# The Digestive System

10-15 days

## Authors

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## SUBJECT/GRADE LEVEL

Anatomy & Physiology
11-12 grade

## Materials

- Digestion Lab per groups of 2-4
  - 1- Banana
  - 6- Crackers
  - 25 mL Vinegar/lemon juice
  - 1- Pantyhose/tights
  - ~25 mL Distilled water
  - 1- Thermometer
  - 1- Plastic sandwich bag
  - 1- Scissors
  - 1- plastic/paper cup
  - 1- Tray
- Macromolecule Lab per groups of 2-4 for Part 1 Lab, Part 2 lab will depend on what students decide to alter
  - 0.5 g Amylase
  - 0.5 g Lipase
  - 0.5 g Protease
  - ~10 mL Biuret Solution
  - ~10 mL Benedict's Solution
  - ~5 mL Sudan III Solution
  - ~5 mL Lugol's Iodine
  - 50 mL of simulated stomach content
    - can of unsweetened corn
    - cup of cooked pasta
    - half cup of vegetable oil
    - a source of protein such as an egg yolk
    - blender
  - 1- 250 mL beaker
  - 5- Pipettes
  - 1- Water bath
  - 4- Test tubes
  - 1- test tube rack
  - 1- Test tube tongs
  - 50-100 mL Distilled water
  - Balance (exclusively part 2)
  - Weigh boats (exclusively part 2)
  - 1 Spatula (exclusively part 2)

## STANDARDS

### Next Generation Science Standards

**HS-PS1-5:** Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.

**HS-LS1-1:** Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins, which carry out the essential functions.

**HS-LS1-2:** Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

### Mathematics Standards | Common Core State Standards

**CCSS.MATH.CONTENT.HSS.ID.C.9:** Distinguish between correlation and causation.

**CCSS.MATH.CONTENT.HSS.MD.B.7**: Analyze decisions and strategies using probability concepts.

**CCSS.MATH.CONTENT.HSN-Q.A.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

**CCSS.MATH.CONTENT.HSN-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

### English Language Arts Standards | Common Core State

**CCSS.ELA-LITERACY.SL.11-12.1.A:** Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.

## LESSON OBJECTIVE(S)

Students will plan & conduct an experiment to illustrate the necessity of mechanical digestion for efficient chemical digestion and analyze the activity of digestive enzymes within different organs of the digestive tract, connecting enzyme function to environmental factors such as pH, temperature, concentration, etc.

## CAREER CONNECTION(S)

**Mentor Background:** Dr. Jesse Roberts: My name is Dr. Jesse Roberts, I'm a research chemical engineer within the Environmental Laboratory at the U.S. Army Engineering Research and Development Center (ERDC) in Vicksburg, MS. We provide solutions for tomorrow's environmental challenges by finding new ways to clean water and remediate environmental contaminants. My role focuses on developing and

characterizing new materials for synthetic biology and environmental applications. Specifically, I work with graphene nanomaterials to remove harmful cyanotoxins from water sources that pose a significant risk to human health. I have my PhD in chemical engineering from the University of Arkansas where I focused on biomaterial development for tissue engineering and biosensing applications. My team serves to make the world better by developing and utilizing materials to provide sustainable water infrastructure through clean and safe water.

**STEM Careers:** Primary care provider, Gastroenterologist, Hepatologist, Nurse practitioner, Registered dietitian, Radiologist, Physician assistant, Chemists, Pharmaceuticals

## CENTRAL FOCUS

Why do we eat food? Because it gives us the energy we need to do everything including growing and repairing our cells. How do we get this energy from our food? We need to break it down. This doesn't just mean breaking it down into smaller chunks of food, this means breaking it down into its building blocks – proteins into amino acids, complex carbohydrates into sugars, and fats into fatty acids and glycerol. In order to break down our food into these basic units, our digestive systems use two broad categories of digestion: mechanical digestion and chemical digestion. Mechanical digestion involves physically breaking the food down into smaller pieces without any chemical changes to the food. Chemical digestion involves breaking chemical bonds to split the food into simpler nutrients. As you work through this lab you will see chemical digestion at work.

## ENGAGEMENT

**Brief Description:** Students will be introduced to the digestive system by creating a model of the digestive system in groups of 2-4.

