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Wrinkling in Nature

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Wrinkled Peas?

Introduction

Brother Gregor Mendel chose pea plants as his model partially for their flower shape, which helps prevent cross-pollination. One of the characteristics he focused on was the shape of the pea seed. Some pea seeds are wrinkled, and some pea seeds are smooth in their appearance. When Mendel crossed plants grown from round (or smooth) pea seeds with plants grown from wrinkled pea seeds, the first generation pea seeds were all round and smooth. He called it the F1 generation. When he crossed two offspring from the first generation, the second generation (F2) produced an almost perfect 3:1 phenotypic ratio. Three-fourths of the second generation produced round seeds, and one-fourth produced wrinkled seeds. Combined with his studies of six other traits, Mendel concluded that pea plant traits were governed by two determiners (we now call these genes). One of the determiners was contributed by the pollen, the other by the pea-plant ovule. His further conclusion, important to this learning experience, was that smooth pea seed factors are dominant to factors for wrinkled pea seeds. Mendel's findings were made before knowledge of cell structure. He knew nothing about chromosomes and genes. He was not aware of the diploid state found in most eukaryotic cells. But he was a mathematician, and he did deduce the probability that two determiners control hereditary traits in pea plants. However, why are some peas wrinkled? In this investigation, we will explore the scientific principles that lead to peas becoming wrinkled.

This lab experience is separated into four investigative segments:

1. Human saliva and enzymes
2. Osmosis and Dialysis Tubing
3. Analyzing dry and imbibed weights of wrinkled and smooth pea seeds
4. Putting it All Together, What makes Wrinkled Peas?

<u>NGSS Science Standards:</u>

HS-LS1-6. Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.

HS-LS1-7. Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.

Human Saliva and Enzymes

LEARNING OBJECTIVE:

- Be able to identify the importance of enzymes as it relates to digesting food consumers eat.
- Explain the effect enzymes have on long chain macromolecules.
- Recognize the importance of saliva in one's digestive tract.
- Differentiate between a monosaccharide, disaccharide and polysaccharide.

INTRODUCTION:

In this laboratory experiment, we will be investigating the ability of enzymes to break down starch. There will be five test tubes with different mixtures in them. Using the information we have already discussed, predict whether the test tube already has monosaccharides or polysaccharides, and if the enzyme will break down polysaccharides to monosaccharides. Before you start, refresh yourself with enzymes and whether honey and starch are mono or polysaccharides. You will be provided with Benedict's solution, which can detect for the present of monosaccharides, but not polysaccharides. The Benedict's solution will turn a different color when there are monosaccharides in a solution.

PROBLEM: How does your body break down long polysaccharides (starch) and disaccharides (sugar), to monosaccharides in order to use them for energy?

HYPOTHESIS: Predict whether you will see a color change representing a presence of glucose in each of the test tubes.

<u>Test tube 1: Honey Mixture (monosaccharide)</u>

Prediction:

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<u>Test tube 2: Sugar Mixture (disaccharide)</u>

Prediction:

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<u>Test tube 3: Corn Starch Mixture (polysaccharide)</u>

Prediction:

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<u>Test tube 4: Sugar Mixture (disaccharide) with saliva</u>
Prediction:

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<u>Test tube 5: Corn Starch mixture (polysaccharide) with saliva</u>
Prediction:

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MATERIALS:
5 test tubes
One 250 ml beaker in order to carry test tubes
10 ml graduated cylinder
Dixie cup
Water dropper
Benedict's Solution
Thermometer
Warm water bath ($37^{O}C$)

PROCEDURE:
1. Label each test tube with a 1,2,3, 4 and 5.
2. In test tube 1, add 5 ml of honey mixture
3. In test tube 2, add 5 ml of sugar mixture
4. In test tube 3, add 5 ml of starch mixture
5. In test tube 4, add 5 ml sugar mixture and saliva
6. In test tube 5, add 5 ml starch mixture and saliva
7. Put all five test tubes in a warm bath at 37 degrees C for five minutes.
8. After five minutes, add 20 drops of Benedict's solution to each test tube.
9. Place test tubes in hot ($90\text{-}100^{o}C$) water bath for a few minutes
10. A color change will represent a positive result.

Name: ______________________________________ *Assignment: Wrinkled Peas?*

DATA:

Test Tube	Result (positive or negative)
1	
2	
3	
4	
5	

CONCLUSION: (What happened in each of the tests tubes and was your hypothesis right?)

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Lab Questions:

1. What can you say about saliva and the presence of enzymes and digesting food? Does chewing your food help with digestion? Why?

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2. What kind of organic molecule is an enzyme? What does it mean for organic molecule become denatured?

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3. Convert 37 degree C to F. Why do you think the water bath was 37 degrees Celsius? Do you think the temperature of the water is an important variable? Why?

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Investigation with Dialysis Tubing

LEARNING OBJECTIVE:

- Explain osmosis and diffusion and why it occurs.
- Identify the directional flow of water through a semipermeable membrane.

