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Name: _____ Date: _____

Lesson 3.4: "Blood Doping: Messing with Metabolism to Win Races"

Energy is constantly being released in your cells, even when you're just sitting around and thinking—so imagine what must be happening in the cells of an elite athlete during a competition! Today, you will read about a controversial and illegal procedure called blood doping, which some athletes have used to increase their cellular respiration and enhance their athletic performance. Understanding how this process works will help you deepen your understanding of metabolism.

Unit Question

- How do the trillions of cells in the human body get what they need to function, and what do the cells do with the things they absorb?

Chapter 3 Question

- How do molecules in the cells of the body release energy?

Key Concepts

- In order to release energy, cells need both glucose and oxygen molecules.
- Inside the cell, the atoms that make up glucose and oxygen can be rearranged to make different molecules. This chemical reaction is called cellular respiration and releases energy.
- Cells can grow and repair themselves by combining amino acid molecules to form larger protein molecules. This growth and repair requires energy release from cellular respiration.

Vocabulary

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

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Warm-Up

Read the message from Dr. Walker. Then, answer the questions below the message.

To: Medical Students
From: Dr. Walker
Subject: Elisa Rodriguez

Thank you for wrapping up the diagnosis of Elisa. Thanks to your careful investigation, we've been able to get started with a course of treatment that should have Elisa feeling more energetic soon.

We have a new assignment for you now. We want you to learn about the metabolism of athletes—not just any athletes, but world-class athletes that train for many hours every day. Energy release in the cells is very important to these athletes. To start your thinking about the energy needs of these athletes, please answer the following questions with your best ideas.

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? (check one)

   ☐ foods high in fiber

   ☐ foods high in protein

   ☐ foods high in starch

2. Explain your reasoning.

_____

_____

_____

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

_____

_____

_____

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Reading "Blood Doping"

1. Read and annotate the article "Blood Doping: Messing with Metabolism to Win Races."
2. Choose and mark annotations to discuss with your partner. Once you have discussed these annotations, mark them as discussed.
3. Now, choose and mark a question or connection, either one you already discussed or a different one you still want to discuss with the class.
4. Answer the reflection question below.

Rate how successful you were at using Active Reading skills by responding to the following statement:

As I read, I paid attention to my own understanding and recorded my thoughts and questions.

- ☐ Never
- ☐ Almost never
- ☐ Sometimes
- ☐ Frequently/often
- ☐ All the time

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Active Reading Guidelines

1. Think carefully about what you read. Pay attention to your own understanding.
2. As you read, annotate the text to make a record of your thinking. Highlight challenging words and add notes to record questions and make connections to your own experience.
3. Examine all visual representations carefully. Consider how they go together with the text.
4. After you read, discuss what you have read with others to help you better understand the text.

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Homework: Reading *Odd Organisms and How They Get the Molecules They Need*

You have learned a lot about body systems in humans, but how are other organisms similar and different? From the *Odd Organisms and How They Get the Molecules They Need* article set, choose one organism to read about and answer the questions below.

I read about the (check one)

- ☐ blue whale
- ☐ grasshopper
- ☐ sea sponge
- ☐ trout
- ☐ water bear

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

_____

_____

_____

_____

_____

_____

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

_____

_____

_____

_____

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The world of international bicycle racing can be so competitive that some athletes cheat by blood doping.

Blood Doping:

Messing with Metabolism to Win Races

To win international bicycle races, you can't just be in good physical shape—you have to be in AMAZING shape. Your metabolism has to work like a well-oiled machine. The world's top cyclists work to perfect their muscles and body systems so that they process oxygen, glucose, and amino acids better than almost any other humans on Earth.

A Cyclist's Metabolism

What's so special about a top cyclist's metabolism? Cyclists' muscle cells contain unusually high numbers of mitochondria, where glucose and oxygen combine to release energy. That means their muscles can release more energy than most people's muscles. To bring in more oxygen, top cyclists breathe hard: up to 75 breaths per minute. To bring in more glucose, they eat lots of carbohydrates, such as starch, even while they're riding! Cyclists often slurp down special gels filled with glucose while they're on their bikes, one hand on the handlebars and the other popping open the gel. To transport these molecules more quickly to their muscle cells, their hearts beat fast: up to 200 beats per minute. A faster heart rate pushes the molecules through the circulatory system more quickly and out to all the cells in the body sooner.

The problem for top cyclists is that even all that isn't always enough to win. Every cyclist in the race is in perfect physical shape, and all of them are looking for an edge to help them win. Sadly, that means some decide to break the rules to help them get ahead . . . not by taking a shortcut on the racecourse or breaking a competitor's bike, but by injecting themselves with extra blood from their own bodies—a practice known as blood doping. Blood doping is banned, meaning it's not allowed in competition, but some cyclists secretly do it to improve their performance. The most famous example of an athlete who used blood doping is Lance Armstrong, who was known as the best cyclist in the world until he admitted to blood doping in 2013.

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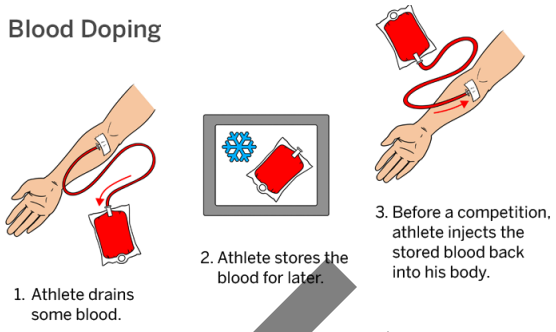
What Is Blood Doping?

