Science and Society Unit:
Energy and Your Body

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CHAPTER 2: Energy Balance

Has anyone ever told you, “You have too much energy today!”? Why do you think the person said that? What do you think happens to the energy from the food you eat? In chapter 1, You Are What You Eat, you focused on food. You learned that humans get energy from food that has been broken down in their bodies. You also calculated how many Calories (Cal), the unit of food energy, you need per day.

Once you have the energy from food, how does your body use it? One of the big ideas in science is that energy cannot be created or destroyed. This means that if you are taking in energy, it must either be stored in your body or leave your body. Think of your body as a system. If the system is in balance, over time the energy coming into your body should equal the energy used by your body.

In chapter 2, Energy Balance, you will examine more about energy coming into and going out of the body. You will also learn why it is important to balance these processes! As you work through the activities in this chapter, you will be working both by yourself and with a team. In science, teamwork is important. There are certain skills that can help you work in a team more easily. In this chapter, you will work on the teamwork skill of making sure everyone understands.

Goals for the Chapter

By the end of this chapter, you will
- describe the parts of the body that help us digest food for energy as well as the functions of those parts,
- explain the relationship between the digestion of food and Energy in,
- describe ways the body uses energy,
- use evidence to explain the importance of energy balance, and
- use the information in graphs to make an explanation about the relationship between eating food and exercising.

To help you reach these goals, you will complete the following activities and have a chance to think about each big idea:

Engage—Get Moving!
Explore—A Delicate Balance
Explain—Balancing the System
Elaborate—Why Do I Need Balance?
Evaluate—Creating a Balance

Remember to use the chapter organizer to help you see where you have been and where you are going in your learning. Look every day at the pathway shown by the organizer.
**Energy Balance**

**Major Concepts**
- There are many different ways that the body uses energy.
- A person has a healthy energy balance when $Energy_{in}$ is about equal to $Energy_{out}$.
- The body has parts with specific functions to help us digest food for energy.
- Once food is digested, it can be used in other areas of the body to provide energy.
- Energy balance is one way to describe the link between food and exercise.

**Linking Question:**
How does the energy we take in from food relate to the energy used by exercise?

**Explore—A Delicate Balance**
**Key Idea:** Organisms achieve energy balance when $Energy_{in} = Energy_{out}$.

**Linking Question:**
How does energy balance relate to humans?

**Evaluate—Creating a Balance**
**Key Idea:** Suggestions based on a person’s lifestyle can help the person achieve a healthy energy balance.

**Linking Question:**
How does information about energy balance apply to a real situation?

**Elaborate—Why Do I Need Balance?**
**Key Idea:** Energy balance is important for a healthy lifestyle.

**Linking Question:**
Why is energy balance important?

**Engage—Get Moving!**
**Key Idea:** Exercise is one way the body uses energy from food.

**Linking Question:**
How does the energy we take in from food relate to the energy used by exercise?
Engage

Get Moving!

In chapter 1 of this unit, you learned that your body breaks down food for energy. How do you think energy is used by your body? In this Engage activity, Get Moving!, you will keep track of some of the ways your body uses energy. Later in this chapter, you will estimate how many Calories your body used in a day.

Materials

For each student

- 1 copy of Typical Activities handout
- 1 copy of Physical Activity Diary handout
- different-colored pens or pencils

Process and Procedure

Think of all the ways your body uses energy. In this activity, you will keep a diary of the things you do that require energy. Begin the activity by working by yourself.

1. Make a list in your science notebook about the ways you think human bodies use energy.

   You have started a new activity, but also a new chapter. Did you set up your science notebook to show these changes? If not, set it up now.

2. Contribute to a class list of ways human bodies use energy.

3. Answer the questions in Steps 3a–b by yourself in your science notebook.

   a. Do you think all the activities you listed require the same amount of energy? Why or why not?

   b. What do you think affects the amount of energy you need to do a particular activity? You might think of ideas that relate to the activity or to your body.
4. In your science notebook, draw a table like the one shown in figure 2.1. Choose some activities from the class list that you think fit into each column of the table. Write at least 3 activities in each column.

5. Look at the *Typical Activities* handout. Compare how you sorted the activities you chose. If you need to move some of the activities to a different column, do so in a different color.

6. Study the *Physical Activity Diary* handout on your own. Once you are familiar with it, meet with a partner to discuss what you notice about the chart.

   A good way to get started is to discuss the characteristics of the chart. You may wish to talk about how long each time period is, what time the first time period starts, and what you think should be recorded in each column.

7. Study the sample physical activity diary your teacher will show you. Notice how each row is completed.

8. With your class, create a list of notes you think will help you complete your diary.

   For example, one note that might help you fill in the chart is to write on it every time you change activities.

9. Begin your own physical activity diary. Your teacher may give you further instructions on how to do this.

   For each row, list your activities in the “activity” column. Enter the minutes spent at each intensity level. The total number of minutes in each row should equal 60.
10. Add the number of minutes in each column. Fill in the numbers in the row labeled “total minutes.”
   Make sure that all the numbers in this row add together to give you 1,440. That is the total number of minutes in 24 hours.

Reflect and Connect

Answer each of the following questions on your own. Write your answers in your science notebook.

1. Did you find it easy or difficult to keep track of all the activities you carried out in a day? Why?

2. Do you think the types and levels of activity you did in a day would be very different on a school day than on a weekend day? Explain your answer.

3. Do you think that all the activities you have listed in your chart represent all the energy your body uses? Explain your answer.
**Explore**

**A Delicate Balance**

So far in this unit, you have thought about the energy that goes into your body. In the Engage activity, you thought about the ways your body uses energy. How do you think these two ideas relate to one another? What happens over time if you balance the energy you take in and the energy your body uses?

In this Explore activity, *A Delicate Balance*, you will look at data from studies on mice. You will use information from graphs to answer a question about the energy an organism takes in and the energy it uses.

