RET Lesson Plan-2015

Module Topic: Chemical reactions of sugar molecules and sugar-coated substances in the presence of different solvents.

Lesson 1: Chemistry of Carbohydrates

Standards and Indicators:
NGSS:
- HS-LS1: From Molecules to Organisms: Structures and Processes.
- 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.
- LS1.C: Organization for Matter and Energy Flow in Organisms.

Science and Engineering Practices
- (HS-LS1-2):Developing and Using Models.
  Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.

Learning Objectives: Students will be able to:
Predict the chemical interaction of different sugar molecules in the synthesis of polysaccharides
Define and discuss hydrolysis reactions of complex sugar molecules
Create a model of chemical bonds using chemical model kit describing different bond interactions of sugars with water.
Create 3D models of sugar structures to determine the differences between different molecular structures and compare structures of disaccharides, mono-saccharides, polysaccharides

Materials: Chemical modeling kits- 1 per two students, Student worksheets.

List of Handouts: Student Instructions, Analysis/Conclusion questions.

Background Information: In order to excel in this lesson, students must have a basic knowledge of chemical bonds, ionic, hydrogen and covalent. These lessons will be covered prior. Students must review and understand basic carbon chemistry, which will also be done in prior class periods.

Classroom Activity Description
Following the activity guide, students will be given several examples of disaccharides and polysaccharides and they will have to create a 3D structure for them using the chemical modeling kits. Students will then explain the products of the reactions between these molecules and water (hydrolysis). Students will continue to explain the reverse reaction and model the outcome (polymerization).

Upon concluding these activities, students will be asked to predict the solubility (hydrolysis) of different compounds. Students will practice naming compounds, drawing and completing chemical reactions on a worksheet (see attached).

Sample Questions to Elicit Class Discussion:
What are the three elements in a carbohydrate?
Why are carbohydrates important for living things? What are their functions?
Can carbohydrate molecules be broken down?
What is the difference between a carbohydrate and a water molecule?
What kinds of chemical bonds hold carbohydrates together?

Homework Activity /Exercise/ Problems: Following along with the activity worksheet, students will complete all questions included in the exercise.
Reflection/extension questions will include:
(1) How many bonds can carbon make? Why?

(2). What kinds of bonds hold these molecules together?

What is happening to the electrons in the bonds?

(3). Why does the structure H-C=C-H fail to make sense chemically? Explain.

(4). If you were a pharmaceutical researcher, why would you need to learn the three dimensional shapes of naturally occurring molecules?

Parameters to evaluate Student Work Products:
Answers to exercise questions will be scored based on answer key. Student answers to Extension questions will be scored based on PARCC rubric for writing a constructed response (see attached). Explanations must be detailed and include an example in order to be scored.

Lesson 2: Chemical behavior of coated substances and products

Standards and Indicators:

NGSS:

- HS-LS1: From Molecules to Organisms: Structures and Processes
- 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

CCSS-Mathematics MP.4

- HSF-IF.C.7 Model with mathematics. *(HS-LS1-4)*
- HSF.BF.A.1 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. *(HS-LS1-4)*

Science and engineering Practices:

Constructing Explanations and Designing Solutions

- Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations and models (HS-LS1-6)

Planning and Carrying Out Investigations

- Planning and carrying out in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.
- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-LS1-3)

Objectives: Students will be able to:

- Explain Polarity
- Explain the properties of water that make it a good solvent
- Design an experiment/exercise to demonstrate that nonpolar liquids are not good at dissolving sugar. (Activity 1)
- Model how water dissolves sugar (Activity 2)

Materials

Activity 1:

- M&M's
- Water
- Mineral oil or vegetable oil
- Isopropyl alcohol (70%)
- Small white plastic plate
- clear plastic cups or beakers
- White paper
- Flour
- Cornstarch
- Lab Notebook

List of Handouts:
Activity 1
Student procedure, questions for discussion/reflection
Activity 2
Student Procedure guidelines, Student questions for discussion/reflection, Recipe worksheet
Grading rubrics

Background Information:
For Both Activity 1 and 2:
- Review experimental design, controls, variables in an experiment. Review Safety procedures and cleanup protocols
- Review polarity and water properties
- Review structure of a sugar molecule

Classroom Activity Procedure:
Activity 1:
1. Obtain the materials.
2. Decide how much of each material you want to include in your coatings.
3. Once you have reached a decision, fill out your experimental design.
4. Complete a procedure in your lab notebook and make a flow chart of your experimental procedure for others in your group.
5. Predict the data and your results before you do the experiment.
6. Once the planning is complete, carry out the experiment noting any changes you may make along the way.
7. Gather quantitative data, noting the time the candy will dissolve.
8. Analyze data/ Present in graphs.
9. Repeat and Improve.

