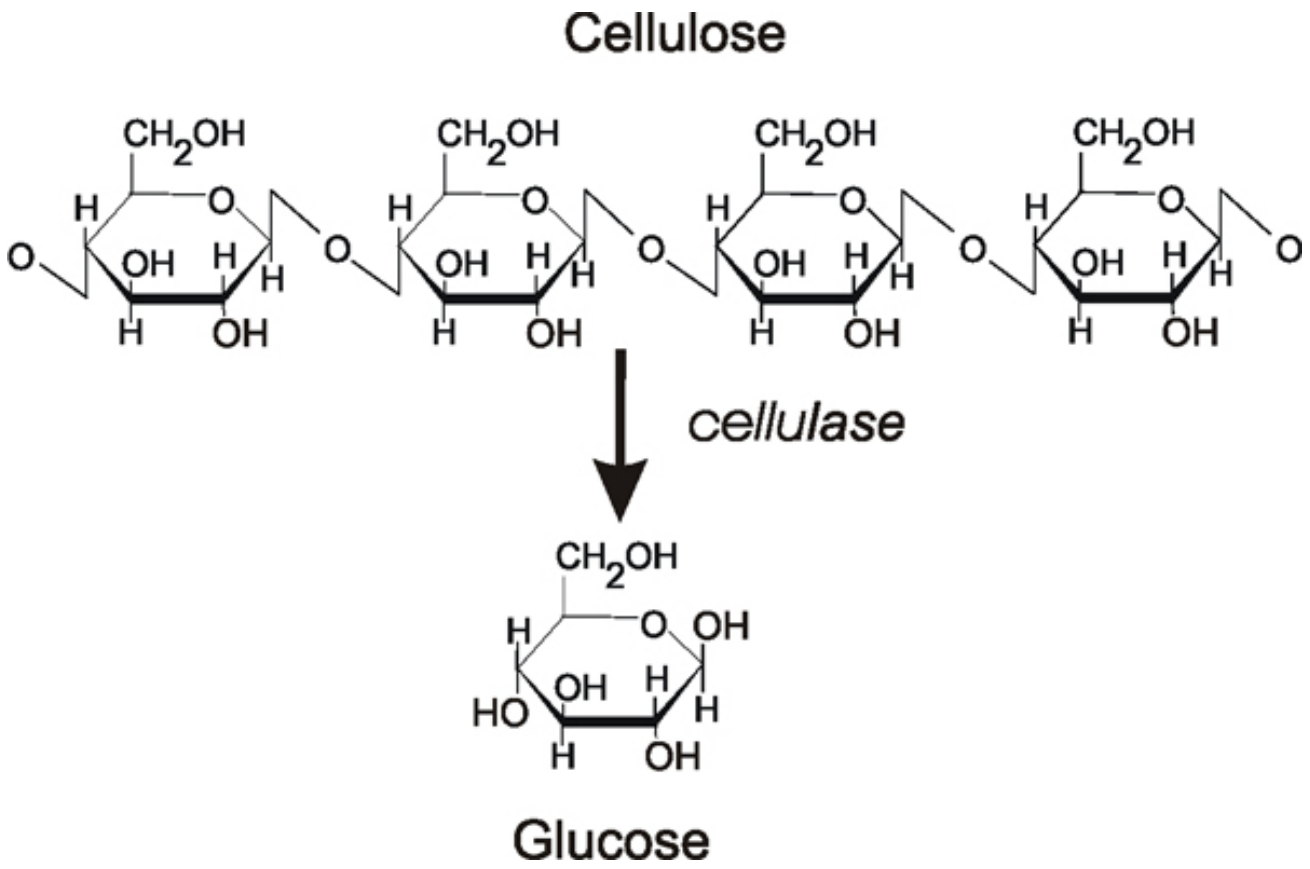
- Cellulase to break down cellulose

Weigh 0.05g of enzymes.

- Add 0.05 g of enzyme to the appropriately labeled beakers.



