

Lab 3: Phlegm: Liquid or Solid?

HASPI Medical Middle School Physical Science



Background/Introduction

Mucus vs. Phlegm

Mucus and phlegm are not always the same. Mucus is a thick, sticky substance produced by mucus membranes (linings). The human body has mucus membrane in a number of different places. The stomach, intestines, nose, lungs, eyes, mouth, reproductive organs, and urinary tract all contain mucus membranes that secrete mucus. This mucus serves as a mechanism to keep tissues from drying out and cracking as well as providing a layer of protection against infectious agents, since it contains antibodies that help the body recognize foreign invaders. Phlegm is more related to the secretion in the airways during disease and inflammation. Phlegm is a combination of mucus, debris, and inflammatory cells.



<http://upload.wikimedia.org/wikipedia/en/thumb/a/a2/Phlegm.jpg/220px-Phlegm.jpg>



<http://www.grossology.org/recipes/snot.html>

The Importance of Mucus in the Respiratory System

In the respiratory system, mucus plays a key role in filtering out the air we breathe. Along with the oxygen that humans need to survive, air is filled with dust, smoke, tiny fungi, bacteria, pollen, dead skin cells, ash, grains of dirt and sand, and even viruses that need to be filtered out. Larger, coarse nose hairs trap bigger objects from entering the lungs, while these tinier objects not visible to the naked eye get stuck in the thick, sticky mucus that line the respiratory system. The mucus is then removed from the body in a few different ways. It can be expelled out of the nose when an individual blows his/her nose or when he/she sneezes. Quite often, mucus travels back up towards the nose, joining the larger objects trapped by nose hairs to form what are known as “boogers”, which stick around until picked out, breathed in, or blown out.

On average, the mucus membrane in the nose makes a new batch about every twenty minutes and about 1 to 1.5 liters of mucus per day, most of which goes unnoticed as it trickles down the throat. Millions of tiny hairs, called cilia, push mucus towards the back of the nasal cavity at a rate of about one-quarter of an inch per minute. When it reaches the back of the throat, the body’s natural instinct is to swallow it, allowing it to be digested in the stomach. On average, humans swallow about a quart of mucus each day!

Why Does Mucus Change Color and Consistency?

If an individual has a bad cold, allergy, or comes in contact with something irritating, the body’s mucus production in the nose increases. During an allergic response, certain cells in the body produce a substance called histamine, which triggers sneezing, itching, and nasal stuffiness. Think of

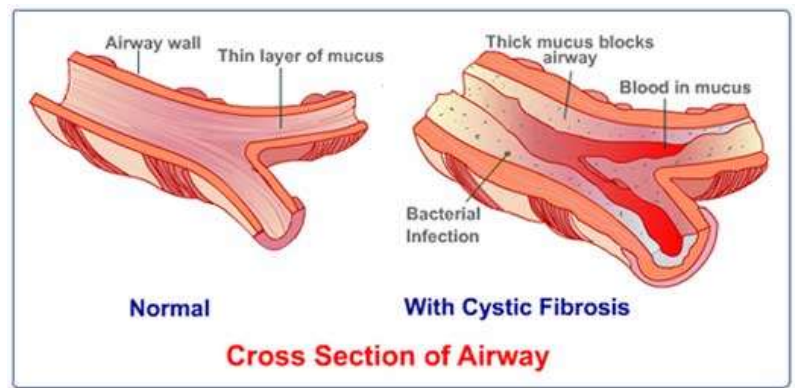
allergy and sinus medication as commonly being called anti-histamines. Histamine causes the tissues of the mucus membrane to start leaking fluid, creating the sensation of a runny nose.

On the other hand, mucus can increase in thickness if the air that is breathed in contains more debris. As more particles get trapped in the sticky mucus, it gains mass and becomes denser. In the event of a cold, the body's immune system sends white blood cells called neutrophils to the area to combat the "foreign invaders," which adds to the thickness of the mucus. At this stage, the thick mucus is also referred to as phlegm because it fits the definition of such.

