

Unit 3

Metabolic Reactions:

How do things inside our bodies
work together to make us feel
the way we do?

Student Procedure Guide



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How do things inside our bodies work together to
make us feel the way we do?

Student Procedure Guide

Core Knowledge Science®



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Metabolic Reactions

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Lesson 1: What is going on inside M’Kenna’s body that is making her feel the way she does?

Exploring an Interesting Phenomenon

We will hear about a real case study from a 13-year-old girl, M’Kenna, who has recently started feeling sick all the time. Her primary complaints are that her stomach hurts after she eats and that she has diarrhea and stomach cramping.

Turn and talk



1. Knowing that M’Kenna’s primary complaints are that her stomach hurts after she eats and that she has diarrhea, are there other symptoms you might expect M’Kenna to have as well?

Make observations of the doctor’s note.

In your notebook



2. Create a table in your science notebook.

Notice	Wonder

3. Make observations about *M’Kenna’s Doctor’s Note*. What do you **NOTICE**?
4. Where do you **THINK** each symptom might occur in M’Kenna’s body? Write each symptom on the body system you think it is affecting on *Map M’Kenna’s Symptoms to Her Body Systems*.
5. What does this make you **WONDER** about M’Kenna and her symptoms?
6. Share your Notice-Think-Wonderings with a partner and add to them.

With a partner



Develop initial models.

On your own



7. Develop an initial model to explain: “How can M’Kenna be having symptoms in all of these different parts of her body?” Use pictures, symbols, and words.

Additional guidance:

- How could all of those symptoms in different body systems be happening at the same time?
- Why did some symptoms start happening before others?
- It may be useful to think about a healthy person compared to M’Kenna. You may wish to show the differences using different colors.

Share our initial models.

Turn and talk



8. Make a T-chart in your science notebook titled, “Comparing our models.”
9. Write down similarities and differences between your and your partner’s models in your notebook.

With your class



10. Compare models during a silent gallery walk.
 - Leave your model at your seat.
 - Walk to another student’s model.
 - Record similarities and differences you see about the ideas in the model.
 - Wait until your teacher says “go” to find another model.

Initial Consensus Model in a Scientists Circle

With your class



11. Develop a whole-group record of what we agree on and where we have competing ideas across the initial models.
 - What do we all seem to agree on?
 - What do we disagree on?
 - What are some new ideas that we may want to consider?

Progress Trackers: What have you figured out?

In your notebook



12. Count off 4 pages in your science notebook. Then create a T-chart under the heading “Progress Tracker.” Leave some space after the heading.
13. Keep track of the important discoveries you make during this unit in your Progress Tracker.
 - Write the question we are working on in the left column:
 - What’s going on with M’Kenna’s body that is making her feel the way she does?

- Write what you have figured out so far in the column on the right. You can write in pictures or words. Take as much space as you need to record your thoughts.

Share related phenomena.

On your own



14. Write about when you or someone you know experienced more than one of these symptoms happening at the same time, like M’Kenna.
15. If you knew the cause of the symptoms, was the cause occurring in the same body part as the symptom or a different part of the body?

For example, I had a headache and started to get tired, but what was actually causing it was that I didn’t drink enough water (not actually something going on with my head).

Be ready to share these ideas with others.

Turn and talk



16. Share your related experiences with a partner, then share them out loud with the whole class.

Develop questions.

On your own



17. Look back at:
 - your Notice-Think-Wonder notes about the Doctor’s Note,
 - your initial model, and
 - our list of related phenomena.
18. Take a minute to review these to find questions that you have about the phenomena we have explored so far (including any of our related phenomena).
 - Write one question per index card.
 - Write in marker—big and bold.
 - Put your initials on the back in pencil.
 - Write only one question per card.

Driving Question Board

Scientists Circle



19. Bring your index cards with questions to our Scientists Circle, along with your science notebook.

20. Build a Driving Question Board with your class.

- The first student reads his or her question aloud to the class, then posts it on the DQB.
- Students should raise their hands if they have a question that relates to the question that was just read aloud.
- The first student selects the next student whose hand is raised.
- The second student reads his or her question, says why or how it relates, and posts it near the question that it most relates to on the DQB.
- The student selects the next student.
- We will continue until everyone has at least one question on the DQB.

Ideas for Investigations

With a partner



21. Write what investigations we could do to help us figure out what is going on inside M'Kenna and to help us answer our DQB questions.

- Add your ideas to a new notebook page titled, "Ideas for future investigations and data we need."

With your class



22. Share your ideas for investigations with your class.

Update your table of contents.

In your notebook



23. Add the titles and page numbers to the table of contents to include all the work we have done so far.

Navigation

With your class



24. Decide as a class which question you want to investigate next.

Lesson 2: Can we see anything inside M’Kenna that looks different?

Navigation

Last time, we met M’Kenna and learned that she was really sick and was having a lot of alarming symptoms. Many of these were in her digestive system.

With a partner



1. Turn and talk with your partner about the following questions:
 - What ideas did we have for ways to investigate what was going on with M’Kenna’s digestive system?
 - How would we (or doctors) be able to see if anything was different in M’Kenna’s digestive system?

What makes up the digestive system?

With a partner



2. Turn and talk with your partner about the following question:
 - What structures inside our bodies come to mind when you think of the digestive system?

Look at structures of the digestive system.

With your group



3. Obtain a copy of *Analyzing Endoscopy Images*.
4. Examine a set of illustrations of a few structures that make up the digestive system.
 - Use *Analyzing Endoscopy Images* to record what you notice about similarities and differences between the structures.
5. Think about the following questions:
 - Do you think the diagrams you saw look the same as organs do in the body?
 - What do you think doctors do when they want to get a better look at real organs inside a healthy person?

M’Kenna’s Endoscopy Report

We have endoscopy images in a computer interactive that we will use to look at the organs in M’Kenna and a healthy person to see if we can find any evidence that M’Kenna’s digestive system might be the cause of her symptoms.

With your class



6. Examine M’Kenna’s endoscopy report and identify the organs in the digestive system that will be examined using the computer interactive.

Studying Endoscopy Images

With your group



7. Locate your copy of *Analyzing Endoscopy Images*.
8. Use the computer interactive A Look Inside the Digestive System and keep track of what you notice about the structures you are examining using *Analyzing Endoscopy Images*.

Making Sense of Endoscopy Images

Can we see anything in M’Kenna’s digestive system that looks different compared to a healthy digestive system?

With your group



9. Turn and talk to your group about the following questions:
 - What inside M’Kenna’s digestive system looks most different from the healthy patient?
 - What questions are you wondering about?

Navigation

Focus on the question: “What happens to food in the small intestine?”

With a partner



10. Turn and talk with your partner about the following questions:
 - Do we know what is wrong with M’Kenna or how it could be impacting her?
 - What do you think happens to M’Kenna’s food when it gets to the small intestine?

Analyzing Data with the I² Strategy - WIS

What happens to a graham cracker as it passes through M’Kenna’s small intestine versus a healthy person’s? We’ll use the Identify and Interpret (I²) strategy to help us analyze graphs of food as it enters and reaches the middle of the small intestine.

In your notebook



Make observations of graphs of food as it enters and reaches the middle of the small intestine using the Identify and Interpret (I²) strategy. Write “What I see” statements:

11. Draw an arrow to something you notice in the graphs.
12. Write “What I see” (or WIS).
13. Then write your observation in a complete sentence.
14. Share your observations.

Analyzing Data with the I² Strategy – WIM

In your notebook



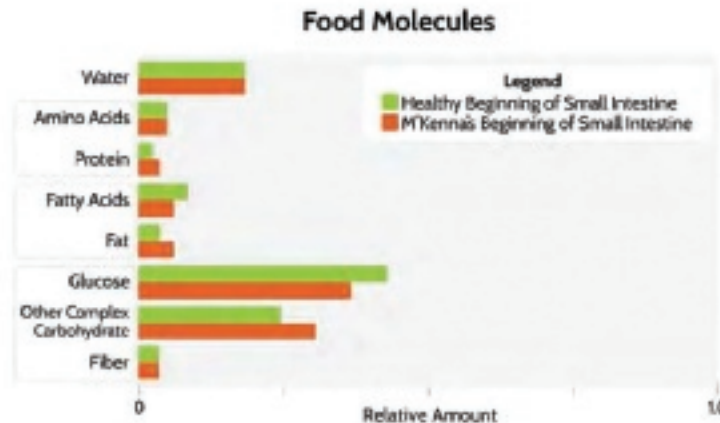
15. Interpret what your observations mean.
16. Write “What it means” (or WIM) statements next to the observations.

Analyzing Data with the I² Strategy

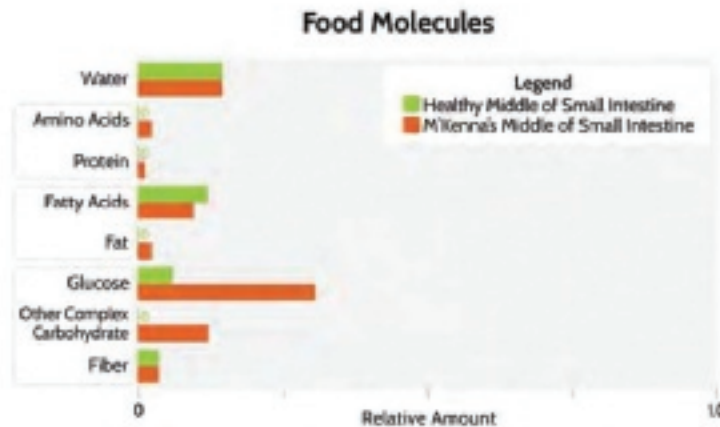
In your notebook



17. Use the I² strategy to analyze the graph below or on the handout *What happens in the small intestine?* to see what is happening to the amount of these types of molecules as they enter the **beginning of the small intestine** in a healthy person and M’Kenna.



18. Analyze the graph below or on the handout *What happens in the small intestine?* to see what is happening to the amount of these types of molecules as they enter the ***middle of the small intestine*** in a healthy person and M’Kenna.



Progress Trackers: What have you figured out?

In your notebook



19. Set up your 2-column Progress Tracker.

- Write the question in the left column (How is M’Kenna’s digestive system different from a healthy person’s?).
- Write what you have figured out so far in the right column.

Next Steps

Turn and talk



20. Turn and talk to your partner about the following questions:

- What ideas do we have about what is happening to the molecules that are disappearing from the small intestine?
- What questions are you wondering about now?

Lesson 3: Why do molecules in the small intestine seem like they are disappearing?

Navigation

Last time, we analyzed data that showed us how the amounts of different substances changed inside M’Kenna’s small intestine and a healthy small intestine as they traveled through the digestive system.

Turn and talk



1. Discuss the question:
 - a. What were some ideas we had for what might be happening to the food molecules as they traveled through the small intestine of a healthy person?
2. Be ready to share your thoughts with the whole group.

Investigation Planning: Model of the Small Intestine

We want to investigate the question: “Why do molecules in the small intestine seem like they are disappearing?”

With your class



3. Discuss the questions:
 - a. Why might it be difficult for us to do this investigation using a real small intestine?
 - b. What hopes would we have if we were designing our own model of a small intestine?

Plan our dialysis tube investigation.

With your class



4. Scientists and engineers have developed a type of special material (dialysis tubing) that has very similar properties to those that make up the surface of the small intestine. Let’s look at how we might be able use this special material to investigate our question.

Dialysis Tube Model of the Small Intestine

Let’s draw a dialysis tube model system in our notebooks. If we are going to use this tubing to represent our small intestine, we need to make sure we are all on the same page about not only how we are going to use it but what each part of our model represents in the human body.

In your notebook



5. Label on your model: What does the dialysis tube represent?
6. Label on your model: What should the outside of the dialysis tube represent?

7. Label on your model: Where should we put the food (molecules) in the dialysis tube system model?
8. Why did you choose to put the food molecules where you did in the dialysis tube model system?

Evaluate the limitations of dialysis tube model system.

Think back to food molecule data and the images of the small intestine from Lesson 2. Turn and talk with your partners about how we could make our model more similar to an actual human body.

Turn and talk



9. How could we make our model more similar to an actual human body?
10. What's different about our model system compared to the small intestine in a real human body?
11. How might these limitations be necessary for us to do our investigation?

Revise our dialysis tube model system.

On your own



12. Revise your dialysis tube model system to include the qualities you discussed during the limitations discussion.

Conducting Our Dialysis Tube Investigation

Conduct an investigation to help answer: Could food molecules be getting absorbed through the surface of the small intestine?

With your group



13. Part 1: How do we set up our dialysis tube system?
 - a. Refer to *Day 1 Dialysis Tube Investigation Instructions*. This is what you will read to figure out what you need to do next.
 - b. Keep a record of your findings in *Dialysis Tube Investigation*, which should already be in your science notebook.

Making and Recording Our Predictions

On your own



14. Finish Part 2: Record your predictions on the *Dialysis Tube Investigation*.
15. Make sure *Dialysis Tube Investigation* is taped in your science notebook.
16. Return the *Day 1 Dialysis Tube Investigation Instructions* to your teacher.

Navigation

In Lesson 2, we had different ideas about what might be happening to food molecules in the small intestine.

With your group



17. With another group, share your predictions about what food molecules you will find when you sample the liquid on the inside and outside of the dialysis tubing.

Collecting Data from Our Dialysis Tube

Collect your data from your investigation to help answer: Could food molecules be getting absorbed through the surface of the small intestine?

With your group



Refer to *Day 2 Dialysis Tube Investigation Instructions*. This is what you will read to figure out what you need to do next. Keep a record of your findings in *Dialysis Tube Investigation*, which should already be in your science notebook.

18. Complete Part 3: What do iodine and Benedict's look like with just water?
19. Complete Part 4: What food molecules are outside of the tube?
20. Complete Part 5: What food molecules are inside of the tube?

Making Sense of Dialysis Tube Results

In your notebook



21. Complete Part 6: Making sense of our results.

Building Understandings Discussion: Dialysis Tube Results

Bring your science notebook to the Scientists Circle.

With your class



22. Did any food molecules end up on the outside of the dialysis tube?
23. Did any food molecules stay inside of the dialysis tube?
24. What do our results tell us about the surface of dialysis tubing? What can you conclude about its structure?
25. What do our results tell us about what might be different about the structure of starch (complex carbohydrate) versus glucose (sugar) molecules?

Connect your model of the small intestine.

Turn and talk



- 26.** If there are small openings or gates in the dialysis tubing, and we said that the dialysis tubing was similar to our small intestine, then what should our small intestine have, too?

Compare molecular representations of glucose and starch.

Look at the *Starch and Glucose Molecules* to help answer the question: How does the structure of a complex carbohydrate molecule (like starch) compare to that of a sugar molecule (like glucose)?

With a partner



- 27.** Where is the glucose molecule in this model?
- 28.** Where is the starch molecule in this model?
- 29.** How do the glucose and starch molecules compare?
- 30.** What is different about the glucose and starch molecules?
- 31.** How does this help us confirm or revise the ideas we have developed so far about why glucose (sugar) can go through the surface of the dialysis tubing but starch cannot?
- 32.** If the surface of the small intestine has a similar structure, what can we say about the size of the molecules that can pass through/across its surface?

Argue for evidence.

With a partner



- 33.** Work with a partner to construct an argument using evidence and scientific reasoning that can support how we should revise our model of the small intestine and add to our Progress Tracker.

Adding to Our Progress Trackers

In your notebook



- 34.** Record the lesson question.
- 35.** Record the sources of evidence.
- 36.** In the bottom row: Use your argument from evidence with your partner and add your current thinking about what you have figured out about the structure of the small intestine and food molecules in words/pictures.

Navigation

New Ideas and Next Steps: Let's take what we have figured out and return to our driving question: How do things inside our bodies work together to make us feel the way we do?

In your notebook



37. What else are we wondering about now?

38. Are there any ideas from our ideas for investigation chart that you want to investigate next?

Lesson 4: What happens to food molecules as they move through the small intestine and large intestine?

Navigation

Last time, we investigated how molecules could be absorbed through membranes in the small intestine.

Turn and talk



1. Discuss the questions:
 - a. What are some discoveries that we made?
 - b. What were the big questions we came up with?
 - c. What data did we decide would be useful for answering these questions?

Analyzing Data with the I² Strategy

With your group



2. What happens to a graham cracker as it comes out of the small intestine and goes into the large intestine? Look at the data in *Graham Cracker Data* that shows how starch (a complex carbohydrate) changes as it moves through the digestive system. Use the Identify and Interpret (I²) strategy to take notes on handout *Analysis Strategy for Graham Cracker Data*.
 - a. Make observations:
 1. Draw an arrow to something you notice in the graphs.
 2. Write “What I see” (or WIS), then write your observation in a complete sentence.
 3. Share your observations.
 - b. Interpret what these observations mean:
 1. Think about what each observation means.
 2. Write “What it means” (or WIM), then add your explanation next to the observation.

Patterns in Different Substances

With your class



3. Follow the complex carbohydrate. Answer the question:
 - a. What changes do you notice as it moves through the digestive system?

4. Now, follow the fiber. Answer the questions:
 - a. What do you notice as it moves through a healthy digestive system?
 - b. What do you notice as it moves through M’Kenna’s digestive system?

Predictions

Turn and talk



5. Examine the Molecules Found in Poop chart. Discuss the question:
 - a. How does this compare to our large intestine data?

Using a Model

With your group



6. Examine the molecular structure of the fiber, starch, and glucose molecules. Discuss the questions:
 - a. How does the structure of fiber compare to starch and glucose?
 - b. What do you think happens to these molecules as they move through the digestive system?

Add to the Progress Tracker.

In your notebook



7. Record the lesson question.
8. With a partner, in pictures and words, represent what the graham cracker and poop data tell you about what is happening in the large intestine in a healthy person and in M’Kenna.

Navigation

Turn and talk



9. Work with a partner to brainstorm ideas to answer the following questions:
 - a. If big molecules can’t get absorbed in the small intestine, why aren’t there other big molecules besides fiber, like complex carbohydrates, coming out in the poop of healthy people?
 - b. What’s happening to the other big molecules like complex carbohydrates? How can we explain why the amount of complex carbohydrates could be decreasing as food travels through the digestive system?