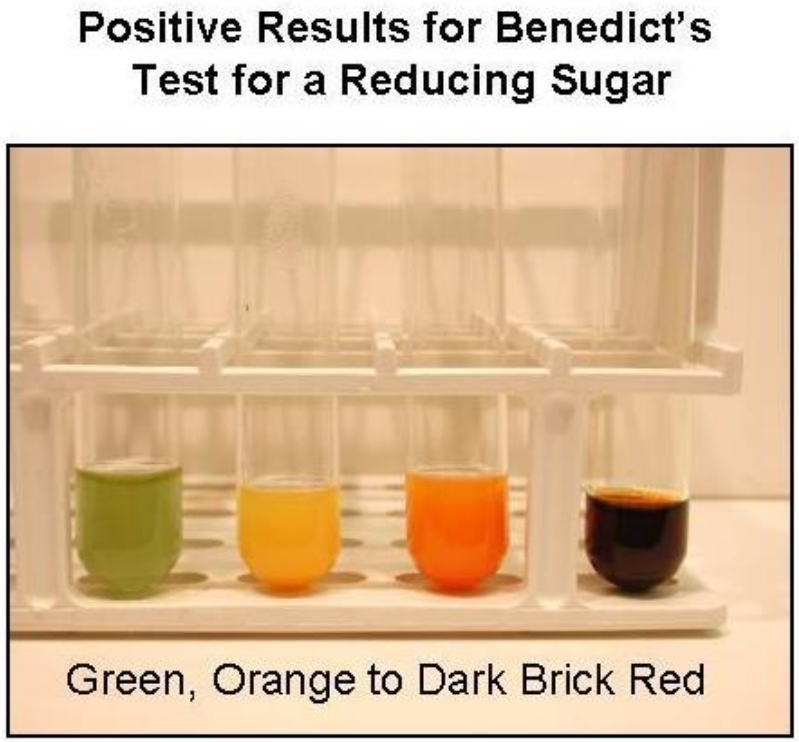
What is happening inside the beaker?



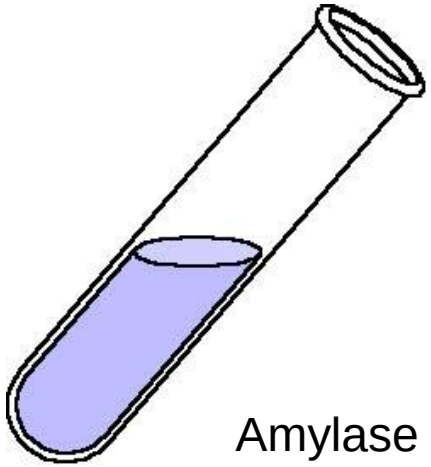
Day 2

How do you know if the enzymes did their job?

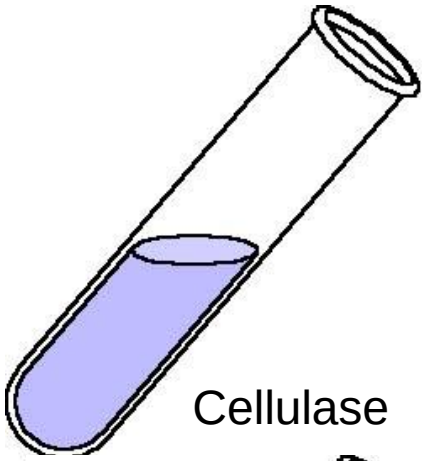
Test for glucose using Benedicts solution.



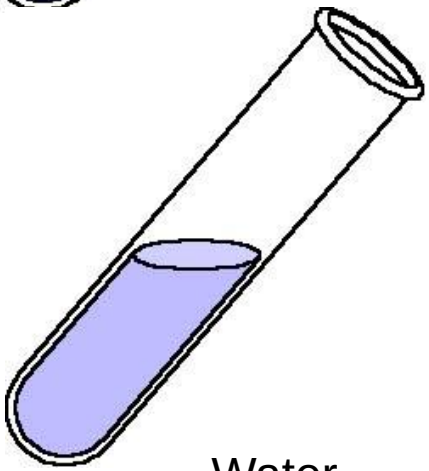
Safety equipment !



Amylase



Cellulase



Water

Procedure:

To test for glucose: take three tubes, Label,
Add:
0.5ml of water to one tube
0.5 ml of sample + amylase to one tube
0.5ml of sample + cellulase to one tube

Add 5 drops of Benedict's reagent.

