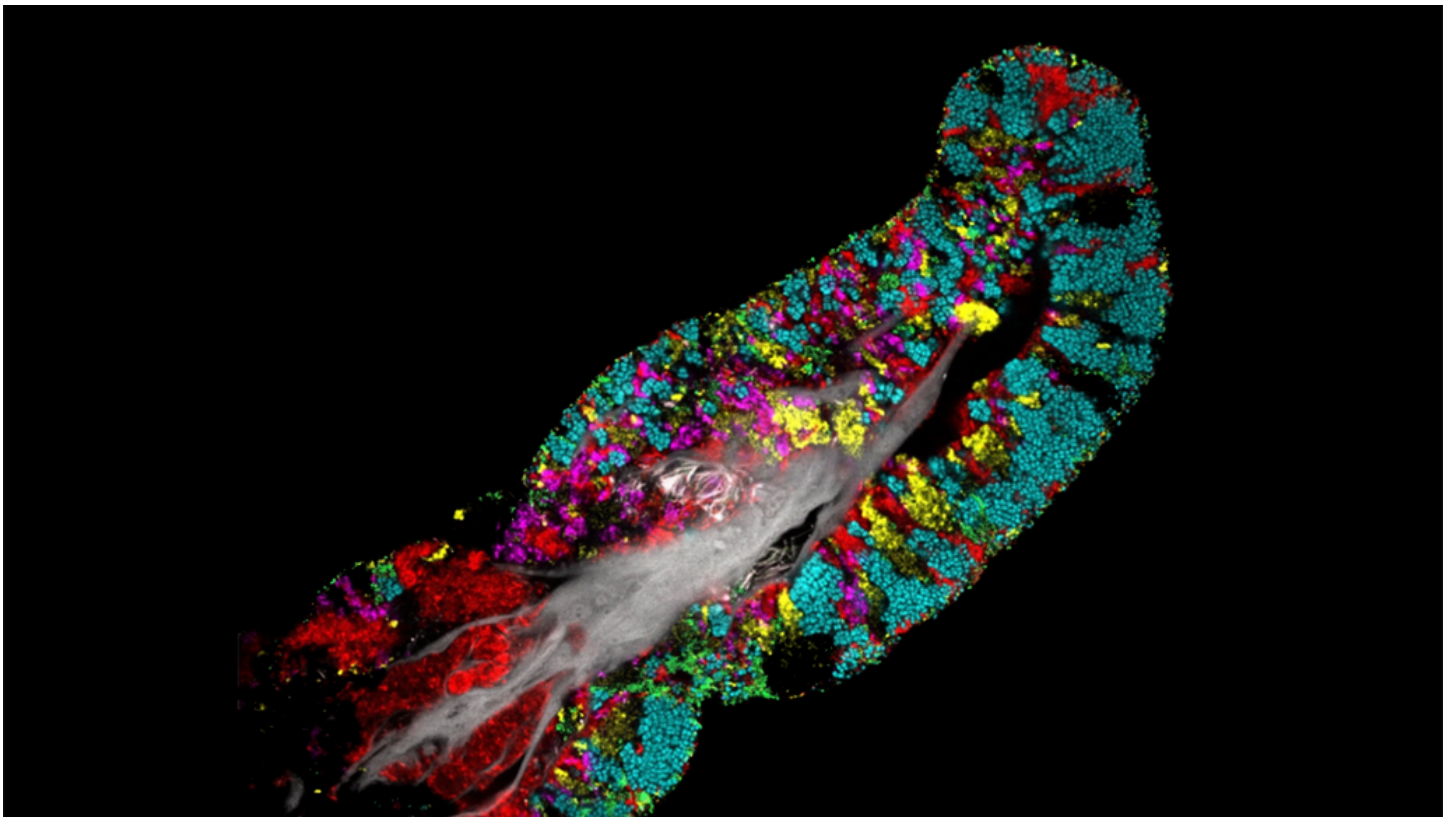
Science News

EDUCATOR GUIDE



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April 25, 2020

Where Bacteria Live on Our Tongues

SOCIETY FOR SCIENCE & THE PUBLIC

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Where Bacteria Live on Our Tongues

About this Guide

In this Guide, based on the online *Science News* article "Here's where bacteria live on your tongue cells," students will learn about bacterial communities on the human tongue and use existing knowledge of interspecific interactions to create metaphors about relationships in the students' own communities. In an activity, students will practice note-taking and summarizing skills.