The neutrophils that are sent to attack foreign invaders entering the body at the nose contain a greenish-colored enzyme called Myeloperoxidase. Because the enzyme has a color, it causes mucus to appear yellow and green in appearance. Mucus can also appear to be reddish or brown from the presence of blood, which can be a result of the nose drying out or excessive irritation from too much rubbing, blowing, or picking. The blood comes from an area just inside the nostril, which is where most of the blood vessels in the nose are located.

Cystic Fibrosis

Cystic fibrosis is a rare genetic disorder that causes mucus in the body to become extra thick and sticky. When it builds up, it can cause a number of problems in many of the body's organs, especially the lungs and pancreas. Individuals who have cystic fibrosis can develop serious breathing problems and lung disease. Individuals going through the early stages of cystic fibrosis may experience nonstop coughing, extensive phlegm production, and a decrease in the ability to exercise.



<http://pathologyproject.wordpress.com/2011/02/04/cystic-fibrosis/>

The extra thick and sticky mucus also decreases the body's ability to fight against the foreign invaders that are breathed in, so cystic fibrosis patients become more susceptible to lung infections like pneumonia. If the mucus continues to thicken or even harden in the lungs, airways can be permanently blocked, drastically decreasing the amount of oxygen the body taken in by the body.

There are no current cures for cystic fibrosis and the average life expectancy for an individual dealing with the disease is about 30-40 years old. However, advancements in respiratory therapy and the development of new treatment plans are making it possible for some individuals to live well into their 40s and longer.

Review Questions

1. What is the difference between mucus and phlegm?
2. In what parts of the body can you find mucus?
3. What is the main purpose of mucus in the respiratory tract?
4. How much mucus is produced in the respiratory tract?
5. How does the body get rid of mucus?
6. Explain what happens to your mucus when you have an allergic reaction.
7. Explain what happens to your mucus when you have a cold.
8. What are the common colors of mucus and what causes it to turn those colors?
9. What are the symptoms of cystic fibrosis?

Phlegm: Liquid or Solid?

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Scenario

Normally, mucus produced in your respiratory tract is a clear, viscous (thick) liquid that is often unnoticed even when you are swallowing about a quart of it each day. When you get sick, however, it can change its consistency and color to a yellowish-green, thick, and “chewy” chunk of phlegm that you can feel in the back of your throat.

By now, you and your classmates should have an understanding of the differences between liquids and solids. Individual particles in a solid vibrate in place, while individual particles of a liquid slide past one another. Solids have a fixed shape, while liquids take the shape of their container.

In your groups, create a batch of fake phlegm and analyze its properties to determine if it should be classified as a solid or a liquid.

Materials Needed

White Glue	Food Coloring
Water	Digital Balance
Borax	Weighing Boat
Clear Mixing Cups	Permanent Marker
Mixing stick	Cold Water Bath
Graduated Cylinder	Hot Water Bath

Procedures

Your lab team will be given tasks, or directions, to perform on the left. Record your questions, observations, or required response to each task on the right.

Task		Response
1	Make a hypothesis: Do you think phlegm is a solid, liquid, or something else? Be sure to explain your hypothesis.	
2	Obtain the materials provided by your instructor. Record the amount of each material you received.	
3	Label the 3 mixing cups A, B, and C with a permanent marker.	
4	Using a graduated cylinder, measure 30mL of water into Cup A.	
5	Add two drops of food coloring to Cup A (you may need to ask your teacher to do this step) List the physical properties of the contents of Cup A in the right column. Be sure the properties listed help you decide if the contents is a liquid or a solid	

