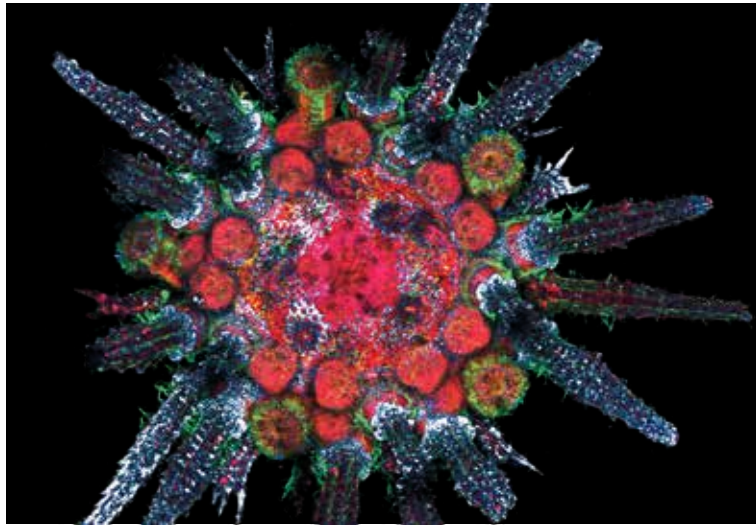


ScienceNews

IN HIGH SCHOOLS | EDUCATOR GUIDE



Strange VISIONS



SOCIETY FOR
SCIENCE & THE PUBLIC

About the Guide

The *Science News* article “Strange visions” explores the unconventional and unexpected ways that some animals see, and asks the interesting question: “What does it mean to have ‘eyes’?”

“Strange visions” can be used across a wide range of curricula, with a focus on **biology** and **physics**. The activities, questions and discussions in this educator guide can be used to support the following education standards:

Next Generation Science

From Molecules to Organisms: Structures and Processes: [HS-LS1-2](#)

Biological Evolution: Unity and Diversity: [HS-LS4-1](#)

Reinforcement for Middle School:

From Molecules to Organisms: Structures and Processes: [MS-LS1-1](#), [MS-LS1-3](#), [MS-LS1-8](#)

Biological Evolution: Unity and Diversity: [MS-LS4-2](#)

Common Core

ELA Standards: [Reading Informational Text](#) (RI): 1, 2, 3, 4, 7

ELA Standards: [Writing](#) (W): 1, 3, 4, 5, 7, 8, 9

ELA Standards: [Speaking and Listening](#) (SL): 1, 2, 3, 4

ELA Standards: [Language](#) (L): 1, 2, 3, 4, 5, 6

ELA Standards: [Reading for Literacy in Science and Technical Subjects](#) (RST): 1, 2, 4, 6, 9

ELA Standards: [Writing Literacy in History/Social Studies and Science and Technical Subjects](#) (WHST): 2, 4, 5, 6, 7, 8, 9

Prior to reading

Guide student reading by pointing out connections between this article and what students are learning in class. Here, find ideas for standard-aligned paths to follow while reading:

- Ask students to think about the structure of the human eye. Which parts of the eye do they know? (*Students might remember the lens, pupil, retina, cornea and optic nerve.*) Ask students to think about other things that “see” – cameras, for example, or the eyes of other organisms. How are they similar to the human eye? How are they different? What features do all of these types of eyes share?
- Why is seeing beneficial? How does it help an animal survive and thrive? Encourage students to think about how the structure of the eye relates to its function. For example, you might explore what function the lens serves. (*The lens changes the path of light by changing its shape so an image can form in focus on the retina.*) What might vision be like for an animal without a lens? (*Animals without lenses probably don’t form clear images but instead sense light and dark to detect movement.*)
- Distribute [Blackline Master 1](#), which provides diagrams of a human eye and the eyes of various animals that will appear in the story. Have students compare and contrast the eyes. Which features of vision are shared by all the organisms? Are any features unique? Students can try to match the eye with the organism. Discuss what characteristics students used from the diagrams to decide on their pairings. Which were harder to match and why? By reading the article, students will find out whether their labels were correct.