Lesson 5: Why do large food molecules, like some complex carbohydrates, seem to disappear in the digestive system?

Navigation

Last time, we examined data from the digestive system and from poop to figure out what happens to large and small food molecules as they pass through the digestive system.

Turn and talk



1. Turn and talk with your partner about the following questions:
 - What are some discoveries we made about what happens to large and small food molecules as they pass through the digestive system?
 - What are some discoveries we made about what might be different about M’Kenna’s digestive system?

Looking Forward to Our Investigation

With your class



2. With your class, discuss the following questions:
 - What did we decide we needed to figure out today?
 - How would figuring this out help us to explain what is going on with M’Kenna?
 - Do we have any ideas on our “Ideas for Investigations” board that may help us with our investigation today?

Predict: What will happen (in our mouths) when we eat a cracker?

We are going to slowly eat a cracker to make observations about what happens to complex carbohydrates in the mouth.

In your notebook



3. Add a “Make Observations About Eating Complex Carbohydrates” section to your science notebook and jot down your ideas in response to the following question:
 - Think about the first “stop” for a complex carbohydrate in the digestive system—the mouth. What kinds of things do you think will happen to the cracker when it is in the mouth?
 - Be prepared to share these ideas with the whole class.

Make Observations: What happens to the cracker in the mouth?

In your notebook



4. Slowly eat the cracker or watch a video, Animation of a Person Chewing, and make observations about what happens to the cracker when it is in the mouth.
5. In the same “Make Observations About Eating Complex Carbohydrates” section of your science notebook, jot down your ideas in response to the following question:
 - What happens to the cracker when you slowly chew it in your mouth?
 - Be prepared to share these ideas with the whole class.

Connections to Previous Instruction

With your class



6. Think back to our unit on chemical reactions:
 - How did we describe chemical reactions?
 - How did we describe physical changes?
 - What kinds of changes do you think are happening in your mouth when you eat the cracker?
 - Be ready to share these ideas with the whole class.

Analyze data from eating a graham cracker.

In your notebook



7. Obtain a copy of *Analyze Data from Eating a Graham Cracker*.
8. Analyze the data from the mouth of a healthy person eating a graham cracker. Record your analysis in your science notebook.
 - The light-colored bar shows the amount of the molecule in the previous location in a healthy person. The dark-colored bar shows the amount of the molecule in the new location in a healthy person.
 - Record whether amount of food molecules goes up(↑), goes down (↓), or stays the same (=) from the previous location to the new location.
9. Discuss patterns in the data with your class.

Read “What’s Spit?”

In your notebook



10. Read the article, “What’s spit?” and respond to the following questions in your science notebook under the heading, “What’s spit?”:

- What kinds of evidence did the article provide to help you answer the question, “Do chemical reactions happen in the mouth?”
- How might we use what we learned from the article to plan and conduct an investigation to help us answer the question, “Do chemical reactions happen in the mouth?”

Navigation

In our last class, we made observations about what happens when we eat a cracker, we analyzed data from a graham cracker in someone’s mouth, and we read an article, “What’s spit?”

Turn and talk



11. Turn and talk about the following questions with your partner:

- What ideas did we generate so far related to this question, “When eating a graham cracker, why do complex carbohydrates decrease in the mouth while glucose increases?”
- How could comparing molecular representations of these substances (showing the atoms that make them up) help us determine what might be happening?

Look for patterns in food molecules.

With your class



12. Obtain a copy of the complex carbohydrate and glucose cards from *Food Molecule Cards*.

13. Examine the cards to help answer the question, “How do these patterns help explain why the amount of one type of molecule (e.g., a complex carbohydrate) might be decreasing by the same amount that another type of molecule is increasing (e.g., glucose) in the graham cracker in the mouth?”

14. Share your ideas with the class.

Plan an investigation to test for chemical reactions in the mouth.

We think that there might be a chemical reaction happening in our mouths to break complex carbohydrates down into glucose molecules, but we don’t have enough evidence yet to support this claim.

Turn and talk



15. Turn and talk with a partner to brainstorm ideas about the following question:

- What kind of additional evidence could we collect to test our ideas about what is happening to the complex carbohydrates that we eat once we put them in our mouths?

Turn and talk



- 16.** Read the information about amylase, a chemical found in saliva.
- 17.** Turn and talk with a partner to brainstorm ideas about the following question:
- How could we use this substance to test our ideas about what is happening to a food that has complex carbohydrates in it when it is put in our mouths, without needing to actually put that food into our mouths?

With your group



- 18.** Obtain a copy of *Data Table for Chemical Reactions in the Mouth* and *Chemical Reactions in the Mouth Investigation*.
- 19.** Follow the steps on *Chemical Reactions in the Mouth Investigation* to plan how you will answer the question, “Do chemical reactions occur in the mouth?” Record your plans on *Data Table for Chemical Reactions in the Mouth*.
- 20.** After you have planned your investigation, have your procedures approved by your teacher.

Conduct an investigation to test for chemical reactions in the mouth.

With your group



- 21.** Follow the steps on *Chemical Reactions in the Mouth Investigation* to conduct an investigation to answer the question, “Do chemical reactions occur in the mouth?” Record your findings on *Data Table for Chemical Reactions in the Mouth*.

Building Understandings Discussion: Interpreting our Data

With your class



- 22.** Bring your science notebook to the Scientists Circle.
- 23.** With your class, have a Building Understandings Discussion, using evidence, to answer the question, “Do chemical reactions occur in the mouth?”

Navigation: Exit Ticket

On your own



- 24.** Complete an exit ticket to answer the following questions:
- Do you think that chemical reactions could occur in other places in the digestive system? Where do you think the chemical reactions would take place?
 - If so, what do you predict the “old stuff” and the “new stuff” in the chemical reaction would be?
 - How does what we figured out today help us figure out what might be going on with M’Kenna?
- 25.** Update your table of contents and your Progress Tracker.

Lesson 6: What happens to the different substances in food as it travels through the digestive system?

Navigation

Last time, we conducted a series of investigations to determine if chemical reactions happen in the mouth. We:

- Made observations about eating a cracker.
- Analyzed data from eating a graham cracker.
- Conducted an investigation to determine if chemical reactions happen in the mouth.

Turn and talk



1. Turn and talk with your partner about the following question:
 - What evidence did we use to support our claims to answer the question, “Do chemical reactions occur in the mouth?”

Adding to Our Progress Trackers.

In your notebook



2. Work with a partner to construct a 30-second argument using evidence and scientific reasoning that can support how we should add to our Progress Trackers and revise our model for what happens to food as it passes through the digestive system. You will spend two minutes with your partner finding evidence in your science notebooks and creating an argument to share with the whole group.
3. Share your ideas with the class.
4. After arguing from evidence with your class, add to your Progress Tracker.

Analyze data to determine if chemical reactions happen throughout the digestive system.

In your notebook



5. Obtain a copy of *Food Molecule Data for a Healthy Person* and *Table to Organize Food Molecules Data*. Tape *Table to Organize Food Molecules Data* into your science notebook.
6. Work in groups to examine data as a graham cracker moves through the digestive system of healthy person. The data include important food molecules.
 - The light-colored bar shows the amount of the molecule in the previous location. The dark-colored bar shows the amount of the molecule in the new location. Record whether the food molecule

increases ($\uparrow$), decreases ($\downarrow$), or stays the same ($=$) from the previous location to the new location.

- If the amount is zero in the new location (dark bar), record a zero (0).

Graham Cracker to Mouth

In your notebook



7. Work in groups to examine data as a graham cracker moves through the digestive system of a healthy person. The data include important food molecules.
 - The light-colored bar shows the amount of the molecule in the previous location. The dark-colored bar shows the amount of the molecule in the new location. Record whether the food molecule increases ($\uparrow$), decreases ($\downarrow$), or stays the same ($=$) from the previous location to the new location.
 - If the amount is zero in the new location (dark bar), record a zero (0).

Mouth to Esophagus

In your notebook



8. Work in groups to examine data as a graham cracker moves through the digestive system of healthy person. The data include important food molecules.
 - The light-colored bar shows the amount of the molecule in the previous location. The dark-colored bar shows the amount of the molecule in the new location. Record whether the food molecule increases ($\uparrow$), decreases ($\downarrow$), or stays the same ($=$) from the previous location to the new location.

Esophagus to Stomach

In your notebook



9. Work in groups to examine data as a graham cracker moves through the digestive system of healthy person. The data include important food molecules.
 - The light-colored bar shows the amount of the molecule in the previous location. The dark-colored bar shows the amount of the molecule in the new location. Record whether the food molecule increases ($\uparrow$), decreases ($\downarrow$), or stays the same ($=$) from the previous location to the new location.

Stomach to Beginning of Small Intestine

In your notebook



10. Work in groups to examine data as a graham cracker moves through the digestive system of healthy person. The data include important food molecules.

- The light-colored bar shows the amount of the molecule in the previous location. The dark-colored bar shows the amount of the molecule in the new location. Record whether the food molecule increases ($\uparrow$), decreases ($\downarrow$), or stays the same ($=$) from the previous location to the new location.

Beginning of Small Intestine to Middle of Small Intestine

In your notebook



11. Work in groups to examine data as a graham cracker moves through the digestive system of healthy person. The data include important food molecules.

- The light-colored bar shows the amount of the molecule in the previous location. The dark-colored bar shows the amount of the molecule in the new location. Record whether the food molecule increases ($\uparrow$), decreases ($\downarrow$), or stays the same ($=$) from the previous location to the new location.

Middle of Small Intestine to Large Intestine

In your notebook



12. Work in groups to examine data as a graham cracker moves through the digestive system of healthy person. The data include important food molecules.

- The light-colored bar shows the amount of the molecule in the previous location. The dark-colored bar shows the amount of the molecule in the new location. Record whether the food molecule increases ($\uparrow$), decreases ($\downarrow$), or stays the same ($=$) from the previous location to the new location.

Look for patterns in food molecules.

With your group



13. Examine the *Food Molecule Cards*. With your group, discuss your response to the question:

- How do these patterns help us explain why the amount of one type of molecule (e.g., a protein) might be decreasing by the same amount that

another type of molecule (e.g., amino acids) is increasing in the graham cracker in different parts of the digestive system?

14. Share your ideas with the class.

Building Understandings Discussion

With your class



15. Meet in a Scientists Circle with your class. Begin the discussion by focusing on the question:

- What patterns do we notice in the data?

16. After identifying patterns in the data, focus on the question:

- Based on the data, what claims can we make about the functions of each of the organs in the digestive system?

Navigation

Turn and talk



17. Turn and talk with your partner about the following question:

- How do all of our ideas help us explain what might be going on with M'Kenna?

18. Update your Progress Tracker and table of contents.

Lesson 7: What is the function of the digestive system, and how is M’Kenna’s digestive system different?

Navigation

Review M’Kenna’s symptoms and the investigations we have completed thus far to figure out how M’Kenna can experience symptoms in so many different parts of her body.

Turn and talk



1. Open your science notebook to the page where you have *M’Kenna’s Doctor’s Note* with her symptoms.
2. Turn and talk with a partner about the following questions:
 - When we decided to investigate what was happening to food as we digested it, which of M’Kenna’s symptoms were we trying to explain?
 - What have we noticed so far in our investigations?

What can we explain now?

In your notebook



3. Obtain a copy of *Compiled Models from Progress Tracker*.
4. Compile all of the models from your Progress Tracker into a larger model.
 - Focus on the breakdown and absorption of large food molecules.
5. Record questions that come to mind as you are reviewing your model.

Gotta-Have-It Checklist

Think carefully about what to include in your model. To do so, create a Gotta-Have-It Checklist. For the Gotta-Have-It Checklist, decide which ideas from the Progress Trackers are the most important for explaining how a healthy digestive system works.

In your notebook



6. Obtain *Gotta-Have-It Checklist* and attach it to your science notebook.
7. Work on your own to develop a Gotta-Have-It Checklist.
 - Locate your Progress Trackers in your science notebook.
 - Decide which ideas from your Progress Trackers are the most important for explaining how a healthy digestive system works.
8. Answer the question, “How does a healthy digestive system work?”

Develop models in small groups.

With a partner



9. Turn and talk to a partner about the following questions:
 - What are the different structures in the digestive system? How do the functions of each structure distinguish it from other structures in the digestive system?
 - What happens to food when it enters the digestive system? What kinds of food molecules are broken down? Where are they broken down?
 - What kinds of food molecules are absorbed? Where are they absorbed? What kinds of food molecules are excreted?
10. Use pictures, symbols, and words in your model.
11. Record questions that come to mind as you are constructing your model.

Preparing for Consensus Model: Gallery Walk

With a partner



12. Examine at least two other small-group models.
13. At each model, do the following:
 - Write down an idea from the model that you could use to improve your own model.
 - Write one sentence to respectfully critique one input, process, or output in the model.
 - Write a second sentence to cite the evidence from our investigations to support your critique.
14. Brainstorm parts of M’Kenna’s digestive system that you think may be functioning abnormally.

Preparing for Our Classroom Consensus Model

With a partner



15. Return to your own model.
 - Place your “Take It” sticky notes on your model.
 - Read through all of the notes on your model.
 - With your group, jot down notes about things in your model that you want to keep or change when we develop a class consensus model.
16. Record questions that come to mind as you are reviewing your model.

Developing Our Classroom Consensus Model

With your class



17. Gather in a Scientists Circle and place your small-group posters in the middle of the circle.
 - Develop a consensus model to answer the questions:
 - How does a healthy digestive system work?
 - How is M’Kenna’s digestive system functioning differently than a healthy one?
18. As you develop the consensus model, consider the following questions:
 - What ideas should we include?
 - How should we represent them?
 - Do we have evidence to support them?

Developing Our Consensus Model: Model Limitations

With your class



19. Work with your class to answer the questions:
 - Does our model fully explain all the parts of M’Kenna’s digestive system that are functioning differently?
 - Does our model fully explain all of M’Kenna’s symptoms?
 - What do we still need to figure out?
 - What kinds of evidence do we need?
 - Add these ideas to the “Ideas for Investigations” board.

Adding to our Progress Trackers.

In your notebook



20. Obtain a copy of *Progress Tracker*.
21. Think about the following questions as you individually update your Progress Tracker.
 - How does a healthy digestive system work?
 - How is M’Kenna’s digestive system functioning differently than a healthy one?
22. List all of the sources of evidence you used to develop your updated model.

Navigation

In the student assessment, you will be presented with different conditions that could be causing M’Kenna’s symptoms. Your task will be to argue from evidence to eliminate two of the possible conditions as the likely cause.

With a partner



23. Turn and talk to a partner about the following question:

- Why do you think doctors eliminate possible conditions rather than selecting the condition that best fits the symptoms?

24. Be prepared to share your thoughts with the whole class.

Student Assessment

Now that you have put together some really important ideas, let’s pause to assess our understanding of the ideas that we have developed thus far.

Check your learning



25. Think about the purposes for this assessment.

- It will serve as evidence of our understanding of the ideas we develop thus far.
- It will help us make progress on M’Kenna’s case as we work to figure out what might be causing her symptoms.

Assessment Task Part 1: Eliminate possible conditions.

Check your learning



26. Obtain a copy of *Task Parts 1 and 2: Eliminate Possible Conditions and Identify Missing Evidence*.

27. Work on the assessment following the directions of your teacher.

Assessment Task Part 2: Identify missing evidence.

Check your learning



28. Revisit the “Causes” column of the Gastrointestinal Conditions chart.

- What additional evidence will you need to decide which of the remaining conditions is likely the cause of M’Kenna’s symptoms?

29. Write your ideas for the evidence you still need.

30. Be ready to share your ideas with the class.

Navigation

On your own



31. When you finish your assessment, visit the Driving Question Board and read all of the questions.

- Select one question that you think we have answered.
- Record the question at the top of a new sticky note.
- Record your answer, based on evidence, on the same sticky note.
- Post your sticky note under the original question on the DQB.

Lesson 8: What does the surface of M’Kenna’s small intestine look like up close compared with a healthy one?

Navigation

With a partner



1. Have a discussion with your class about the following question:
 - a. What evidence were we missing that would help us determine which of the diagnoses was most likely causing M’Kenna’s symptoms?

Examine the small intestine.

Your teacher will show you some images on a projector. These images show the lining of the small intestine.

With your class



2. Have a discussion with your class about the following questions:
 - a. What are you able to tell about the function of these structures?
 - b. What would you need in order to be able to understand the function of these finger-like structures? Were you able to get a really good view of the structures?

Examine the lining of the small intestine.

With a partner



3. Examine the micrograph of the small intestine on page 2 of *Zoomed-In Images of the Small Intestine* with a partner.

Examine the function of the villi.

With your class



4. Have a discussion with your class about the following questions:
 - a. What do you notice about the images of M’Kenna’s small intestine as compared with the images of a healthy small intestine?
 - b. What have we figured out so far about the way food molecules are absorbed in the small intestine in both a healthy system and in M’Kenna’s?
 - c. Think about the images of a healthy small intestine lining and the villi that we examined. If we were to look at a micrograph of M’Kenna’s tissue, what do you predict we would observe?

Examine the function of the villi with a simulation.

With a partner



5. Use your Chrome browser to go to this website: <https://openscienced.org/villi-absorption/>
6. Run the NetLogo interactive simulation.
 - a. Use *Connecting the Structure of Villi to Their Function* as a guide.
 - b. Run a minimum of three trials.

Consensus Building Discussion

Bring science notebooks and the results of the data collection and analysis on *Connecting the Structure of Villi to Their Function* to the Scientists Circle.

With your class



7. Come to a consensus on what you've figured out about the role of the villi.
 - a. What are some of the key things we figured out about the structures of the small intestine?
 - b. What are some of the key things we figured out about the functions of those structures?
 - c. How does M'Kenna's small intestine compare with a healthy system?
 - d. What is the role of the villi? What do the villi have to do with M'Kenna's symptoms?

Update the 3-column Progress Tracker.

Use words and pictures to update your Progress Tracker.

In your notebook



8. Update the 3-column Progress Tracker in your science notebook.
 - a. Use the results of the Consensus Building Discussion.
 - b. Use the results of the Netlogo Interactive Simulation.
 - c. Use the close-up images of the villi.