INTRODUCTION:

Videos:

http://highered.mcgraw-hill.com/sites/0072495855/student_view0/chapter2/animation__how_osmosis_works.html

MATERIALS:

- Dialysis Tubing (3 – 12 cm strips)
- White sugar from the grocery store
- Cornstarch from the grocery store
- 10 or 50 ml graduated cylinder
- Scissors
- Two Dixie cups
- 3 - 250 ml beakers or large cups
- Paper towel
- Digital balance
- Thread
- Water

PROCEDURE:

1. Using a balance, weigh out 5 grams of sugar and put into a paper cup. Add 10 ml of water. Set aside.
2. Repeat step 1 using cornstarch.
3. Cut three 12 cm sections of dialysis tubing.
4. Immerse both sections in water for 30-45 seconds.
5. Take the sections out of the water and open them into tubes by rolling between the thumb and index finger.
6. With a piece of thread, securely tie off one end of one of the tubes (leaving about .5 cm between the end of the tubing and the thread.)
7. Pour the sugar solution into the open end. Once the solution is inside, use another piece of thread to tie off the open end.
8. Repeat steps 6 and with the starch solution and tap water.
9. Put the sugar solution/dialysis pouch on a balance. Record the mass in grams in the data table.

10. Repeat Step 9 using the starch solution/dialysis pouch **and** tap water/dialysis pouch.
11. Put all three of the pouches in I a beaker with 200 ml of water making sure the pouches are submerged under the water.
12. Wait for 15 minutes.
13. Remove each pouch and dry the outside thoroughly with a paper towel.
14. Put each pouch onto a balance again and record the final mass (after being in water).

DATA:

Contents in dialysis pouch	Mass Before Putting in Water (dry weight)	Mass after Putting in Water (wet weight)	Weight Difference	% increase= Weight difference/ Dry weight
Tap H_2O				
Sugar				
Corn Starch				

RESULTS:

1. Which dialysis pouch gained more mass or more water?

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CONCLUSION:

2. What pouch was your control?

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3. What do you suppose caused the sugar pouch to gain mass? Please answer this question by drawing a picture of the two different dialysis bags and explaining osmosis (the movement of water and attraction of water to different compounds) caused by starch and sugar. View this video for help: http://highered.mcgraw-hill.com/sites/0072495855/student_view0/chapter2/animation__how_osmosis_works.html This can be found on the google site under links.

Sugar Pouch	Explanation:

Starch Pouch	Explanation:

Analyzing dry and imbibed weights of wrinkled and smooth pea seeds

INTRODUCTION:

Seeds often contain starch, which is composed of thousands of glucose molecules joined end to end in long chains. Starch is a good way to store carbohydrate because it is less reactive than sugars, basically insoluble, and does not attract water by osmosis. Because sugars, like glucose and sucrose, attract water by osmosis, a fresh seed with a lot of sugars has a higher water content. When it dries out, it loses more water and wrinkles. Sweet corn (Zea mays) is a seed with higher sugar content, hence the sweet taste. Smooth corn seeds are higher in starch so would not be eaten fresh like sweet corn. Similarly, smooth peas (Pisum sativum) are less sweet and are used in soups and were once even used to make flour. Wrinkled peas are sweeter so are eaten whole as a vegetable. The purpose of a seed is to store food, which gives energy to the baby plant to help it grow until it can make its own sugar by photosynthesis. One of the sources of energy stored in the seed is a simple sugar, called glucose. Another source of energy for the baby plant is starch. Starch is made up of glucose molecules put together. In this investigation, you will see how sugar and starch relate to water flow. Observe the picture to the right, can you identify wrinkled and smooth peas?

PURPOSE:
Is there a difference between how much water wrinkled and smooth peas can absorb?

MATERIALS:
10 smooth peas
10 wrinkled peas
2 small beakers (or waxed cups)
digital balance
paper towels
water

PROCEDURE:

1. Weigh ten smooth pea seeds and place them in a beaker or waxed paper cup labeled "S" for "smooth." Record your result under dry weight.
2. Weight ten wrinkled peas placed in a beaker or waxed paper cup labeled "W" for "wrinkled." Record your result under dry weight.
3. Add 100 ml of water to a 250 ml beaker and add both samples to cover peas completely.
4. Allow one day for peas to absorb water
5. **NEXT DAY:** Fish out imbibed peas. Place the peas on separate paper towels and blot them dry. Reweigh each sample and record the weight data under "weight wet" in your table. Calculate the percent of weight increase for each pea variety and record the data.
6. Complete the data table.

DATA:

Pea variety	Dry weight	Wet weight	% increase
Wrinkled			
Smooth			

RESULTS:

Please show your work for finding percent increase

Wrinkled:	Smooth:

Percent Increase Example:

CONCLUSION:

1. What pea variety absorbed more water?

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2. Looking back at your dialysis experiment, why does one pea absorb more water than the other?

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3. If you were going to grow peas in your garden, which ones would you grow and why?

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Putting it All Together, What makes Wrinkled Peas?

INTRODUCTION: In this final experiment, you will need to determine which peas lack the enzyme that convert sugar within the pea to starch. What makes this challenging is you will not be able to tell by how they look, because the peas will be soaked overnight and they will look the same. You will need to develop a procedure that will help you decide which pea is wrinkled or smooth. Some general materials will be provided, but if you want additional materials please ask. *This experiment will be formally written up.*

PURPOSE: Which peas lack the enzyme that converts the sugar within the pea to starch and are wrinkled and which ones have the enzyme and are round?

HYPOTHESIS:

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MATERIALS

- 4 peas (2 from beaker 1 and 2 from beaker 2))
- test tubes (labeled beaker 1 and beaker 2)
- 250 ml Beaker
- warm water bath
- Digital balance
- water, H2O
- Benedict's solution
- Pipettes

PROCEDURE:

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Name: ____ *Assignment: Wrinkled Peas?*

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DATA TABLE:

RESULTS:

CONCLUSION:

<u>Additional question:</u> Take two peas from each sample and allow them to dry out. Make sure you indicate which are from the smooth group and which are from the wrinkled group. Allow one to two days for the peas to dry.

Did your results match up with what was observed when you dried out a pea from each beaker?