What color is the Benedicts reagent?

What color is in the tube after adding the sample ?

After adding the Benedict's reagent, incubate sample for about 5 minutes at >70°C.

Did the color change in your samples?

What is the color of your samples?

Which sugar did you detect: glucose or starch?

How do you know?

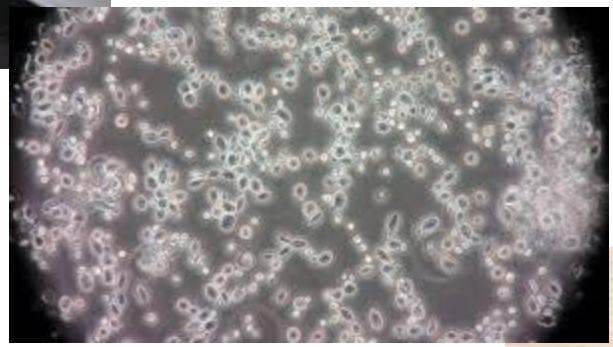
Test for Sugar using Benedicts Solution

	+Amylase	+ Cellulase
Corn		
Potato		
Paper		
Duck Weed		
Water		

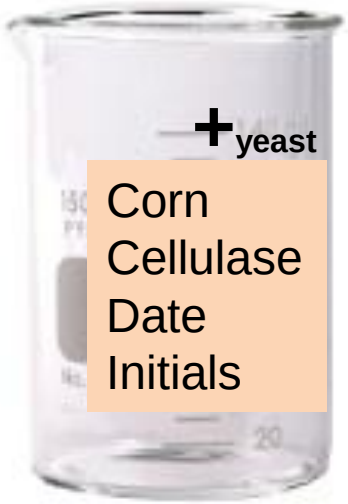
Positive Results for Benedict's Test for a Reducing Sugar

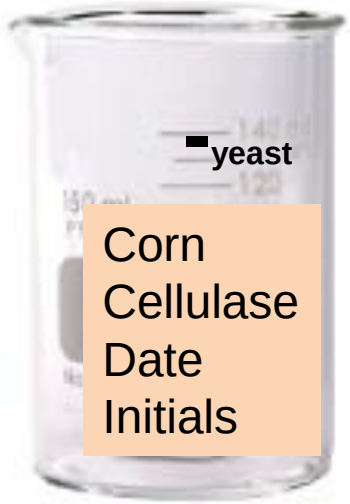
Green, Orange to Dark Brick Red

Yeast as a tool.



Label one beaker "+yeast" and the other "-yeast", and date.
Add 0.05g (pinch) of yeast to beaker labelled "+ yeast" only. Mix by swirling.
Cover both beakers tightly with parafilm.
Incubate at room temperature for 48 to 72 hours.