As you work, remember the teamwork skill you are practicing in this chapter. Try to make sure that everyone understands the information in this activity. Some steps in *Process and Procedure* will help you practice this teamwork skill. Each of you will need to understand the graphs and results before you move on to the next activity.

**Materials**

For each team of 2 students

- 1 copy of a graph from *Mouse Studies* handout
- tape or glue

**Process and Procedure**

Imagine that you and your partner are scientists. You have been studying the effects of different amounts of food and exercise in mice. The results from different groups of mice are coming in. It is time to analyze what happened.

1. Answer the following question by yourself in your science notebook.

   All people take in energy in the form of food. All people use energy, too. What do you think happens when the amount of energy a person takes in is very different from the amount of energy the person’s body uses?
2. Look at figure 2.2 with your partner. Together, you will compare 2 groups of mice. Other teams will compare different groups of mice. Decide which 2 groups you want to compare in your study.

   Remember that in a fair test you only change one variable. You may wish to compare groups that had similar amounts of exercise but different amounts of food. You may instead compare groups that had similar amounts of food but different amounts of exercise.

3. Discuss your choice with your teacher. Be sure both you and your partner can explain your choice and the variable that changed. Once your teacher has approved your decision, you will receive a graph of the results from your study. Tape or glue the graph into your science notebook.
4. Follow Steps 4a–e to use the Identify and Interpret (I) strategy to analyze your graph. Work by yourself for Steps 4a–c.
   a. Identify any changes, trends, or differences that you see. Draw arrows on the graph to show what you have identified.
      Think about overall trends and changes. For example, think about whether the weight increases or decreases overall, rather than each month. If you need help, look at I Can Interpret Patterns and Trends.
   b. Next to each arrow, write “What I see.” Then write a statement of what you see. Leave room to write more information under each statement.
   c. Interpret each change you saw on the graph. To do this, write “What I think it means” underneath each statement from Step 4b. Then write a statement that describes what you think each change, trend, or difference means.
      If you need more help with this strategy, see I Can Use the Identify and Interpret Strategy.
   d. Discuss Steps 4a–c with your partner. Make sure each of you understands why you drew arrows where you did and the meaning of each change. You may add to your I statements if you have new information.
   e. Underneath your graph, write a caption that summarizes the important changes in the graph. Continue working with your partner for this step.

5. Present the findings of your study to the class. As you listen to other presentations, make notes in your science notebook about the mouse groups each team studied and the results.
   A table is a good way to organize your notes. You should include columns for the mouse groups, the variable that changed, and the results.

6. On your own, write a few sentences to summarize how you think the energy a body takes in (Energy_in) relates to the energy the body uses (Energy_out). Include what you think might happen if the two amounts are not balanced (are not about equal).

Reflect and Connect

Answer these questions by yourself in your science notebook.

1. The studies you did in this activity used mice as an example. Scientists often use mice as a model for what happens in humans.
   a. Do you think that the results of these studies on exercise and the amount of food would be similar in humans?
   b. Why do you think scientists use mice as models for humans?
2. Look back at *The Processes of Scientific Inquiry* diagram from *Please Explain*, the Explain activity of the *Science as Inquiry* chapter. It should be taped in your science notebook. Then answer the following questions about this activity.
   a. How were you practicing inquiry when you completed the I² strategy?
   b. What other ways did you practice inquiry in this activity?

3. Think about how you made sure both partners understood in Step 4d.
   a. What was an effective way that you made sure both of you understood?
   b. Do you think that same strategy would work if you were explaining the graph to an adult? Why or why not?

4. At this point, you should realize from chapter 1 that food provides the energy that goes into the body. However, the food you eat is not in a form that is usable by the body.
   a. What parts or system of the body do you think starts the process of getting the valuable nutrients in food to the rest of the body?
   b. How do you think the body gets energy out of food?
Explain

Balancing the System

In the Explore activity, you thought about the link between food and exercise in mice. This represents the link between $\text{Energy}_{\text{in}}$ and $\text{Energy}_{\text{out}}$ in their bodies. What happened when $\text{Energy}_{\text{in}}$ and $\text{Energy}_{\text{out}}$ in the mice were not balanced? How do you think the balance between $\text{Energy}_{\text{in}}$ and $\text{Energy}_{\text{out}}$ is similar in humans?

To understand energy balance in humans, we need to take a closer look at energy and the body. At the end of the Explore activity, you thought about how the body gets energy out of food. In this Explain activity, Balancing the System, you will learn about the system that helps process food into usable materials. This will help you understand more about $\text{Energy}_{\text{in}}$.

But $\text{Energy}_{\text{out}}$ is important for balance, too. To look at this process, you will learn about the amount of energy used when you do different activities. You will also learn to calculate the amount of energy your body requires in a day. Finally, you will see what factors affect the amount of energy that is used.

### Materials

**For each student**

- 1 copy of The Digestive System handout
- 1 copy of Calories Used Per Day handout
- 1 calculator
- different-colored pens or pencils

### Process and Procedure

Begin working by yourself to complete the following steps. The instructions will let you know when to work with your partner.

1. Imagine you were talking to a fifth-grade friend about what you have been learning. She asked you the following question. Read the question and think about how you would answer it.

   “I feel much hungrier on the days I have soccer practice than on the days I walk the dog after school. Should I eat more on the days I play soccer?”
2. Draw a KWL chart, like the one in figure 2.3, in your science notebook. Make sure you notice what K, W, and L stand for. Leave plenty of space to write in your chart.

<table>
<thead>
<tr>
<th>K</th>
<th>What I KNOW</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>W</th>
<th>What I WONDER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>L</th>
<th>What I LEARNED</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Complete the first 2 columns of the chart by following Steps 3a–b.
   a. In the “K” column, write what you know that would help you answer your friend’s questions.
   b. List specific information you wonder about to the “W” column.
      You should list questions that would help you answer your friend’s question if you knew the answer to them.