This Guide includes:

Article-based Comprehension Q&A — Students will answer questions about the online *Science News* article "Here's where bacteria live on your tongue cells" (Readability: 13.6), which maps how bacteria build communities on human cells. A version of the story, "Where bacteria live on our tongues," can be found in the April 25, 2020 issue of *Science News*. Related standards include NGSS-DCI: HS-LS2; HS-LS1.

> **Student Comprehension Worksheet** — These questions are formatted so it's easy to print them out as a worksheet.

Cross-curricular Discussion Q&A — Students will use their knowledge of interspecific interactions to explore bacterial communities on human tongue cells. Then, students will apply those concepts to create metaphors for relationships in their own community. Related standards include NGSS-DCI: HS-LS2; HS-LS1; HS-ESS3.

> **Student Discussion Worksheet** — These questions are formatted so it's easy to print them out as a worksheet.

Activity: Taking Notes and Creating Visual Summaries

> **Summary:** This activity asks students to practice two literacy skills: note-taking and summarizing. Note-taking helps students identify and remember important information, enhancing comprehension as they read. Creating a visual summary encourages students to consolidate and communicate key information. Related standards include NGSS-DCI: HS-LS2; HS-LS1; HS-ETS1.
>
> **Approximate class time:** 1 class period.

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Article-based Comprehension, Q&A

Directions for teachers: After your students read the online *Science News* article "Here's where bacteria live on your tongue cells," ask them to answer the following questions. A version of the story, "Where bacteria live on our tongues," can be found in the April 25, 2020 issue of *Science News*.

1. What does the image at the top of the article show? What do the different colors represent?

The main image shows a single human tongue cell coated in different types of bacteria. The tongue cell is gray, and the types of bacteria are represented by different colors including red, yellow, blue, green and purple.

2. The author says that bacteria on tongue cells build "neighborhoods." What are bacterial neighborhoods? What literary device is the term an example of?

Bacterial neighborhoods are clusters of different types of bacteria on the surface of human tongue cells. The author's use of "neighborhoods" to describe these clusters is an example of a metaphor.

3. How did scientists map bacterial neighborhoods on human tongue cells?

Scientists attached differently colored fluorescent markers to each type of bacteria in samples scraped from people's tongues. Under a microscope, the colors let scientists see where on a cell's surface different bacteria were found.

4. Paraphrase (restate in your own words) the article's second paragraph, which describes the main research finding.

On the surface of human tongue cells, various types of bacteria form distinct groups. As these groups grow, they create microenvironments where bacterial species can flourish.

5. How was the distribution of bacteria on different tongue cells similar? Be as specific as possible in terms of bacteria type and location on tongue cell.

The patchwork pattern of neighborhoods was consistent across cells from different samples and people. And three types of bacteria were common across samples: *Actinomyces* bacteria tended to form groups close to the human tongue cell. *Rothia* bacteria clustered away from the human cell. *Streptococcus* bacteria formed a thin outer layer.

6. How was the distribution of bacteria on different tongue cells different?

The specific type and placement of bacteria differed from cell to cell.

7. Why are scientists interested in understanding bacterial neighborhoods?

Scientists are interested in how groups of bacteria arrange themselves on the tongue because it could shed light on how the bacteria work together to maintain healthy environments — in this case, the environment is a person's mouth.

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Where Bacteria Live on Our Tongues

Student Comprehension Worksheet

Directions: After reading the online *Science News* article "Here's where bacteria live on your tongue cells," answer the following questions.

1. What does the image at the top of the article show? What do the different colors represent?

2. The author says that bacteria on tongue cells build "neighborhoods." What are bacterial neighborhoods? What literary device is the term an example of?

3. How did scientists map bacterial neighborhoods on human tongue cells?

4. Paraphrase (restate in your own words) the article's second paragraph, which describes the main research finding.

5. How was the distribution of bacteria on different tongue cells similar? Be as specific as possible in terms of bacteria type and location on tongue cell.

6. How was the distribution of bacteria on different tongue cells different?

7. Why are scientists interested in understanding bacterial neighborhoods?

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Where Bacteria Live on Our Tongues

Cross-curricular Discussion, Q&A

Directions for teachers:
Ask your students to read the online *Science News* article "Here's where bacteria live on your tongue cells" and answer the individual questions, which ask them to define and give examples of ecological relationships. Have students partner up to discuss the last prompt, which asks them to describe relationships in their community as interspecific interactions, and create metaphors based on those descriptions. Bring the class back together as a group and have each set of partners share one of their metaphors.

