A Guide to Developing Literacy Practices in Science

Reading for a Purpose: Molecules the Human Body Needs

Overview

What's in this guide? This strategy guide introduces an approach for having students read reference texts for a purpose. Students learn to identify appropriate sections of a reference text to read in order to gather evidence to answer a focus question. This guide includes a plan for introducing students to reading with a purpose with the reference text *Molecules the Human Body Needs*, which details the ways our bodies use oxygen and glucose, as well as describes how our bodies use amino acids for growth and repair.

Why read for a purpose? Giving students explicit instruction and practice in reading with a purpose helps them develop the ability to read science texts to answer questions and find evidence from the text to support their answers. While students may be accustomed to the drill of reading for the purpose of answering end-of-chapter questions, they have likely not realized that science reading at its best can be a form of inquiry. By engaging students with a compelling, authentic, relatable question before reading and by demonstrating specific strategies for answering that question, students can learn how to inquire purposefully into text. Curiousity-driven reading is both motivating and prepares students to read authentically within the discipline of science. In addition, students learn that text features, such as headings and visual representations, can help them find information quickly.

How This Fits Into Your Science Curriculum

Reading *Molecules the Human Body Needs* introduces students to the idea that humans need specific molecules in order to survive. It also provides details about how oxygen and glucose molecules are necessary components for the release of energy in cells. In addition, students can also read about amino acids, which are the building blocks of proteins and are used for cellular growth and repair. This strategy guide fits well toward the beginning of a unit on cellular respiration and other metabolic processes. The article provides an overview of the following concepts: what a molecule is, how the body breaks down molecules, the relative size of molecules, and the role that molecules play in cellular respiration. Before reading the article, it is important for students to have a basic understanding of what cells are.

Addressing Standards

NEXT GENERATION SCIENCE STANDARDS

Disciplinary Core Ideas

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.

Crosscutting Concepts

Energy and Matter: Within a natural system, the transfer of energy drives the motion and/or cycling of matter. **Science and Engineering Practices**

Obtaining, Evaluating, and Communicating Information: Critically read scientific texts adapted for classroom use to determine the central ideas and/or obtain scientific and/or technical information to describe patterns in and/or evidence about the natural and designed world(s).

COMMON CORE STATE STANDARDS FOR ELA/LITERACY

Reading Standards for Literacy in Science and Technical Subjects 6-12

RST.6–8.1: Cite specific textual evidence to support analysis of science and technical texts. **RST.6–8.5:** Analyze the structure an author uses to organize a text, including how the major sections contribute to the whole and to an understanding of the topic.





Earth Science

Grades 6-8

Science Background

Cells are the smallest unit that can carry out all of life's functions. Cells are made of and maintained by even smaller parts called **molecules**, which are not alive but when combined can create a living cell. Certain molecules are essential to sustaining human life—we need to take in **oxygen**, **glucose**, and **amino acid** molecules from the environment. We breathe oxygen molecules from the air, and glucose and amino acid molecules come from our food. Our digestive system breaks down starch into glucose and breaks down proteins into amino acids. While starch and proteins are larger molecules, glucose and amino acids are smaller. The circulatory system can carry the smaller glucose and amino acid molecules to the cells of the body. Students are likely to know that oxygen comes from the air we breathe, but they probably don't know the reason we breathe—to get energy. Oxygen molecules alone don't provide the body with energy; both oxygen and glucose combines with oxygen to produce carbon dioxide and water, releasing **energy**. This reaction takes place in the **mitochondria** of each cell.

Getting Ready

- Read the first page of *Molecules the Human Body Needs* and prepare to model finding evidence in the text to answer a question. Make sure you have a way to project the article during class.
- 2. Make one copy of the article and one copy of the Finding and Recording Evidence from the Text copymaster for each student.
- 3. On the board, write "Why do people breathe?"
- 4. On the board, create a class version of the Finding and Recording Evidence from the Text table.