4. Your friend mentioned she is hungrier on certain days. She wanted to know if she should eat more. It might be helpful to explain what happens between the time a person eats food and the time some of it leaves the body as waste. To help you, obtain a copy of the handout titled The Digestive System. Label any parts you already know.

5. To help you complete your description of the digestive system, read Breaking Down Food. As you read, draw a line on your handout to each part you read about. Then label the part and write its function. Also answer the questions in the tasks in the reading.

**Reading: Breaking Down Food**

The bell to go back to class is about to ring. You are still eating your lunch. You take the last bite. Chew, chew, chew, and then swallow. You grab your books and head off to class. You are finished with your lunch. Do you think your body is finished with your lunch? In fact, the work is just getting started.

As you may remember, food provides your body with the nutrients it needs for energy and to function. When you eat food, it is not in a form that your body can use. The food needs to be broken down first. This process of breaking down food is called digestion. Digestion is done by the digestive system. This system is made up of several parts, each with its own function.

*continued*
Digestion begins when you put food in your mouth (figure 2.4). Your **teeth** and **tongue** move the food around and begin breaking it into smaller pieces. Small glands underneath the tongue and in other parts of the mouth are called **salivary glands**. These glands release saliva, or spit. Saliva contains an enzyme that starts to break down the bonds in the food. An enzyme is a chemical that breaks down food molecules. The enzyme in saliva can break the bonds in carbohydrates.

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**Figure 2.4: The teeth, the tongue, and the salivary glands.** Notice where each part is located in the mouth.

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**Figure 2.5: The stomach.** This hollow sack holds food and releases acid that helps with digestion.
Once you swallow, the food goes through a tube called the **esophagus**. This tube helps move the food, but no digestion takes place here. At the end of the esophagus is the **stomach**, as shown in figure 2.5. This is a hollow sack that holds food during the first, main step in the digestion process. The stomach looks a little like the letter J. After food enters your stomach, the cells that line the stomach wall release a strong acid. The walls of the stomach also have muscles that help move the food around and mix it with the acid. All that mixing causes the food to be broken down into a liquid mush. This is one form of digestion where bigger pieces of food are being processed into smaller pieces. There is also an enzyme in the stomach that helps break down proteins. Remember the enzymes in saliva that start to break down carbohydrates? The enzymes released in the stomach begin to break apart chemical bonds in food proteins.

Name some foods that contain a lot of protein.

The muscles in your stomach push the food into your **small intestine**. This tube is coiled up in the abdomen. It is about 7 meters (23 feet) long! The small intestine is where most digestion takes place. There are some enzymes in the intestine. These help digest carbohydrates and proteins. Other enzymes in the small intestine are made in the **pancreas**, a small organ that sits under the stomach. The pancreas is shown in figure 2.6. The pancreas makes enzymes that can break down carbohydrates, proteins, and fats. One enzyme breaks down carbohydrates. Another enzyme breaks down proteins. Still another enzyme breaks down fats.

*continued*
There is also a part of the digestive system called the liver, shown in figure 2.7. The liver makes a substance called bile. Bile helps enzymes from the pancreas break fats into smaller pieces. The liver sits on top of the intestines, on the opposite side of the body from the stomach.

**Figure 2.7: The liver.** The liver sits on top of the intestines on the opposite side of the body from the stomach.

What are some foods that would be broken down with chemicals from the liver and pancreas?

Once all the digestion has taken place in your small intestine, the food has been broken down into a form that your body can use. At this point, all the energy-yielding nutrients have been broken into their smallest pieces. These small pieces of nutrients are in a form that the body can use. The different pieces move out of your intestine and into your bloodstream. From there, the small pieces of nutrients can move into your cells and be used for different processes. One important process is that the cells can use these pieces to change chemical energy into a form of energy the body can use. Your body can then use the energy to function. Once the pieces move out of your intestine, they are no longer in the digestive system. The actual change of the chemical energy in food into a usable form does not take place in the small intestine. It is important to remember, however, that all of the necessary preparation of breaking down the food happens in the digestive system.

Even after all of the nutrient pieces move out of your small intestine, there is still some material left in your intestine. This is the part of the food that the body cannot use.

Do you remember from chapter 1 what the name is of the part of food that cannot be used by the body for energy?

*continued*
The material moves from your small intestine into your large intestine. The large intestine is a tube that goes up one side of your lower body between your ribs and hips, cuts across the middle, and goes down the other side. The large intestine is about 1.5 meters (almost 5 feet) long. The tube is wider than the small intestine, which gives it the name “large” intestine. In the large intestine, most of the water is removed from the material so it becomes more solid. The material then leaves the body as waste.

You’ve now followed the food you finished as the bell was ringing, tracking it all the way through your digestive system. How long do you think the process took? It is different for different people, but it takes an average of one to three days. It usually takes about two hours for the food to make it through the stomach and enter the small intestine. The food then begins to be moved into the bloodstream. It takes another six hours for the food to pass all the way through the small intestine. The rest of the time is spent in the large intestine so enough water is removed. Did you know it would take so long from the time you finished your lunch until the process of breaking down the food was done?

6. Compare the labels and functions you put on your handout with your partner’s work. Take turns explaining the functions of each part. Think of specific tasks that you can do to make sure you both understand. Do these tasks to show that you understand.

Remember to make any revisions that are necessary by using a different-colored pen or pencil.

Optional Extension Activity

1. Learn more about digestive enzymes by making observations of the function of real digestive enzymes. Record, in your science notebook, the contents and the results for each test tube in the demonstration your teacher does.

