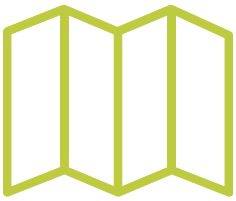


Lesson 3.4

"Blood Doping: Messing with Metabolism to Win Races"

Lesson Overview

Students apply their Active Reading skills to an article about blood doping. Blood doping is an illegal process in which athletes increase their bodies' ability to carry out cellular respiration by storing their own blood and then injecting the stored blood back into their bodies before competitions. Students annotate the article about blood doping, continuing to focus on the strategy of asking meaningful questions, and then discuss their annotations with a partner. This lesson provides students with an intriguing new context in which to apply their understanding of cellular respiration and also provides background for students' discussions in the Science Seminar in Chapter 4.

Investigative Phenomenon: Blood doping leads an athlete's body to release more energy than usual.

Students learn:

- Increased cellular respiration can occur when more oxygen is available to the cells of the body.
- Some athletes increase the amount of oxygen that can be carried by their circulatory systems through a process called blood doping.
- Training at high altitude can also increase the amount of oxygen that can be carried by the circulatory system.

Lesson at a Glance

ACTIVITY		
1	**Warm-Up** (10 min) In order to prepare for today's reading, students activate prior knowledge, considering their initial ideas about how cellular respiration might be different for elite athletes.	WARM-UP
2	**Active Reading: "Blood Doping"** (20 min) By reading about how metabolism is altered in the illegal process of blood doping, students practice their Active Reading skills and deepen their understanding of metabolism.	READING
3	**Discussing Annotations** (15 min) Students have time to discuss their thinking about the reading they did in order to share important insights and/or correct alternate conceptions.	STUDENT-TO-STUDENT DISCUSSION
4	**Homework** Students have an opportunity to learn about how body systems work differently in organisms other than humans.	HOMEWORK

Materials & Preparation

Materials

For the Class

- 1 copy of the Annotation Tracker*

For Each Student

- optional: printed copy of the "Blood Doping: Messing with Metabolism to Win Races" article*
- optional: printed copy of the *Odd Organisms and How They Get the Molecules They Need* article set*
- optional: *Metabolism* Investigation Notebook, pages 79–82*

Digital Tools

- "Blood Doping: Messing with Metabolism to Win Races" article in the Amplify Library
- *Odd Organisms and How They Get the Molecules They Need* article set in the Amplify Library

*teacher provided

Preparation

Before the Day of the Lesson

1. **Read the "Blood Doping: Messing With Metabolism to Win Races" article.** You can find the article in the Digital Resources or the Amplify Library. Students will read and annotate the "Blood Doping" article in this lesson. Familiarizing yourself with the entire article will help you support students in adding questions and comments as they read.
2. **Prepare to model Active Reading.** Review Activity 2 of this lesson and plan how you will model the process of Active Reading. Note that you can use the suggestions provided or modify them to reflect your own questions, ideas, and connections.
3. **Print a copy of the Annotation Tracker for each class.** A PDF file of the Annotation Tracker can be found in the Digital Resources.

VOCABULARY

- blood doping
- cellular respiration
- circulatory system
- energy
- glucose
- metabolism
- oxygen

UNPLUGGED?

Digital Devices Not Required

This lesson can be taught without devices. If students do not have devices, print copies of the "Blood Doping" article and the Investigation Notebook pages for this lesson. (PDF files of both can be found in the Digital Resources.)

If students do not have access to Amplify Science at home, provide them with copies of page 82 from the Investigation Notebook as well as printed copies of the *Odd Organisms and How They Get the Molecules They Need* article set.

DIGITAL RESOURCES

Blood Doping: Messing with Metabolism to Win Races

4. **Choose exemplary student annotations from Lesson 2.2 and prepare to share them with the class.** You may have already shared some annotations from Lesson 2.2 in Lesson 2.3. For this lesson, choose some new annotations to share, focusing on examples that demonstrate good annotation practices such as asking deeper questions.
5. **Preview the *Odd Organisms and How They Get the Molecules They Need* article in the Amplify Library.** Locate and read the article in Digital Resources or the Amplify Library. Students will be reading the article for homework.