Activating Background Knowledge (5 minutes)

- 1. Pose question. Have students think about the question you wrote on the board: *Why do people breathe?* Ask them to think about what they already know that will help them answer this question.
- 2. Students respond. Ask students to record their ideas about the question individually. Alternatively, you could ask students to discuss their ideas with a partner.
- **3. Debrief.** Lead a class discussion in which volunteers share their responses to the question.

Reading the Introduction (10 minutes)

1. Set purpose for the session. Explain to students that although they may think the answer to the question *Why do we breathe?* is *in order to stay alive*, the answer is more

complex than that. Explain that today, students will read sections of a reference text in order to learn more about what breathing helps our bodies do that keeps us alive.

- 2. Discuss reference texts. Project page 1 of the article and distribute one copy of the article to each student. Explain that this is a reference text, which people read in order to find out specific information. Have students look through the article to see what they notice about how the text is organized. Have a few volunteers share their ideas about the following questions.
 - What do you notice about how this text is organized? [There are four sections. There are headings and subheadings. There are many photographs and diagrams.]
 - What do you think you might learn from this text about why people breathe?
- 3. Preview the introduction. Say, "Reference texts often begin with an introduction. An introduction provides important background information about the topic. It also provides an overview of what you will find in the rest of the text."
- 4. Model reading and annotating. Explain that you are going to show students how to read the introduction while keeping the focus question in mind. Read the first paragraph aloud and then say, "I read that in order to stay alive, the human body needs certain molecules from the environment. I wonder if those molecules are part of the reason we need to breathe."

Supporting English Language Learners

Some ELLs may understand science concepts but may have difficulty demonstrating this understanding in English. To get a clearer picture of students' understanding, find ways for them to show their ideas that are not entirely dependent on language. Allowing ELLs to create annotated drawings provides them with more opportunities to express what they know. As students read the article, they can use drawings and words to record their ideas in their tables. Students can also respond to the focus question by making an annotated drawing to show their ideas about why we need to eat and breathe. You might also want to direct ELLs to read the "Oxygen" section of the article, since students are likely to have more background knowledge about oxygen than they have about glucose.

Next to the last sentence of the first paragraph of the article, write "I wonder if those molecules are part of the reason why we need to breathe."

- 5. Students read the introduction. Invite students to read the remainder of the first page independently. Let them know that they should write notes about anything they find that connects to the focus question, as you just modeled.
- 6. Debrief the introduction. After students have read the introduction, have a few volunteers share any annotations they made that relate to the focus question.

Using Headings to Find Information (5 minutes)

- 1. Preview the remaining information. Explain to students that they will now read in more depth about two of the molecules described in the introduction—oxygen and glucose.
- 2. Introduce the Finding and Recording Evidence from the Text student sheet. Distribute one copy of the Finding and Recording Evidence from the Text student sheet to each student. Explain that the table will help them keep track of the evidence they find in the text that addresses the focus question.
- 3. Provide another strategy for reading reference texts. Project page 2 of the article. Say, "When people read reference texts

in order to answer a question, they don't necessarily read all the information. They use headings and subheadings to find which parts might be most relevant to their question, and then they read those parts carefully."

- 4. Explain what students will do. Remind students that you are using the text to try to find out why people breathe. Explain that when you find important information in the text, you will indicate this on the article, as well as record notes about the idea in the table. Invite students to record notes in their tables while you are modeling.
- 5. Model reading and writing notes. Read aloud the first paragraph of page 2 and underline or highlight the following phrases: oxygen is made of molecules and found in water, as well as in the bodies of humans. Explain to students that you are going to write a quick note in the table that describes what you just read. In the table you created on the board, write "Page 2: Oxygen molecules are in my body." Point out that you also included the page number from the article to indicate where you found the information.
- 6. Model how to use subheadings. Read the subheadings in the article aloud and have students help you decide whether or not the section will help you answer the focus question. For example:
 - Read aloud the first subheading, "Oxygen in the Human Body." Say, "This section of the text may provide me with information about breathing. I will read this section to see if I can learn more

Reading Reference Texts

Reference texts provide in-depth information about specific topics and are typically read for particular purposes. For this reason, people do not read every section in reference texts, nor do they read reference texts from beginning to end. Rather, they search for the information they need and then read the relevant sections carefully. In this session, you will model the process of identifying sections of the reference text that relate to the focus question. Reading reference materials in this way is authentic to how scientists use reference materials, and it encourages students to read complex text both purposefully and carefully. about the relationship of oxygen and the human body." Read the section aloud and highlight the following: *Every cell in an* organism needs oxygen molecules. Record a note about this in your table and include the page number of the article.