2. Draw, in your science notebook, an analogy map like the one in figure 2.8. Fill it out based on what you observed for the test tubes that contain digestive enzymes. Be sure to include as many parts of the digestive system as you need to in order to fully explain the results.
7. Find the KWL chart you created in Step 2 and answer the following questions.
   a. Have the steps you have completed so far in this activity answered anything from your “W” column? Put a check mark beside anything that you know the answer to now.
   b. Add to the “L” column anything you have learned that would help you answer your fifth-grade friend’s question (see Step 1).
      You may still have questions that have not been answered. That is OK. The tasks in this step help you keep track of what you have learned already.

8. You probably now know some information to help answer your friend’s question. Your friend also mentioned two activities: walking the dog and soccer practice. Both of these activities require energy. Answer the following questions related to energy.
   a. How do you think the amount of energy needed for soccer compares to the amount needed for walking the dog?
   b. Would a person who sleeps all day require any energy? Explain your answer.
   c. Would a person who just ate a big meal and is sitting down while the food digests require any energy? Explain your answer.

9. Take out your Physical Activity Diary handout from the Engage activity. Make sure that you have the “total minutes” row at the bottom of the chart completed.

10. Get a copy of the handout Calories Used Per Day. With your partner, take turns explaining the information that goes in each row and column. Use the number of minutes from your physical activity diary to complete the handout. Follow your teacher’s instructions on what to do if you have questions.

11. Complete the table on the Calories Used Per Day handout.
    You may use a calculator if you need to.

12. Relate the number of Calories you should take in during a day to the number of Calories you used in a day. To do this, complete Steps 12a–d in your science notebook.
   a. Write down the number of Calories that were recommended for you to take in during a day. You found this number during the Elaborate activity, What Should I Eat?, in chapter 1 (Step 17).
   b. Write down the total number of Calories you used in a day. This can be found in the bottom right corner of the chart on the Calories Used Per Day handout.
   c. How do these numbers compare to one another?
   d. What do you think these numbers mean about your own energy balance?
13. Look back at your answers to the questions in Step 8. Based on the information in the Calories Used Per Day handout, revise your answer.

14. Choose the question in either Step 8b or 8c to answer in more detail. Draw an explanation template that you will use to answer the question. Use the information in the reading Your Body Needs Energy to Function to help you write your explanation. As you read, list the evidence that you will use in your explanation.

Refer to I Can Develop a Scientific Explanation if you need help.
This I Can has a picture of the explanation template. It also has more information about writing explanations.

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Reading: Your Body Needs Energy to Function

Imagine that you are running to kick a ball. Once you kick the ball, energy from your foot and leg transfer to make the ball move forward. You have just used some energy! Whenever you use energy, it represents part of $\text{Energy}_{\text{out}}$ in your energy balance.

Even if you are sitting on the sofa, you are using energy. Energy helps your body sit up. Energy is also used as your eyes watch the TV and your ears hear the TV. This is because energy helps your eyes and your ears function. Your brain uses a lot of energy to process information. In addition, some energy from your body is also released as heat, even when you are just sitting around.

But what about growing bigger or digesting food? What about events in your cells, like making cell parts? Do you need energy for each of these processes?

As a matter of fact, each of the processes above requires energy. Even though digestion is the start of breaking down food for energy, it also requires energy. Making all the parts of your body and cells requires energy, too. About 60–70 percent of the energy you need in a day is used for the basic functions of the body. These functions must take place even if you are not moving, just to keep you alive. You need energy for your heart to beat, to breathe, and to keep your body at a constant temperature. We take many of these activities for granted, but we still need energy to get them done.

Using the information in the last few paragraphs, list at least five activities that represent $\text{Energy}_{\text{out}}$. 

continued
All the reactions that occur in our bodies that help us grow and live are called our **metabolism**. Some of these reactions make cell parts. Other reactions are part of getting energy from the small pieces of nutrients after they are digested. There are many other reactions that are part of metabolism. Metabolism also releases a lot of energy as heat. Our **basal metabolic rate**, or BMR, represents the energy we need to carry out the basic needs of the body. “Basal” is a word that means “the minimum, or base, amount.” “Metabolic” comes from the word “metabolism.” “Rate” is the speed at which energy is used, such as “per hour” or “per day.” This means that BMR is how much energy a person uses in a day just being alive. Your BMR represents the energy that your body uses to keep your heart beating. It includes the energy needed to make sure you are breathing. Your BMR includes energy to keep your body at a constant temperature. It also includes energy for other processes to keep your body working correctly.

Some people have higher BMRs than others, meaning they use more energy in a day just to stay alive. Children have high BMRs because they need a lot of energy to grow. Athletes have high BMRs. Remember, your BMR does not include running and jumping, so that is not the reason athletes have high BMRs. The reason athletes have high BMRs is that people with more muscle mass have higher metabolisms. Athletes tend to have a high muscle mass. Muscle tissue stays very active, even when we are sleeping. So the more muscle a person has, the more energy the person uses. As people get older, they tend to have less muscle mass. This means BMR can decrease as people age. Other factors can also affect BMR. If a person is under stress or doesn’t get enough sleep, the person usually has a lower BMR. A person with a fever has a higher BMR. Being too hot or too cold can also raise a person’s BMR.

Remember when you used the ChooseMyPlate website in chapter 1 to find out how many Calories are recommended for you in a day? You had to put in your age, sex, height, and weight. MyPlate used that information to calculate your BMR! It also used your activity level to determine the total amount of energy that you require in a day. Your BMR, the energy you use to digest food, and your physical activity together equal your **Energy_out** for a day.

15. Write an explanation to answer the question you chose in Step 14.

Your explanation template should be partially filled in with the evidence from the reading. Add your claim and reasoning. Be sure to include scientific principles in your reasoning.
16. Share your explanation with the class as your teacher directs.

17. Revisit your KWL chart. Check off any questions in the “W” column that have been answered. Add new information to the “L” column that would help you explain the answer to your friend’s question.

**Reflect and Connect**

Work by yourself to complete the following tasks.