Argue from Evidence: Diagnostic Task.

Check your learning



9. Complete Part 3 of the Assessment Diagnosis Task.
 - a. Use everything you've figured out so far in this unit to argue from evidence which diagnosis best explains why M'Kenna is experiencing her symptoms.

Revisit the Driving Question Board: What questions have we made progress on?

With a partner



10. Take a minute to review your science notebook, Progress Tracker, and class charts to find questions that you have made progress toward answering on our Driving Question Board.

Lesson 9: How can a problem in one body system cause problems in other systems?

Navigation: Which questions have we made progress on?

With a partner



1. Take out *Revisit Questions from Our DQB!*
2. Turn and talk with your partner about the evidence we used to support our answers to the questions we think we made progress on.

Navigation: Which questions have we made progress on?

With your class



3. Visit the Driving Question Board.
 - a. Take your handout and sticky dots over to the Driving Question Board.
 - b. Place your sticky dot on the sticky note that matches your question.
 - c. Once you have placed your sticky dots, step back to form the Scientists Circle.
 - d. As you are waiting for others to place their sticky dots:
 - i. Be prepared to share out your evidence for why you placed the dot where you did.
 - ii. Notice and wonder about which questions have the most sticky dots.

Revise our Driving Question Board.

With your class



4. Talk with your class about the following questions:
 - a. Which questions have we made the most progress on?
 - b. What new questions do we need to add?
 - c. Are there any questions we need to refine or revise?
 - d. Do we need to reorganize any clusters of questions?

Revisit M’Kenna’s doctor’s note.

With a partner



5. Look back at our symptoms/systems mapping and think about which symptoms are connected to what we have figured out and which ones we still can’t explain.
6. Obtain *Symptoms and Systems* to record your thinking.

7. Turn and talk with your partner about the following questions:
 - a. Part 1: Which of M’Kenna’s symptoms could be connected to what we’ve figured out?
 - b. Part 2: Which of M’Kenna’s symptoms have we not found a connection to yet?
8. Be prepared to share your ideas with the class.

Problematize M’Kenna’s symptoms in other systems.

With your class



9. Obtain *Symptoms and Systems*.
10. Talk with your class about the following questions:
 - a. What do we notice about M’Kenna’s other symptoms and systems?
 - b. What else are we wondering about?
 - c. How could something so small in one subsystem (the digestive system) have that much impact on other parts of the body?

Navigation

With a partner



11. Turn and talk with your partner about the following question:
 - a. What else are we wondering about now?

Add what you’ve figured out to your Progress Trackers.

In your notebook



12. Write the following question in the left column of your 2-column Progress Tracker:
 - a. How can a problem in one body system cause problems in other systems?
13. Individually think about what is happening inside the digestive system.
14. Write what you have figured out so far in the column on the right.
 - a. You can write in pictures or words.
 - b. Take as much space as you need to record your thoughts.

Lesson 10: Why is M’Kenna losing so much weight?

Navigation

Turn and talk



1. Turn and talk with your partner about the following questions:

- What did we figure out last class?
- Which symptom might be the easiest to figure out next?

Navigation: M’Kenna’s Other Symptoms

Look at *M’Kenna’s Doctor’s Note*. Previously, we decided that we were not able to explain most of M’Kenna’s non-digestive symptoms.

Turn and talk



2. Turn and talk to your partner about your initial ideas about the following questions:

- What are your initial ideas about why M’Kenna is losing so much weight?
- What sort of data could help us investigate this question?

Identify patterns in M’Kenna’s weight.

Focus on the weight chart first. When reading the chart, be aware that the 50th percentile means that 50% of kids weigh less than M’Kenna and 50% weigh more. If she is on the 50th percentile line, she is right in the middle in terms of weight for her age.

On your own

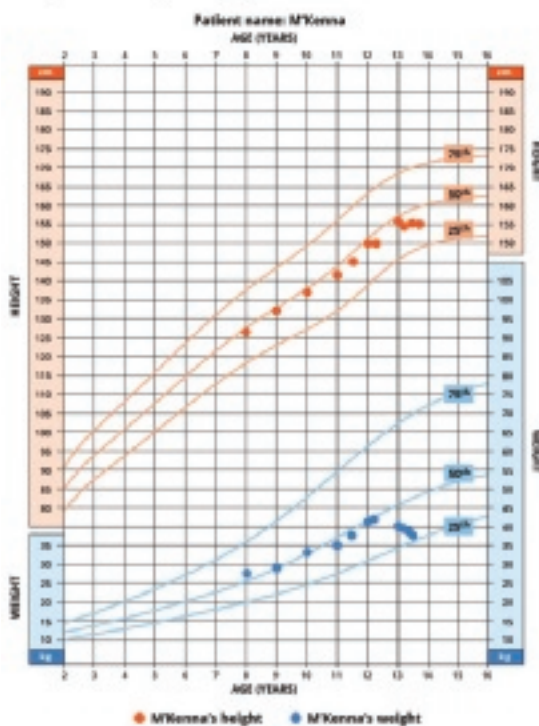


3. Obtain *Patterns in M’Kenna’s Weight*.

4. Make sense of M’Kenna’s weight data using “What I see” (WIS) and “What it means” (WIM) statements.

- Analyze M’Kenna’s weight graph individually, then write “What I see” (WIS) statements. Write directly on the graphs, drawing arrows to your observations.
- Continue analyzing M’Kenna’s weight graph

GROWTH CHART - 2 TO 18 YEARS: GIRLS
Height and Weight for age percentiles



individually, then write “What it means” (WIM) statements. Write directly on the graphs, drawing arrows to your observations.

Building Understandings: Looking for Patterns

With your class



5. Using M’Kenna’s weight graph as evidence, talk with your class about the following questions:
 - What was the pattern in M’Kenna’s weight before she got sick (ages 8-12)?
 - How did M’Kenna’s weight pattern change? If M’Kenna’s weight continues on the new pattern, where do you expect her weight to be at age 14?
 - If M’Kenna was your patient and you saw this change in her weight pattern, would you be alarmed? Why or why not?

Building Understandings: Where do our bodies lose weight?

With your class



6. Talk with your class about the following question:
 - How has the man’s body tissue changed after he has lost weight?

Building Understandings: Where do animals lose weight?

With your class



7. Talk with your class about the following question:
 - How has the dog’s body tissue changed after it has lost weight?

Where does fat go when lost?

Turn and talk



8. Turn and talk with your partner about the following question:
 - Where do you think the fat goes when someone loses weight?

Article: Where does fat go when lost?

On your own



9. Obtain a copy of *Children Need More Fat in Their Diets Compared to Adults*.
10. Work on your own for a few minutes and read the article silently.
 - Circle any words you do not know. Try to think about the main idea of the article.

11. Read the article a second time. The goal is to answer the questions in the next section.

Article: Where does fat go when lost?

In your notebook



12. For your second read of the article, “Children need more fat in their diets compared to adults,” answer the following questions with a partner:
- According to the article, which age group needs the most fat?
 - What is fat used for in kids?
 - What did the researchers find with children who were 8 years old on average?

Last Class

With your class



13. Have a discussion with your class about the following questions:
- What were we wondering about in the last class?
 - What did we decide to do?

Investigation: Burning Fat

Turn and talk



14. Turn and talk with your partner about the following question:
- What types of fat do you think we should burn?

Analyze nutrition labels.

Turn and talk



15. Look at the nutrition labels.
16. Turn and talk with your partner about the following questions:
- What are the foods made up of?
 - Do they contain other substances besides fat?
 - Do they both have calories?

Prepare for our investigation.

In your notebook



17. Using a new page in your science notebook, write the question we are investigating at the top: “What happens to fat when it burns?”
18. Tape *What Happens to Fat When It Burns?* in your science notebook.

Conduct the fat burning investigation.

In your notebook



- 19.** Obtain *Fat Burning Lab Protocol* and tape it into your notebook.
- 20.** Work with a group to figure out what you need to do next.
- 21.** Keep a record of your findings in *Fat Burning Lab Protocol*.
- 22.** Conduct the Fat Burning Investigation.
 - Part 1: Prepare samples for burning.
 - Part 2: Collect data from the Fat Burning Investigation.
 - Part 3: Make sense of your results.

Progress Trackers: What have you figured out?

In your notebook



- 23.** Set up the 2-column Progress Tracker to keep track of the important discoveries you make during this unit.
- 24.** Write the question we are working on in the left column.
 - What happens to fat when it's burned?
- 25.** Write what you figured out so far in the column to the right.
 - You can write in pictures or words.
 - Take as much space as you need to record your thoughts.

Next Steps

Home learning



- 26.** In the next class we will work together to decide what we have figured out from this investigation and where we should go next.
- 27.** In order to prepare for that, make sure to complete the four making-sense questions in Part 3 of the investigation for home learning if you did not finish them in class.

Lesson 11: What happens to matter when it is burned?

Navigation

Last time, we burned vegetable oil and duck fat and saw that, after several minutes of burning, the mass of both fats decreased. Look back at your responses to Part 3: Making Sense from the Lesson 10 handout. Pick one question and explain your reasoning to your group.

With your group



1. Discuss the questions from *What Happens to Fat When It Burns?*:
 - a. How does the color, odor, and hardness of the substances that you ended up with compare to what you started with?
 - b. Based on the property changes you observed, what claim can you now make about what happened to the original substances in these containers beyond just saying “they burned”?
 - c. Compare the mass of the substance in each container before and after it burned. If matter can’t disappear, how can you explain the patterns in your data?
 - d. What clues does this give you about what might be happening to food inside our bodies and M’Kenna’s body when it is used for energy? Or, what new questions does this raise for you?

Redesigning our Investigation

Brainstorm how to redesign the investigation to capture what is produced from burning the oil. If we now claim that some of the stuff produced by this chemical reaction escaped into the air during the burn, then...

Turn and talk



2. What could we do as we burn the foods to capture those products and examine them more closely?
 - a. What will we change?
 - b. What will we need to keep similar?

Plan and conduct a class demonstration to capture the products from burning fat.

In your notebook



3. Tape *Burning Fat in Open and Closed Systems* into your science notebook.
 - a. Label the first row of the table in part 1 as an OPEN system and the second row of the table as a CLOSED system.
 - b. Record the initial mass of the entire system before the burn.
 - c. Record the initial mass of the closed system before the burn.

4. Burn the oil in the closed and open systems.
 - a. Record the final mass of the open system after the burn.
 - b. Record the final mass of the closed system after the burn.
 - c. Record any additional observations of each system.

Building Understandings Discussion: What have we figured out from burning fat in open/closed systems?

Turn and talk



5. Your teacher will assign you one of the following questions to discuss with your partner.
 - a. When burning the fat, why did the mass of the closed system remain stable, while the mass of the open system changed?
 - b. Why did the flame in the closed system go out so much sooner than the one in the open system?
 - c. What did you see on the sides of the closed-system container walls when the burn was done? What do think that substance might be?

Analyze data to determine what is in air.

With your class



6. What do you notice and wonder about the gases typically found in air?
7. Which of these gases have you heard of before?
8. Notice the symbols for the atoms that make up the molecules—N, O, C, H, Ar. Which of these symbols have we seen in our previous investigations?

Predictions: Plan and conduct an investigation to measure the gases produced from burning fat.

We will do the test again for just a closed system, following a similar procedure, but this time using a tool to measure the gas levels in each system so that we can see whether the amounts are changing.

On your own



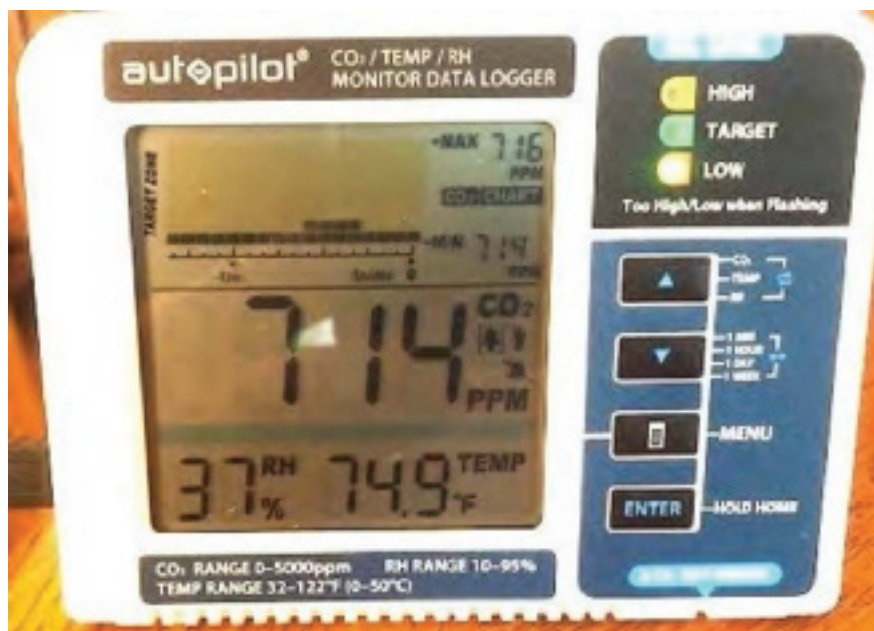
9. Reopen your science notebook to *Burning Fat in Open and Closed Systems*.
10. Prepare to conduct the investigation to measure the gases.
 - a. Fill in the first column of the part 2 data table shown on *Burning Fat in Open and Closed Systems* for the substances we have been investigating: something from the air, oil/fat, water vapor, and carbon dioxide.
 - b. Record your thinking (for each substance) in column A: What do we predict will happen to the amount of this substance in the system?

How to measure the gases in air?

With your group



11. Examine the device we will use to detect gases in the air.



Initial Measurements: Plan and conduct an investigation to measure the gases produced from burning fat.

With your class



12. Before you burn the oil:

- Record your thinking (for each substance) in column B: Amount of substance measured (before the burn).

Final Measurements: Plan and conduct an investigation to measure the gases produced from burning fat.

With your class



13. Burn the oil in the closed system with the carbon dioxide and humidity detector.

- Record your thinking (for each substance) in column C: Amount of substance measured (after the burn).
- Individually add arrows in column D, showing: What happened to the amount of this substance in the system (based on the results measured from columns B and C)?

On your own



Make sense of our closed versus open system results.

Return to your seats to individually process your thinking on the Making Sense questions on your *Making Sense of Burning Fat Investigation Results*. We will share out next class.

On your own



14. What state of matter is each substance? Describe what happened to the amount of the substance during the investigation.
15. Think about when we burned the vegetable oil. Where do you think the matter from this fat is going?
16. What do you think is causing these changes to occur when a food item is burned? Explain your reasoning.
17. What clues does the claim give you about what might be happening to food inside our bodies and M’Kenna’s body when it is used for energy? Or, what new questions does this raise for you?

Navigation

In your notebook



18. Open your science notebooks to the Making Sense questions on your *Making Sense of Burning Fat Investigation Results*.

Consensus Discussion: What happens to matter when burned? (Talking Sticks Protocol)

We want to see what we can agree upon regarding what happens to matter and energy when fat is burned in a closed system.

With your group



19. Small Group Talking Stick Round 1:
 - a. Pass around a pencil as a talking stick to take turns having each person share their response to question 1 [30 seconds per person].
 - b. As each person shares, think about how this connects to your response in the next question.
20. Small Group Talking Stick Round 2:
 - a. Pass around a pencil as a talking stick to take turns having each person share their response to question 2 [30 seconds per person].
 - b. As each person shares, think about how this connects to your response to the next question.
21. Small Group Open Discussion:
 - a. Each person shares a connection that they noticed about matter and energy in regard to something that was said by another group member.

Consensus Discussion: What happens to matter when burned?

With your class



22. Talk with your class about the following questions:

- What connections about matter and energy did you make to other students' ideas during the talking stick protocol?
- How do we know energy is provided to the system?
- How do we know energy was produced in this reaction?
- Where did that energy come from, and what evidence do we have that there was energy there to start?

Analyze nutrition labels.

Turn and talk



23. Look closely at the nutrition labels with your partner:

- Do these foods contain other food molecules besides carbohydrates and protein?
- Do they both have calories?
- Do you think that, if we burn these foods, the same thing would happen as when we burned the oil?
- Do you think we could burn other non-food things and get energy from them? Explain why or why not for each of your examples.
- The examples you mentioned are likely all types of fuel. A fuel is any material/matter that can react with other substances so that it releases energy.
- If you burned these others foods as fuel, what do you predict would be the products?

Compare carbon dioxide and water to food molecules.

Let's revisit the molecular representations of food to look for evidence for the source of matter in the products of carbon dioxide and water.

With your class



24. Look closely at *Air Molecule Reference*:

- Where do you think the atoms that make up the carbon dioxide and water molecules that started appearing in the container came from as we burned the food?
- What happened to the amount of each substance during our investigations?
- Why is what happened during the investigations considered a chemical reaction?

- d. What could we identify as our reactants and products as we burn fat as fuel in this chemical reaction?

Adding to Our Progress Trackers

We have just spent a lot of time building understanding and then coming to a consensus on what we think is happening to food molecules when fat is burned. Now, we are going to individually construct an explanation in the form of a model (or some other representation) for showing how what we have figured out helps explain what happens to food molecules when they are burned.

In your notebook



- 25.** Someone will give a 30-second speech summarizing everything we have figured out about burning fat today. The rest of the class will listen to make sure we have evidence to support those ideas and be ready to agree or disagree.
- 26.** Add what we figured out to your Progress Tracker along with the lesson question and source of evidence that led to these findings.

Navigation

New Ideas and Next Steps: Let's take what we have figured out and problematize where to go next.

Turn and talk



- 27.** Brainstorm our next steps with a partner:
- Do you think a similar kind of chemical reaction is happening in our bodies to provide us with energy from food to do things?
 - Do we have little fires to burn things like fat, protein, and glucose, for energy inside our bodies?
 - What additional evidence could we collect to help us investigate this?

Lesson 12: Does this chemical reaction to burn food happen inside our bodies?

Navigation

With a partner



1. Work with a partner about the following questions:

- What did we figure out last class?
- What questions did this raise for us?

Navigation: Predictions

Turn and talk



2. Turn and talk to a partner about the following questions:

- How could we investigate this question?
- If this chemical reaction was happening in our bodies, what evidence would we see of substances going into or coming out of our bodies?

