Review and apply
Investigation 1

Let's review
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1. **Describe an activity you did where you had to control variables. Explain what you did to control them.**
   All of the M&M activities described in Investigation 1 require students to control variables. For example in *Activity 1.5—M&M's in different temperatures*, students place an M&M in hot, room temperature, and cold water. Students should make sure that all of the plates are similar, the same color of M&M is used in each plate and that the M&M's are placed in each plate in the same way (same position, M-side all up or all down), with the same amount of water. The only difference should be the temperature of the water.

2. **Write one or two things you discovered about the way the colored coating from an M&M dissolves and moves in water.**
   Students may mention any of the following characteristics or others that they noticed about M&M's in water.
   - The color moves from an M&M in all directions making a round area of color around the M&M.
   - Different colors of M&M's move through water at about the same rate. Some students may have observed that some colors tend to move faster than others.
   - The "M" on an M&M can sometimes lift off an M&M and float in water.
   - The area of color from different M&M's placed in the same plate of water stops in a "line" between them. The colors do not readily combine.
   - The color from an M&M dissolves faster and moves through the water faster in hot water than it does in room temperature and cold water.
   - The more sugar that is dissolved in water, the slower the color will dissolve and move.

Science in action!
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Answers will vary. Students should ask a question they can investigate, design an experiment with only one variable, plan to control variables, and describe the procedure they plan to follow. All results should be recorded, and students should discuss the similarities and differences between their experiment and the experiments they conducted with M&M's.

Think about it

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1. **What is the main idea of the reading about Louis Pasteur?**
   a. Louis Pasteur wanted to test ideas in a laboratory.
   b. Louis Pasteur designed and conducted an experiment to test the theory of spontaneous generation.
   c. Louis Pasteur was the inventor of pasteurization.
   d. Louis Pasteur was a scientist.

2. **The term *spontaneous generation* means:**
   a. to suddenly catch on fire.
   b. to have a large and complicated family tree.
   c. a living thing can come from a non-living thing.
   d. to get power from a generator.

3. **Pasteur *predicted* that bacteria from the air caused broth to spoil. What does the word *predicted* mean in this sentence?**
   a. expected
   b. exposed
   c. produced
   d. designed

4. **In his experimental design, Pasteur kept everything about the containers the same except bacteria could get in one container but not the other. He designed his experiment this way so that it was a *fair* test. In a *fair* test:**
   a. No variables are used.
   b. There are at least three variables used.
   c. All variables are kept the same except for the one you are testing.
   d. Two variables are changed at the same time.

5. **In Pasteur's experiment, he used a curved-neck container and a straight-neck container. Why did he use different shaped containers?**
   a. The straight one allowed air to get in.
   b. The curved one prevented the broth from spoiling.
   c. They both allowed air in, but the curved one prevented bacteria from getting in.
   d. He could heat both without the broth boiling over.

6. **If you were to come up with a title for this reading, it might be:**
   a. Louis Pasteur solves many problems.
   b. Louis Pasteur likes milk.
   c. Louis Pasteur experiments with broth.
   d. Louis Pasteur tests the theory of spontaneous generation.

7. **In Louis Pasteur's experiment to disprove the theory of spontaneous generation, what were some of the variables that he needed to keep the same so that his experiment was fair?**
   Pasteur controlled variables by using the same amount and type of broth and by giving each sample of broth a similar exposure to air, light, and temperature.

8. **In Pasteur's experiment, what was the one variable that was different between the two containers?**
   The difference was the ability of microorganisms to get in the broth in one container but not the other. The shape of the containers allowed air to get into the broth in both containers, but bacteria, mold, or other microorganisms could only enter the broth in the straight neck container. Bacteria in the air over the curved neck container would collect in the "bend" of the curved neck and not enter the broth.

9. **If Pasteur wanted bacteria to get into one container of broth but not the other, why didn't he just leave one open and put a lid on the other?**
   Pasteur did not leave one container open and put a lid on the other because then both containers would not be exposed to the same amount of air. If one container is closed with a lid, less air will be over the broth. Pasteur would not be able to tell whether the broth spoiled because of bacteria from air or because of something else about air.

10. **In your own words, explain how the careful setup of Pasteur's experiment added evidence to the case that the theory of spontaneous generation is not true.**
    The different shaped necks affected the amount of microorganisms allowed to enter each sample of broth. By keeping all other conditions of the experiment the same, Pasteur was able to show that microorganisms from the air caused broth to spoil. If broth spontaneously turned into rotten broth, the broth in both containers would have spoiled. This evidence showed that the theory of spontaneous generation is not true.

What's going on here?

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1. **What atoms is water made of? Hint: The chemical formula for water is H_2O.**
   Water is made of two hydrogen atoms and one oxygen atom.

2. **Why are water molecules attracted to each other?**
   Water molecules are attracted to each other because of the way they are covalently bonded together. Water has a slightly positive charged area near the hydrogen atoms and a slightly negative charge around the oxygen. Because positives and negatives attract, the positive area on one water molecule is attracted to the negatively charged area of another water molecule.

3. **Why is water able to dissolve sucrose?**
   The slight positive and negative areas on water molecules are attracted to the positive and negative areas on other molecules. Sucrose, like water, also has positive and negative areas on it. The positive and negative areas on water molecules are attracted to the negative and positive areas on sucrose molecules. These attractions pull the sucrose molecule away from other sucrose molecules. When the water molecules have pulled the sucrose molecules away from each other, then the sucrose has dissolved in the water.