Immediately Before the Lesson

1. **Have on hand the following materials:**
   - Annotation Trackers
   - optional: digital devices
   - optional: printed copies of the "Blood Doping: Messing with Metabolism to Win Races" article
   - optional: *Odd Organisms and How They Get the Molecules They Need* article set
   - optional: *Metabolism* Investigation Notebook, pages 79–82

Between-Class Prep

1. **Print or locate a new Annotation Tracker for the next class.**
2. **Erase digital annotations.** Erase the digital annotations you made in the article in the Amplify Library before modeling for the next class.

At the End of the Day

1. **Print a copy of the Annotation Summary Sheet for each class.** A PDF file of the Annotation Summary Sheet is in the Digital Resources.
   - **Use the Annotation Trackers to review students' submitted articles.** If you have time to review students' submitted articles and annotations, continue to fill out each Annotation Tracker to identify questions, alternate conceptions, and exemplary annotations.

Printable article: "Blood Doping: Messing with Metabolism to Win Races"

Annotation Tracker

Annotation Summary Sheet

Odd Organisms and How They Get the Molecules They Need

Printable article set: Odd Organisms and How They Get the Molecules They Need

Metabolism Investigation Notebook, pages 79–82

Metabolism Glossary

Metabolism Multi-Language Glossary

- **Use the Annotation Summary Sheets to analyze students' annotations.** The Annotation Summary Sheet is intended to help you identify trends in student thinking, recurring questions students have about the text, and other issues that you might want to address. Use your Annotation Trackers to fill out the Annotation Summary Sheets.
- **Collect exemplary annotations and recurring alternate conceptions to share with the class.** Exemplary annotations and recurring alternate conceptions can be shared in the subsequent lesson. Identify examples of student annotations that are thought provoking, exemplify the Active Reading approach, and/or target key science ideas. Choose a few exemplary annotations to discuss with students in Lesson 3.5.

Differentiation

Embedded Supports for Diverse Learners

Teacher modeling of Active Reading. You will model Active Reading before students read the "Blood Doping" article. This serves both to guide students in how to engage with the article and to introduce the article and the topic of blood doping to students.

Potential Challenges in This Lesson

Reading-focused. This lesson may be difficult for students who struggle with reading. Several diagrams are key to making sense of this article, so students with little experience with science diagrams may find this especially challenging.

Specific Differentiation Strategies for English Learners

Extra discussion time during reading. Providing extended time for discussion during reading gives English learners and other students who might need more reading support a chance to practice using new science vocabulary and to process what they read. Frequently invite students to discuss the reading with a partner. You may want to suggest they read 1–2 paragraphs individually, annotating as usual, and then come together with their partners to discuss what they just read. Stopping to discuss more often can help some students to process what they are reading more thoroughly and efficiently.

Glossary and Reveal Tool. Remind English learners about the Reveal Tool and remind Spanish-speaking English learners about the *Metabolism* glossary. Encourage them to take advantage of these tools if they find them helpful while reading.

Specific Differentiation Strategies for Students Who Need More Support

Read with a small group. You could choose to read the "Blood Doping" article with a small group of students. Have one student read aloud each paragraph as others in the group read along to themselves. After each paragraph, stop to annotate. You can have students discuss as they annotate to help them generate ideas and questions about the article. You can also stop to discuss as a group the diagrams and any particularly challenging sections of the article.

Specific Differentiation Strategies for Students Who Need More Challenge

Writing opinions about blood doping. After reading, students who need more challenge can write a paragraph about whether or not they think blood doping is something that should be allowed in competitions and why.

Standards

Key
Practices Disciplinary Core Ideas Crosscutting Concepts

3-D Statement

Students obtain and evaluate information about body systems (systems and system models) and energy release (energy and matter) as they actively read an article about how athletes can increase the body's ability to carry out cellular respiration by blood doping. Students focus on asking meaningful questions about the text.