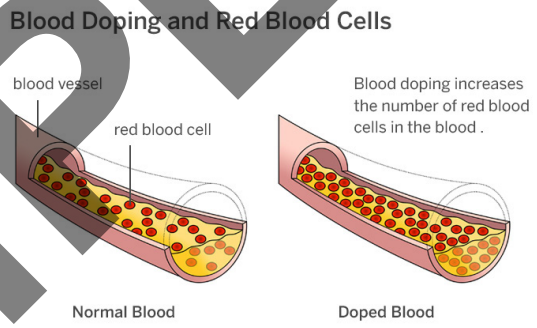
In most cases of blood doping, an athlete drains some of his or her own blood, chills the blood to keep it fresh, and stores it for several weeks or even months. The athlete's body naturally works to replace the lost red blood cells. Then, just before a competition, the athlete injects the stored blood back into his or her body. Injecting blood increases the number of red blood cells in the athlete's body.



Blood doping requires athletes to remove and store their own blood, then inject it back into themselves later.

How Blood Doping Works in the Body

Red blood cells carry oxygen from your lungs to every cell in your body, including your muscle cells. The red blood cells fill up with oxygen in the lungs and then are pumped out to the body cells, where they drop off the oxygen before returning to the lungs. Each red blood cell can only carry a certain amount of oxygen. Once your red blood cells are full, you can't get any more oxygen into your blood with that breath, no matter how much air you take in. Blood doping improves the body's ability to carry oxygen by increasing the number of red blood cells in the circulatory system. With more red blood cells, the circulatory system can deliver more oxygen to all the cells of the body. The extra oxygen delivered to the body's cells can increase the rate of cellular respiration, which can help an athlete perform better and for a longer time without becoming tired. This happens because oxygen is necessary for the release of energy in the body.



Blood doping increases the number of red blood cells in the body.

The body's cells release energy through a chemical reaction called cellular respiration. For cellular respiration to happen, cells need both oxygen and glucose. Oxygen enters the body through the respiratory system and is delivered to all the cells of the body by the circulatory system. At the same time, the circulatory system provides the cells with glucose produced when the digestive system breaks food down. Inside the cells, the glucose and oxygen react to produce carbon dioxide

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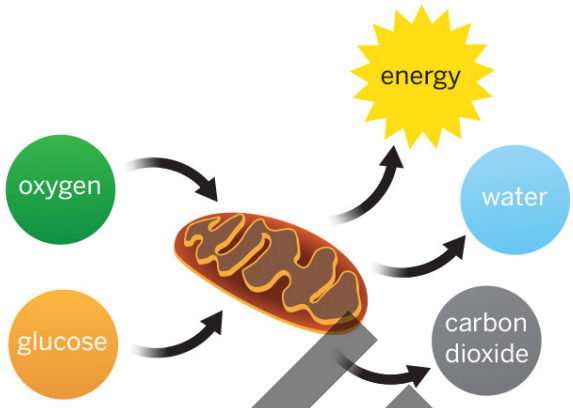
and water, and release energy for the body in the process. More oxygen in the body means a faster rate of cellular respiration and increased release of energy.

Catching Blood Dopers

Blood doping is very difficult to detect. Since the body always contains red blood cells, it is difficult to find evidence that an athlete has injected extra red blood cells into his or her bloodstream. One detection method involves testing the age of the red blood cells in a blood sample. The human body constantly produces new red blood cells to replace cells that have died. Blood doping means injecting stored blood, and the red blood cells in stored blood are older than the new red blood cells constantly being produced in the body. A blood sample with an unusually high number of older red blood cells can be evidence of blood doping.

Another method scientists use to detect blood doping is testing the amount of hemoglobin (HEE-moe-globe-in) in the athlete's blood. Hemoglobin is a protein made by the body that carries oxygen in red blood cells. The more red blood cells a person has, the more hemoglobin you'll find in his or her blood. If an athlete has a hemoglobin level that is higher on the day of a race than it was a week before the race, that provides evidence that the athlete might be blood doping. The athlete might even be disqualified from the race if his or her hemoglobin levels are too high.



In the parts of the cells called mitochondria, glucose and oxygen combine to make carbon dioxide and water, releasing energy. This is called cellular respiration.

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Dangerous Side Effects

One serious potential side effect of blood doping is that increasing the number of red blood cells also increases the thickness of the blood. This unusually thick blood makes the heart work harder and can even cause heart failure.

An Alternative to Blood Doping

There is a legal way for athletes to increase the number of red blood cells in the body: high-altitude training. In the weeks leading up to a competition, some athletes train in the mountains. At high altitude, there is less oxygen in the air than there is at sea level. The athlete's body adjusts to the lack of oxygen by producing more red blood cells: because the body senses that less oxygen is available, it produces more red blood cells so that more oxygen can be picked up with each breath. It takes the body several weeks to adjust and increase the number of red blood cells. High-altitude training takes a longer time than blood doping, but it has the same effect and is not considered cheating. However, high-altitude training may have the same harmful side effect of making blood thicker.

High-altitude training has similar effects to blood doping, but it's legal.

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