1. Think about a person eating a pepperoni pizza. In which part(s) of the digestive system would each of the following be digested?
   - a. Crust
   - b. Cheese
   - c. Pepperoni

   *Do you remember which energy-yielding nutrients are highest in each part of the pizza? Refer back to your answer to chapter 1, Explain activity (Different Foods, Different Amounts of Energy), Reflect and Connect Question 1 if you need help remembering.*

2. Write the following sentences in your science notebook. Then correct the sentences in a different color so the whole statement is true.

   Food is broken down in the digestive system. When the food is broken down in the stomach and small intestine, energy is released. This energy goes to other parts of the body for cells to use. Any energy that is not used leaves the body as waste.

3. Draw a diagram that shows the flow of energy through a person. Be sure to include the following.
   - a. Indicate where the energy is before it is in a person.
   - b. Show what happens to the energy in the person.
   - c. Indicate how the energy leaves the person.

4. The name of this chapter is *Energy Balance*. In the chapter introduction, you read:

   “If the system is in balance, over time the energy coming into your body should equal the energy used by your body.”

   Explain how this sentence relates to the activities you have done so far in this chapter.

5. What specific tasks did you and your partner do in Step 6 to make sure you both understood the functions of the parts of the digestive system? How did these tasks help you make sure you understood?
Elaborate

Why Do I Need Balance?

In the Explore activity of this chapter, you looked at studies on mice. What happened when $\text{Energy}_{\text{in}}$ did not equal $\text{Energy}_{\text{out}}$? In the Explain activity, you took a closer look at how the body gets energy from food. You also looked at ways that energy was used. How do these amounts of energy relate to one another in humans? What happens to the body if more energy is coming into the body than is being used? What happens if more energy is used by the body than comes in? In this Elaborate activity, Why Do I Need Balance?, you will study what happens when the human body does not have a balance of energy input and output.

To do this, you will use a simulation that allows you to control the energy coming into and the energy going out of a body. You will work to be sure that everyone on your team understands the ideas you are studying.

**Materials**

*For each team of 2 students*

1 computer with Internet access

different-colored pens or pencils

1 calculator

2 graphs from the *Energy Balance Diagram* handout

glue or tape

**Process and Procedure**

In the Explore activity, you thought about how $\text{Energy}_{\text{in}}$ relates to $\text{Energy}_{\text{out}}$ in mice. In this activity, you will think about the relationship between these two processes in humans.
1. In your science notebook, write down the focus question, “What happens when a person does not have a healthy energy balance?” Draw a box around the question.

2. Open the *Eating and Exercise* simulation by clicking *Run Now!* Look for the items you see labeled in figure 2.9. These will help you do the rest of the activity.

3. Choose characteristics for your person. Your person is an imaginary person, so you can make the person different from yourself. The characteristics are on the left-hand side of the window. You should fill out the following information for the person:
   - Select whether your person is female or male.
   - Choose your person’s activity level from the drop-down menu.
     You may read what each level means by clicking on the ? button.
   - Fill in your person’s age.
   - Fill in your person’s height.
   - Fill in your person’s weight.

   The amount of body fat will adjust automatically according to the other information you filled in.
4. Record all the information about your person in your science notebook. You will need this information later in the activity.

5. Create a situation where your person has a higher Energy_in than Energy_out. To do this, complete Steps 5a–e.

   a. Look at the amount of energy that the body is using in a day. This number is found by first looking at the Calories/Day scale in the middle of the screen. There is a bar that shows the number of Calories the person is using. At the top of the bar, there is a number to show the amount of energy being used. This number is equal to your person’s resting BMR and lifestyle.

   b. You may add exercise to the amount of energy used in a day by dragging activities to the Exercise Log. You may drag the same activity to the log more than once.

      Scroll through the activities by clicking the More buttons on each side of the Exercise Catalog box in the upper right. Make sure you are including a reasonable amount of exercise for your person to do.

   c. Record the total amount of energy used in a day in your science notebook.

      The total amount of energy is equal to the energy used by resting BMR, lifestyle, and exercise.

   d. Drag the Healthy Breakfast, Lunch & Dinner triangle, at the bottom of the Food Catalog box on the left, to the plate. This represents a healthy menu for the day.

      The triangle is a picture of the Food Pyramid before 2005. The Food Pyramid was designed by the same people who created MyPlate. At this point, only use the Food Pyramid for your person’s food.

   e. Click on the red Edit button at the top right of the Healthy Breakfast, Lunch & Dinner triangle. Change the number so it is higher than the energy used by the body. For the best results, the number of Calories per day from food should be between 300 and 1,000 Cal greater than the energy used by the body. This is because you are creating a situation where Energy_in > Energy_out. Then press Enter on your keyboard.

      To give you an idea of how much energy this represents, 300 Cal is about equal to two sodas or a slice of pizza. One thousand Cal is about equal to a ¼-pound burger and fries or a milk shake.
6. Create a table like the one shown in figure 2.10. You will use this table to record the results of the simulation.

Figure 2.10: Results of the Eating and Exercise simulation. As you run the simulation, fill in the results in a table like this one.

<table>
<thead>
<tr>
<th></th>
<th>Column 1</th>
<th>Column 2</th>
<th>Column 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Weight in pounds when $E_{in} &gt; E_{out}$</td>
<td>Weight in pounds when $E_{in} = E_{out}$</td>
<td>Weight in pounds when $E_{in} &lt; E_{out}$</td>
</tr>
<tr>
<td>Initial</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 months</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 months</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 months</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 months</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 months</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 year</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7. Press the Play button near the bottom right corner to run the simulation. Fill in column 1 of your table as the simulation runs.

   The easiest way to get your results is to have one partner calling out the weight and one partner recording it in his or her science notebook. The partner calling out numbers should pay attention to the age of the person in the Age box on the bottom left of the window. When it increases by two months, call out the weight. Make sure to record the data when the simulation is done.

8. Press the Reset All button in the middle of the bottom of the window. A box will pop up to confirm that you want to reset the values. Click Yes.