Next Generation Science Standards (NGSS)

NGSS Practices

- **Practice 1:** Asking Questions and Defining Problems
- **Practice 8:** Obtaining, Evaluating, and Communicating Information

NGSS Disciplinary Core Ideas

- **LS1.A: Structure and Function**:
  - In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions. (MS-LS1-3)
- **LS1.A: Structure and Function**:
  - Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. (MS-LS1-2)

- **LS1.A: Structure and Function**:
  - All living things are made up of cells, which is the smallest unit that can be said to be alive. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular). (MS-LS1-1)
- **LS1.C: Organization for Matter and Energy Flow in Organisms**:
  - Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, to support growth, or to release energy. (MS-LS1-7)
- **PS3.D: Energy in Chemical Processes and Everyday Life**:
  - Cellular respiration in plants and animals involve chemical reactions with oxygen that release stored energy. In these processes, complex molecules containing carbon react with oxygen to produce carbon dioxide and other materials. (secondary to MS-LS1-7)

NGSS Crosscutting Concepts

- Scale, Proportion, and Quantity
- Systems and System Models
- Energy and Matter

Common Core State Standards for English Language Arts (CCSS-ELA)

- **CCSS.ELA-LITERACY.RST.6-8.4:** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6–8 texts and topics
- **CCSS.ELA-LITERACY.RST.6-8.8:** Distinguish among facts, reasoned judgment based on research findings, and speculation in a text
- **CCSS.ELA-LITERACY.WHST.6-8.9:** Draw evidence from informational texts to support analysis, reflection, and research
- **CCSS.ELA-LITERACY.CCRA.SL.1:** Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively

Common Core State Standards for Mathematics (CCSS-Math)

CCSS-Math Practices

- **CCSS.MATH.PRACTICE.MP1:** Make sense of problems and persevere in solving them.
- **CCSS.MATH.PRACTICE.MP2:** Reason abstractly and quantitatively.

CCSS-Math Content

- **CCSS.MATH.CONTENT.6.RP.1:** Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities.

1 WARM-UP
Warm-Up

Warm-Up

10 MIN

A message from Dr. Walker asks students to record their initial thinking about the cellular respiration needs of an athlete.

Instructional Guide

1. Project Warm-Up; students work independently. Collapse the instructional guide and project the student screen, or have students turn to page 80 in their Investigation Notebooks. Allow a few minutes for students to individually respond to the Warm-Up.

2. Have students discuss their Warm-Up responses. Ask students to discuss the first question with a partner and then share thinking with the class. Follow the same procedure with the second question. (Note that the goal is not to get the right answer for the second question, but to begin to elicit thinking about the possible cellular respiration needs of athletes.)

3. Discuss the focus on athletes as a way to learn more about metabolism and cellular respiration. Remind students that they started learning about metabolism by investigating several medical conditions in which things were going wrong with metabolism. Now, students will examine the other end of the spectrum; they will consider how elite athletes are able to increase their cellular respiration in order to compete at the highest levels.

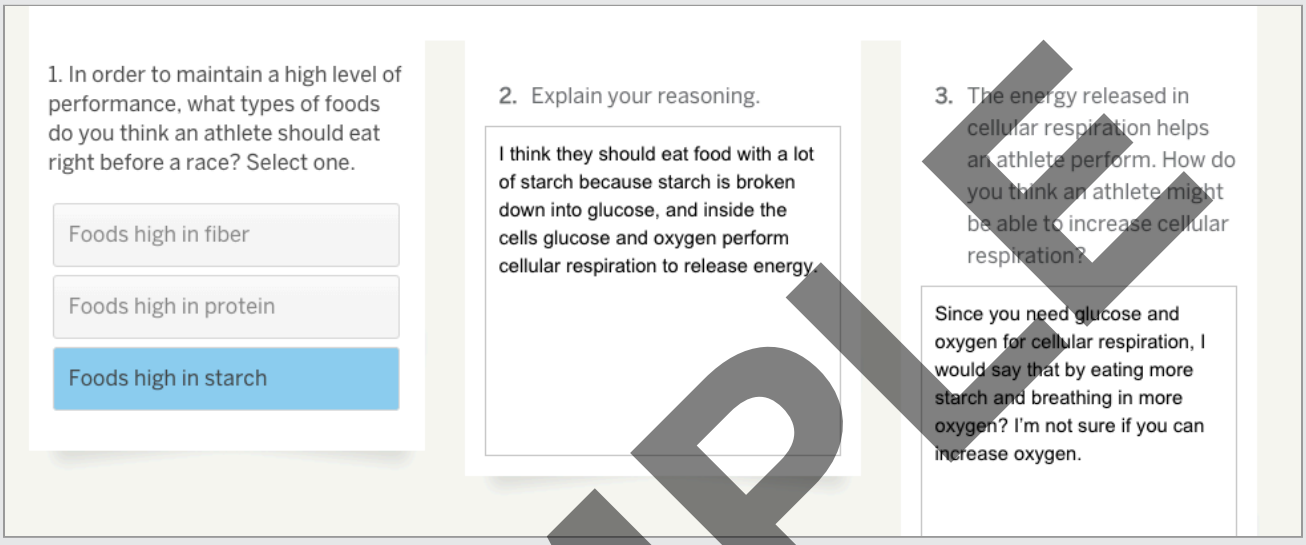
4. Debrief the homework reading. Ask for volunteers to share their responses to the questions from the homework assignment. Focus on the part of the article that described the signals that are sent within Diego's body.