Want to make it a virtual lesson? Post the online *Science News* article "Here's where bacteria live on your tongue cells" to your virtual classroom and ask students to read the article and answer the individual questions. Pair up students to discuss and answer the partner prompt using a video conferencing platform, or talking by phone. They can collaborate in a shared document during the conversation. Post the partner discussion prompt to an online discussion board. Have students give feedback about another partnership's response.

Individual Questions
1. What organisms make up the ecological community identified in the article? Describe the community's environment.

Humans and the different types of bacteria that live on human tongue cells, including Actinomyces, Rothia *and* Streptococcus*, make up the ecological community. A human tongue is a warm and moist environment. The tongue moves a lot and often is exposed to air and food that humans eat.*

2. What are the general interactions among the organisms in the ecological community?

Bacteria interact with their human host as well as with each other.

3. Relationships between different species shape how ecological communities form. Scientists define the relationships, called interspecific interactions, by the beneficial, harmful or nonexistent effects the interactions have on species. Do your own research to define and give an example of each type of interspecific interaction listed below. Indicate the effect of the interaction on both species. Be sure to use reliable sources.

Competition
Competition is an interaction in which two species use the same limited resource, such as food or building materials. Competition generally has a negative or harmful effect on the involved species. For example, green anole lizards in Florida compete for habitat and food with brown anole lizards — an invasive species

introduced from Cuba and the Bahamas. Over time, one species may outcompete the other for resources, leading to population declines and even local extinction of the weaker species.

Predation

Predation is an interaction in which one species uses another species as a resource. Predator species benefit from this interaction, while prey species are harmed by it. An example is African lions that kill and eat gazelles. A special case of predation is herbivory, in which a plant is the prey species.

Commensalism

Commensalism is an interaction that benefits one species and has no effect on the other species. An example is remora fish, which harmlessly attach themselves to sharks and other fishes and feed on scraps left over from the hosts' meals.

Mutualism

Mutualism is an interaction that benefits both species by increasing their chance of survival or reproduction. An example is the relationship between red-billed oxpeckers and black rhinos. The birds feed on ticks and other parasites on the rhinos' hides. In return, the oxpeckers appear to warn the mostly blind rhinos of nearby potential threats, such as people. (See the Science News *article "Hitchhiking oxpeckers warn engendered rhinos when people are nearby.")*

Parasitism

Parasitism is an interaction in which one species depends on the other species for survival. The interaction benefits the parasite species and harms the host species. An example is tapeworms that live in the intestines of animals. Tapeworms absorb some nutrients as food is digested, depriving the animals of those nutrients.

4. What interspecific interactions exist between the organisms in the article? Explain the effects the interactions have on each organism.

Bacteria interacting with their human host could be an example of mutualism. The interaction would benefit both the human host and some of the bacteria — the tongue provides a habitat and nutrients for Actinomyces *and* Rothia *bacteria, and the bacteria may convert dietary nitrate to nitric oxide that helps regulate blood pressure.*

The interactions between different types of bacteria may be an example of mutualism. Some bacteria might work together to create a healthy environment in which they all can thrive.

5. What other examples of interspecific interactions do you think might exist in the community?

Bacteria likely compete for resources on the tongue. Some types of bacteria may also have commensal relationships with each other or with the human body. For example, the bacteria might benefit from inhabiting the tongue, but have no effect on the human.

6. Why do you think the different types of bacteria found on tongue cells are organized into "neighborhoods"?

The patterns found within the bacterial community on tongue cells are likely due to the resources available in the environment, as well as the interspecific interactions that exist among the different types of bacteria.

Partner Discussion

With a partner, think about a community you are familiar with, such as your school, your neighborhood or your town. Identify relationships among people in your community. Next, choose three types of interspecific interactions and explain how some of the community relationships you identified may be similar to those interactions. Finally, create metaphors based on your explanations.

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Student Discussion Worksheet

Directions:

After reading the *Science News* article "Here's where bacteria live on your tongue cells," answer the following questions.

Individual Questions

1. What organisms make up the ecological community identified in the article? Describe the community's environment.

2. What are the general interactions among the organisms in the ecological community?

3. Relationships between different species shape how ecological communities form. Scientists define the relationships, called interspecific interactions, by the beneficial, harmful or nonexistent effects the interactions have on species. Do your own research to define and give an example of each type of interspecific interaction listed below. Indicate the effect of the interaction on both species. Be sure to use reliable sources.