After reading: Comprehend

You can adapt and print these questions ([Blackline Master 2](#)) to check for comprehension and analysis before or after discussion:

1. **What is the main topic of the article?** (*Organisms “see” their environments in a great variety of ways. Many have eyes or eyelike organs that don’t look like humans’ eyes. Scientists are deepening their understanding of what sight is and the mechanisms used by different organisms.*)
2. **What is the “crawling eyeball hypothesis”?** (*The “crawling eyeball hypothesis” is the idea that instead of sea urchins having a single organ for vision, their whole body serves as an eyeball, moving on many tiny, soft feet. In other words, the body of a sea urchin is itself an eye.*)
3. **What are opsins?** (*Opsins are light-sensitive proteins that set off a series biochemical events that result in seeing.*)
4. **How is genetic testing being used to understand sea urchin vision?** (*Gene sequencing has revealed that sea urchins have genes for various opsins. The data from these tests were then used to locate the opsins within the urchin’s body, which showed where the sea urchins are sensitive to light.*)

After reading: Analyze

1. **Describe a simple experiment that could test whether an organism such as a beetle or sea urchin can sense light?** (Students' answers will vary, but a basic experiment would be to place the organism in a dark, confined area and shine a flashlight just in front of the organism. Does it move consistently into or away from the light?)
2. **What are some of the limits to our current understanding of vision?** (Scientists know the basic structures of the eye, and some of the important proteins involved, opsins for example. Scientists have also studied the visual systems of vertebrates very closely. Scientists know less about how eyes that don't look like human eyes might work. Scientists know that urchins and other animals with different types of structures perceive the world through vision, but they don't yet know how each organism does this or what the experience of vision is like for those organisms.)
3. **What can you infer about the evolution of vision from this story?** (Answers will vary, but students might suggest: The eye organ is only one solution to an organism's need to perceive light. Organisms have evolved different ways to solve the puzzle of perceiving their environment. The phenomenon known as vision evolved along different paths for different species depending on their existing biology and their environment. The benefits of vision for finding food, mating and to escaping prey might have led to the evolution of the eye. The eye evolved differently in different organisms depending on the environment. Complex eyes evolved from more simple forms.)

Discuss and Assess

After students read the article independently, return as a group to the concepts outlined prior to reading. Invite students to share their answers and observations from the article and lead a class discussion that further underscores your current curriculum. The discussion can serve as an informal assessment. Ideas for further reading discussion or writing prompts include:

- After reading the article, ask students to define what it means to “see” or to possess “vision.” Are these words interchangeable in the story? Do students use the words interchangeably in their everyday lives? If so, why? Does vision, as the students define it, require a brain? How does a brain help? How is the definition biased by our perspective as humans? Encourage students to draw on ideas from the article as well as from their personal background and beliefs as they consider these questions.
- Ask students to consider some of the technologies available to assist people with vision impairments. Students might first think of glasses or medical procedures to correct vision, but you could also introduce the concept of [sensory substitution devices](#) as part of this conversation. How might the study of nonhuman eyes inspire different technologies for human vision?
- What is the author trying to accomplish by introducing Charles Darwin and his ideas about eyes into the story? How do the quotes from *On the Origin of Species* add to the story? What do we understand now that we didn't know in Darwin's time? How does this affect your thinking about Darwin and his work? What does it tell you about the scientific process and scientific advancement?
- The article focuses on eyeballs “in creatures too small to have brains to use them.” Think about the scope of the article. What does it include? What does it intentionally leave out? What questions do you have about vision that you cannot answer based on the article? How would you go about answering those questions?

Extend Offer students other ways to explore the content of the article as it relates to your curriculum, such as:

SEEING THE WORLD THROUGH DIFFERENT EYES

Purpose: Writing is about more than summarizing facts. It's also about giving the reader a new perspective on the world. This exercise allows students to use factual information to offer readers a view of the world from an unfamiliar vantage point — in this case, the perspective of another organism. To succeed, students will have to consider tone, descriptive language, sentence structure and other writing techniques and will have to think creatively.

Notes to the teacher: Often times, popular literature and multimedia use concepts from science to create powerful ideas. This writing assignment can be adapted to the writing level of your students in a variety of ways.

Directions:

1. Give students [Blackline Master 3](#) to guide their work and ask students to select an animal of their choosing from the article. (You can adapt this step with other animals to make the exercise more or less challenging.)
2. Encourage students to do a bit of research about the animal, such as where it lives, its life span and behaviors, specific physical characteristics that make it unique and so on.
3. Introduce the concept that animals see the world in different ways. You might want to show the first 45 seconds of this short [video](#) from National Geographic to introduce the idea.
4. Tell students to imagine that they are the animal they selected. Have students use their research notes to help them think about what they

might see. Would they perceive shape, color, depth, detail, for example? If so, how?