- Read aloud the second subheading, "The Scale of Oxygen." Let students know that this section may be important. However, after reading the first sentence, which talks about the size of molecules, you don't think it will help you answer your question about breathing. Therefore, you will not continue reading the section.
- Read aloud the remaining four subheadings, "Oxygen in Air," "Oxygen in Water,"
 "Oxygen in Cellular Respiration," and "Oxygen Producers." Ask, "Do any of these subsections seem relevant to learning about why people breathe?" If students don't point it out, explain that when you hear the word respiration, you know it relates to breathing, so even if you're not sure what cellular respiration is, you probaly want to read that section, too.
- Let students know that they will want to use the same process to decide what subsections in the "Glucose" section they might want to read.

Reading and Recording Evidence (15 minutes)

- 1. Students read about oxygen and glucose. Have students read what they think might be relevant portions of the "Oxygen" or "Glucose" sections of the article and record in their tables the information that relates to the focus question. You can also encourage students to record annotations on the article for additional questions, connections, and ideas they have as they read.
- 2. Pairs discuss. As students finish reading, ask pairs to use the text and the notes they recorded in their tables to discuss the focus question. Make sure that students refer back to the text as they discuss.

Synthesizing Ideas (10 minutes)

1. Students share and reflect. Ask a few pairs to share their responses, pointing to specific evidence in the text that supports their answers

to the focus question. Encourage students to respond by asking the following questions as needed.

- "How did you know which sections to read?"
- "Where in the article did you find the evidence to support your answer?"
- "How does this evidence address the focus question?"
- 2. Students write a brief response to the focus question. In their tables, have students respond in writing to the focus question: *Why do we breathe?* Encourage them to think about how their ideas may have changed as a result of reading the article.
- **3. Prompt further questions.** Ask students to look back over the article and think about additional questions they had. Lead a brief discussion about what else students wonder about why we breathe, or other topics from the article.
- 4. Going further: read about amino acids. As an extension, you could ask students to read the "Amino Acids" section, which describes the role of amino acids in cellular growth and repair. This section adds additional complexity to the question of why we breathe.

Connecting to Standards

Reading reference text for a purpose is an approach that capitalizes on the overlap between the science practices in the Next Generation Science Standards (NGSS) and the Common Core State Standards (CCSS) for English Language Arts. For example, learning to ask questions and answer them with evidence is an important skill for students to develop (NGSS Science Practice 1: Asking Questions and Defining Problems). When students read sections of reference text closely, it helps them learn how to locate and cite specific textual evidence in support of these questions (CCSS.ELA-Literacy.RST.6-8.1). In addition, students learn to synthesize information from text into a coherent understanding of a concept (NGSS Science Practice 8: Obtaining, Evaluating, and Communicating Information).

Generalizing This Practice

Reading reference text for a purpose reflects the way scientists read when they are doing research—they read for the purpose of answering specific questions, locating particular pieces of information, or further exploring an interesting topic about which they already know a little. Reading with a focus question in mind helps students break down complex text so they can experience how focused reading helps them gain knowledge about the world. Use the following steps to teach this strategy with a variety of topics and texts.