Activity 2**:**
1. Using the chemical modeling kit, create a model of sucrose.
Note: Sucrose is a disaccharide**.**
2. Use your model to follow along and answer all the questions in the activity

Sample Questions to Elicit Class Discussion:
Activity 1:
Pre-Lab Discussion:
Ask students to make a prediction:
- Do you think water, alcohol, or oil would be better at dissolving the sugar and color coating of an M&M? Explain.
- Discuss with students how to design an experiment to compare how well water, alcohol, and vegetable oil dissolve the color and sugar coating from an M&M. Be sure students identify variables such as:
    - Amount of water, alcohol, and oil used.
    - Temperature of each liquid.
    - Same color of M&M.
    - Time and location the M&M's are placed in each liquid.

Activity 2**:** Pre-Lab Discussion:
The chemical formula for sucrose is $C_{12}H_{22}O_{11}$. What do these letters and numbers mean?

Homework Activity/Exercise/Problems

Activity 1:

Discussion Post Lab:

Have students explain on the molecular level why citric acid dissolves so well in water.

Have students explain their results speculating on the reaction(s) that took place.

Mention equilibrium and add to explanation.

Were the results what you expected? Why or why not.

Post-Activity Discussion and reflection:

1. As a class, discuss what goes on during each step of the engineering process and relate each step to some part of the activity just performed.
2. Have students research the different materials used as pill coatings and the different mechanical systems used to coat pills. Challenge the students to design their coatings based on taste, marketability, cost and ease of shipping and handling while still meeting a certain benchmark protection time. What parameters need to be considered? Why?
3. Answer Extension questions

Activity 2:

Discussion Post-Lab

(1) How many bonds can carbon make? Why?

(2). What kinds of bonds hold these molecules together?

What is happening to the electrons in the bonds?

(3). Why does the structure H-C=C-H fail to make sense chemically? Explain.

Extension Question:

If you were a pharmaceutical researcher, why would you need to learn the three dimensional shapes of naturally occurring molecule?

Parameters to evaluate student work products

Activity 1: Mastery of concepts demonstrated as a lab report in lab NB, presenting data and relevant conclusions. Lab report rubric will be used to determine grade.

Relevant conclusions will include but are not limited to an understanding of hydrolysis of polymers, rationale and use of water as a universal solvent, presenting dissolvability in each solvent and predicting other future experiments that may be relevant.

Activity 2: After discussion of reflection questions, students will provide a formal answer to each question as well as a final procedure /engineering design for their experiments noting any changes made. Student answers to Extension questions will be scored based on PARCC rubric for writing a constructed response (see attached). Explanations must be detailed and include an example in order to be scored.

Grades will be determined according to a rubric (see attached) and final reports in Notebooks will include the steps in the engineering design process presented as a flowchart for this activity.

References:

https://www.teachengineering.org/view_activity.php?url=collection/cub_/activities/cub_biomed/cub_biomed_lesson05_activity1.xml

http://www.middleschoolchemistry.com/lessonplans/chapter5/lesson4

www.megamolecules.com/.../molecular_modeling_**activity**_for_**carbohy**...

Mega Molecules, LLC
Hands-On Science with Molecular Models

Name: ____________________
Date: ____________________
Hour: ____________________

Molecular Modeling Activity for Carbohydrates

Time required: one 50-minute period

Introduction

Carbohydrates are naturally occurring compounds that are produced by green plants in the process of photosynthesis. Carbohydrates are an important part of a healthy diet. Carbohydrates provide the body with the fuel it needs for physical activity and for proper organ function. Carbohydrates come from a wide array of foods such as bread, beans, milk, popcorn, potatoes, cookies, spaghetti, corn, and cherry pie.

In this activity, you will;
(a) learn to interpret the molecular and structural formulas of some carbohydrates.
(b) construct molecular models of some carbohydrates.