5. Have students create a short story from the perspective of their animal. Maybe the story is about an important event (hatching, giving birth, being caught as prey, for example) or a victory (catching prey or finding a mate). Encourage students to use what they are learning in language arts, such as language choice, sentence structure and their skills in writing in a specific genre or form. The story should not directly reveal what animal the student has chosen.
6. Have students read their stories out loud without saying the name of their animal. See if others can guess correctly. If so, discuss what made it easy to determine the identity of the animal. If not, what made it challenging?
7. Students can use the feedback to revise their writing to make it more detailed and expressive. Use [Blackline Master 4](#) as a simple rubric to accompany this exercise. Consider handing out the rubric as students work so they know the criteria to focus on. Students could even peer-edit each other's work before turning it in.
8. Once students have completed the exercise, ask them to think about the elements of their stories that were based on facts they researched and which were fantasy. How accurate do they think their representations are? In what ways did they anthropomorphize their animals? Can they think of other literature or works of television and film in which an animal is anthropomorphized? Students might want to rank and categorize these works according to their factual accuracy.

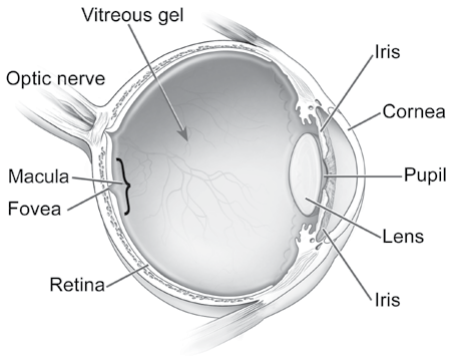
A CAMERA'S EYE

The article says that the eye of the nautilus functions similarly to a pinhole camera. You can make a pinhole camera for classroom demonstration relatively easily, or more advanced students can make these cameras themselves. This [YouTube video from The Royal Institution of Great Britain](#) provides straightforward instructions and a [printable template](#). Once the camera is made, students can adapt it to explore the effect of hole size (aperture) and the intensity of light on the captured image. Does the camera work better when it is sunnier outside, for example? Or, does the image change when lamps of different brightnesses are turned on and off in the classroom?

Students can also explore the intersection of physics and art by examining work by artists who use the principle known as "camera obscura," Latin for "dark room" ([Abelardo Morell](#), for example). In this technique, an optical lens is often used in the place of the pinhole to adjust the focus of the image. The image can be cast on a piece of photosensitive paper to be captured exactly as it appears, or it can be cast on a canvas or wall to be traced by the artist. [David Hockney](#) has suggested that many of the great masters used the camera obscura approach to create their art.

Whose eye is it?

This is an image of the human eye:

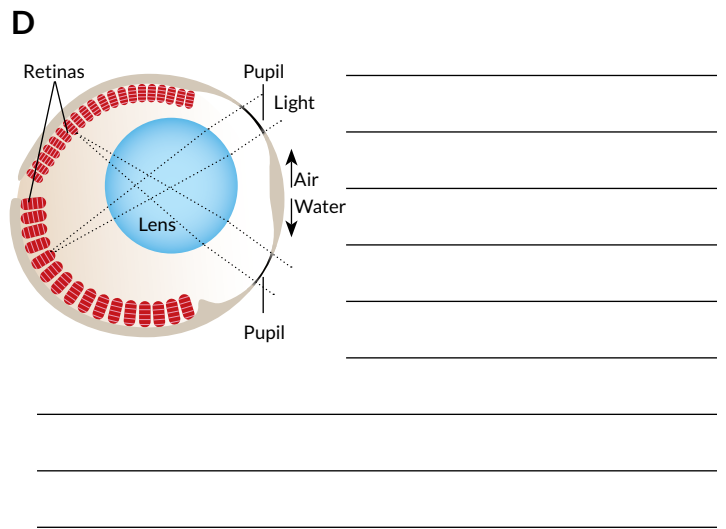
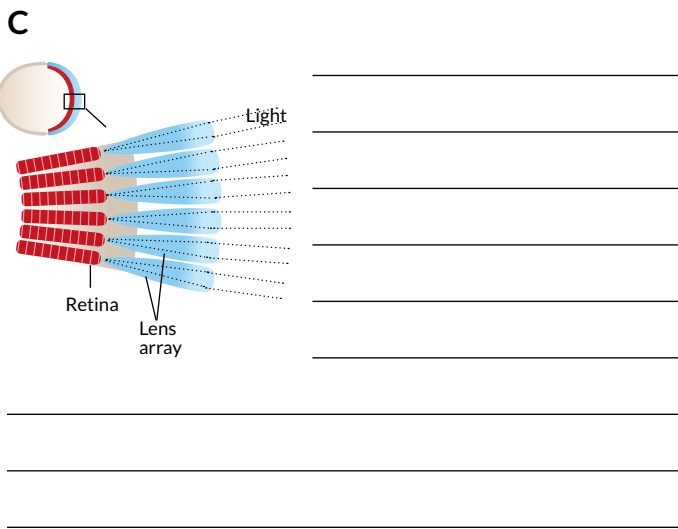
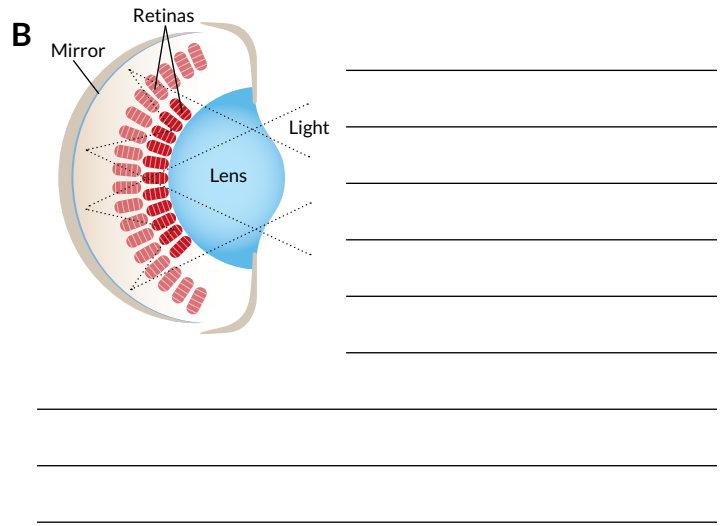
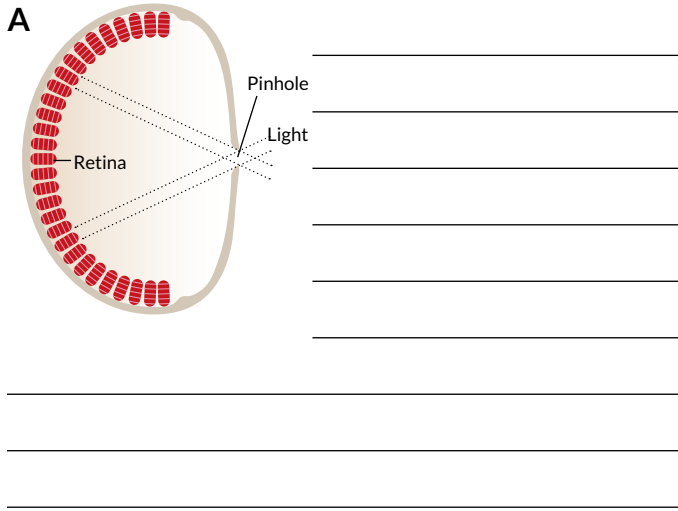


Notice the human eye's structures and their orientation. Compare it to the four eyes below, belonging to the nautilus, the mantis shrimp, the scallop and the four-eyed fish.

What are the similarities?

What are the differences?

Use your predictive skills to match each organism to its eye. Write your answer and justification in the space given. You can find the correct answer in the article.



1. What is the main topic of the article?

- ### 3. What are opsins?

- BLACKLINE MASTER 2, P1

Analyze

1. Describe a simple experiment that could test whether an organism such as a beetle or sea urchin can sense light?
2. What are some of the limits to our current understanding of vision?
3. What can you infer about the evolution of vision from this story?

