## SBI3U: Animals, Structure, and Functions

# Teacher Demos: A. Digestive enzymes, B. Control of Breathing, C. Baroreceptor Reflex

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| TopicsDigestive systemRespiratory system Circulatory system | Timingpreparation: 2 mindemonstration: A.5min, B.20min, C.15min |

## Introduction

These three demos allow students to experience applications of knowledge of the digestive, respiratory, and circulatory systems by doing very short activities on themselves. They also allow the opportunity to discuss the pros and cons of using humans as test subjects. It is very useful for students to get the idea that scientific experiments do not have to be very complicated.

## Materials

Crackers (plain)

Ziploc or paper bags (sandwich sized)

Timer/cell phone

Blood pressure cuffs (optional)

## Safety Considerations

* Students should check cracker ingredients for food allergies (ex., gluten).
* If students become light headed during demo B (Control of Breathing), they should stop the activity immediately.

## Procedure

1. **Digestive Enzymes**
2. Students attempt to chew (or not chew) a cracker for 60 seconds to show the effectiveness of salivary amylase.
3. Discuss why the cracker dissolves into mush long before the 60 seconds are over. Do other foods do this?
4. **Control of Breathing**
5. Students predict how long they can hold their breath.
6. Students try to hold their breath; times are recorded.
7. Students hypothesize what will allow them to hold their breath longer.
8. Students will try hypoventilating into a ziploc bag (loosely cover the nose and mouth) for 60 seconds, then holding their breath; record results, look for trends.
9. Students will try hyperventilating for 60 seconds, then holding their breath; record results, look for trends.
10. Have students try to explain trends in the results.
11. Discuss theory behind results.
12. **Baroreceptor Reflex**
13. This activity can be done with blood pressure monitoring equipment if available. If so, in the instructions below, replace “taking their pulse” with “taking their blood pressure”.
14. Students are taught to take their own pulse either at the wrist or neck.
15. Students sit quietly for 2 minutes.
16. Students take their pulse for 15 seconds while sitting at rest.
17. Students then stand up and immediately take their pulse for 15 seconds.
18. Students remain standing for 2 minutes, and then take their pulse for 15 seconds.
19. Class results are recorded; try to identify trends.
20. Have students brainstorm/discuss the possible causes of the trends in the data.
21. Discuss the baroreceptor reflex (optional link to evolution).

## Disposal

Ziploc/paper bags should not be reused.

## What happens?

1. Digestive Enzymes – Salivary amylase breaks down the cracker.
2. Control of Breathing – Students should be able to hold their breath for a shorter time period after hypoventilating into the bag, and for a longer time after hyperventilating.
3. Baroreceptor Reflex - Pulse rates should be lowest for sitting rest, highest for just after standing, and medium for standing rest.

## How does it work?

1. Digestive Enzymes – salivary amylase breaks down the cracker. You will notice a slight sweet taste, not as sweet as candy. Amylase breaks down the starch molecules (polymers) into sugar (glucose) molecules (monomers). Starch molecules are too large to pass through the membranes of your cells. The glucose molecules are small enough to move through the cell membrane to be used by your body.
2. Control of Breathing – when hypoventilating into the bag, CO2 builds up in the blood causing the Medulla Oblongata (located in the brainstem anterior to the cerebellum) to quickly register a dangerously high blood pH level when holding your breath and forcing the diaphragm to contract. When hyperventilating, CO2 is removed from the blood causing a longer time period of holding your breath before the Medulla Oblongata registers a dangerously high level of alkalosis and forces the diaphragm to contract.
3. Baroreceptor Reflex - Baroreceptors are nerves located in the carotid artery. Their function is to sense pressure changes (like those caused by standing up quickly; known as Postural hypotension, this occurs when a person’s blood pressure falls when suddenly standing up from a lying or sitting position). The baroreflex mechanism is a fast response to changes in blood pressure. When students stand up, there is a drop in blood pressure in the carotid artery which could cause fainting; to counter this, the Medulla Oblongata quickly increases heart rate and blood pressure by triggering a release of norepinephrine. After standing for a minute or two, pressure and heart rate slow a bit as the initial response of the baroreceptor reflex is usually more than what is actually required for blood to reach the head in the new position. This is a negative feedback response.

## Teaching Suggestions/Hints

Each of these demos is best done as you teach each section of this unit, instead of all at once.

1. Digestive Enzymes – Ask students how long they think they can chew the cracker without swallowing (this can become a contest). Bring in other foods to try this with (could be a good inquiry into what the enzymes in the mouth do).
2. Control of Breathing – With adequate instructions, students can perform this task in pairs with minimal supervision. Class data will still need to be shared to identify trends and correct for any anomalous data due to effort level of individual students.
3. Baroreceptor Reflex - This is best done as a class with the teacher timing (calling out starts and stops) and then recording data of several students on the board after each part of the experiment. Students should practice taking their pulse/blood pressure several times before starting.

## Next Steps

* Ask students to consider human trials/experiments, and problems with them (ex.,small sample sizes).
* Ask students to brainstorm possible ways to improve the experimental designs (ex., better controls).
* Ask students to design their own quick and achievable investigation into a question they have about organ systems. (ex., investigate heart rate changes after different forms of exercise; compare resting heart rate of athletes vs. non-athletes, etc.).

## Specific Expectations

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**E2.** investigate, through laboratory inquiry or computer simulation, the functional responses of the respiratory and circulatory systems of animals, and the relationships between their respiratory, circulatory, and digestive systems;

**E2.3** use medical equipment (e.g., a stethoscope, a sphygmomanometer) to monitor the functional responses of the respiratory and circulatory systems to external stimuli(e.g., measure the change in breathing rate and heart rate after exercise)

**E3.1** explain the anatomy of the respiratory system and the process of ventilation and gas exchange from the environment to the cell (e.g., the movement of oxygen from the atmosphere to the cell; the roles of ventilation, hemoglobin, and diffusion in gas exchange)

**E3.2** explain the anatomy of the digestive system and the importance of digestion in providing nutrients needed for energy and growth (e.g., the body’s mechanical and chemical processes digest food, which provides the proteins needed to build muscle, and the fibre, water, vitamins, and minerals needed to regulate body processes)