- 1. Select appropriate reference texts. Reference materials should address the science content you are teaching as well as the goals of your curriculum. If your students do not have experience reading reference texts, consider finding (or have students find) a variety of examples of reference texts, both print and digital, to help them understand what these texts are like.
- **2. Create a focus question.** The focus question should relate to students' lives, should be interesting to them, and should motivate them to read the reference text. Make sure that the question is one that students will be able to answer from reading the text.
- **3. Introduce the focus question and reference text.** Introduce students to the topic and the focus question. Show them the reference text and ask them to observe how it is organized.
- **4. Model thinking as you read.** Read a portion of the example text and stop to think aloud. Explain that you are reading with the focus question in mind. Point out specific areas of the reference text that address the question. Write annotations on the text to show students how to indicate which parts of the text answer the focus question. You could also model how to rephrase key ideas from the text in your own words. Write these on a separate page.
- **5. Have students read.** Encourage students to read and annotate their reference text independently, using the strategies that you modeled. Though they should keep the focus question in mind as they read, they may also want to write additional annotations on the article about their own questions and ideas. (These can be good fodder for further reading, discussion, and investigation.)
- 6. Encourage student collaboration. After students have had a chance to read through the text, have them work with partners to discuss their annotations as well as to respond to the focus question. Make sure that students refer to the text as they discuss.
- **7. Synthesize ideas.** Have the class discuss the answer to the focus question. During the discussion, encourage students to cite specific places in the text that provide evidence for the focus question.
- 8. Formative assessment opportunity. Ask students to use the text, their annotations, and the understanding gained during partner and class discussions to independently respond in writing to the initial question.
- **9. Reflect on the process.** Invite students to reflect on the strategies they used while reading the reference text. Encourage them to approach other reference texts in the same way in the future.

Finding and Recording Evidence from the Text

Focus Question: Why do we breathe?

- 1. As you read, write notes on your article of any information that helps you answer the focus question.
- 2. In your own words, record the information in the table below. For each piece of information, be sure to record the page number of the article on which you found that information.

Oxygen	Glucose

- 3. Discuss your annotations and research notes with a partner. Write notes in the table about the section of the text that your partner read as well.
- 4. Based on what you read, answer the focus question. Be sure to include evidence from the text that supports your ideas.

MOLECULES THE HUMAN BODY NEEDS

Molecules are so small, we can't see them. In fact, they're too small to see through most microscopes! Only the most powerful microscopes can make images of molecules, and even then they appear blurry.

Molecules may be tiny, but they are hugely important: there are some molecules your body can't survive without. In order to stay alive, the human body has to get these molecules from the environment.

One of these molecules might be easy to guess: oxygen. We need to get oxygen molecules from the air around us to keep our bodies alive.

Our bodies get other essential molecules from the food we eat: glucose and amino acids. We get glucose molecules mainly by breaking down foods that contain starch, such as fruits and vegetables. Amino acid molecules are the building-blocks of proteins, and we get them from protein-rich foods such as beans, meat, and eggs.

To learn more about these molecules, turn to the following pages:

- oxygen—page 2
- glucose—page 4
- amino acids—page 6







OXYGEN

Oxygen is an invisible gas with no smell or taste. Even though oxygen is invisible, it is a kind of matter—oxygen is made of molecules, it weighs something, and it takes up space. The air on Earth is made of oxygen and other gases. Oxygen can also be found in water, as well as in the bodies of humans and other living things.

Oxygen in the Human Body

Humans need oxygen to survive, and so do most living things on Earth. Every cell in an organism needs oxygen molecules. In humans, the respiratory system brings molecules of oxygen into the body. Then the circulatory system carries oxygen molecules to every body cell.

The Scale of Oxygen

Like all molecules, oxygen molecules are too small to see. However, oxygen molecules are especially small, even for a molecule. They are much smaller than amino acid molecules, for example. Oxygen molecules are small enough to pass from the lungs in the respiratory system into the blood of the circulatory system.

Oxygen in Air

Air is not all oxygen. The air in Earth's atmosphere is a mixture of gases, with about 21% oxygen. You can't see oxygen in the air around you, but it is visible from space. Viewed from space, oxygen and the other gases in Earth's atmosphere look like a blue glow above the clouds.



This is a model of an oxygen molecule. Models like this one just represent the structure of molecules—oxygen molecules don't really look like this. They are invisible!



Your respiratory system brings oxygen into your body whenever you breathe.



Oxygen is one of the gases that make up the air in Earth's atmosphere.