BTB Investigation: Demonstration

We will use an indicator called bromothymol blue, or BTB for short, that indicates the presence of carbon dioxide.

In your notebook



3. Create the table in your notebook to record your observations.

4. Examine the ingredients label on slide C.

5. Create the table found on slide C.

- Record your observations for the first row of the table.

6. Observe the color changes that occur with a known source of carbon dioxide (carbonated water) and with a control (water alone).

7. Make predictions about what we will see if we mix BTB with the air we exhale.

8. Conduct the investigation.

Building Understandings Discussion

In your notebook



9. Jot down the answers to the following questions in your science notebook to prepare for the whole class discussion.

- What does the color change from blowing into the BTB tell you about the air coming out of our lungs?

- How does this color change provide evidence about a chemical reaction that might be occurring in our bodies?
- Where does the air go when we breathe it in, and where is carbon dioxide coming from when we breathe out?
- Be ready to share these ideas in the discussion.

Follow the path of air in our lungs.

With your class



10. Work with your class to answer the following questions.

- Which path does the air we breathe in and out follow?
- Tiny air sacs (alveoli) line the sides of these air passages. What other structure do you predict to see in this part of the lung tissue?

Follow the path of air in our lungs.

With your class



11. Share your observations and ideas about the following questions with your class.

- What do you notice about the structures in this part of the lungs?
- How might these structures help explain where the gases that reach here go to next or come from?

Follow the path of air in our lungs.

With a partner



12. Turn and talk to a partner about the following questions.

- How does glucose get from the small intestine into the blood? Why?
- How does this help you predict how the air we breathe in and the carbon dioxide we breathe out might pass between the lungs and the blood?

Follow the path of air in our lungs: Making Sense.

With your class



13. Work with your class to answer the following questions.

- Could the molecules in the air get into the blood from the lungs? Could carbon dioxide move through the lungs? Why or why not?
- Which gas molecule is most likely the one that is needed in the chemical reaction that burns food?

Analyze oxygen and carbon dioxide levels in the blood.

With your group



14. Obtain a copy of *Oxygen and Carbon Dioxide in the Blood - Part 1* and tape it into your science notebook.
15. Work with your group to analyze and interpret the blood data.
16. Use the evidence from the blood data to answer the questions on *Oxygen and Carbon Dioxide in the Blood - Part 1*.

Navigation: Analyze oxygen and carbon dioxide levels in the blood.

With a partner



17. Work on your own to answer the following question on your exit ticket.
 - Do you think we have a chemical reaction to burn food happening inside our bodies? Why or why not?

Check your learning



18. Discuss the following questions with a partner.
 - Which cells from which parts of the body would likely need to use the most energy in a typical day?
 - How would energy needs change if you were running or jogging? Why?
 - How would energy needs change if you were studying? Why?

Navigation: Making Sense

In the last class, you and a partner started making some predictions based on the claim that the chemical reaction that releases energy from food molecules is happening throughout our bodies.

With your group



19. Share your predictions with the whole class.
 - Which cells from which parts of the body would likely need to use the most energy in a typical day?
 - How would energy needs change if you were running or jogging? Why?
 - How would energy needs change if you were studying? Why?

Navigation: Interpreting Data

With a partner



20. Turn and discuss the following questions with a partner.
 - What kind of data might be helpful for us to figure out which cells in which parts of the body use the most energy during a typical day?

- What kind of data would we need to see if exercise or studying changed how much energy cells need?
- How would knowing the amount of oxygen or glucose used by the cells in different tissues in the body help us check our predictions?
- What other data could we use to determine which cells in different tissues are using glucose to make energy?

Interpreting Activity Data

With your class



21. Work with your class towards answering the question on slide M.

- In which kind of cells is this reaction occurring the most?

22. Analyze the data in the graph and answer the following questions.

- What patterns do you notice?
- Why would cells in some organs be consuming more oxygen than cells in other organs?

Interpreting Activity Data: Making Sense

With your class



23. Share your ideas with the class about these questions.

- Do you think these percentages would stay the same when you exercise?
- What do you predict would be the effect of exercising on the amount of glucose in our blood?
- What effect do you predict eating would have on glucose levels in our blood?

Interpreting Activity Data

With your group



24. Obtain a copy of *Interpreting Activity Data – Part 2* and tape it into your science notebook.

- Analyze the graph using the I² sensemaking strategy.
- Answer the question on the work page.

Interpreting Activity Data: Making Sense

With your class



25. Bring your science notebook and join the Scientists Circle.

26. Share your ideas with the class about the following:

Check your learning



- What chemical reaction is happening in our bodies that uses food as fuel, and where does it happen?
 - What does that provide to cells in our bodies?
 - How do reactants get into the body and to the cells?
 - How do products leave the cells and the body?
 - How do our energy needs affect the reaction?
 - How are our circulatory and respiratory systems involved in providing the reactants to the cells and in removing the products from them produced by this chemical reaction?
 - How does this help explain how the digestive, circulatory, and respiratory systems might be connected?
- 27.** Argue from evidence for how what we figured out helps explain:
- Whether a chemical reaction between food and oxygen happens in our bodies, and if so, how our energy needs affect the reaction.
- 28.** Add these ideas to your 3-column Progress Tracker in *Progress Tracker*.

Navigation: Taking Stock

Home learning



- 29.** Complete the following assignment as home learning.
- Tape *Lesson 12 - Student Handout 3* into your science notebook.
 - Use *Lesson 9 - Student Handout 1* to fill in the symptoms you haven't yet been able to connect to what we've figured out. Use what we've figured out in Lessons 10-12 to complete *Lesson 12 - Student Handout 3*.

Lesson 13: How does a healthy body use food for energy and growth, and how is M’Kenna’s body functioning differently?

Navigation

We figured out some big punchlines last class about how a healthy body uses food for energy! Let’s look back at our Progress Trackers to make sure we are all on the same page with what we’ve just figured out.

On your own



1. Review your ideas from Lessons 8-12 in your Progress Tracker.
2. Make notes and highlight ideas on your Progress Tracker that might help explain the question, “How do our bodies use food for energy?”
3. Add those ideas to your Gotta-Have-It Checklist.

What can we explain now?

With your class



4. As a class, determine which ideas seem the most useful to help us answer the question: How do our bodies use food for energy?
5. Record a class list of agreed-upon ideas in a Gotta-Have-It Checklist.

Develop a model to answer our question.

On your own



6. Use the top third of your *Three Pathways Inside Our Bodies* to build an individual model to explain:
 - Pathway 1: How do our bodies use food for energy?
7. Record questions in your science notebook that come to mind as you are creating your model.

Build a small-group model.

Develop small-group models to explain: “How do our bodies use food not needed right now? How do our bodies use food needed for growth?”

With your group



8. Using chart paper, build your models in small groups for the next two pathways.
 - a. Pathway 2: How do our bodies use food not needed right now?
 - b. Pathway 3: How do our bodies use food needed for growth?

- Record questions in your science notebook that come to mind as you are creating your model.

Compare models with another small group.

The purpose of our small-group discussions are to surface areas of agreement and areas of lingering questions or disagreement. Your jobs are to place ideas on the table, clarify other students' perspectives, and evaluate your own ideas and the ideas of others. At the end of the discussion, you should be prepared to share your ideas with the whole group as part of the class Consensus Discussion.

With your group



- Pair up with another small group and share your model.
- Make a T-chart in your notebook to record your thoughts.

Comparing energy and matter inputs, outputs, and processes in a healthy body

Similarities

Differences

- Before you share, review our discussion norms and sentence frames. Remember, it is important for us to have a space in which we can share our ideas and push each other's thinking.
- As you share your models, use the T-chart you created to record similarities and differences in the **inputs**, **processes**, and **outputs** that each group has represented in their model.

Developing a Consensus Model for a Healthy Body

Gather in a Scientists Circle and place your small-group posters in the middle of the circle. We're going to take stock of the ideas in everyone's models and build a classroom consensus model that everyone agrees upon to explain how a healthy body uses food. After coming to a consensus on what is happening in a healthy body, we are going to try to figure out what could be functioning differently in M'Kenna's body.

With your class



- As a class, develop a consensus model to answer the questions for a HEALTHY body:
 - Pathway 2: How do our bodies use food not needed right now?
 - Pathway 3: How do our bodies use food needed for growth?

14. As you develop your consensus model, consider the following questions:

- a. What ideas should we include?
- b. How should we represent them?
- c. Do we have evidence to support them?
- d. What is our reasoning?

How can we explain M’Kenna’s weight loss?

Let’s try to use the pathways in our model to explain M’Kenna’s weight loss.

Turn and talk



15. Turn and talk with your partner about the following questions:

- a. Does M’Kenna have a lot of food molecules in her blood? Why or why not?
- b. So what if her body ran out of fat stores? Where might her body use energy from instead?
- c. Be prepared to share your ideas with the class.

Compare fat molecules to glucose molecules.

With your class



16. Use slide I or the food molecule cards to compare a glucose with a fat molecule.

17. Report out similarities and differences between the glucose and fat molecules.

18. Do you think a fat molecule stored in our arm, leg, or stomach could be used for a chemical reaction?

Update our Gotta-Have-It Checklist.

With your class



19. As a class, summarize your findings to answer the question:

- Why was M’Kenna losing weight?

20. Update the Gotta-Have-It Checklist with your new ideas.

Revisit M’Kenna’s symptoms.

Turn and talk



21. Use your ideas on *M’Kenna’s Doctor’s Note* to answer the following question:

- Which of M’Kenna’s symptoms could be connected to what we have figured out?

How can we explain M’Kenna’s other symptoms?

The focus should be on being able to reason through a connection between what we have figured out about how things inside our bodies work together and how that might have impacted the way M’Kenna is feeling. By the end, each body system should have its own short explanation for how a food shortage in M’Kenna might be connected to the related symptoms in that body system.

On your own



- 22.** Using everything we’ve figured out so far, explain: How could a shortage of food entering M’Kenna’s bloodstream be connected to so many different symptoms in different systems of her body?
- 23.** As we share out connections, update the Gotta-Have-It Checklist with our new ideas.

Add to our Progress Trackers.

In your notebook



- 25.** Work individually to update your Progress Tracker. Focus on the key ideas to go along with your models to explain:
 - a. How does a healthy body use food for energy needed now? Needed for growth? Not needed now?
 - b. How is M’Kenna’s body functioning differently?

Who is M’Kenna, and how is she doing now? (Optional)

You’ve figured a lot out about how the things inside M’Kenna’s body were working together to make her feel the way she did! Let’s conclude our investigations into M’Kenna’s symptoms by learning a little bit more about who M’Kenna is and how she is doing now.

With your class



- 26.** Obtain the *Who is M’Kenna, and what happened to her?* reading.
- 27.** Read about M’Kenna.
- 28.** Take some time to have open conversations about M’Kenna, what happened to her, and answer any lingering questions that the class may have.

Lesson 14: Do all animals do chemical reactions to get energy from food like humans?

Navigation: Stop and Jot

In your notebook



1. Think of an animal of your choice. In your notebook, write about the following questions:
 - Do you think this animal does chemical reactions to break down and burn food molecules the same way as humans?
 - Does it have the same structures as humans inside its body that work together to do those functions? Why or why not?

Navigation: Turn and Talk

With a partner



2. Share your thoughts with a partner about the following questions:
 - Do you think this animal does chemical reactions to break down and burn food molecules the same way as humans?
 - Does it have the same structures as humans inside its body that work together to do those functions? Why or why not?

Research about your animal.

On your own



3. On your own, choose an animal you would like to know more about.
 - Read about your animal.

Make an argument from evidence.

With your group



4. In your small group, use your Gotta-Have-It Checklist to construct two arguments in response to the following questions:
 - Do you think your animal does chemical reactions to break down and burn food molecules the same way as humans?
 - Does it have the same structures as humans inside its body that work together to do those functions? Why or why not?
5. Write each argument on a separate piece of chart paper. Be ready to share with your classmates.

Gallery Walk to Compare Across Organisms

On your own



6. Working with a partner or on your own, post your arguments around the room.

7. Review rubrics and guidelines for giving peer feedback.

With a partner



8. Work with a partner and use the general argumentation from evidence rubric and your Gotta-Have-It Checklist to provide feedback to other groups.

9. Modify your work after looking through your feedback.

Consensus Discussion About Our Animals

With your class



10. Gather in your Scientists Circle and bring your science notebooks.

11. Work with the members of your Scientists Circle to answer the following questions:

- Do you think your animal does chemical reactions to break down and burn food molecules the same way as humans?
- Does it have the same structures as humans inside its body that work together to do those functions? Why or why not?

Progress Tracker: What have you figured out?

In your notebook



12. Individually update your 2-column Progress Tracker:

- Write the question we are working on in the left column: Do all animals do chemical reactions to get energy from food like humans?
- Write what you have figured out so far in the column on the right. You can write in pictures or words. Take as much space as you need to record your thoughts.

Navigation

Home learning



13. Look through our questions on our DQB. Mark questions you think the class has answered by putting different symbols next to each question:

- We did not answer this question or any parts of it yet: o

- Our class answered some parts of this question, or the ideas we developed help me see how I could now answer some parts of this question: ✓
 - Our class answered this question, or the ideas we developed help me see how I could now answer this question: ✓ +
- 14.** Pick three of the questions you marked and write what you think that answer would be.

Lesson 15: What questions on our Driving Question Board can we now answer?

Navigation: Evaluate our DQB questions.

With a partner



1. Take out your home learning *Let's Answer Questions from Our DQB!* and tape it into your science notebook. Compare your notes about which questions you think we've answered on our DQB.

Symbols:

- We did not answer this question or any parts of it yet: O
- Our class answered some parts of this question, or I think I could answer some parts of this question: ✓
- Our class answered this question, or using the ideas we have developed, I could now answer this question: ✓ +

What questions have we made progress on?

On your own



2. Take your handout and 10 sticky dots over to the DQB.
3. Place your sticky dots on the sticky notes that match questions that you think we've made progress on.
4. Once you have placed your 10 dots, step back to form the Scientists Circle.
5. As you are waiting for others to place their sticky dots
 - Be prepared to share out your evidence for what the answers to the questions might be, and
 - Notice and wonder about which questions have the most sticky dots.

Revisit our Driving Question Board.

With your class



6. In your Scientists Circle, look for patterns in the sticky dots. Work together to answer the following questions:
 - Which questions have we made the most progress on?
 - What have we figured out?

Add to our Progress Trackers: What have you figured out?

During your time revisiting the DQB, new ideas that you want to include on your Progress Trackers may have surfaced.

In your notebook



7. Individually update your 2-column Progress Tracker:

- Write the question we are working on in the left column: What questions on our DQB can we now answer?
- Add any additional ideas you want to review in the column on the right. Go back and revise any previous rows as well. You can write in pictures or words. Take as much space as you need to record your thoughts.

Demonstrate understanding on an assessment task.

On your own



8. Use what you've figured out to demonstrate your learning on an end of unit assessment.

Quick Write: Reflect on our experiences.

On your own



9. Answer the following questions in your science notebook:

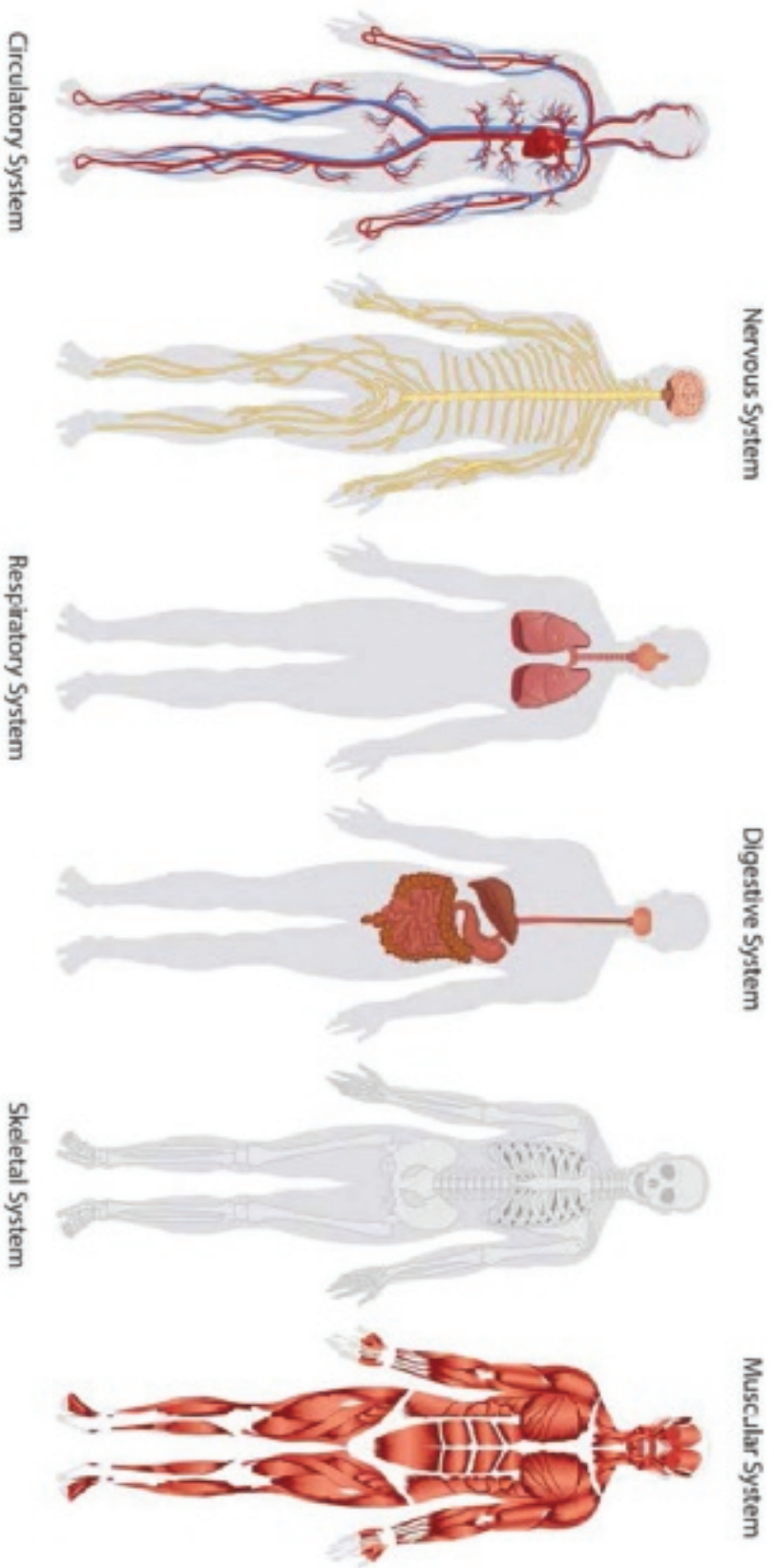
- What was most challenging in this unit?
- What was most rewarding?
- Think about how you engage in sensemaking discussions with classmates. How would you want to engage in those experiences the next time around?
 - What would you do the same?
 - What would you do differently?