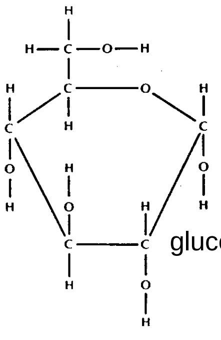
Materials

The Chemistry of Carbohydrates Kit or Food Chemistry Set

The Structure of Monosaccharides

Carbohydrates contain three different elements—carbon (C), hydrogen (H), and oxygen (0). There are many different types of carbohydrates. They have been placed into three groups based on size: monosaccharides, disaccharides, and polysaccharides.

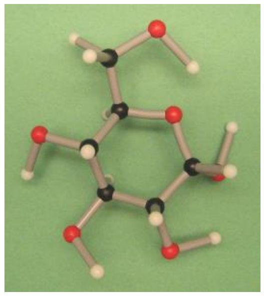
The simplest group of carbohydrates is the monosaccharides. The prefix "mono" means one. Monosaccharides are sugars that are made up of only one molecule. Thus, they are called single sugars. The one molecule, however, can have different shapes due to a different arrangement of atoms. Common hexose monosaccharides are glucose, fructose, and galactose. Glucose is the most abundant monosaccharide in the body.



glucose

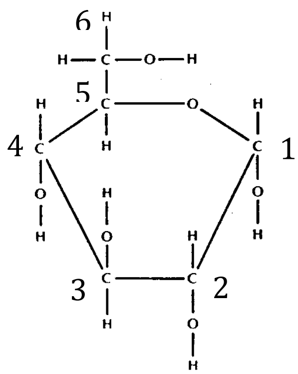
Examine the structural formula and the molecular model of glucose.

Carbon: black models
Hydrogen: white models
Oxygen: red models

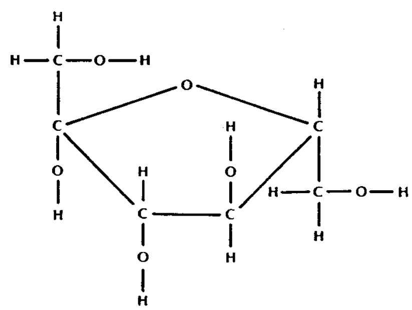


Fructose is found in fruit, honey, and high-fructose corn syrup, which is used in the production of soft drinks, desserts, and confections. The presence of fructose in these products makes it a major sugar in our diet. Galactose is the third major monosaccharide of nutritional importance. Notice that glucose and galactose are almost identical except that the hydrogen (-H) and the hydroxyl group (-OH) on carbon-4 are reversed. Galactose is not usually found free in nature in large quantities but, rather, combines with glucose to form a disaccharide called lactose which is present in milk and other dairy products.

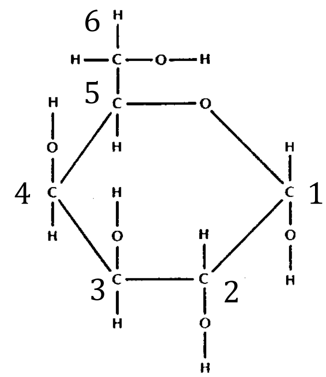
glucose



fructose



galactose



Examine the structural formulas for these three sugars. Using the Chemistry of Carbohydrates Kit of molecular models and the structural formulas for the three monosaccharides above, build models of glucose, fructose, and galactose.

1. What three elements are present in glucose, fructose, and galactose? ______
____

2. How many atoms of carbon are present in a molecule of
glucose? ____
fructose? ____
galactose? ____

3. Add subscripts to the following that indicate the proper molecular formula. Do this by counting the total number of carbon, hydrogen, and oxygen atoms in each molecule.
glucose C__H__O__
fructose C__ H__O__
galactose C__H__O__

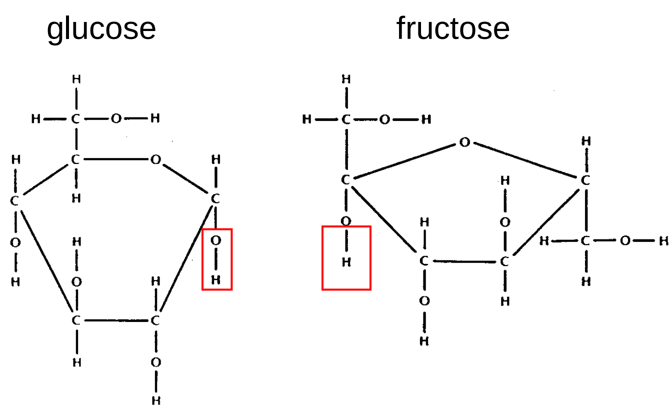
4. How many times larger is the number of hydrogen atoms than oxygen atoms in a molecule of
glucose? ____
fructose? ____
galactose? ____