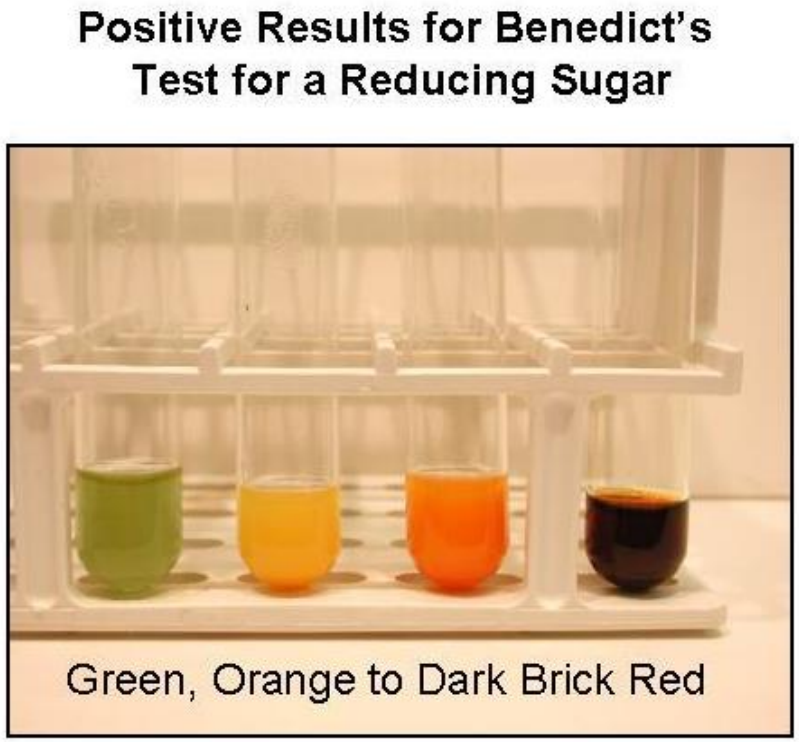


Day 5

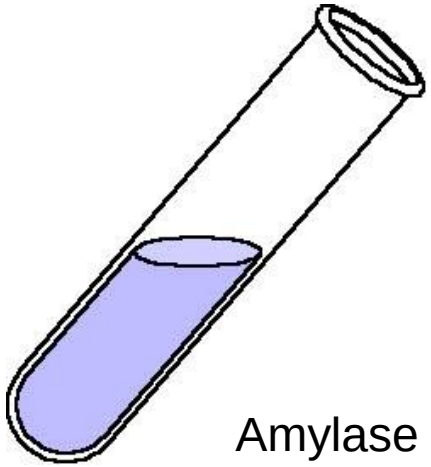
- Test for sugar.
- Test for alcohol.

Did the yeast consume the sugar?

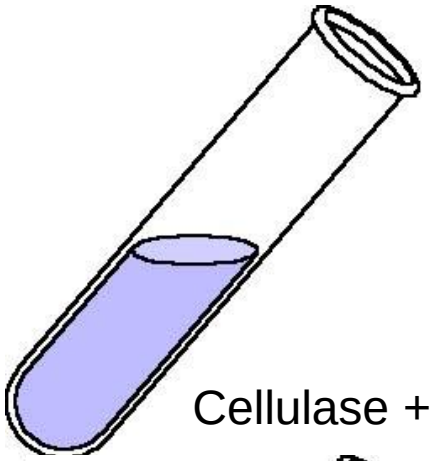
Test for glucose using Benedicts solution.



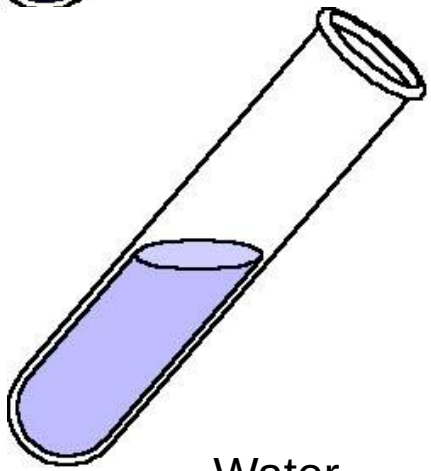
Safety equipment !



Amylase +



Cellulase +



Water

Procedure:

To test for glucose: take three tubes, Label,
Add:
0.5ml of water to one tube
0.5 ml of sample + amylase + yeast to one tube
0.5ml of sample + cellulase + yeast to one tube

Add 5 drops of Benedict's reagent.

What color is the Benedicts reagent?

What color is in the tube after adding the sample ?

After adding the Benedict's reagent, incubate sample for about 5 minutes at >70°C.

Did the color change in your samples?

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How do you know?

Test for Sugar using Benedicts Solution

	+Amylase	+ Cellulase
Corn		
Potato		
Paper		
Duck Weed		
Water		

Positive Results for Benedict's Test for a Reducing Sugar

Green, Orange to Dark Brick Red

Test for Sugar using Benedicts Solution

	Amylase + Yeast	Cellulase + Yeast
Corn	L green	Celery
Potato	L green	Blue
Paper	Yellow	Blue
Duck Weed	green/blue	blue
Cicada	Blue	Blue / Yellow