10. Be prepared to share your thoughts out with your class.

Transcript of M’Kenna’s symptoms

- Narrator:** Today you’ll hear about a girl named M’Kenna. She is a real person and was in middle school when she started to feel really sick. She was 13 years old when she first got sick. Her doctors were trying to figure out what was causing all of her symptoms. And we’re lucky enough to be able to hear from M’Kenna herself. So thank you, M’Kenna, for sharing your story with us! Can you tell us how you felt when you first started feeling bad?
- M’Kenna:** At first, I thought it was just an upset stomach, but then I started to throw up three times a week or more. And so then I started to get a sense that maybe this isn’t just a stomach bug. This is kind of embarrassing, but I also had a lot of diarrhea during this time and became very hungry; but I just couldn’t eat.
- Narrator:** Wh-why wouldn’t you eat?
- M’Kenna:** It just made it worse. I’d throw it up, and I’d feel worse.
- Narrator:** Oh, OK. You said this was happening when you first started feeling bad. Did the symptoms change as you continued to feel sick?
- M’Kenna:** It got worse.
- Narrator:** Oh.
- M’Kenna:** I got tired all the time. I couldn’t play sports because I had muscle cramps, uh, my heart was pounding, and I was breathing really hard. As if I was out of shape, but I-I wasn’t, I was just so sick. I also started to fall asleep in class, and my head was really fuzzy. And, and towards the end I got really skinny and just couldn’t do anything ‘cause I wasn’t eating.
- Narrator:** I’ll bet you were scared! I know your parents were. M’Kenna, thanks for sharing your story and your medical information with us. Hopefully we can learn from your experience and figure out what is causing your body to have all these different symptoms.

Reference: Map M'Kenna's Symptoms to her body systems.



Day 1 Dialysis Tube Investigation Instructions

Part 1: How do we set up our dialysis tube system?

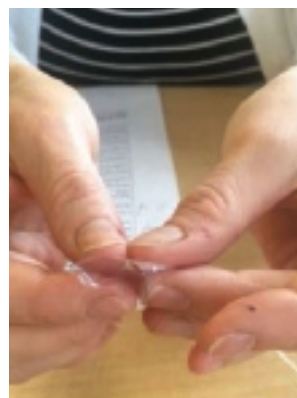
1. Gather your materials: one piece of dialysis tubing, two pieces of dental floss, two pipettes, a ruler, a piece of tape, and a beaker or cup to construct your setup. Get the three cups containing glucose, starch, and distilled water.



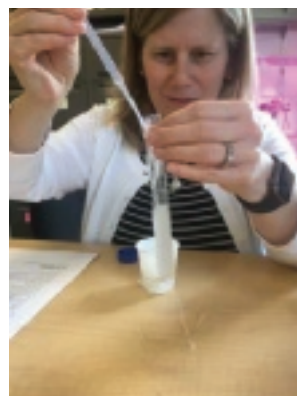
2. Fold back one end of the tubing to overlap the rest by 1 inch. Tie a tight double knot of dental floss around this end of the tubing.



3. Rub the other end of the tubing together to separate one side from the other.



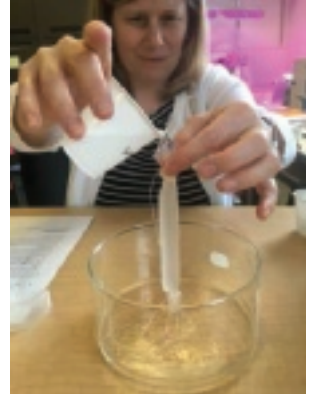
4. Fill a pipette with the starch solution and carefully squirt it into the inside of your tube. Do this five times (about 5 mL total).



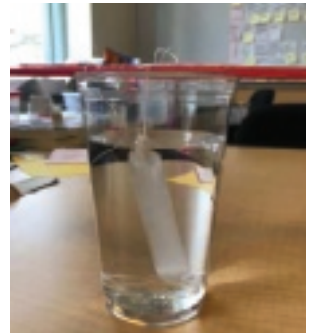
5. Fill a pipette with the glucose solution and carefully squirt it into the inside of your tube. Do this five times (about 5 mL total).
6. Fold back the other end of the tubing so that it overlaps the rest by 1 inch. Use a 12–14-inch piece of dental floss to tie this end of the tubing, leaving 6–8 inches to tape to the ruler.



7. Rinse the outside of the tubing with distilled water to make sure that none of the solution you have poured into the tubing has spilled on the outside. Dry off using a paper towel.



8. Tape the dental floss to a ruler so that it is suspended in the middle of the beaker or clear plastic cup. Add enough water outside of the tubing so that it covers the suspended tubing. Add your name to a piece of tape on the ruler and store the setup where your teacher tells you.



Part 2: Predictions

Record your predictions on your *Dialysis Tube Investigation* handout.

Day 2 Dialysis Tube Investigation Instructions

Part 3: What do iodine and Benedict's look like with just water?

Wear safety goggles throughout all of these steps.



1. Gather your materials: two microcentrifuge tubes, distilled water, Benedict's solution, iodine solution, and three pipettes, a permanent marker, and a coffee cup.
2. Label two microcentrifuge tubes with "Water."
3. Use a clean pipette to suck up and then squirt 1 mL of distilled water into each tube.



4. Use a clean pipette to add 5 drops of iodine to the first tube and add the label "Iodine." Record your results for iodine in the table in your student handout.



5. Use a clean pipette to add Benedict's to the second tube and add the label "Benedict's."



6. Put the Water + Benedict's tube in the empty coffee cup (or beaker) and leave off to the side.

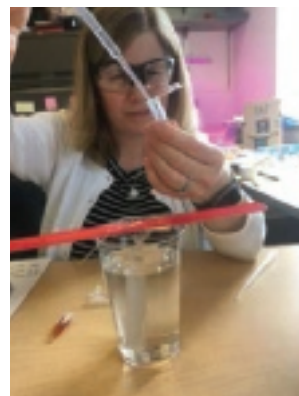
Part 4: What food molecules are outside of the tube?

Wear safety goggles throughout all of these steps.

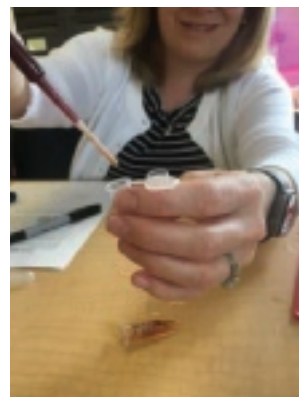


1. Gather your materials: two microcentrifuge tubes, distilled water, Benedict's solution, iodine solution, one new pipette, a permanent marker, the coffee cup, and your dialysis tube setup.
2. Take two 1.5 mL tubes and label them "Outside."

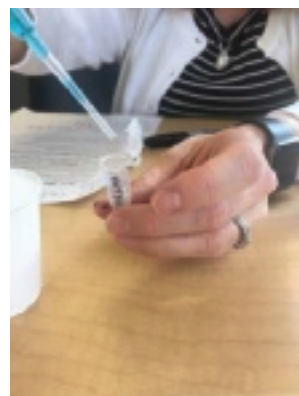
3. Use the pipette to suck up and then squirt 1 mL of the outside liquid into each tube.



4. Add 5 drops of iodine to the first tube and add the label "Iodine." Record your results for iodine in the table in your student handout.



5. Add 5 drops of Benedict's to the second tube and add the label "Benedict's."



6. Put the Outside + Benedict's tube into the empty coffee cup (or beaker) and leave off to the side. You should now have two tubes in the cup.

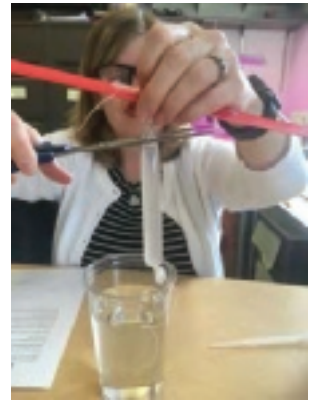
Part 5: What food molecules are inside of the tube?

Wear safety goggles throughout all of these steps.

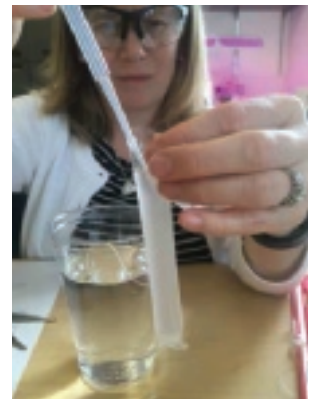


1. Gather your materials: two microcentrifuge tubes, distilled water, Benedict's solution, iodine solution, scissors, one new pipette, a permanent marker, the coffee cup, and your dialysis tube setup.
2. Take two tubes and label them "Inside."

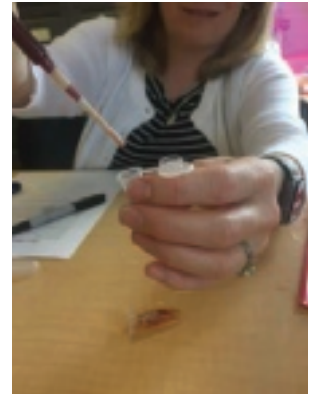
3. Lift the dialysis tube out of the beaker. Carefully have a partner hold the tube while you use scissors to cut the top of the bag open.



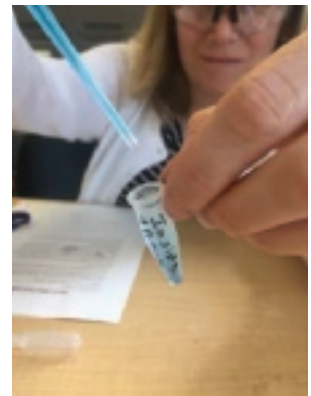
4. Use the pipette to suck up and then squirt 1 mL of the inside liquid into each tube.



5. Add 5 drops of iodine to the first tube and add the label "Iodine." Record your results for iodine in the table in your student handout.

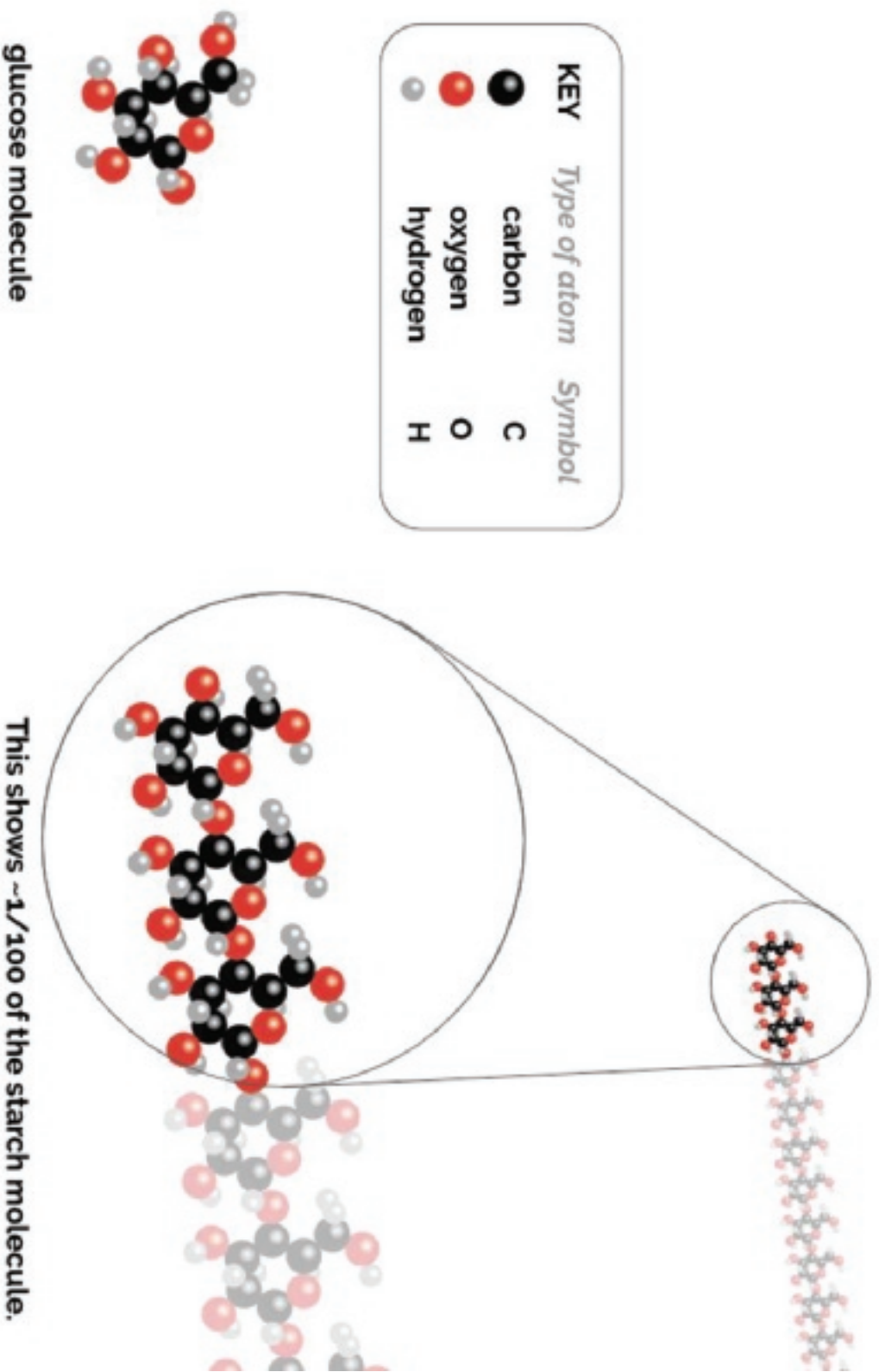


6. Add 5 drops of Benedict's to the second tube and add the label "Benedict's."

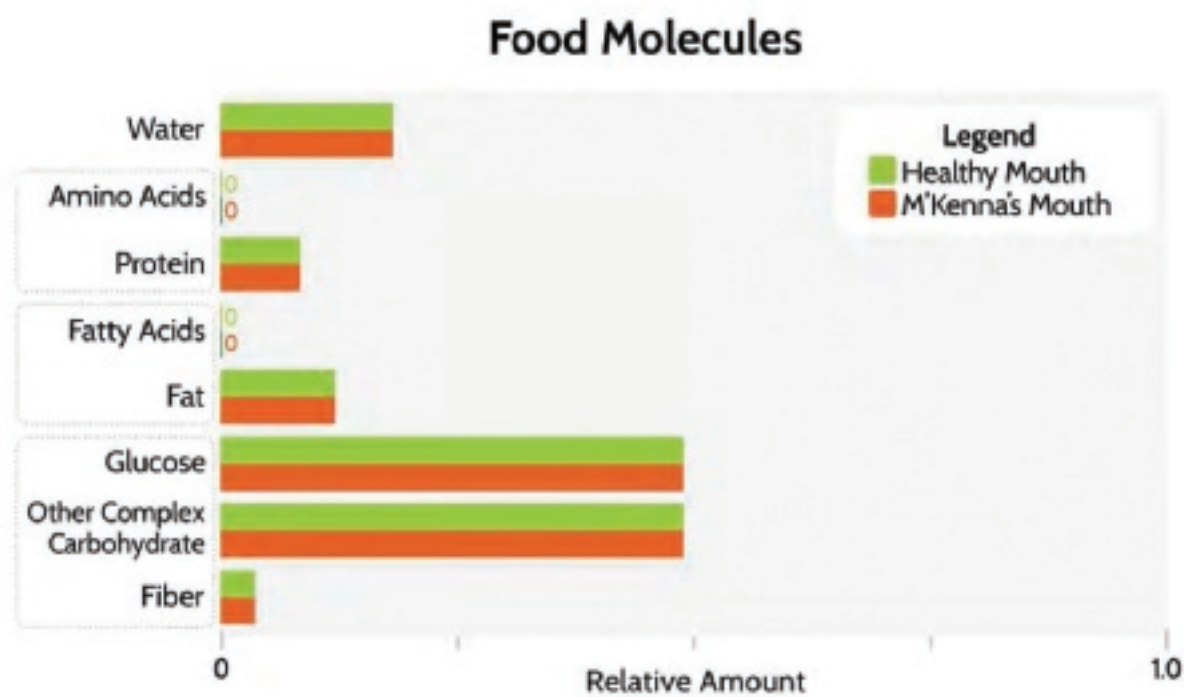
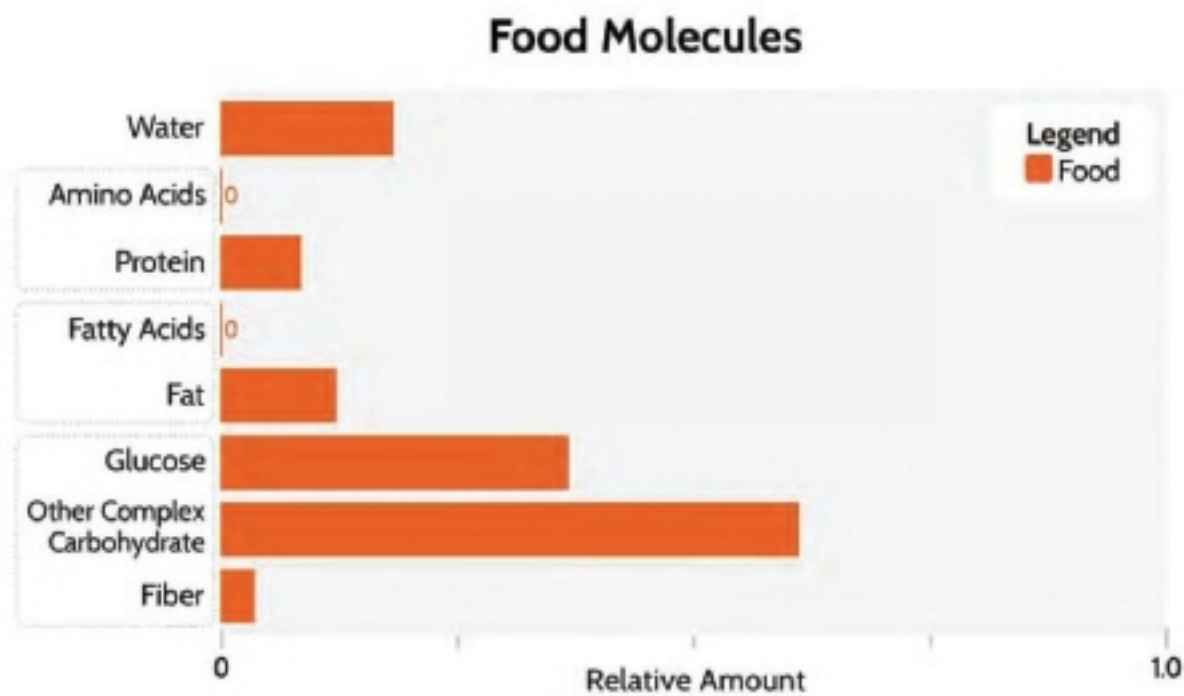


- 7.** Put the Inside + Benedict's tube into the empty coffee cup (or beaker). You should now have three tubes in the cup. Pour near-boiling water (about 100 mL) into the coffee cup and make sure to cover the three tubes.
- 8.** After 5 minutes use a spoon to scoop the tubes out of the hot water and record your results for Benedict's (for Parts 3, 4, and 5).