5. The molecular formula for water is H_2O.
(a) How many times larger is the number of hydrogen atoms than oxygen atoms in a molecule of water? ____
(b) Is the number the same for monosaccharides and for water? _____________

6. Compare the model of glucose to fructose.
(a) Are they exactly the same in shape? ______________________________
(b) Are they both monosaccharides? _________________________________

Procedure for the Construction of a Disaccharide

Two monosaccharide sugar molecules can join together chemically to form a larger carbohydrate molecule called a double sugar, or disaccharide. The prefix "di-" means two. By chemically joining a glucose molecule with a fructose molecule, a double sugar called sucrose and a water molecule are produced.



In order to join the molecules, remove an –OH end from one molecule and an -H end from another.

7. Does removing the -H and –OH ends allow the molecules to fit easily together?

____

8. The -H and –OH ends that were removed can also fit together with each other to form a molecule. This new molecule has a molecular formula of ___________ and is called ____

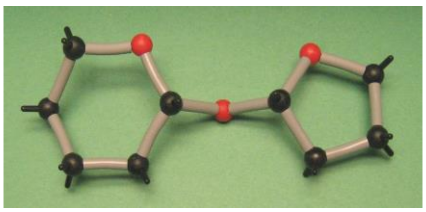
9. Write the molecular formula for sucrose. ______________________________

10. How many times larger is the number of hydrogen atoms than oxygen atoms in a disaccharide? ____

11. How many monosaccharide molecules are needed to form one sucrose molecule? ____

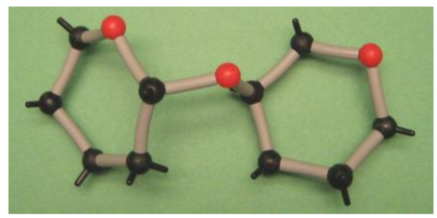
The production of a disaccharide is a chemical reaction called a dehydration synthesis reaction. In such a reaction, the elements of water are removed and the glucose and fructose molecules are joined to form the disaccharide. One carbon on each participating monosaccharide is chemically bound together by oxygen. Two forms of this C–O–C bond exists in nature, called alpha (α) bonds and beta (β) bonds. The beta bond makes lactose difficult to digest for individuals who show a low activity of the enzyme lactase. The beta bond cannot be broken by human intestinal enzymes during digestion when it is part of a long chain of glucose molecules.

Ring-structure of sucrose, table sugar



Alpha (α) bond between glucose and fructose

Ring-structure of lactose, milk sugar



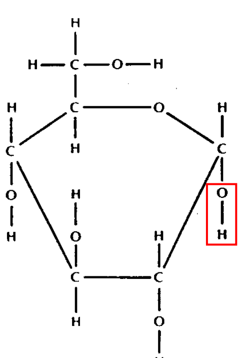
Beta (β) bond between glucose and galactose

Procedure for the Construction of a Polysaccharide

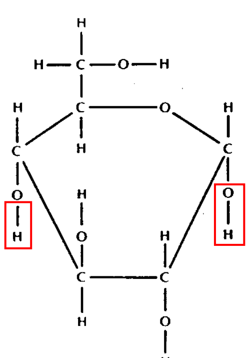
Just as double sugars were formed from two single sugar molecules using a dehydration synthesis reaction, polysaccharides and water are formed when many single sugars are chemically joined together. The prefix “poly-” means many. Starch, glycogen, and cellulose are the three most common polysaccharides in biology. Starch, the major digestible polysaccharide in our diet, is composed of many glucose units linked by alpha bonds and is the storage form of energy in plants. Glycogen, the storage form of carbohydrate in humans and other animals, is a glucose polymer with alpha bonds and numerous branches. Cellulose, dietary fiber, is a straight-chain glucose polymer with beta bonds that are not broken down by human digestive enzymes.

Disassemble the molecular models of sucrose and galactose and build three molecules of glucose.

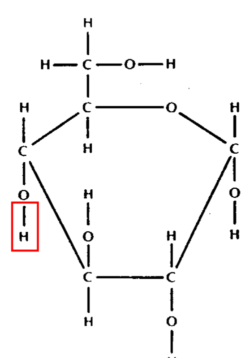
glucose



glucose



glucose



Construct a portion of a starch molecule by joining three glucose molecules. This will represent only a small part of a starch molecule because starch consists of hundreds of glucose molecules.