Competition

Predation

Commensalism

Mutualism

Parasitism

4. What interspecific interactions exist between the organisms in the article? Explain the effects the interactions have on each organism.

5. What other examples of interspecific interactions do you think might exist in the community?

6. Why do you think the different types of bacteria found on tongue cells are organized into "neighborhoods"?

Partner Discussion

With a partner, think about a community you are familiar with, such as your school, your neighborhood or your town. Identify relationships among people in your community. Next, choose three types of interspecific interactions and explain how some of the community relationships you identified may be similar to those interactions. Finally, create metaphors based on your explanations.

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Where Bacteria Live on Our Tongues

Activity Guide for Teachers: Taking Notes and Creating Visual Summaries

Purpose: This activity asks students to practice two literacy skills: note-taking and summarizing. Through different note-taking strategies, students will learn how to organize the important parts of an article about a science discovery. Creating a visual summary of a science-related article will give students practice identifying and consolidating important information.

Procedural overview: While reading articles about scientific discoveries, students will use different strategies to take notes. Students will discuss the importance of taking notes, employ various methods of note-taking and then compare methods to find the one that they like best. Students will then create a visual summary of the article they read.

Approximate class time: 1 class period

Supplies:
Science News article ("Here's where bacteria live on your tongue cells" or another *Science News* article)
Notepaper
Writing implement
Supplies for organizing notes (highlighters, sticky notes, text flags)
Computer with Internet access
Virtual space (for discussions and sharing information with the class)
"Taking Notes and Creating Visual Summaries" student worksheet

Directions for teachers:
Part 1 of this activity will introduce students to the importance of note-taking and different methods of note-taking. Students will use various methods to take notes on a *Science News* article and then discuss what methods might work best for them.

Part 2 of this activity will ask students to create a visual summary of a *Science News* article. Students will explore how to create a visual representation of the article they read, including selecting the most important concepts. This exercise will help students understand different strategies for conveying information.

This activity is ideal for a virtual-learning environment. Discussions can be completed via Zoom, Skype or another chat program.

Teachers can have students read the *Science News* article "Here's where bacteria live on your tongue cells" or choose a different article from *Science News*. If students read "Here's where bacteria live on your tongue cells," they can complete the activity extension, which asks them to compare their visual summary with the graphical abstract from the primary research paper.

Part 1: Taking and organizing notes
Place the students into groups and ask them to discuss the importance of note-taking and different note-taking strategies using the background questions provided on the student worksheet. Questions No. 1 through 5 will guide the students in their discussions.

Provide each group with the article the students will read. Each student will read the article and then take notes on the article using a different note-taking method, selected from the examples given or using their own. Once students have their notes, encourage them to go back and organize the notes to better keep track of what they have recorded. Students may choose to organize their notes by using different colored highlighters to identify related concepts, placing color-coded sticky note flags on related ideas or drawing different shapes around similar ideas. Questions No. 6 through 12 will guide students through the note-taking process.

Next, the group will meet virtually and compare note-taking methods. Students will present their notes to the group, explain what they did and did not like about the method and answer any questions the group has. The students will critique the methods to determine which method each student thinks is best. Students may not agree on which method is best, but what is important is for each student to determine the method they think will work best for them and why. Students should also determine if they found a particular style of organizing the notes more helpful and why. Questions No. 13 through 19 will guide students through comparing the note-taking methods and selecting the ones that are right for them.

Part 2: Summarize a visual or create a visual summary
After students have compared their notes on the article, they will create a visual summary of the article. They will use questions No. 20 through 25 to draw their visual summary before sharing their summaries with classmates and getting feedback.

If students read "Here's where bacteria live on your tongue cells," they can complete the activity extension, which asks them to compare their visual summary with the graphical abstract from the primary research paper.

Student directions:

Part 1: Taking and organizing notes
Taking notes is a very important skill, helping you to identify key concepts or important details. Sometimes by the time you finish learning about the subject, you may have forgotten the material that came before.

In this activity, you will be taking notes on an article about a scientific discovery. Each member of your group will take notes using a different method, so that you can compare the methods and find one that works best for you. This activity is going to take place in a virtual environment. You should follow your teacher's instructions on how to set everything up and how you should go about sharing your findings remotely.