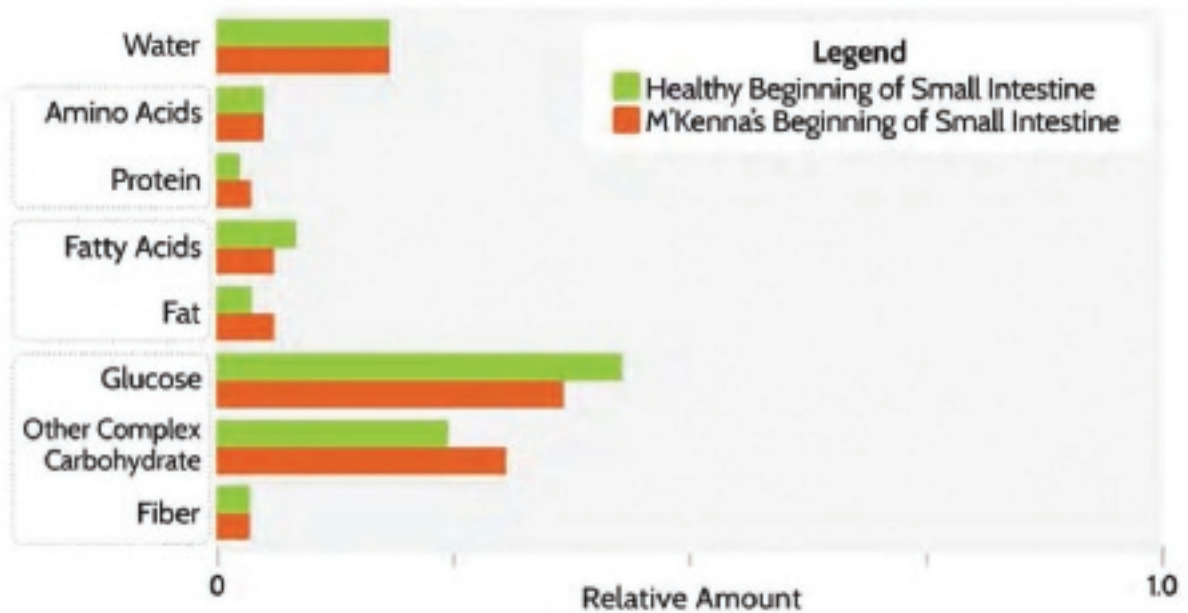
Starch and Glucose Molecules



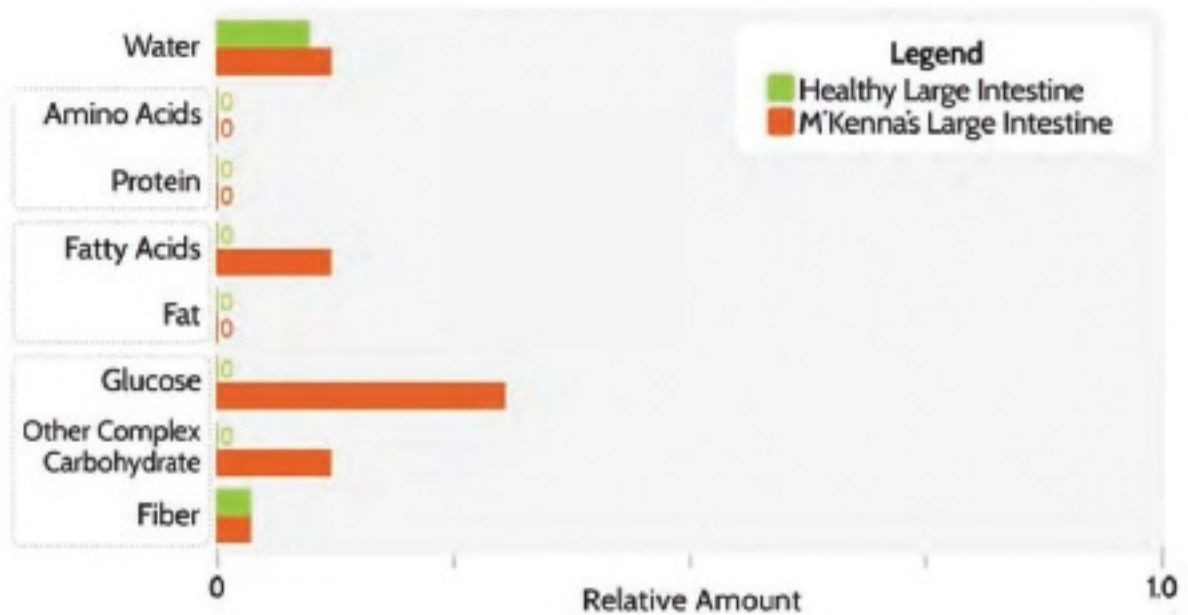
Graham Cracker Data



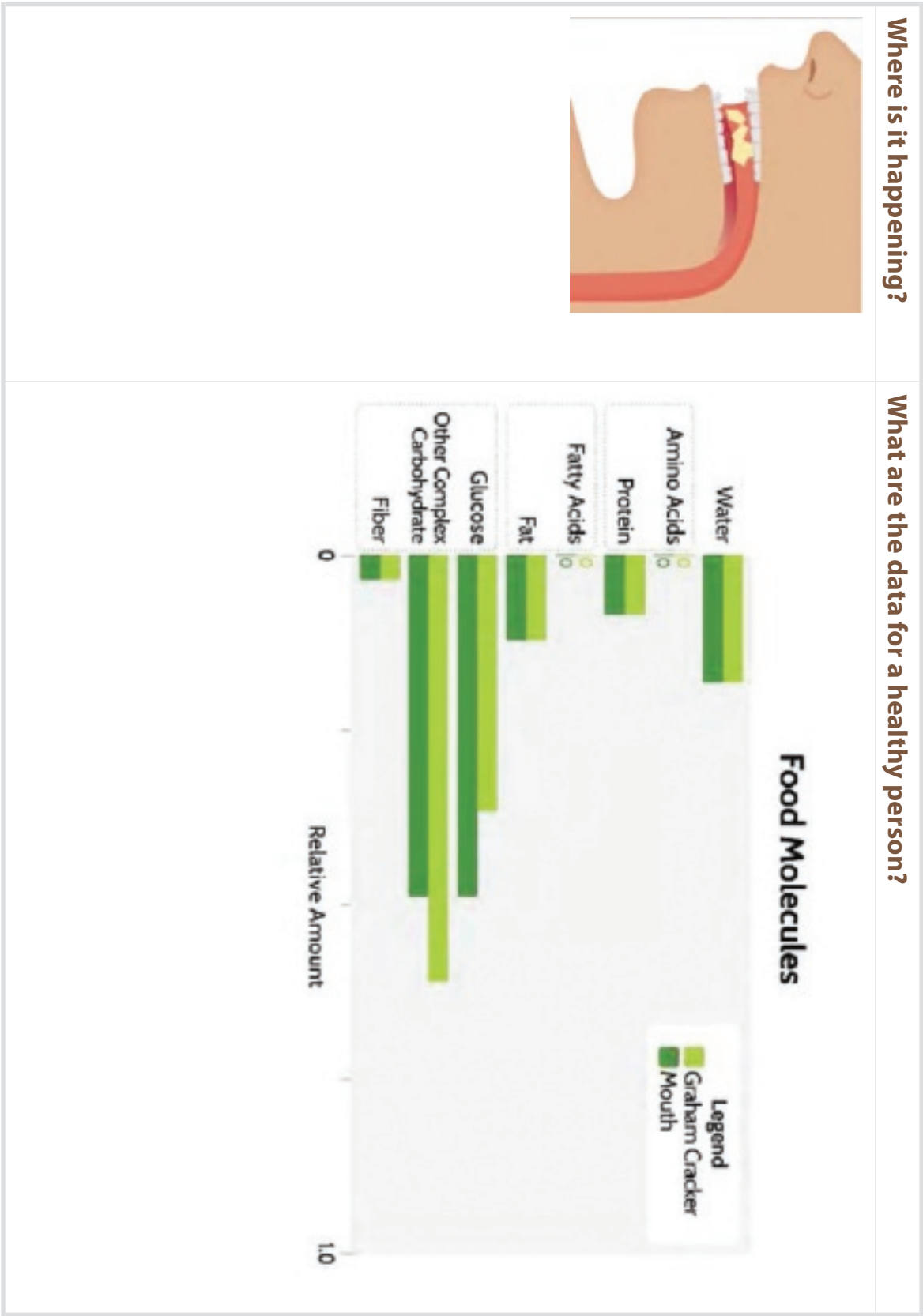
Food Molecules



Food Molecules

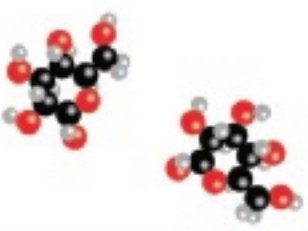
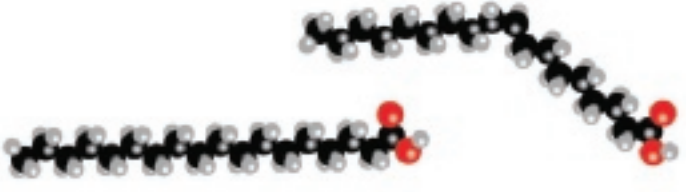
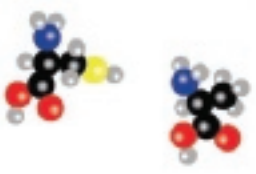
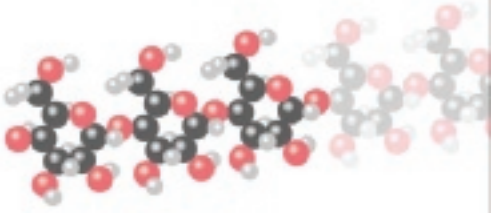
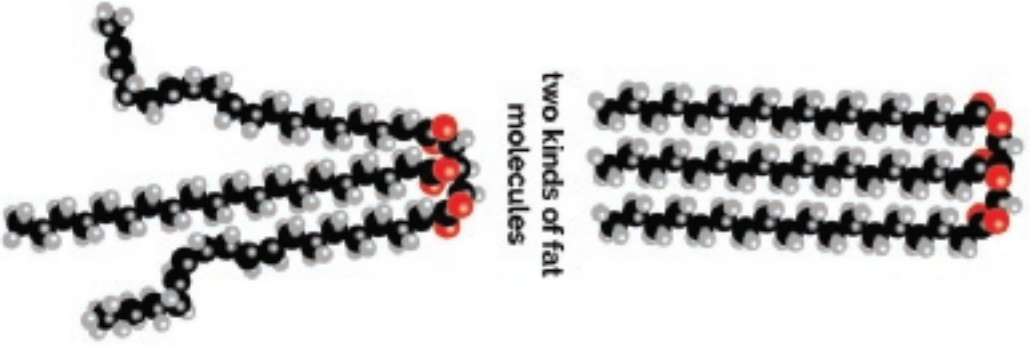


Analyze data from eating a graham cracker.



Food Molecule Cards

KEY		Type of atom	Symbol
	carbon	C	
	oxygen	O	
	hydrogen	H	
	nitrogen	N	
	sulfur	S	

two glucose molecules 	two kinds of fatty acid molecules 	
two kinds of amino acid molecules 	the tail end of one kind of complex carbohydrate (starch) molecule 	two kinds of fat molecules 
	the tail end of one kind of protein molecule 	

Chemical reactions in the mouth investigation

Part 1: Plan the investigation.

Recall that the goal of this investigation is to figure out an answer to the question, “**Do chemical reactions really occur in the mouth?**” We decided to investigate whether a substance in saliva, amylase, could break complex carbohydrates down into glucose molecules. In previous investigations, we learned that we can use indicators to test for the presence of complex carbohydrates and glucose.

- Iodine is an indicator for starch (one type of complex carbohydrates)
 - If starch is not present, iodine stays brown
 - If starch is present, iodine turns black or dark purple
- Benedict’s solution is an indicator for glucose
 - If glucose is not present, Benedict’s stays blue
 - If glucose is present, Benedict’s turns orange or dark brown

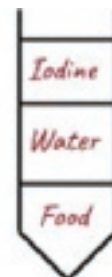
You have the following substances available for your use in this investigation:

- Food samples soaked in water: crackers, taco shells, cooked rice
- Amylase solution
- Water
- Benedict’s solution
- Iodine

You have the following materials available for your use in this investigation:

- 4 microcentrifuge tubes
- pipettes

Think about which substances you will need to add to each tube in order to figure out the answer to the question, “Do chemical reactions really occur in the mouth?” On *Data Table for Chemical Reactions in the Mouth*, Part 1, label each tube with the substances you plan to add. See the example to the right. Remember that scientists do controlled experiments, so you may want to include control groups.



Part 2: Plan your Procedures

Think about in which order you will need to add substances to your tubes. It may help to look ahead to the procedures in Part 3. Record the procedure titles you need in each box of Part 2 on *Data Table for Chemical Reactions in the Mouth*.

1. Food
2. Water
3. Iodine

Part 3: Make a Prediction

In Part 3 of *Data Table for Chemical Reactions in the Mouth*, make a prediction to answer the following question: What color do you predict the indicators will be after the investigation?

Part 4: Conduct the investigation.

Below, you will find the procedures for adding each substance to your tubes. Follow the order of procedures you created in Part 2 and the instructions below to add each substance to your tubes.

General procedures to follow

1. Gather your materials: four microcentrifuge tubes, distilled water, amylase solution, Benedict's solution, iodine solution, four eye droppers, and a coffee cup. Wear goggles throughout all of these steps.
2. Label all four microcentrifuge tubes to indicate what you decided to put in each tube.



Procedures to add FOOD to your tube

1. In a small cup, obtain a small amount of your food sample soaked in water.
2. Using a pipette, add approximately 0.5 mL of the food sample into the microcentrifuge tube (either 5 drops or approximately $\frac{1}{3}$ of the microcentrifuge tube).



Procedures to add WATER to your tube

1. In a small cup, obtain a small sample of your distilled water.
2. Using a pipette, add approximately 0.5 mL of the distilled water to your tube (either 5 drops or approximately $\frac{1}{3}$ of the microcentrifuge tube).



Procedures to add AMYLASE to your tube

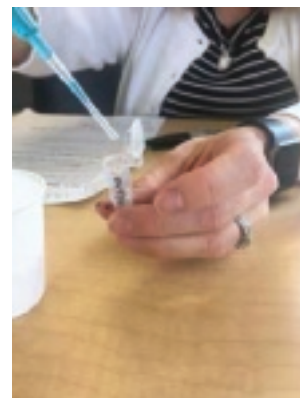
1. In a small cup, obtain a small sample of amylase solution.



2. Using a pipette, add approximately 0.5 mL of the amylase solution to your tube (either 5 drops or approximately $\frac{1}{3}$ of the microcentrifuge tube).



2. Using a pipette, add approximately 0.5 mL of the Benedict's to your tube (either 5 drops or approximately $\frac{1}{3}$ of the microcentrifuge tube).



Procedures to add IODINE to your tube

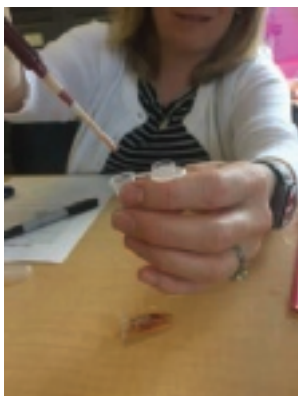
1. In a small cup, obtain a small sample of iodine.



3. Pour boiling water into a cup or beaker. Add your tube to the cup or beaker and let it sit for approximately 10 minutes.



2. Using a pipette, add approximately 0.5 mL of the iodine to your tube (either 5 drops or approximately $\frac{1}{3}$ of the microcentrifuge tube).



4. Using a spoon or tongs, remove the tube from the hot water.



Procedures to add BENEDICT'S to your tube

1. In a small cup, obtain a small sample of Benedict's.



Procedures to MIX your tube.

Turn your tube upside down and right side up several times until all of the substances have been completely mixed.