Oxygen in Water

Oxygen can dissolve in water: most of Earth's water has oxygen in it. The oxygen is invisible, just as oxygen in the air is invisible. You can't breathe underwater, but some organisms can. Fish and aquatic plants and animals take in oxygen from the water where they live, using gills and other organs. Water in different places can have different amounts of oxygen dissolved in it. One pond might have lots of oxygen in the water, and a different pond might have almost none.

Oxygen in Cellular Respiration

Humans, and almost all other kinds of living things, need oxygen to survive. Within every cell of an organism, oxygen and glucose release energy in a chemical reaction called cellular respiration. This released energy allows the body to move, grow, and keep warm.

Oxygen Producers

Plants and other plant-like organisms (such as algae or seaweed) produce oxygen, sending it into the air or water. Oxygen is an output of photosynthesis, the reaction plants use to produce their own food. Plants also use oxygen—they need it for cellular respiration, just as animals do.



FWS/Eric Engbretso S

Fish get their oxygen from the water by using organs called gills, which are part of their respiratory systems.



In cell parts called mitochondria, oxygen plus glucose combine to make carbon dioxide plus water, releasing energy. This process is called cellular respiration.



Plants and algae produce oxygen. These algae are producing so much oxygen that bubbles are forming on them!

GLUCOSE

Glucose is a molecule that cells can use to release energy. For humans and many other organisms, glucose comes from food.

Glucose in the Human Body

Humans need glucose to survive, and we get our glucose from food. The human digestive system breaks food down, and some of the digested food releases glucose. This glucose is absorbed in the small intestine where the glucose moves from the digestive system into the blood of the circulatory system. From there, the circulatory system carries glucose to all the cells of the body.

Glucose from Food

Most of our glucose comes from foods such as bread, potatoes, rice, and pasta. These foods contain a large molecule called starch, which is made up of long chains of glucose molecules. Our digestive system breaks down starch into glucose. We can also get glucose from foods that are high in natural sugars, such as fruit and milk. The digestive system breaks down these natural sugars into glucose. Other animals can get glucose from foods that humans can't digest. For example, cows can digest a molecule found in grass called cellulose. Cows can break cellulose down into glucose, but humans can't. That's why humans don't eat grass, but cows do.



This is a model of a glucose molecule. Glucose does not really look this way; it's just a model to show the molecule's structure. Molecules are too small to see, so scientists who study molecules use models like this one to understand them better.



USDA/Photo by Peggy Greb

Humans get glucose from foods such as pasta, rice, bread, fruits, and vegetables.

Photo by Scott Baue



Starch molecules are long chains made up of glucose molecules. The digestive system breaks down starch molecules into glucose.

The Scale of Glucose

All molecules are small, but some are smaller than others. For example, glucose molecules are much smaller than starch molecules. Starch molecules, found in foods such as bread, are long chains made up of a lot of glucose molecules. While starch molecules are too large to pass through cell membranes, glucose molecules are small enough to enter a cell.

Glucose in Cellular Respiration

Why do humans and so many other organisms need glucose? Without glucose, none of the cells in our bodies could release energy to move, grow, and reproduce. Glucose is essential for a chemical reaction called cellular respiration. Inside a part of the cells called the mitochondria, glucose combines with oxygen to produce carbon dioxide and water, releasing energy.

Glucose Producers

We get our glucose from food, but some organisms can make their own glucose. Plants and algae are glucose producers: they make glucose through the process of photosynthesis. Photosynthesis is a chemical reaction that happens inside plant cells. Using energy from sunlight, plants take in carbon dioxide and water to produce glucose and oxygen. That's why foods made from plants, such as fruits and grains, are good sources of glucose.

Glucose Can Be Stored

Glucose that is not immediately needed for cellular respiration can be stored for when it is needed later. The human body can store glucose in the form of fat or large molecules called glycogen. Plants can store glucose as starch or as cellulose, a tough fiber.



Starch molecules are too large to pass through the cell membrane, but glucose molecules are small enough to enter cells.



In the mitochondria, glucose plus oxygen combine to make carbon dioxide plus water, releasing energy. This process is called cellular respiration.