9. Put in all your person’s traits again. Use the numbers that you recorded in Step 3. Be sure to use exactly the same numbers so that you are making a fair test.

10. Create a situation where $E_{in}$ is equal to $E_{out}$. Follow Steps 5a–e again, but this time edit the Healthy Breakfast, Lunch & Dinner Calories to be the same number as the Calories used by the body.

   This person is maintaining a healthy energy balance.

11. Run the simulation by clicking the Play button again. Record the results in column 2 of your table. Change jobs so that the partner who was recording before calls out weights this time.

12. Reset the simulation and fill in the traits for your person again. Use the numbers from Step 3.
13. Create a situation where $\text{Energy}_{in}$ is less than $\text{Energy}_{out}$. This time, the energy used by the body should be between 300 and 1,000 Cals greater than the energy from food.

14. Run the simulation by clicking the Play button again. Record the results in column 3 of your table. The partner who was recording before calls out weights this time.

15. Make sure that both partners have the data for all 3 simulations recorded in their science notebooks.

16. Create a graph of your results as your teacher directs. All 3 situations should be on the same set of axes. Be sure to label which situation each line represents as well as the difference in the number of Calories. Also include the traits of your person.

17. Present your results to the class. Take notes on what happened in each of the 3 situations for the different teams.

   Think about the general trends of the graphs. Did the same thing happen if the person was an adult or a child? Were the trends the same if the person was very big or very small?

18. Write an explanation to answer the focus question, “What happens when a person does not have a healthy energy balance?”

   You might want to use the explanation template to organize your explanation.

19. Read Out of Balance to help you add to your explanation in Step 18. As you read, record notes about the evidence you would like to include in your explanation. Also make sure you complete the tasks in the hints as you read.

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**Reading: Out of Balance**

What does it mean to have a healthy energy balance? Your $\text{Energy}_{in}$ and $\text{Energy}_{out}$ do not have to be equal every day. But when these numbers are about equal over time, you have a healthy energy balance. Why is this important? For adults who are at a healthy weight, energy balance means they can maintain that weight. A healthy weight adds to a person’s overall health.

How do children and adolescents achieve a healthy energy balance? People who are still growing need energy to help their bodies build tissue and bone. So they need more energy going into their bodies. Remember that children and teenagers have high BMRs. This reflects the idea that they need more energy coming in. The energy is then used by activities and metabolism as well as by growth. So $\text{Energy}_{in}$ should about equal $\text{Energy}_{out}$ in children and teenagers, too. A healthy energy balance will give children just enough energy to grow, but not to gain excess weight.

*continued*
Teenage boys need more energy than teenage girls because boys are gaining more muscle than girls during this time. This is a result of the difference between male and female hormones. Figure 2.11 shows the amount of weight 12- and 13-year-olds are expected to gain in a year.

A 12-year-old girl is expected to gain 8–13 pounds over the next year. Average weight gain is 10 pounds.

A 12-year-old boy is expected to gain 8–15 pounds over the next year. Average weight gain is 11 pounds.

A 13-year-old girl is expected to gain 7–11 pounds over the next year. Average weight gain is 7 pounds.

A 13-year-old boy is expected to gain 9–14 pounds over the next year. Average weight gain is 12 pounds.

Some people want to gain or lose weight. How do you think understanding energy balance could help these people change their weight?

Write down your ideas about the relationship between energy and changing weight.

If people want to gain weight, then $E_{\text{in}}$ should be greater than $E_{\text{out}}$. But $E_{\text{in}}$ does not have to be greater than $E_{\text{out}}$ every day. Over a period of a few days, though, the energy taken into the body should be more than the energy used by the body. If people want to lose weight, the energy coming into the body should be less than the energy going out. Like with energy gain, this does not mean that $E_{\text{in}}$ has to be less than $E_{\text{out}}$ every single day.

Draw a table like the one in figure 2.12. Then complete the second column.

Figure 2.11: Healthy weight gain for 12- and 13-year-olds.

Figure 2.12: Relationship between $E_{\text{in}}$ and $E_{\text{out}}$. What happens over time when the amount of energy a person takes in is not equal to the amount the person uses?
What if people want to gain or lose a certain number of pounds? The good news for people who want to gain or lose weight is that scientists have found the amount of energy needed to gain or lose 1 pound (lb). Let's think about how the body handles excess energy. Remember, the energy the body uses is in the form of chemical energy. When there is excess chemical energy, the body makes molecules that store lots of energy that the body can use at a later time. These molecules are called fats. A person will store 1 lb of fat that contains 3,500 Cal of excess energy.

Imagine a person who is interested in losing weight. A healthy rate of weight loss is 1–2 lb per week. The person is interested in losing 1 lb per week. This means that the total $\text{Energy}_{\text{out}}$ should be 3,500 Cal more than the total $\text{Energy}_{\text{in}}$ during that week. Since there are seven days in a week, the person should try to have $\text{Energy}_{\text{in}}$ be less than $\text{Energy}_{\text{out}}$ by about 500 Cal per day.

What would a person do to gain 2 lb a week?

One way people can change the difference between $\text{Energy}_{\text{in}}$ and $\text{Energy}_{\text{out}}$ is to change the amount they eat. It is important to remember that a healthy diet is always needed. People who want to change their weight—whether it is to gain weight or lose weight—should always eat a balanced diet.

Another way to change the difference between $\text{Energy}_{\text{in}}$ and $\text{Energy}_{\text{out}}$ is to change the amount of activity a person does. Think again about the person that wants to lose weight. Imagine that this person eats a menu with 2,500 Cal of energy per day. To lose weight, the person might eat less food, taking in only 2,250 Cal of energy each day. This would decrease $\text{Energy}_{\text{in}}$ by 250 Cal. The person might also begin exercising. If the person exercises enough to use 250 Cal of energy per day, then $\text{Energy}_{\text{in}}$ will be 500 Cal less than $\text{Energy}_{\text{out}}$ each day. This should lead to about a pound of weight loss each week.