12. What must be removed from the glucose model molecules in order to have them easily fit together? ____

The molecular formula for a polysaccharide is written as $(C_6H_{10}O_5)_n$. The n equals the number of times the $C_6H_{10}O_5$ group is repeated. You can see this group as the middle glucose of your model. REMEMBER: The -H and –OH ends of the middle molecule are missing.

13. How many times larger is the number of hydrogen atoms than oxygen atoms in a polysaccharide molecule? ____

14. Describe the process of dehydration synthesis. ________________________

____

15. The word carbohydrate is derived from carbon and water (hydrate). Explain why this combination correctly describes this chemical group. ________________

____

____

16. Why are carbohydrates important in our diet? ________________________

17. Which elements are found in carbohydrates? _________________________

18. Name the three major groups of carbohydrates. _______________________

____

19. Name the most abundant monosaccharide in the human body. ___________

20. Name three foods that are good sources of carbohydrates. ______________

____

Extension Questions:

1How many bonds can carbon make? Why?

2. What kinds of bonds hold these molecules together?

What is happening to the electrons in the bonds?

3. Why does the structure H-C=C-H fail to make sense chemically? Explain.

4. If you were a pharmaceutical researcher, why would you need to learn the three dimensional shapes of naturally occurring molecules?

Teacher's Key

1. The 3 elements present in glucose are carbon, C, hydrogen, H and oxygen, O.

2. Glucose, fructose, and galactose each has 6 carbon atoms.

3. Glucose, fructose, and galactose each has the molecular formula, $C_6H_{12}O_6$.

4. Glucose, fructose, and galactose each has twice the number of hydrogen atoms as the number of oxygen atoms.

5. Water has twice the number of hydrogen atoms as the number of oxygen atoms.

6. Glucose and fructose are not exactly the same shape. The two molecules are isomers. Isomers are compounds that have identical molecular formulas but different structures. Glucose and fructose are both monosaccharides. Monosaccharides are sugars that cannot be broken down into simpler sugars by hydrolysis.

7. By removing the –H and –OH ends, the carbon atoms of glucose bonds to the oxygen atom of fructose to form sucrose.

8. This new molecule has a molecular formula of H_2O and is called water.

9. The molecular formula for sucrose is $C_{12}H_{22}O_{11}$.

10. This disaccharide, sucrose, has twice the number of hydrogen atoms as the number of oxygen atoms.

11. Two monosaccharide molecules are needed to form one sucrose molecule.

12. The glucose molecules can be joined together to form a small part of a starch molecule by removing a water molecule between the glucose molecules.

13. The polysaccharide has twice the number of hydrogen atoms as the number of oxygen atoms.

14. The production of a disaccharide or a polysaccharide from monosaccharide molecules is a chemical reaction called dehydration synthesis. In such a reaction, the elements of water are removed and the monosaccharide molecules are joined to form the disaccharide or polysaccharide.

15. In a carbohydrate, there is 1 carbon atom for each water molecule.

16. Carbohydrates are an important part of a healthy diet. Carbohydrates provide the body with the fuel it needs for physical activity and for proper organ function.

17. The 3 elements found in carbohydrates are carbon, C, hydrogen, H and oxygen, O.

18. Carbohydrates have been placed into three groups based on size: monosaccharides, disaccharides, and polysaccharides.
19. Glucose is the most abundant monosaccharide in the body.

20. Carbohydrates come from a wide array of foods such as bread, beans, milk, popcorn, potatoes, cookies, spaghetti, corn, and cherry pie.