**Part 5: Record your results.**

In Part 5 of *Data Table for Chemical Reactions in the Mouth*, record your results in response to the question: What color were the indicators after the investigation?

Part 6: Record your interpretation.

In Part 6 of *Data Table for Chemical Reactions in the Mouth*, record your interpretation of the results in response to the question: Which food molecules were detected in each tube?

Food molecule data for a healthy person.

With your group

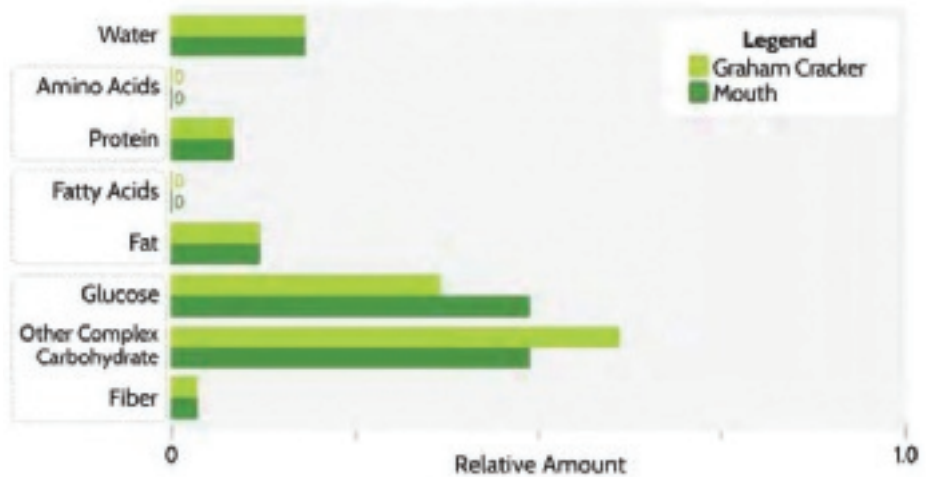
1. Work in groups to examine data as a graham cracker moves through the digestive system of a healthy person. The data include important food molecules.
2. The light-colored bar shows the amount of the molecule in the previous location. The dark-colored bar shows the amount of the molecule in the new location. Record whether the food molecule increases ($\uparrow$), decreases ($\downarrow$), or stays the same ($=$) from the previous location to the new location.
3. If the amount is zero in the new location (dark bar), record a zero (0).
4. Here are helpful tips for interpreting the bars in the graph:
 - If both bars are equal, that means the amount of that type of molecule did not change.
 - If the light bar is less than the dark bar, that means the amount of that type of molecule increased.
 - If the dark bar is less than the light bar, that means the amount of that type of molecule decreased.

Where is it happening?

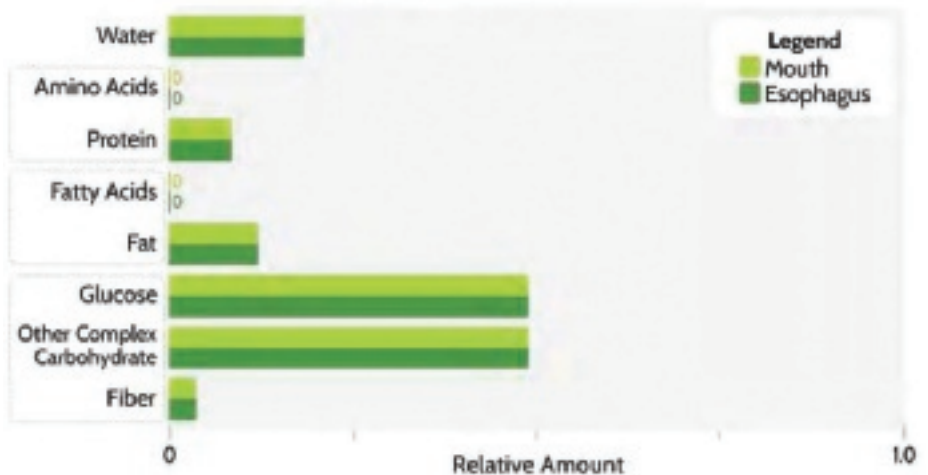


What are the data for a healthy person?

Food Molecules

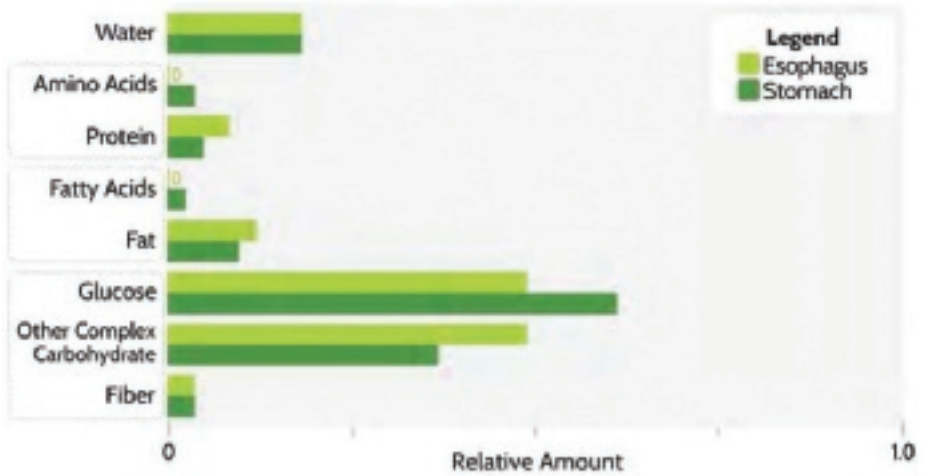


Food Molecules

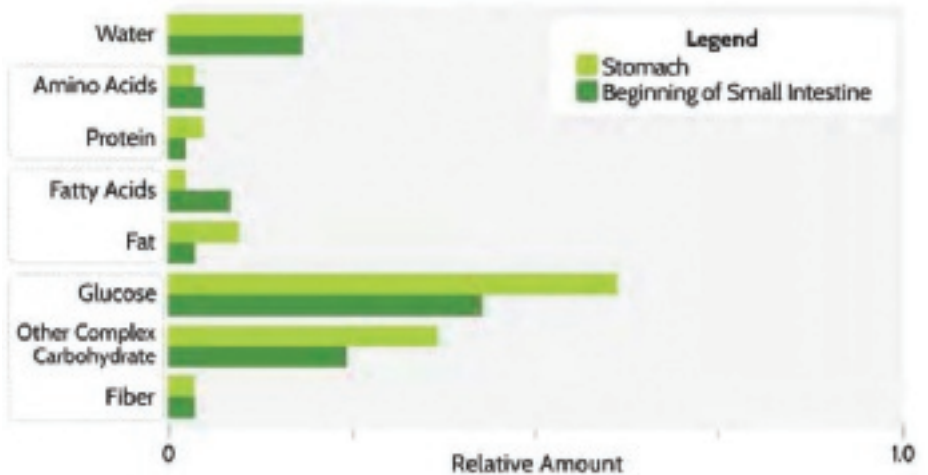




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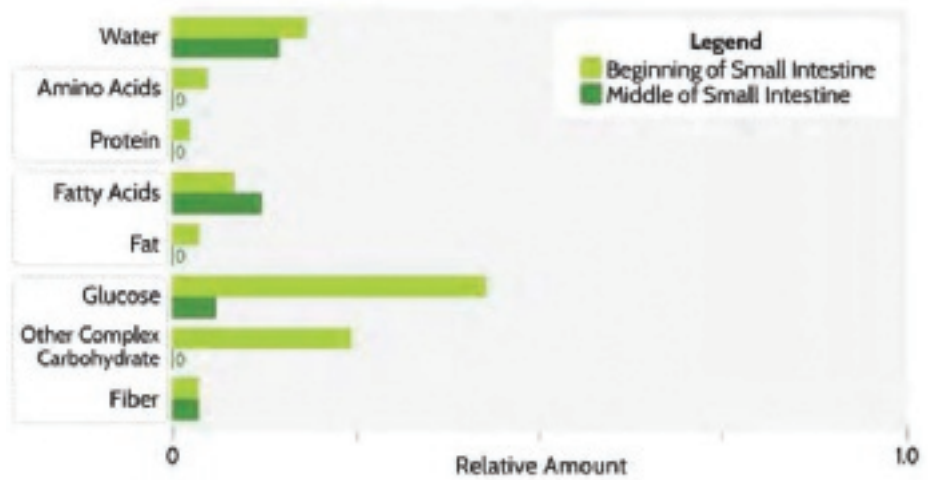


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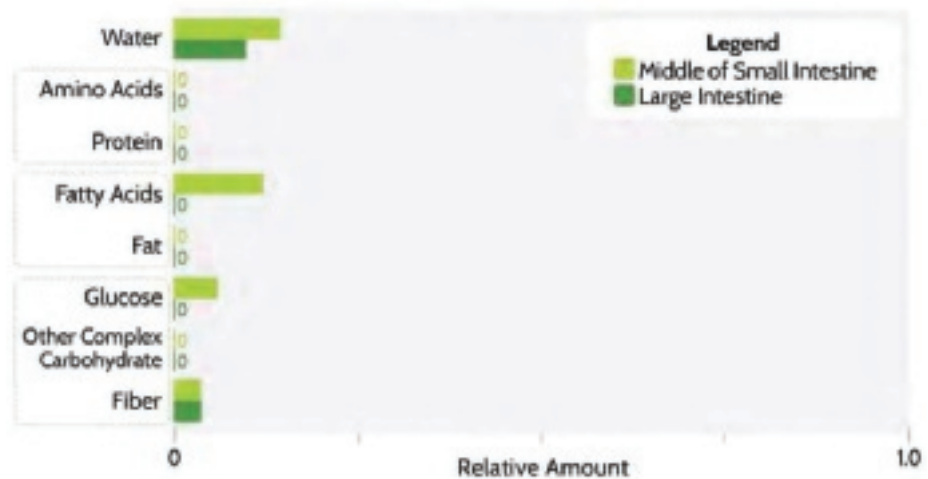




Food Molecules



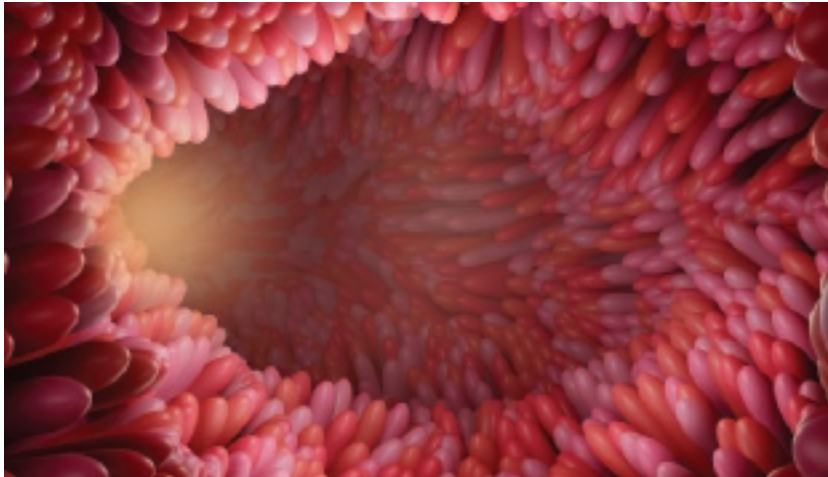
Food Molecules



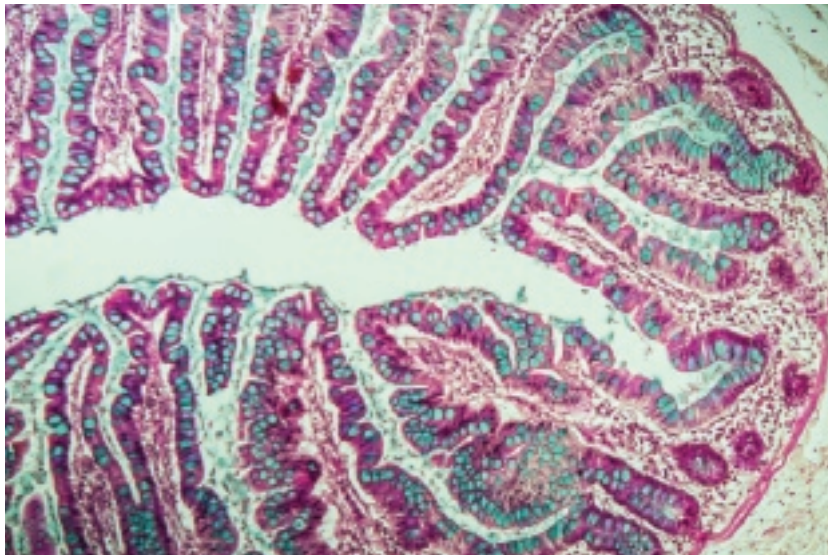
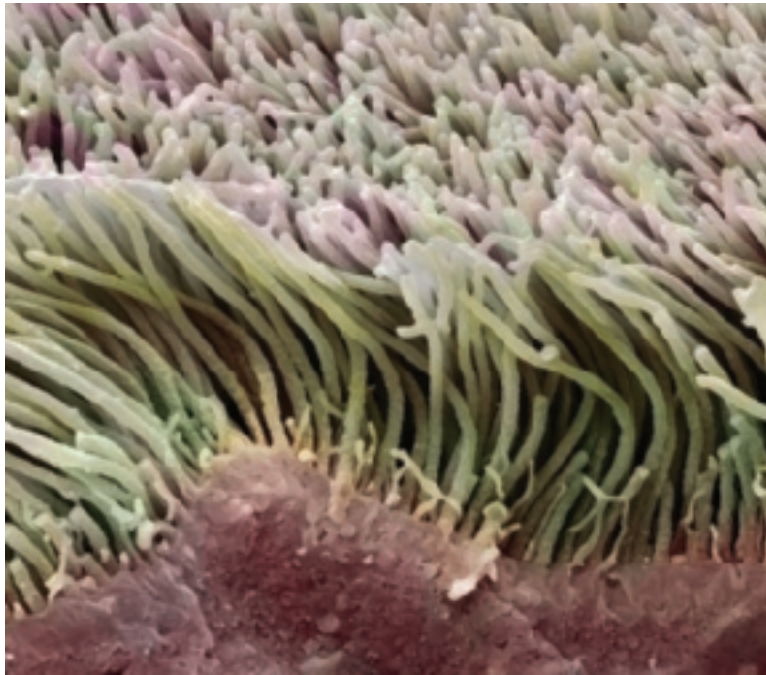
Zoomed-in images of the small intestine



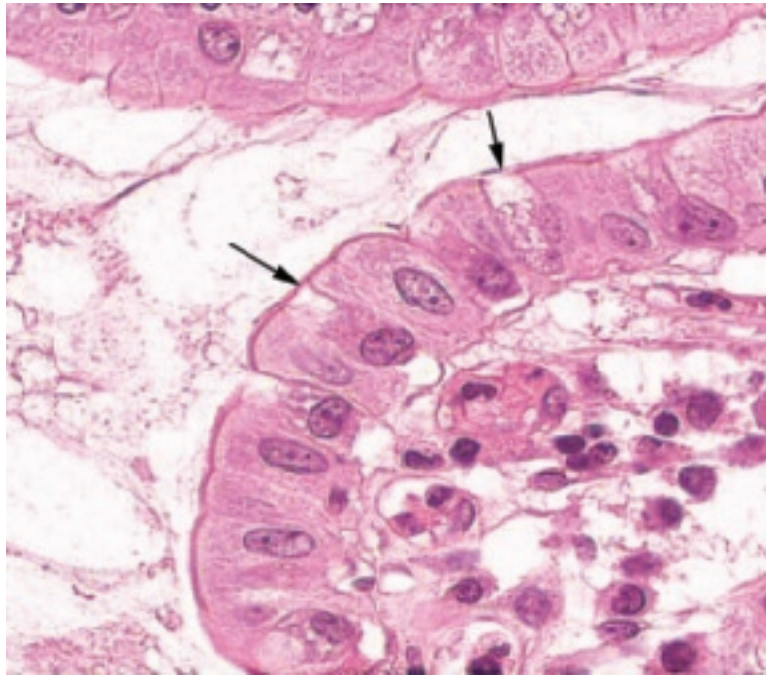
Image of the small intestine



Intestinal lining



David Litman



Name: _____

Date: _____

Peer Feedback Guidelines

Giving feedback to your peers is an important skill. Use this document to help you give and receive feedback from others in your class.

Giving Feedback

Feedback needs to be specific and actionable. That means it needs to be related to science ideas and provide your own suggestion for improvement.

Productive examples:

- "Your argument from evidence has a claim that you think your animal burns food molecules the same way as humans, but I think you should add in some evidence and reasoning for why you think that."
- "You make the claim that you don't think birds and humans do similar chemical reactions to break down food, but we disagree because they both have the same inputs of oxygen and food and outputs of carbon dioxide and water. We suggest looking at the inputs and outputs of cells again."

Non-productive examples:

- "I like your drawing."
- "I agree with everything you said."
- "Your poster is really pretty."
- "I disagree."

How to Give Feedback.

Your feedback should give ideas for specific changes or additions the person or group can make. Use the sentence starters below if you need help writing feedback.

- The poster said _____. We disagree because _____. We think you should change _____.
- I like how you _____. It would be more complete if you added _____.
- We agree that _____. We think you should add more evidence from the _____ investigation.
- We agree/disagree with your claim that _____. However we do not think the _____ (evidence) you used matches your claim.
- Do you think you should add _____?

Receiving Feedback

The purpose of feedback is to get ideas from your peers about things you might improve or change to make your work more clear, more accurate, or better supported by evidence you have collected.

When you receive feedback, you should:

- Read it carefully, ask someone else to help you understand it, if needed
- Decide if you agree or disagree with the feedback and say why you agree or disagree
- Revise your work to address the feedback

Fat Burning Lab Protocol

Part 1: Prepare samples for burning.

Tape *What Happens to Fat When It Burns?* in your notebook.