You can use this information to predict the amount of weight a person will gain or lose over time. To do so, use the following equation:

$$\text{amount of weight} = \frac{\text{Energy}_{\text{in}} - \text{Energy}_{\text{out}}}{3500} \times \text{number of days}$$

If the amount of weight is negative, the person will lose that amount of weight during the specified time. If the amount of weight is positive, the person will gain that amount of weight during that time. For example, a woman might eat enough to take in 1,800 Cal of energy per day and use 2,300 Cal of energy. Over the course of 90 days, she would lose 12.9 lb. The result is about a pound lost per week, which is a healthy amount to lose in that time.

continued
The woman’s weight change can be represented in an energy balance diagram like the one in figure 2.13. Notice how the number of Calories taken in and used by the body is shown. Also, the arrow helps you understand how much weight she lost. The arrow should always be centered on the tip of the triangle. The arrow should point to the change in weight. Since the woman lost weight, the arrow points down. If it tilted upward, the diagram would show the weight gained. Since the woman lost 12.9 lb, the end of the arrow points to around –13. If she had an energy balance, the arrow would line up with the dotted line.

This diagram can be used to show weight loss that has already happened, as in this example. It can also be used to help people understand what could happen in the future. It could show people their potential weight change if they followed the numbers at the bottom.

Figure 2.13: Energy balance diagram. This diagram shows that the woman lost 12.9 lb. The arrow tilts down from the tip of the balance to the amount of weight lost. If the arrow tilted upward, it would show weight gain.

20. Add the new evidence that you wrote down to the explanation you began in Step 18. Add the new information with a different-colored pen or pencil.

21. If you would like more information about what happens when a person does not have a healthy energy balance for a long time, read the sidebar Unhealthy Weights.
Unhealthy Weights

Gaining or losing a few pounds isn’t cause for a lot of concern. In fact, it is typical for most people. However, weighing too much or too little can cause serious health problems.

You may have heard the words *overweight* and *obesity*. These words describe when a person weighs more than what is considered healthy for the person’s height. Being overweight or obese can cause health problems. An overweight person has a higher risk of developing heart disease, type 2 diabetes, and high blood pressure. Overweight people are also at risk for developing some types of cancer. You will learn more about diabetes in chapter 4 (*Diabetes*) of this unit.

Although it can cause health problems to weigh too much, there can also be problems when someone does not weigh enough. Sometimes not weighing enough is the result of an eating disorder. There are two main types of eating disorders.

**Anorexia nervosa** is one type of eating disorder. The name is often shortened to anorexia. In anorexia, a person is constantly working to be very thin and will not maintain a normal weight. The person might not eat enough food or might exercise excessively. Some people who suffer from anorexia take laxatives or cause themselves to vomit. Many people with anorexia think they are overweight, even when other people see them as very thin. People with anorexia often do not take in enough energy and nutrients. This makes it difficult for their bodies to function properly. As a result, they may have thinning bones, brittle hair and nails, and growth of fine hair all over their bodies. They may also be tired all the time. In severe cases, a person may die of a heart attack. Anorexia can cause serious problems, so it is important to get help in dealing with this disorder. To treat anorexia, doctors help the patient get back to a healthy weight. The doctors also work to help the patient change the behaviors and thoughts that led to anorexia.

Another type of eating disorder is **bulimia nervosa**. People who suffer from bulimia go through episodes of eating an unusually large amount of food. These times are called binges. These people usually feel like they cannot control what they are eating. Afterward, they will try to make up for the binge by vomiting, taking a laxative, or exercising a lot. Unlike anorexia, people who have bulimia may have an average weight. There may still be serious health problems, however. People with bulimia often...
have problems with their mouths and teeth from vomiting. They may have problems with their kidneys or intestines, or they may be dehydrated. To treat bulimia, patients often go to counseling. They may also take medicines to help with depression or anxiety.

Although women and girls are more likely to be affected by an eating disorder, men and boys may be as well. These are complex disorders, so it is important that people who have them get help from a doctor.

Being overweight or being underweight can cause serious health problems. These are often the result of not having a healthy energy balance. One way to help you stay as healthy as you can is to make sure you maintain a healthy energy balance.

Reflect and Connect

Work by yourself to complete the following tasks.

1. Complete the following tasks to help these patients determine how much weight they can gain or lose.

   a. Sara has started a new health plan. She is eating 2,000 Cal of energy each day and putting out 2,500 Cal of energy. How much weight will she lose in six months (180 days)?

   b. Reggie wants to gain weight. If he eats 1,000 more Cal of energy than he uses each day, how much weight can he gain in two months (60 days)?

   c. Do each of these patients’ plans show a healthy amount of weight to gain or lose in the time period given? Explain your answer.
2. Read the following scenario. As you read, write down the numbers you need to calculate the weight change for the person described in the scenario.

**Scenario**

A fast-food restaurant just opened up the street from Joseph's house. Since it opened, he has been walking to the restaurant most days. He has found that he can get pizza and chicken wings at any time during the day. He has also tried the restaurant's fries, ice cream, and burgers. He wonders if walking to the restaurant is enough exercise to keep him from gaining weight.

Joseph's BMR is 1,885 Cal. He is on the basketball team, so he uses about 500 more Cal practicing each day. He has been eating a lot of food, but he tells himself that he needs it since he is playing basketball so much. In a typical day, he has cereal for breakfast; a burger, fries, and a soda for lunch; half a pizza and another soda for dinner; and six chicken wings for a snack. That is about 3,050 Cal in a day.

The basketball season—including preseason practice and games—is 16 weeks long. If Joseph keeps this lifestyle for the whole season, how will his weight change?

Calculate the change in Joseph's weight over the basketball season. Then draw an arrow in the appropriate place on the **Energy Balance Diagram** handout. Glue or tape the handout into your science notebook.