Writing Written Expression	The student response _addresses the prompt and provides **effective and comprehensive** development of the claim or topic that is **consistently appropriate** to the task by using **clear and convincing** reasoning supported by **relevant textual** evidence; _demonstrates **purposeful** coherence, clarity, and cohesion, making it **easy to follow** the writer's progression of ideas; _establishes and maintains an **effective** style, attending to the norms and conventions of the discipline.	The student response _addresses the prompt and provides **mostly effective** development of the claim or topic that is **mostly appropriate** to the task, by using **clear** reasoning supported by **relevant textual** evidence; _demonstrates coherence, clarity, and cohesion, making it **fairly easy to follow** the writer's progression of ideas; _establishes and maintains a **mostly effective** style, while attending to the norms and conventions of the discipline.	The student response _addresses the prompt and provides **some** development of the claim or topic that is **somewhat appropriate** to the task, by using **some** reasoning and **text-based** evidence; _demonstrates **some** coherence, clarity, and/or cohesion, making the writer's progression of ideas **usually discernible but not obvious**; _has a style that is **somewhat** effective, **generally** attending to the norms and conventions of the discipline.	The student response _addresses the prompt and develops the claim or topic and provides **minimal** development that is **limited in its appropriateness** to the task by using **limited** reasoning and **text-based** evidence; *or* _is a developed, text-based response with **little or no awareness** of the prompt; _demonstrates **limited** coherence, clarity, and/or cohesion, making the writer's progression of ideas **somewhat unclear**; _has a style that has **limited** effectiveness, with **limited** awareness of the norms of the discipline.	The student response _is **undeveloped** and/or **inappropriate** to the task; **_lacks** coherence, clarity, and cohesion. _has an inappropriate style, with **little to no** awareness of the norm
Writing Knowledge of Language and Conventions	The student response to the prompt demonstrates **full command** of the conventions of standard English at an appropriate level of complexity. There may be a **few minor errors** in mechanics, grammar, and usage, but **meaning is clea**r.	The student response to the prompt demonstrates **some command** of the conventions of standard English at an appropriate level of complexity. There **may** be errors in mechanics, grammar, and usage that **occasionally impede understanding**, but the **meaning is generally clear**	The student response to the prompt demonstrates **limited command** of the conventions of standard English at an appropriate level of complexity. There **may** be errors in mechanics, grammar, and usage that **often impede understanding.**	The student response to the prompt demonstrates **no command** of the conventions of standard English. **Frequent and varied errors** in mechanics, grammar, and usage **impede understanding**.	

Laboratory Exercise: What substances can dissolve in Water?
Pre-Lab Discussion:
Make a prediction:
· Do you think water, alcohol, or oil would be better at dissolving the sugar and color coating of an M&M?

Introduction
Water is a polar molecule. Because of its polarity, water is the universal solvent and responsible for life on earth. Water can dissolve hydrophilic compounds, whereas hydrophobic compounds do not dissolve in water. In this laboratory exercise, you will design an experiment to determine which substances can dissolve the sucrose coating of an M&M.
Materials:
Alcohol, water, oil
M&Ms
Laboratory materials such as beakers, containers, plastic cups
Timer or watch
Procedure:
Design an experiment to compare how well water, alcohol, and vegetable oil dissolve the color and sugar coating from an M&M. Be sure students identify variables such as:
· Amount of water, alcohol, and oil used
· Temperature of each liquid
· color of M&M
· Time and location the M&M's are placed in each liquid
Rationale:
Diagram your laboratory design;
What are the controls?
What are the variables?
What is the experimental variable?

Results:
Record your results in your laboratory notebooks.
Create a chart, table or graph to best represent your data
Analysis
1.Which solvent dissolves the M&M coating?
2. Knowing what you know about the polarity of water, what do your results mean?
3. Is sucrose hydrophobic or hydrophilic?
4. What do you think is happening to the color and sugar in the M&M?

Activity 2:
Investigating the dissolvability of sucrose in water
The chemical formula for sucrose is $C_{12}H_{22}O_{11}$.
What do these letters and numbers mean?

Using the chemical modeling kit, create a model of sucrose.
Note: Sucrose is a disaccharide**.**

Using your model, answer the following questions:
1. In what areas does water dissolve the sucrose molecule? Why?
2. Do you think the molecule itself comes apart? Why or Why not?
3. Explain why the food coloring in the M&M from activity 1 also dissolves. What does this indicate about the composition of the food coloring?

Introduction

Similar to the coatings of candy pieces, medicine pills contain coatings that do not dissolve until after they have passed through our stomachs. These specially-coated pills are called “enteric-coated” pills or tablets. Today, we are going to act as engineers and developing our own “enteric” coating. We will create a recipe for our coating, and then test it by observing its effectiveness in protecting a piece of candy placed in an environment that simulates the stomach’s.

Materials

For each group:

Gather materials and measure specified amounts of flour, cornstarch, sugar and vegetable into individual bowls.
Recipe and Fraction Worksheet.
M&Ms

Procedure
1. Decide amongst your group how much if any of each material you should include in your recipe
2. measure each material and make your mix
3. When your group has finished creating your mixture, apply it to your piece of candy
4.Predict: will your candy coating dissolve in 10 minutes?

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