6	Using a graduated cylinder, measure another 30mL of water into Cup B	
7	Measure 1.0 g of Borax and add it to the water in Cup B. List the physical properties of Borax.	
8	Measure 30 mL of white glue into Cup C. **Do not use the graduated cylinder because it will be extremely hard to clean up. Put all three mixing cups side by side and eye ball 30mL of white glue using the pre-measured 30mL of water in the other cups for comparison. List the physical properties of white glue. Be sure the properties listed help you decide if the contents is a liquid or a solid	
9	Pour the water and food coloring from Cup A into the white glue in Cup C and mix until you have reached a consistent texture.	
<p>*** STOP AND MAKE SURE YOU READ STEPS 10-13 VERY CAREFULLY FIRST. YOU MUST COMPLETE THE REMAINDER OF THIS LAB QUICKLY BUT CAREFULLY! CONTINUAL MIXING AND TIMING IS IMPORTANT.</p> <p>*** NOTICE, YOU WILL BE ASKED TO MAKE OBSERVATIONS. KEEP THEM IN MIND AND WRITE THEM DOWN <u>AFTER</u> YOU HAVE COMPLETED STEPS 10-13.</p> <p>*** MAKE EYE CONTACT WITH YOUR GROUP MEMBERS BEFORE STARTING TO MAKE SURE EVERYONE IS READY!</p>		
10	Have one group member continually swirl the Borax and water mixture in Cup B to keep the Borax evenly distributed.	
11	Another group member needs to continually stir the glue and colored water mixture in Cup C.	
12	While continuing to mix both cups, add the contents of Cup B to Cup C. **Be sure to keep everything moving/mixing/swirling as you combine the contents of your cups. Write down what you notice happening to your mixture. What does it look like? What does it feel like? (Reminder: wait to answer until you have completed step 13 below.)	
13	Continue to mix vigorously and quickly without making a mess. When your fake phlegm thickens up, you can take it out of the cup and knead it with your hands.	

	When your fake phlegm is complete, it should have a consistent color and texture.	
	Go back and write down your observations of Step 12.	
14	List the physical properties of the fake phlegm. Remember: you are trying to decide if it should be categorized as a liquid or a solid.	
15	<p>Run a few tests to discover the physical properties of your fake phlegm:</p> <ol style="list-style-type: none"> 1. Place the phlegm back into Cup C. Hold the cup at a 90-degree angle above your desk and see how many seconds it takes for the phlegm to pour out of the cup. Record your findings in seconds. 2. Roll your phlegm into a sphere and drop it from 1 meter above your desk. Record what happens. 3. Roll your phlegm into a sphere and let it sit on your desk, undisturbed for 30 seconds. Record what happens. 	
16	<p>Repeat your three tests after chilling your phlegm in a cold water bath for 3 minutes. (keep your phlegm in the cup while soaking in the cold water bath)</p> <p>Record your findings.</p>	
17	<p>Repeat your three tests after warming your phlegm in a hot water bath for 3 minutes. (keep your phlegm in the cup while soaking in the warm water bath)</p> <p>Record your findings.</p>	

Analysis & Interpretation

Analysis Questions

1. What physical properties define a liquid?
2. What physical properties define a solid?
3. Draw a diagram that depicts the molecular structure of the contents of Cup A in Step 5.
4. Draw a diagram that depicts the molecular structure of the Borax you used in Step 7.
5. Draw a diagram that depicts the molecular structure of the contents of Cup C in Step 8.
6. Water and white glue are both liquids. What are the differences between these two liquids?
7. What affect does temperature have on the physical properties of your phlegm? (Refer to your observations in Step 16 and 17)
8. Is phlegm a solid or a liquid? Explain your answer.

Connections & Applications

1. Create an informational display board or medical pamphlet on Cystic Fibrosis to share with your classmates. The display board or pamphlet should include, but is not limited to:
 - A brief history of the disease
 - Cause of the disease
 - Most common symptoms
 - Possible treatments for the disease
 - Pictures/Graphs/Diagrams
 - Interesting Facts (famous people with the disease, new research on the disease, etc.)
 - Sources

Resources & References

- <http://www.webmd.com/allergies/features/the-truth-about-mucus?page=3>
- <http://library.thinkquest.org/J0112390/Boogers.htm>
- <http://www.brainpop.com/health/personalhealth/boogers/>
- <http://children.webmd.com/tc/cystic-fibrosis-topic-overview>
- <http://en.wikipedia.org/wiki/Mucus>
- <http://en.wikipedia.org/wiki/Phlegm>
- Branzie, Sylvia. 1995. Grossology: The Science of Really Gross Things. Addison-Wesley Publishing Company. Pg. 12-13, 32-33