“Understanding Hydrogels and the Difference Between Hydrophobic and Hydrophilic Interactions”

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Summary
During this lesson, students will learn the difference between a hydrophobic and hydrophilic substance. They will also learn the importance of these two substances and what role each type plays in the life of a cell. In addition, students will learn about hydrogels and see how these interactions contribute to their structure.

Lesson 1: Hydrophobic vs. Hydrophilic Substances

Lecture: Hydrophobic vs. Hydrophilic (15 mins)
In this lesson the difference between hydrophilic and hydrophobic substances will be taught. First the structure of water will be described. This will give an introduction into different types of bonds and what part of water attracts and repels these substances. Students will also learn how these interactions are important in everyday life pertaining to the body. A small introduction will be given on cell membranes. This will tie together both substances when discussing different proteins in our cells. (Some proteins are hydrophobic and some are hydrophilic). This will lead into the next short lecture on hydrogels and biocompatibility.

Activity: Classifying Substances (20 Mins)
Students will be placed into groups of 3-4. Each group will be given one large bin filled with water as well as numerous different materials. Students will place each material in the bin and see how each substance behaves. Students will then be instructed to classify each material as hydrophobic or hydrophilic based on their understanding from the lecture and behavior of the
substance. The hydrophobic substances will clump together and not disperse into the water. You will still be able to see the two different substances very clearly. However, the hydrophilic substances will dissolve and become uniform with the water.

Needed Materials

- Bin
- Water
- Vegetable oil
- Wax
- Grease
- Sugar
- Rubbing alcohol
- *soap (has both properties)

Class Discussion (15 mins)

Once the activity is complete the class will come back together and discuss the results they found. This image below can be used to better explain the nature of water and the different types of bonding. Students can see the positive and negative parts of the water molecule and better understand what parts of these molecules bond together to form the common substance of water.

Lesson 2: Hydrogels

Activity: Creating Hydrogels (20 mins)
Students will again be placed in groups for 3-4 for this activity. During this activity the class will create their own hydrogels to learn more about these materials. Students will look at what hydrogels are used for in everyday life. Then, students will learn about the structure of hydrogels and how hydrophobic and hydrophilic interactions create this material.

This image shows a printed hydrogel square. This is what the end result of the hydrogel experiment should look similar to.

**Materials**

- Liquid pectin
- Liquid calcium chloride (low molarity)
- Petri dishes
- Pipettes
- Food coloring

**Steps for Making Pectin:**

1. Mix pectin using a hot plate on the stir setting
2. Add food coloring to change the color so it is easier to see
3. Make calcium chloride solution
4. Add the pectin solution to a petri dish
5. Add the calcium chloride using a pipette
6. Observe the physical change of the material
The hydrogel is made by mixing liquid pectin with food coloring. Then the pectin is treated with the calcium chloride solution. Equal parts of liquid calcium and pectin can be used to complete the gelling process.

Lecture/Group Discussion (20 mins)

The class will come together and discuss the hydrogel they created and describe its properties. Then, students will be given a lecture on the chemical structure of the pectin hydrogel and it will be explained that hydrophilic and hydrophobic interactions give the hydrogel its properties that can be preferred by cells. This makes the material biocompatible so that it can be used in tissue engineering applications. The class will then discuss the many types of hydrogels in real life and also everyday applications of pectin. Contact lenses are considered one form of hydrogel. Another use for hydrogels is in drug delivery. Pectin, however, is used to make a lot of different types of chewy candies. As a treat at the end of the lecture, students could be given candy for their hard work.

Supplemental materials

Crash course on hydrophobic vs. hydrophilic molecules. (may be a higher level than 8th grade but the beginning is basic)

https://www.youtube.com/watch?v=PVL24HAesnc

Explanation for teacher of extracellular matrix


http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2212614/

Standards

A.8.1 Develop their understanding of the science themes by using the themes to frame questions about science-related issues and problems

A.8.2 Describe limitations of science systems and give reasons why specific science themes are included in or excluded from those systems
A.8.3 Defend explanations and models by collecting and organizing evidence that supports them and critique explanations and models by collecting and organizing evidence that conflicts with them.

C.8.1 Identify* questions they can investigate* using resources and equipment they have available.

C.8.2 Identify* data and locate sources of information including their own records to answer the questions being investigated.

C.8.3 Design and safely conduct investigations* that provide reliable quantitative or qualitative data, as appropriate, to answer their questions.

C.8.4 Use inferences* to help decide possible results of their investigations, use observations to check their inferences.

C.8.5 Use accepted scientific knowledge, models*, and theories* to explain* their results and to raise further questions about their investigations*.

C.8.6 State what they have learned from investigations*, relating their inferences* to scientific knowledge and to data they have collected.