- What are examples of signals sent within Diego's body? [The sensory receptors send signals to Diego's brain cells. These signals are messages that help Diego figure out what to do next. As Diego thinks, more signals move from one brain cell to another.]

Review the different types of inputs that result in these signals.

- Signals sent from the eyes depend on light, which is an electromagnetic input.
- Signals sent from the ears, or from the fingers through touch, are both examples of mechanical inputs
- Signals sent from the nose (using the sense of smell) are examples of a chemical input.

Possible Responses



1. In order to maintain a high level of performance, what types of foods do you think an athlete should eat right before a race? Select one.

Foods high in fiber

Foods high in protein

Foods high in starch

2. Explain your reasoning.

I think they should eat food with a lot of starch because starch is broken down into glucose, and inside the cells glucose and oxygen perform cellular respiration to release energy.

3. The energy released in cellular respiration helps an athlete perform. How do you think an athlete might be able to increase cellular respiration?

Since you need glucose and oxygen for cellular respiration, I would say that by eating more starch and breathing in more oxygen? I'm not sure if you can increase oxygen.

2 READING
Active Reading: "Blood Doping"

Active Reading: "Blood Doping"

20 MIN

Introduce the article and model Active Reading strategies. Students read and annotate with a focus on asking meaningful questions.

Instructional Guide

1. Introduce the term *blood doping*.

We'll be reading an article about a way in which some athletes have tried to trick their bodies into having just a bit more energy than they would normally have. This process—called blood doping—is illegal, but some athletes do it anyway. The article will explain what blood doping is and how it can provide an athlete with more energy.

2. Project Question Starters. Remind students that in this unit, they are focusing on asking deeper, more meaningful questions. These question starters can help them to work on this strategy.

Question Starters

- What causes . . . ?
- Is this evidence of . . . ?
- Does this support the claim that . . . ?
- Is this like (another idea or activity from class) . . . ?
- Why did . . . ? Why didn't . . . ?
- Would it be better if . . . ?
- Who . . . ? What . . . ? When . . . ? Where . . . ? Why . . . ? How . . . ? Can . . . ?

3. Share the exemplary student annotations that you selected from Lesson 2.2. Explain why you chose to share these annotations.

4. Project the "Blood Doping: Messing with Metabolism to Win Races" article from the Amplify Library, or project the printed article using a document camera. Have students open or turn to the article. Explain that you will now model Active Reading, including asking deeper, more thoughtful questions. Students should read along and make annotations, too.

- **Read the title.**

This title makes me think of a lot of questions! At first, I thought I would just write, "How?" but I want to ask a more thoughtful question. So I'm going to ask, "How can a person change her metabolism?"

- **Highlight part of the title text and press ADD NOTE.** Write "How can a person change her metabolism?" Press SAVE.
- **Model asking another question.** Begin reading the first paragraph of the article. Stop after the third sentence.

The article says that athletes process oxygen, glucose, and amino acids better than almost any other humans. I wonder why they process it better.

- **Highlight part of this text and press ADD NOTE.** Write "Why do athletes process these molecules better?" Press SAVE.
- **Model making a connection.** Read the first four sentences in the second paragraph (through the sentence that starts, "To bring in more oxygen . . .").

Even though we are focusing on asking deeper questions, we also want to use the other strategies that will help us to become better, more sophisticated readers. After reading this section, I thought of a connection. I remember that when we ran, we found out that our breath rates increased to bring in more oxygen.