**Procedures:** 1 class period

**Teachers:** Students will be shown a diagram of the human body with parts of the digestive system pointed out. At this point, no names will be added to the diagram. Teachers will begin the discussion by showing bananas and crackers and ask the following statements and questions:

- What happens when we eat our food?
- It looks different when it comes out than what it did going in? Where does this difference come from?
- All the healthy ingredients are gone. Where did they go?
- It appears that we have broken down the food and absorbed all the healthy ingredients? How did this happen?
- Now let's make a model of the digestive system.

It's a good idea to keep referring to the route that the food takes through the digestive tract during the activity to let the students know exactly where they are at each step. You will be adding names to the different parts of the digestive system at this point.

**Students:** Students will answer verbal questions and complete the accompanying digestive model worksheet.

## EXPLORATION

**Brief Description:** **Part 1:** Students will perform tests to identify macromolecules in simulated stomach content. This will give them background knowledge of what positive and negative tests look like.

**Part 2:** Students will use enzymes to break down simulated stomach content. Students will then perform confirmation tests using the same procedures from the previous activity that the macromolecules have been broken down.

**Procedures:** **Part 1:** 1 period, **Part 2:** 15 minutes daily for one week

**Teachers: Part 1:** Should prepare the simulated stomach content and the lab materials. Teachers should remind students about lab safety. Be sure to model the tests. Create positive and negative tests for students to compare their results to upon completion of their confirmation lab. **Part 2:** Will prepare the simulated stomach content and supply the necessary material to complete the activity. Teachers will remind students of lab safety procedures. Teachers will monitor student lab activities.
**Students: Part 1:** Should complete the qualitative observation data table. **Part 2:** Will design a procedure using enzymes to break down macromolecules. Students will complete a laboratory notebook.

## EXPLANATION

**Brief Description:** Students will create a formal lab report using their detailed lab notebook. Students will then answer questions and share their findings on a jamboard.

**Procedures:** 2-3 days to write a formal lab report and complete questions on the jamboard.

**Teachers:** Teachers will provide the lab report guidelines and rubric. Teachers will answer questions and guide students while they complete their lab reports. Teachers will ask the following questions on a jamboard:

1. What patterns did you notice?
2. Why do you think that digestion requires enzymes? What evidence do you have of this?
3. Why do you think that concentration, pH, concentration or factors affect digestion?
4. What did you expect to find? Why?
5. How can you explain the need for enzymes in the process of digestion?

**Students:** Will use their detailed lab notebook to create a formal lab report using the rubric and lab report guidelines provided by the teacher. Students will answer the questions and share their findings on a jamboard.

## ELABORATION

**Brief Description:** Students will use enzymes to break down simulated stomach content as well as alter other parameters such as pH, temperature, light, etc.. Students will then perform confirmation tests using the same procedures from the previous activity that the macromolecules have been broken down.

**Procedures:** 1 day to set up the experiment then 10-15 minutes per day for 1 week for observations.

**Teachers:** Will prepare the simulated stomach content and supply the necessary material to complete the activity. Teachers will remind students of lab safety procedures. Teachers will monitor student lab activities. Teachers should have additional material available such as balances, spatulas, thermometers, hot plates.

**Students:** Students will design a lab activity changing parameters such as additional enzymes, pH, temperature, concentration, light, etc. to increase digestion. Students will collect and record data to be used in a formal lab report and oral presentation. Students will complete a laboratory notebook.

## EVALUATION

**Brief Description:** Students will complete a formal presentation of their results.

**Procedures:** 2~3 periods depending on class length. Give time in class for students to create the chosen presentation method. Then 2~3 days to give an oral presentation of their findings.

**Teachers:** Will supply the formal laboratory presentation rubric.
**Students:** will present their findings to their peers. Students will choose from a variety of methods for their presentation including a scientific poster, slide show, video, or another method that has been approved by the teacher using the provided rubric.

## REFERENCES


- https://www.teacherspayteachers.com/Product/Macromolecule-Lab-Investigation-A-Murder-Mystery-2393278
- https://www.sciencejournalforkids.org/articles/lesson-ideas/digestive-system-lab/
- https://www.stocktonusd.net/cms/lib/CA01902791/Centricity/Domain/3232/Science%20Poster%20Rubric%204.19.18.pdf