3. When the number of Calories used in a day is more than the number of Calories taken in, a person will lose weight. This happens whether a person exercises or not. Why do you think it would still be important to exercise?

   If you have time, run the **Eating and Exercise simulation** again. Set up the simulation so that the amount of energy from food is about 500 Cal less than the amount energy used, but do not put in any exercise. What happens to the **Heart Strength scale** on the left side of the window?

4. You have learned a lot about $E_{in}$ and $E_{out}$. Revisit the list of items and activities you made from the **Energy and Your Body** cards in the Unit Engage activity, **What about Energy?** You decided which items and activities provide energy, which require energy, and which do neither. Revise the lists now that you know more about energy and your body.

5. The big idea of this chapter (and the title!) is energy balance. How do you think energy balance is relevant to your life?
Evaluate

Creating a Balance

In this chapter, you have learned about energy balance in your body. You saw that the digestive system starts the process of breaking down food to provide your energy. You calculated your basal metabolic rate. You found out the importance of energy balance in maintaining weight. Now it is time to use this information to help others learn about energy balance. In this Evaluate activity, Creating a Balance, you will play the role of a scientist working in a clinic. You will review the case of one of the patients in the clinic. Then you will create an information sheet to help your patient develop a healthy energy balance.

Materials

For each student

- 1 copy of Patient Information Sheet handout
- 1 copy of a patient file from the Patient Files handout
- 1 copy of Creating a Balance Rubric handout
- 1 calculator
- different-colored pens or pencils
- sticky notes

Process and Procedure

In this activity, you will work with a partner to complete the steps. When you work with a partner, it is important to consider your partner’s ideas. Make sure you and your partner both contribute ideas to your work.
1. Read the following scenario to help you understand what you will be doing in this activity.

**Scenario**

Amrita has been working as a scientist in a clinic. The clinic helps people with their energy needs and energy balance. Today four patients have appointments. After the last appointment, each patient created a food diary for a typical day. Each also listed his or her physical activity in a typical day.

Today Amrita is getting ready for each appointment. She is filling out a patient information sheet for each patient. These are sheets that the patients take home to remind them of important information. The sheets help the patients understand energy balance. They also help show how the body begins the process of breaking down food for energy by using the digestive system. It shows them information about their own energy needs and energy output. Amrita will also make recommendations for the patients. This advice helps the patients see how they can achieve a healthy energy balance. It is important for patients to have all the information so they understand what they need to do and why. Help Amrita as she fills out the sheets for today's appointments.

2. Review the handouts titled *Patient Information Sheet* and *Creating a Balance Rubric* with your partner. Ask any questions you have about the handout.

3. Choose a patient file and read the information. As you read, draw a star next to any information that will help you fill out the *Patient Information Sheet* handout.

4. Discuss your ideas on how to fill out the *Patient Information Sheet* handout with your partner. For now, you and your partner will share your ideas. You will complete the sheet by yourself in the next steps.

5. Work by yourself for Steps 5–10. Describe why a healthy energy balance is important. Write your description in box 1 of *Patient Information Sheet*.

   Remember that the patient may not know much about energy balance. Be sure to explain energy balance in a way that would make sense to the patient. You may use the ideas you have written in your science notebook from previous activities.

6. Help your patient understand how energy balance is determined. Explain what $\text{Energy}_{\text{in}}$ and $\text{Energy}_{\text{out}}$ are. Write the information in box 2.
7. Provide your patient with more information about Energy in. You need to explain to the patient how the digestive system is involved in energy balance. To do that, complete Steps 7a–c.
   a. Label the parts of the digestive system in the diagram in box 3.
   b. Write a brief description of each part to help the patient understand the importance of the part.
   c. Explain how the digestive system relates to Energy in.

8. Provide your patient with more information about Energy out. In box 4, describe the ways the body uses energy.
   
   Remember to help your patient understand that the body uses energy for more than just activities, such as running and playing sports. Also help your patient understand how the level of intensity of activities affects Energy out.

9. Analyze the information from your patient. In box 5, describe why your patient gained or lost weight over the summer. The summer was 80 days long. Include whether your patient should be concerned about the change in weight.
   
   Use information from the patient’s Food and Physical Activities form. You should do your calculations on a different sheet. But use information from the calculations to help your patient understand the weight change.

10. Make recommendations for the patient on how to develop a healthy energy balance. Write these suggestions in box 6.

11. Exchange Patient Information Sheets with your partner. Follow Steps 11a–d as you review your partner’s work.
   a. Provide at least 2 pieces of feedback to your partner. Write the feedback on separate sticky notes and put your initials on each sticky note. Stick the note on your partner’s work near what you are commenting on.
      Feedback should be specific and help your partner improve the recommendations. Avoid general statements like, “This is good.” Try to be more specific, like, “Can you be clearer in your description of the function of the small intestine?”
   b. Return your partner’s work.
   c. Examine the feedback you received from your partner.
      Carefully consider each suggestion.
   d. Revise your recommendations based on helpful feedback.
      Make any revisions in a different color.

12. In your science notebook, describe how you and your partner used your teamwork skills in this activity. Focus on how you made sure both of you contributed ideas to your discussions in Steps 4 and 11.

13. Write a brief paragraph about how you think the information you learned in this chapter will help you or your family make choices.

14. Turn in your work as your teacher directs.
Spanish Vocabulary

bulimia nervosa: bulimia nerviosa
digestion: digestión
digestive system: sistema digestivo
energy balance: balance de energía
Energy$_{in}$: ingreso de energía
Energy$_{out}$: egreso de energía
esophagus: esófago
large intestine: intestino grueso
liver: hígado
metabolism: metabolismo
obesity: obesidad
overweight: sobrepeso
pancreas: páncreas
salivary glands: glándulas salivales
small intestine: intestino delgado
stomach: estómago
teeth: dientes
tongue: lengua