- **Highlight part of this text and press ADD NOTE.** Write "Like when we ran in class and our breath rates increased." Press SAVE.
- **Finish reading the second paragraph and add another annotation.**

I was going to write, "What?" next to this sentence about special gels. But, I know that isn't a very good question. How can I change this into a question that is more thoughtful?

- **Ask students for ideas and choose one of their suggestions.** Highlight part of this text and press ADD NOTE. Write the suggestion and press SAVE.
- **Look ahead to the discussion.**

When you finish reading and annotating the article, you'll select a couple of questions you would like to share. Make sure that you record specific, thoughtful questions that you would like to share with a partner and the class.

5. Students read and annotate the article. Circulate as students read, using the Annotation Tracker to record annotations that you would like to invite students to share during the class discussion.

Teacher Support

Rationale

Science Reading: Benefits of Sharing Student Annotations
Students are motivated by, and respond well to, seeing annotation exemplars from their peers. Using student annotations to model expectations can continue to keep students engaged with this practice.

Background

Science Reading: Asking Questions During Reading Provides Access for All Students
Asking questions about the text is a way for students to show a deep engagement with the reading. Questions provide an access point for all levels of readers. Some students will ask questions about the text that will be answered in the next paragraph, others will ask questions that require research, and some will ask questions that scientists in the field are studying.

Instructional Suggestion

Science Reading: More Practice with Asking Meaningful Questions
If your students need more practice with asking meaningful questions, you may want to take some time, with the whole class, to practice turning less meaningful questions into more thoughtful ones. You can choose a context besides today's article—for example an image or a short article that you can read aloud. Think of a few superficial questions that you could ask and then ask students to offer ideas about how to make those questions deeper and more meaningful. For example, if you were to present an image of a flower, you might start with a simple question such as "What is this?" and encourage students to come up with richer questions such as "What does this part of a flower do?" "Why does this part stick out so much farther than the other parts?" "Does this color attract bees or birds?" "If so, which types?"

Instructional Suggestion

Diverse Learners: English Learners or Other Students Who Are Struggling with Reading Comprehension
Blood doping is a challenging topic that is difficult for many students to comprehend. If you notice that some students are struggling with understanding what happens during blood doping and how it relates to metabolism, you may want to talk with these students in small groups or individually, using the diagrams provided in the article to illustrate and enhance your discussion. Note that students will be rereading the section of the article about how blood doping works in the next lesson, so they will have another opportunity to build their understanding of the blood doping process.

3 STUDENT-TO-STUDENT DISCUSSION
Discussing Annotations

Discussing Annotations

15 MIN

Students identify and tag annotations they would like to share with a partner and then with the whole class.

Instructional Guide

1. Prepare students to move on to partner discussion. Ask students to finish reading and annotating the article.

2. Project and explain Discussing Annotations. Explain that students will review their annotations, choose a question or connection that is interesting to them and that they want to share with a partner, and edit the annotation by pressing EDIT and writing "#share."

Discussing Annotations

#share	Carefully choose an interesting annotation (comment, question, connection, vocabulary word) you'd like to share with your partner and add #share to this annotation.
#discussed	Add #discussed to your annotation if you feel that you and your partner have resolved a question OR if your discussion gave you a deeper understanding about something in the article.
#present	Add #present to your annotation to mark any unresolved questions or ideas you would like to present to the class.

3. Students choose and tag annotations they want to discuss.

4. Partners discuss annotations. Circulate as partners discuss, using the Annotation Tracker and listening for questions and connections that you would like to share during class discussion. Ask students to change the tags in their shared annotations to "#discussed" if they feel that their partner discussions gave them a deeper meaning of their annotations or if they answered their tagged questions.

5. Prompt partners to prepare for class discussion by choosing another interesting or unanswered question they would like to share. Explain that these can be the same annotations they shared with their partners if the questions are still unresolved. Ask students to tag the annotations they would like to present to the class by pressing EDIT and writing "#present."

6. Facilitate a brief class discussion about annotations. Invite students to share their tagged questions and connections. Encourage students to respond to one another and to look back at the article to answer their peers' questions.

7. Highlight exemplary or noteworthy annotations. Refer to your Annotation Tracker and invite students with annotations that you noted to share them with the class. Provide specific, positive feedback as students share, noting when annotations show evidence of Active Reading. Examples might include annotations that make a connection to science ideas, annotations that use vocabulary from the unit, or instances in which students were able to answer their own questions.