Wikimedia/Pauline Eccles

Potato plants make glucose through photosynthesis. The plants store glucose in the form of starch, which makes up the potatoes. That's why humans can get glucose by eating starchy potatoes. SDA/Photo by Peggy Greb

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AMINO ACIDS

Amino acids are small molecules that form the building blocks of large molecules called proteins. You may think of proteins as just food, but they are more than that. Much of your body is made of proteins, and those proteins are made of amino acids. Your body needs amino acid molecules to build proteins and new cells.

Amino Acids from Food

The proteins found in the human body are made of twenty different kinds of amino acid molecules. Eleven of those amino acids can be made by the body itself, but there are nine essential amino acids that the human body cannot make. We have to get these essential amino acids from protein-rich foods, including meat, beans, nuts, eggs, and milk.

Amino Acids in the Human Body

The body can't use the proteins from food until they are broken down into amino acid molecules. This breakdown happens in the stomach. Inside the stomach, digestive enzymes break down proteins into the amino acid molecules they are made of. The amino acid molecules pass into the small intestine where they are absorbed into the blood of the circulatory system. The circulatory system carries amino acids to every body cell.



These models represent three different kinds of amino acid molecules. All three are essential for your body.



We get amino acids from protein-rich foods such as beans, meat, nuts, and eggs.



Amino Acids Build Proteins in the Body

Within your cells, amino acids are combined in many ways to make thousands of different protein molecules. Each type of protein does something different in the cell or in the body. Some proteins build parts of cells, others send messages between different parts of the body, and others help protect the body against disease. Thousands of different kinds of protein molecules perform thousands of different functions in the body.

The Scale of Amino Acids

Proteins are extremely large . . . for molecules. (They're still too small to see.) However, the amino acid molecules that make up proteins are very small. Protein molecules are too big to pass through the cell membrane, but amino acid molecules are tiny enough to enter cells.

Different Proteins in Different Organisms

The proteins in the foods you eat are different from the proteins that make up your body. All the proteins found in the foods you eat were made in the cells of living organisms. For example, the protein molecules in a piece of baked chicken were made in the cells of the chicken when it was alive. The protein molecules in a bite of beans were made in the cells of the bean plant when it was alive. Once you eat these proteins, they are digested into amino acids. When these amino acids get to your cells, they are built into new proteins. These new proteins are different from the proteins you ate. A human cell needs to make different proteins than a chicken cell or a bean cell does!



This is a model of a type of protein made by the human body that helps protect the body from disease. This kind of model is called a ribbon model. It helps show how the large protein molecule is twisted and folded.

Breaking Down Proteins and Putting the Amino Acids Back Together



1. Proteins from food are made of many amino acids joined together.



2. Your digestive system breaks down the proteins from food into individual amino acids.



3. Inside your cells, these amino acids are put together in new ways to form new proteins.

About Disciplinary Literacy

Literacy is an integral part of science. Practicing scientists read, write, and talk, using specialized language as they conduct research, explain findings, connect to the work of other scientists, and communicate ideas to a variety of audiences. Thus, the Next Generation Science Standards (NGSS) and the Common Core State Standards (CCSS) alike call for engaging students in these authentic practices of science. Through analyzing data, evaluating evidence, making arguments, constructing explanations, and similar work, students engage in the same communicative practices that scientists employ in their profession. Through supporting and engaging students in science-focused literacy and inquiry activities that parallel those of scientists, students master discipline-specific ways of thinking and communicating—the disciplinary literacy of science. Strategy guides are intended to help teachers integrate these disciplinary literacy strategies into the science classroom.

About Us

The Learning Design Group, led by Jacqueline Barber, is a curriculum design and research project at the Lawrence Hall of Science at the University of California, Berkeley. Our mission is to create high-quality, next-generation science curriculum with explicit emphasis on disciplinary literacy and to bring these programs to schools nationwide. Our collaborative team includes researchers, curriculum designers, and former teachers as well as science, literacy, and assessment experts.



The Learning Design Group



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These materials are based upon work partially supported by the following: Bill & Melinda Gates Foundation under grant number OPPCR060 Carnegie Corporation of New York under grant number B 8780 National Science Foundation under grant numbers DRL-0822119 and DRL-1119584