1. Take a wick and place it in the center of a 1.5-in. empty tea candleholder. Place this empty candleholder within the larger the 5-in.-diameter foil container as shown in the picture.
2. Fill an eyedropper all the way up with vegetable oil and squirt this into the bottom of the candleholder. Repeat this two times until half of the wick is covered. Be careful not to spill the oil when filling up the candleholder.
3. Take a wick and place it in the center of a 1.5-in. empty tea candleholder. Get a spoonful (or knifeful) of animal fat and scrape it into this empty candleholder. Pack it around the wick so that the wick is sticking out just above it.
4. Place this empty candleholder within the larger 5-in.-diameter foil container as shown in the picture.
5. Record your observations of the substances before the burn in each container in row A of your data table in your science notebook.
6. Measure the mass of each container with the corresponding sample in it on a digital scale. Record this data in row B of the same table in your science notebook.



Part 2: Collect data from the fat burning lab.

Wear goggles for the remainder of the investigation. Remain 3 ft away from any sample that is ignited. Do not try to ignite anything other than the three samples in this procedure.



1. Now that all of the containers are ready to go, use a lighter to ignite each fat one at a time. Let each fat burn for up to 4 minutes. If a sample goes out, and you suspect there is more fuel left, try to reignite it.
2. After 4 minutes, blow out any flames. Do not touch the samples. Use a paperclip to poke at them if you want to check their hardness. Record your observations of the substances in each container in row C of the same table in your science notebook.
3. After the container cools, obtain the mass of each container again. Record this data in row D of the same table in your science notebook.



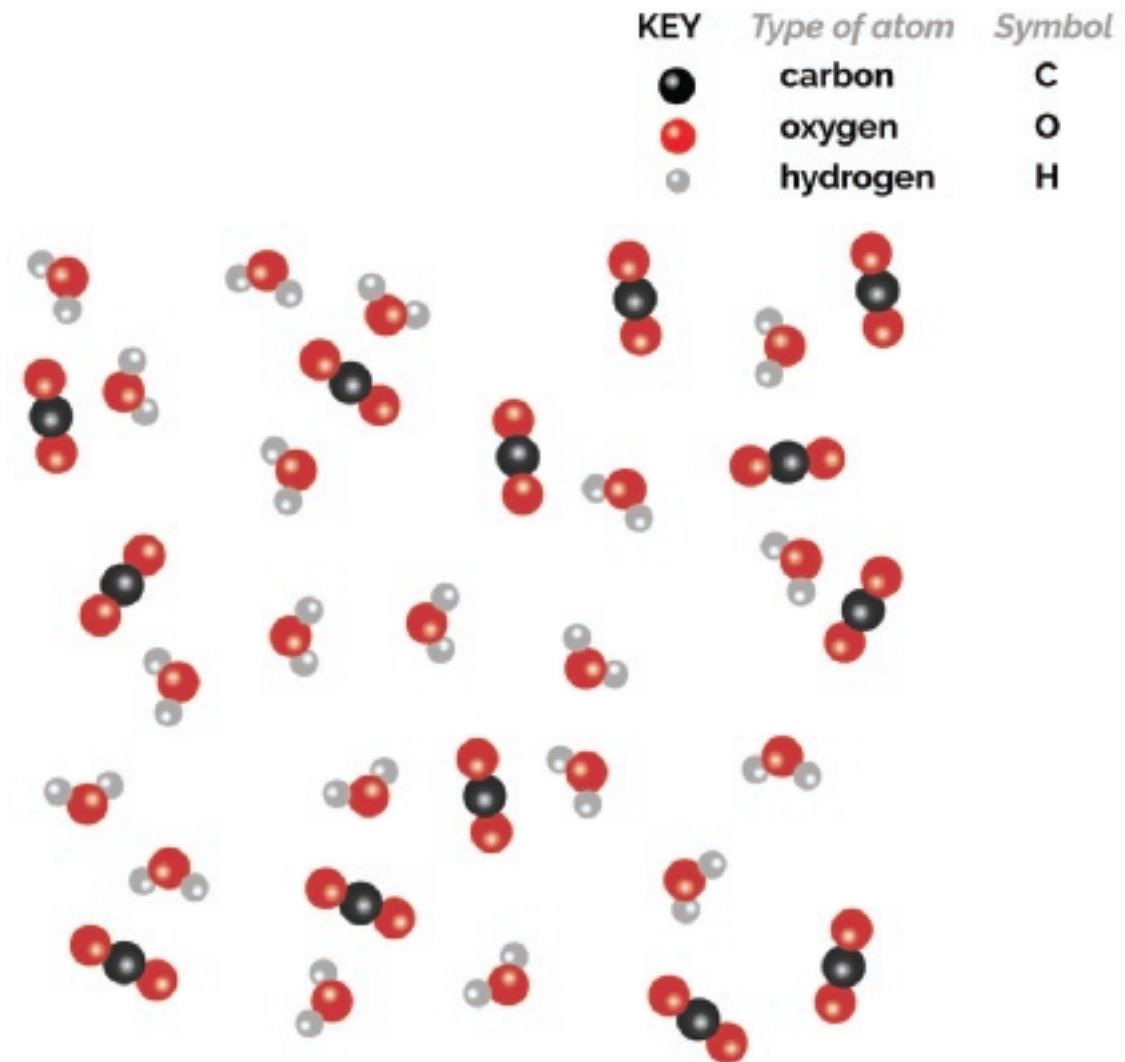
4. Add a few drops of water onto each sample to make sure it is completely cooled. Dispose of everything in each container, except the 5-in. foil container. Return the foil container to your teacher.

Part 3: Make sense of your results.

Complete the making-sense questions found in *What Happens to Fat When It Burns?* in your science notebook.

Air Molecule Reference

If carbon dioxide and water molecules are being produced when foods are transferring energy through burning, then the atoms that make them up must be coming from somewhere. Where are they coming from?



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Reading: What's Spit?

Pull a lollipop out of your mouth, and you'll see it. Wake up after drooling on your pillow, and you'll feel it. That's right. It's spit, which is also known as saliva (say: suh-LIE-vuh).

Saliva is a clear liquid that's made in your mouth 24 hours a day, every day. It's made up mostly of water, with a few other chemicals. The slippery stuff is produced by the salivary (say: SAL-uh-vair-ee) glands. These glands are found on the inside of each cheek, on the bottom of the mouth, and under the jaw at the very front of the mouth. They secrete (say: sih-KREET), or ooze, about 2 to 4 pints (or about 1 to 2 liters) of spit into your mouth every day!

Spit is super for a lot of reasons. Saliva wets food and makes it easier to swallow. Without saliva, a grilled cheese sandwich would be dry and difficult to gulp down. It also helps the tongue by allowing you to taste. A dry tongue can't tell how things taste—it needs saliva to keep it wet.

Spit helps begin the process of digestion (say: dy-JES-chun), too. Before food hits your stomach, saliva starts to break it down while the food's still in your mouth. It does this with the help of enzymes (say: EN-zimes), which are special chemicals found in the saliva. Amylase, which aids in the digestion of complex carbohydrates, is one kind of enzyme that can be found in your mouth. The combination of chewing food and coating it with saliva makes the tongue's job a bit easier—it can push wet, chewed food toward the throat more easily.

Saliva also cleans the inside of your mouth and rinses your teeth to help keep them clean. (But remember that spit isn't enough to keep teeth in tip-top shape; you still need to brush and floss!) The enzymes in saliva also help to fight off infections in the mouth.

Most school-age kids have just the right amount of saliva. Sometimes a person may not have enough saliva, but this is usually the result of certain medicines or treatments, some kinds of diseases, or old age.

Reading: Children need more fat in their diets compared to adults.

As you know, we need to eat to stay alive. Food is made of different types of molecules, mostly fats, carbohydrates, and proteins. Scientists have studied how our bodies use fats, carbohydrates, and proteins in order to make diet recommendations that help people stay healthy. A recent study asked, “Do children use food in the same way that adults do?” To answer this question, the scientists received help from ten healthy children and ten healthy adults. All participants in the study ate the same balanced diet for three days while scientists carefully measured the rate at which they burned fat molecules.



The results showed that children, who were on average 8 years old, burned more fat each day compared to adults. The scientists believe that children need to burn more fat to produce the energy they need to support development, such as bone and muscle growth. So, the reason kids need more fat in their diets is because they burn more fat than adults.

The recommendations for adults is to get about 20-35 percent of their daily calories from fat; for teenagers and children older than 3, it is 25-35 percent; and for babies and toddlers, the recommendation is to get 30-40 percent of daily calories from fat. Very young children need to eat even more fat because they are growing at such a fast rate.

The scientists stressed that although fat is an important part of a child’s diet, the study results should not be interpreted as meaning that children can eat as much fat in their diet as they like. Children should not eat too much junk food, especially junk food containing a lot of sugar, which can lead to unhealthy weight gain.

SOURCE: *Nutrition Journal*, August 15, 2007.

Reading: Investigating Other Animals

Dog - *Canis lupus* (Beagle)

A dog's respiratory system is responsible for taking in oxygen and eliminating waste gases like carbon dioxide. The more a dog moves around, its muscle cells will use oxygen and glucose more quickly than when it is resting. This causes an increase in heart rate, rate of breathing, and how deeply the dog breathes. The increase in heart rate and blood flow around the dog's body is important for carrying out chemical reactions during which oxygen and glucose are changed, releasing carbon dioxide and water and making energy available for the dog's body. Because dogs and cats do not sweat through the skin, the respiratory system also plays an important role in the regulation of temperature.



The cardiovascular system includes the heart and blood vessels and performs the function of pumping and carrying blood to the rest of the body. The blood contains nutrients and oxygen to provide energy to allow the cells of the body to perform work.

When your dog swallows its food, it passes through the esophagus, or gullet. While in the mouth, food is mixed with saliva. The saliva has no enzymes, however it is important for lubricating the passage of food to the stomach, moistening the mouth, and helping dogs stay cool. Strong muscles along the length of the esophagus help to push the food down into the stomach, as part of the chewing process. When food reaches the stomach, the process of dog digestion begins.

Bird - *Cardinalis cardinalis* (Cardinal)

The respiratory system of birds creates a very efficient exchange of carbon dioxide and oxygen via one-way airflow. Bird respiratory systems have lungs, but they also have air sacs. The air sacs keep oxygen-rich blood moving in one direction. A breath of oxygen-rich inhaled air remains in the respiratory system for two complete inhalation and exhalation cycles before it is fully spent (used) and exhaled from the body. The exchange of carbon dioxide and oxygen takes place in the lungs. The air capillaries in the walls of the lungs have a much larger overall surface area than that found in the mammalian respiratory system. The greater the surface area, the more oxygen and carbon dioxide can be passed between blood and tissues, which also makes for more efficient breathing.



The cardiovascular system not only delivers oxygen to body cells and removes metabolic wastes but also plays an important role in maintaining a bird's body temperature. The avian circulatory

system consists of a heart plus vessels that transport nutrients, oxygen, carbon dioxide, other waste products, and hormones.

The gizzard performs the same function as mammalian teeth, grinding and disassembling the food, making it easier for the digestive enzymes to break down the food. Birds have a two-part stomach that includes a gizzard. In most birds, the gizzard contains sand grains or small rocks that the bird eats to aid in the grinding process. The bird stomach also has acid and a digestive enzyme called pepsin that are involved in the chemical reactions that change food into a form that the bird can use.

Jellyfish - *Aurelia aurtia* (Moon jellyfish)

Jellyfish don't use their body energy often to swim around. The current of the water moves jellyfish from one location to the next. Jellyfish have no special structures for respiration or circulation. They also don't have a brain! However, they still need oxygen. They are able to take up oxygen, and even store it. Jellyfish have such thin tissue that they can get most of the oxygen they need by absorbing it directly from the water that they live in.



Jellyfish eat foods, such as mollusks, plankton, and fish eggs. The Moon Jellyfish has a hearty appetite and will consume food as often as it can. They have a very large stomach that allows them to swallow food whole, and then it is broken down. They need protein, carbs, and fats to survive. Food that makes it into the jellyfish's stomach is broken down by digestive enzymes.

A jellyfish body is made up of an outer layer of tissue and an inner layer of tissue, which lines their two-way gut. This means that they take food in, digest it, and expel it through the same opening. Cells in the gut can then absorb and move nutrients around the jellyfish's body.

Sponge - *Aplysina fistularis* (Yellow tube sponge)

Sponges are a type of aquatic animal whose body is covered in tiny pores. Each of a sponge's individual cells can transform to complete the job of any other cell in the body. This lack of specialization means that sponges do not have tissues or organs. As a matter of fact, if you took a sponge and put it in a blender, it could reform itself as the cells swim back together and take on any form and job needed to recover!

All sea sponges are attached to the reef surface and are unable to move. If pieces of an individual are broken off by predators or during a storm, they can reattach and begin growing a new sponge. Since sponges do not move around to get food, food has to come to them. They filter water into and out of the pores. Cells in the pores capture the food, which is digested by each individual cell.



The pores also help flush waste products out of their bodies. The filtered water, including waste products, exits the sponge. These waste materials could poison the sponge if it is left inside their bodies for too long. They also obtain oxygen from the water during this process.

Shark - *Carcharodon carcharias* (Great white shark)

Sharks are fish and use gills to breathe rather than lungs. Sharks use gill slits to add oxygen to their blood. As the shark moves around, water is taken into the mouth and moves over the gills that absorb oxygen from the water and release carbon dioxide back out. When at rest, the shark actively pumps water over its gills.

When oxygen is needed, blood travels to the s-shaped heart, which has only two chambers compared to the four found in mammals and birds.



NOAA

Most sharks are carnivores, eating foods like fish, seals, sea lions, and turtles, but scientists have found that one type of shark, the bonnethead, eats a large amount of seagrass. When sharks eat their prey, there are no digestive juices released into the mouth. Sharks don't chew their food, so the food does not need to begin to undergo chemical reactions until it reaches the stomach. The stomach of a shark has very strong enzymes and other digestive juices including hydrochloric acid. By the time that food leaves the stomach, on its way to the intestine, there is nothing left but mush because the stomach acid dissolves the stomach contents.

Lizard - *Furcifer pardalis* (Panther chameleon)

The respiratory system of the chameleon has two lungs, but they are like sacks with many finger-shaped bulges. Their lungs are divided into different air sacs. With a single breath, a chameleon can achieve twice the oxygen supply into its blood as mammals because the exchange of carbon dioxide, water, and oxygen in these animals takes place during the time that they inhale and also when they exhale.



Chameleons eat insects and birds. To catch their prey, they creep along very slowly. Once the prey is in reach, their suction cup tongue shoots out and sticks to the insect. Their tongues can be twice as long as their bodies when stretched out to catch prey.

In chameleons, leftover waste is expelled through a structure called the vent, which does the same job as a mammal's anus. The digestive tract of chameleons consists of the mouth, stomach, intestines, and vent.

Spider - *Nephila* (Golden orb weaver)

Spiders do not take a breath through their mouths like humans. Instead, they breathe through their skin on the underside of their bodies. Book lungs are a form of respiratory organ found in spiders and scorpions and is where the exchange of carbon dioxide, water, and oxygen takes place.

They don't have true blood or veins to move blood around. Instead, their bodies are filled with a substance called hemolymph, which is pumped by the heart into the spaces surrounding their internal organs. Hemolymph is a clear fluid that transports nutrients, oxygen, and cells. Hemolymph also has another unusual function, as it is used to raise pressure inside the spider's body during the time that it sheds its skin and when stretching the legs.

Spiders are the only animals that digest their food before they eat it. Spiders capture their prey then release digestive enzymes from their intestinal tract into the bodies of the animals they capture. These enzymes break down the body tissue of prey, and, after a few seconds, the spider sucks up the predigested, liquid food.



Archaeobacteria - *Methanospaera* (Methanogens)

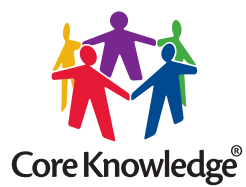
Archaeobacteria are single-celled organisms that were discovered in 1977. They are sometimes called extremophiles because they are found in very harsh conditions, such as in volcanic vents at the bottom of the oceans.

Archaea do a wide variety of chemical reactions to get the energy they need. Some types of archaeobacteria make their food from sunlight, and some take in molecules like carbon dioxide, while some take in molecules that do not contain carbon as a source of energy, such as sulfur. Methanogens are bacteria that live in swamps and the gut of animals. They are anaerobic bacteria, which do not need oxygen. In fact, they are killed when exposed to oxygen! These bacteria do chemical reactions with carbon dioxide and hydrogen as reactants and give off methane gas and water as products. This reaction is responsible for producing swamp gas and flatulence in humans.

Archaea's body structure can be in various shapes, such as spheres, rods, spirals, or plates. The cells of archaea lack interior membranes and organelles. They do have a cell wall. Many types of archaea have flagella, which is a long stalk that spins around to help the bacterium move around.



NASA



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Core Knowledge **SCIENCE™**

Editorial Director
Daniel H. Franck

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Unit Development Team

Tara McGill, Unit Lead, Northwestern University

Michael Novak, Field Test Unit Lead, Northwestern University

Kate Cook-Whitt, Writer, Maine Mathematics and Science Alliance

Kathryn Fattalah, Writer, The Nora Project

Emily Harris, Writer, BSCS Science Learning

Lindsey Mohan, Writer, BSCS Science Learning

Jamie Noll, Writer, Northwestern University

Barbara Taylor, Writer, Charles A. Center at UT-Austin

Heather Galbreath, Pilot teacher, Lombard Middle School

Michael Clinchot, Teacher Advisor, John D. O'Bryant School of Mathematics and Science

Nicole Vick, Reviewer, Abingdon-Avon High School

Betty Stennett, Reviewer, BSCS Science Learning

Katie Van Horne, Assessment Specialist

Kelsey Edwards, Project Coordinator, Northwestern University

Barbara Hug, Unit Advisory Chair, University of Illinois at Urbana-Champaign

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Professional Learning Center at Boston College

Katherine McNeill, Director

Renee Affolter, Assoc. Director

Instructional Materials Center at BSCS Science Learning

Daniel C. Edelson, Director

Audrey Mohan, Assoc. Director

Field Test Implementation and Evaluation Center at Charles A. Dana Center, The University of Texas at Austin

Carolyn Landel, Director

Sara Spiegel, Assoc. Director, Implementation

Carol Pazera, Assoc. Director, Evaluation

Field Test Evaluation Center at Digital Promise

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