Your teacher will assign you to a group to discuss the following questions.

1. Why is it important to take notes?

Note-taking is very important when reading or viewing materials that are complicated and have multiple pieces to them. Notes are also necessary when the information presented is going to be needed later. Notes are also useful when summarizing an article to tell a friend, improving one's own understanding of difficult concepts, preparing for an assessment or writing a thoughtful response to a probing question.

2. When might you take notes?

I might take notes when reading something I need to remember later. I might also take notes when I am given verbal instructions or watching a movie that I might want to tell a friend about.

3. What are some goals of note-taking?

The goals of note-taking are to consolidate, flag and in some cases remember information that might be important later. Trying to remember everything is hard to do. Taking notes creates a record of what was said, read or viewed that can be referred to later.

4. How might your note-taking differ depending on the goals?

Depending on my goals, I might record different information or a different level of detail. I might focus on big-picture concepts or a timeline of events, and I might vary the level of detail depending on the audience that I am sharing it with in the future.

5. How do you typically take notes?

My main way of taking notes is to read the material and then write down the important points made in the reading. These could be sentences, lists or even pictures.

Taking your notes

There are many different methods for taking notes. Review some various approaches at this link: https://miamioh.instructure.com/courses/62085/pages/note-taking-styles. Also think about different ways to organize your notes, such as using highlighters of different colors to identify related concepts, placing color-coded sticky note flags on related ideas or drawing different shapes around similar ideas.

Once you have reviewed note-taking methods, each member of your group should select a different method to apply. You will take notes using this method as you read a *Science News* article assigned by your teacher. After reading the article and taking and organizing your notes, answer the following questions.

6. What article did your group read?

My group read the Science News *article "Here's where bacteria live on your tongue cells."*

7. What method of taking notes did you use? What does this method entail?

I used the outline method. This is the method where you put numbers and letters next to each piece of information, and the numbers and letters indicate how significant the information is.

8. What did you like about this method of taking notes?

I liked the outline method because it allowed me to organize my thoughts in a simple fashion.

9. What didn't you like about this method of taking notes?

It was difficult to remember which number or letter needed to be used next and which gets uppercased and which gets lowercased.

10. What method of organizing your notes did you use? Why?

I used highlighters. Different colored highlighters were used to color the text that falls into each of the categories. Color-coding keeps the main ideas separate, but still lets me know they are important.

11. Based on your notes, what was the main idea or theme of the article you read?

The main idea of the article was that different types of bacteria cluster together on human tongue cells.

12. Into which categories could your notes be classified, based on the article?

The main categories into which the notes could be classified include procedure, results, importance and future implications/experiments.

Comparing methods

Using the chat platform selected by your teacher (such as Zoom or Skype), give a presentation about your note-taking method to the group, explaining what you did and didn't like about the method you used. Be sure to also discuss how you organized your notes. The group should then discuss which methods best capture the following information: What are the main ideas of the article? What is the main theme? Who are the important players? What are the discoveries discussed in the article? What conclusions did the scientists reach from their research and what impacts will they have?

After watching each other's presentations and reviewing the notes created using each of the methods, answer the questions to identify which method of note-taking you think would work best for you. Be sure to discuss your reasoning with your group.

13. Which methods of note-taking made the information easiest to understand? Why?

The charting and the sentence methods were easiest for me to understand. It was easiest to see the information in the charting method, but the sentence method made the notes easier to understand because information was written in full sentences.

14. Which methods of note-taking did you find made it easiest to find information? Why?

The charting was the easiest method for me to find the information because I could cross-reference rows and columns to find information that I was interested in. The next easiest method was the Cornell method because the information was organized in columns that I could search.

15. Which methods of note-taking did you think had the most complete information? Why?

I think the sentence and Cornell methods had the most complete information because the notes were written in complete sentences.

16. Which methods of note-taking did you find to be the most complicated? Why?

I thought the outline method was really complicated because I had to keep track of all of the letters and numbers. If I changed my mind about the importance of a piece of information, then I had to renumber the entire list.

17. Which method of organizing the notes did you like best? Why?

I liked highlighting best because it was easy to associate a color with a concept. Highlighting makes it really easy to find information quickly.

18. Based on your answers above, which method of taking and organizing the notes would you use in the future? Why?

I would use the charting method to take my notes and the highlighting method to organize them. It is really easy to find the information you are looking for using this method and organization.