Ethanol

A + yeast C + yeast

C + yeast

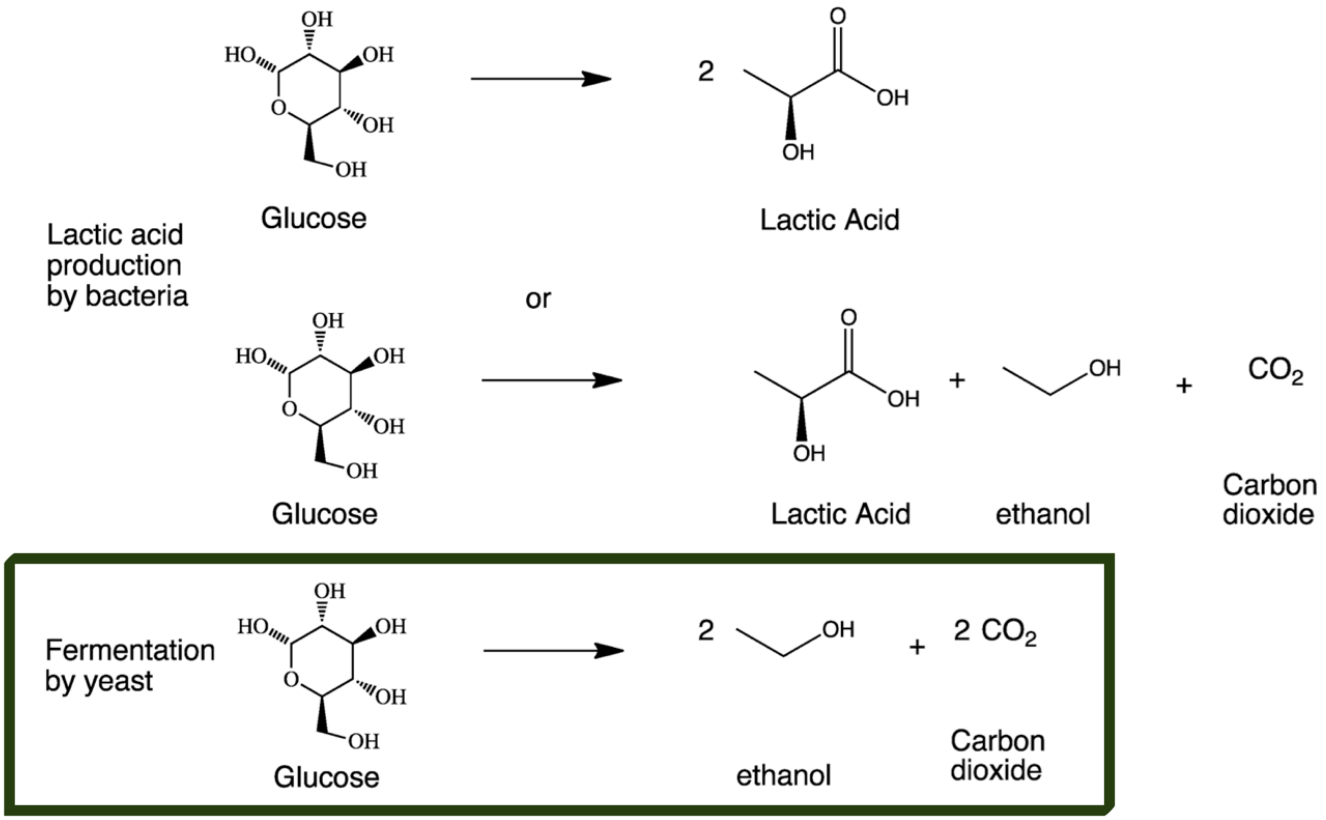
C + yeast

C + yeast

Positive Results for Benedict's Test for a Reducing Sugar

Green, Orange to Dark Brick Red

Conversion of sugar into alcohol



Test for Alcohol

Label

A+Corn +

A+ Corn -

Ethanol

- **E10 and E15**
- E10 and E15 are blends of ethanol and gasoline—the number after the "E" indicates the percentage of ethanol.
- Most of the gasoline sold in the U.S. contains up to 10% ethanol—the amount varies by region—and all auto manufacturers approve blends up to E10 in their gasoline vehicles.
- Vehicles will typically go 3% to 4% fewer miles per gallon on E10 and 4% to 5% fewer on E15 than on 100% gasoline.[3]

https://www.youtube.com/watch?v=cjC7FKpBbso&feature=player_embedded

www.fueleconomy.gov

the official U.S. government source for fuel economy information

Biofuels

- http://www.nrel.gov/learning/re_biofuels.html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