Ask students to press NEXT to continue this activity.

8. Prompt students to submit their annotated articles. On each student's screen, the article and the annotations that each student made in the Amplify Library should be visible. Students should answer the reflection question and then submit their articles and reflection question responses by pressing HAND IN. If students are using printed articles and the notebook, they can answer the reflection question on page 81.

9. Point out the homework assignment to students (Activity 4 or page 82 in the Investigation Notebook). If students do not have access to Amplify Science at home, provide them with copies of page 82 from the Investigation Notebook as well as printed copies of the *Odd Organisms and How They Get the Molecules They Need* article set. Explain that students will be reading about how body systems work in other organisms other than humans. They will choose from a set of articles about different organisms.

Teacher Support

Rationale

Science Reading: The Importance of Making Time to Discuss and Share Annotations
Making time to discuss students' annotations can help achieve the following goals in your classroom:

- **Promote a culture of inquiry.** When students can discuss their own connections and pursue their questions collaboratively, they are able to see how feeling confused and challenged by a text is a normal and productive part of science reading.
- **Help students see value in the Active Reading approach and cultivate intrinsic motivation for reading.** Students annotate their articles in unique and creative ways. When students are exposed to many different ways to annotate a text, they can take ownership over the Active Reading process.
- **Provide an opportunity for formative assessment.** Students' thinking, made visible in their annotations and discussions, can help you identify concepts for which they need more support.

Instructional Suggestion

Providing More Experience: Using Student Annotations as Exemplars

You may choose to use students' annotations as models for thoughtful, reflective reading. As you circulate while students are reading, try to find a few annotations that you think are particularly insightful or interesting. In particular, look for questions or connections that link what students have been learning in class to ideas in the article. You can also make note of any interesting conversations you heard during partner discussions. Summarize these comments for the class as models of thoughtful reading and annotating. Even better, share some exemplary student annotations by connecting student devices to the projector (with their permission, of course).

Homework

Students select an article to read from a set of articles about how body systems work differently in different organisms.

Instructional Guide

1. If needed, make additional time to explain homework. If students do not have access to Amplify Science at home, provide them with copies of page 82 from the Investigation Notebook as well as printed copies of the *Odd Organisms and How They Get the Molecules They Need* article set.

Teacher Support

Rationale

Pedagogical Goals: Reading About Other Organisms

For homework, students read an article from an engaging article set about how other organisms get the molecules they need from food and air. Students choose from a list of organisms that have interesting similarities to and differences from humans. Applying what they have learned about humans to a new context will help students broaden and solidify their understanding.

Possible Responses

Compared to a human, what is different about how this organism gets molecules from food and air?

Answers will vary. Examples are given below.

- Blue whale: Although blue whales get oxygen from the air, they can hold their breath longer than humans can because their heart slows down when they go on a long dive. Blue whales eat krill to get the molecules they need from food.
- Grasshopper: Grasshoppers don't have lungs. Oxygen enters their body through holes in their abdomen. Grasshoppers eat grass, and their digestive systems can break down cellulose into glucose, which the human digestive system cannot do. Also, grasshoppers have several hearts in their circulatory system!
- Sea sponge: Sponges don't have respiratory, digestive, or circulatory systems. Water flows through their bodies, carrying oxygen and molecules from food.
- Trout: Trout have gills instead of lungs so they can get oxygen from water instead of air.
- Water bear: Water bears absorb oxygen directly from water. Molecules from food get to the cells through an open area in the water bear's body. Water bears can also go into a kind of hibernation where cellular respiration stops almost completely.

Compared to a human, what is similar about how this organism gets molecules from food and air?

- Blue whale: The blue whale is a mammal, so it breathes air like humans. Blue whales have a heart, lungs, stomach, and intestines like humans.
- Grasshopper: Grasshoppers still need glucose and oxygen to react in their cells and release energy.
- Sea sponge: Sea sponges still need glucose and oxygen to react in their cells and release energy.
- Trout: Trout eat bugs, worms, plants, and other fish, and their bodies break this food down into glucose. Trouts also have hearts and blood vessels just like humans.
- Water bear: When they are not hibernating, water bears still need glucose and oxygen to react in their cells and release energy.