Research for “Seeing the world through different eyes”

Name of organism:

Get to know your organism:

<p>What do I look like?</p>	<p>What are my unique physical characteristics?</p> <p>What are my unique behaviors?</p>
<p>Describe my life cycle:</p>	<p>What do I prefer to eat?</p> <p>What eats me?</p>
<p>Do I move? If so, how?</p>	<p>How do I see?</p>

Brainstorm words and phrases to describe what and how your animal sees:

Rubric for “Seeing the world through different eyes”

Directions: Highlight those bullets that reflect the work presented. Level score (4, 3, 2, 1) is based on the preponderance of evidence

RUBRIC LEVEL	CONTENT	ORGANIZATION	CONVENTIONS	STYLE/IMPACT
4	<ul style="list-style-type: none"> Includes accurate and detailed facts about the organism Fanciful information heightens interest in the story's character and its actions Includes a specific life event Clearly writes from the perspective of what the animal sees Contains fully-developed ideas 	<ul style="list-style-type: none"> Exhibits logical and explicit sequencing of ideas Uses smooth and specific transitions Connects ideas, paragraphs, and sentences to enhance meaning Contains specific examples and relevant details Contains a clear and concise introduction and conclusion Presents well-developed paragraphs 	<ul style="list-style-type: none"> Uses precise and interesting words Uses varied and complex sentences Contains no errors in mechanics and usage 	<ul style="list-style-type: none"> Exhibits a clear sense of purpose Engages the reader Exhibits a clear voice or sense of self Uses varied, engaging sentences and paragraphs Exhibits originality, liveliness, excitement, humor, or suspense
3	<ul style="list-style-type: none"> Includes factual knowledge of the organism Fanciful information adds to the story and is believable in the context provided Includes a life event Writes what the animal might see, but the perspective may be external Contains ideas that are usually clear and fully-developed 	<ul style="list-style-type: none"> Exhibits logical sequencing of ideas Uses specific transitions Connects ideas, paragraphs, and sentences to enhance meaning Contains some examples and details Contains a clear introduction and conclusion Presents well-developed paragraphs with some lapses 	<ul style="list-style-type: none"> Uses appropriate, functional words Uses varied and complete sentences Contains few errors in mechanics and usage and those that do exist do not interfere with meaning 	<ul style="list-style-type: none"> Exhibits a sense of purpose Engages the reader often Exhibits voice or sense of self Uses varied sentences and paragraphs Exhibits some originality, liveliness, excitement, humor, or suspense
2	<ul style="list-style-type: none"> Includes information about the organism, but not all is factual Fanciful information replaces factual information or detracts from the goal of the story Includes an event that might happen to this animal Writing does not clearly depict the perspective of the animal Contains some unimportant details to support the topic 	<ul style="list-style-type: none"> Exhibits sequencing that make it difficult to follow Uses few needed transitions Connects only some ideas, paragraphs, and sentences Contains details, some of which seem out of place and interfere with meaning Contains both an introduction and a conclusion but one or both may be inappropriate Contains paragraphs with little organization or apparent random order 	<ul style="list-style-type: none"> Uses ordinary or general words Uses mostly simple sentences and incorrectly constructed complex sentences Contains errors in mechanics and usage that interfere with meaning 	<ul style="list-style-type: none"> Exhibits little sense of purpose Engages the reader only occasionally Exhibits little voice or sense of self Uses simple or repetitive sentence structure Exhibits few examples of originality, liveliness, excitement, humor, or suspense
1	<ul style="list-style-type: none"> Includes primarily inaccurate information about the organism Fanciful information is not believable based on the animal's characteristics Omits a life event Writing is not from the animal's perspective Contains few appropriate and on-topic ideas 	<ul style="list-style-type: none"> Exhibits illogical sequencing of ideas Uses few, if any, needed transitions Connects few, if any, ideas, paragraphs, and sentences Contains few, if any, details Contains an introduction and a conclusion but both may be inappropriate and incorrectly placed Contains paragraphs but with little organization and in random order 	<ul style="list-style-type: none"> Uses repeated and incorrect words Uses sentence fragments or run-on sentences Contains frequent errors in mechanics and usage that interfere with meaning 	<ul style="list-style-type: none"> Exhibits no sense of purpose Engages the reader infrequently or not at all Exhibits no voice or sense of self Uses monotonous, simple, and/or repetitive sentence structure Exhibits no originality, liveliness, excitement, humor, or suspense