19. Is there anything else you would change about this method of note-taking or organizing to make it easier for you to use?

I would use complete sentences in the chart so that all of the information I need would be there.

Part 2: Creating a visual summary

Now you will create a visual summary of the article you read. You may find it useful to review how to write a summary by checking out *Science News'* "2019 Year in Review" discussion on how to write summaries. Because the *Science News* article reports on the findings of a primary research paper, be sure to include information about the experiment that was conducted.

Answer questions No. 20 and 21 to plan your visual summary. After creating your summary, answer questions No. 22 through 24. Then share your summary and get feedback from your classmates.

20. Why might it be helpful to create a visual summary?

21. What information is essential to relay in your visual summary?

22. After creating your visual summary, is there information from the article that you left out? If so, why?

23. Would someone seeing your visual summary have a complete understanding of what was discussed in the article?

24. Would someone seeing your visual summary have a complete understanding of the experiment reported in the primary research paper? Explain.

Extension

Look at the graphical abstract from the primary research paper and answer the following questions, comparing and contrasting it with your visual summary of the *Science News* article.

1. What information about the experiment does the graphical abstract include that your visual summary doesn't include?

The visual abstract in the primary research paper includes more detail about the experimental procedure, including how data were analyzed.

2. Why does the information included in the visual summaries differ? What does this tell you about the intended audiences for the two texts and visuals?

The visual summaries differ because the texts the summaries are based on present information appropriate for their intended audiences, which are different. The Science News *article didn't provide a lot of detail about the experimental procedure because the intended audience for that article is the general public. The primary research paper included more detail about the experimental procedure because that audience is other scientists.*

3. What do you think is the goal of the graphical abstract in the primary research paper? How does this goal influence what information is included?

The goal of the graphical abstract in the research paper is to describe the experimental and data analysis procedures. Because the scientific audience has a deep understanding of technical scientific procedures and is more interested in those procedures than the general public, the graphical abstract includes a higher level of procedural detail.

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Activity Guide for Students: Taking Notes and Creating Visual Summaries

Part 1: Taking and organizing notes
Taking notes is a very important skill, helping you to identify key concepts or important details. Sometimes by the time you finish learning about the subject, you may have forgotten the material that came before.

In this activity, you will be taking notes on an article about a scientific discovery. Each member of your group will take notes using a different method, so that you can compare the methods and find one that works best for you. This activity is going to take place in a virtual environment. You should follow your teacher's instructions on how to set everything up and how you should go about sharing your findings remotely.

Your teacher will assign you to a group to discuss the following questions.

1. Why is it important to take notes?

2. When might you take notes?

3. What are some goals of note-taking?

4. How might your note-taking differ depending on the goals?

5. How do you typically take notes?

Taking your notes
There are many different methods for taking notes. Review some various approaches at this link: https://miamioh.instructure.com/courses/62085/pages/note-taking-styles. Also think about different ways to organize your notes, such as using highlighters of different colors to identify related concepts, placing color-coded sticky note flags on related ideas or drawing different shapes around similar ideas.

Once you have reviewed note-taking methods, each member of your group should select a different method to apply. You will take notes using this method as you read a *Science News* article assigned by

your teacher. After reading the article and taking and organizing your notes, answer the following questions.

6. What article did your group read?

7. What method of taking notes did you use? What does this method entail?

8. What did you like about this method of taking notes?

9. What didn't you like about this method of taking notes?

10. What method of organizing your notes did you use? Why?

11. Based on your notes, what was the main idea or theme of the article you read?

12. Into which categories could your notes be classified, based on the article?

Comparing methods

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After watching each other's presentations and reviewing the notes created using each of the methods, answer the questions to identify which method of note-taking you think would work best for you. Be sure to discuss your reasoning with your group.

13. Which methods of note-taking made the information easiest to understand? Why?

14. Which methods of note-taking did you find made it easiest to find information? Why?

15. Which methods of note-taking did you think had the most complete information? Why?

16. Which methods of note-taking did you find to be the most complicated? Why?

17. Which method of organizing the notes did you like best? Why?

18. Based on your answers above, which method of taking and organizing the notes would you use in the future? Why?

19. Is there anything else you would change about this method of note-taking or organizing to make it easier for you to use?

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Extension

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1. What information about the experiment does the graphical abstract include that your visual summary doesn't include?

2. Why does the information included in the visual summaries differ? What does this tell you about the intended audiences for the two texts and visuals?

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