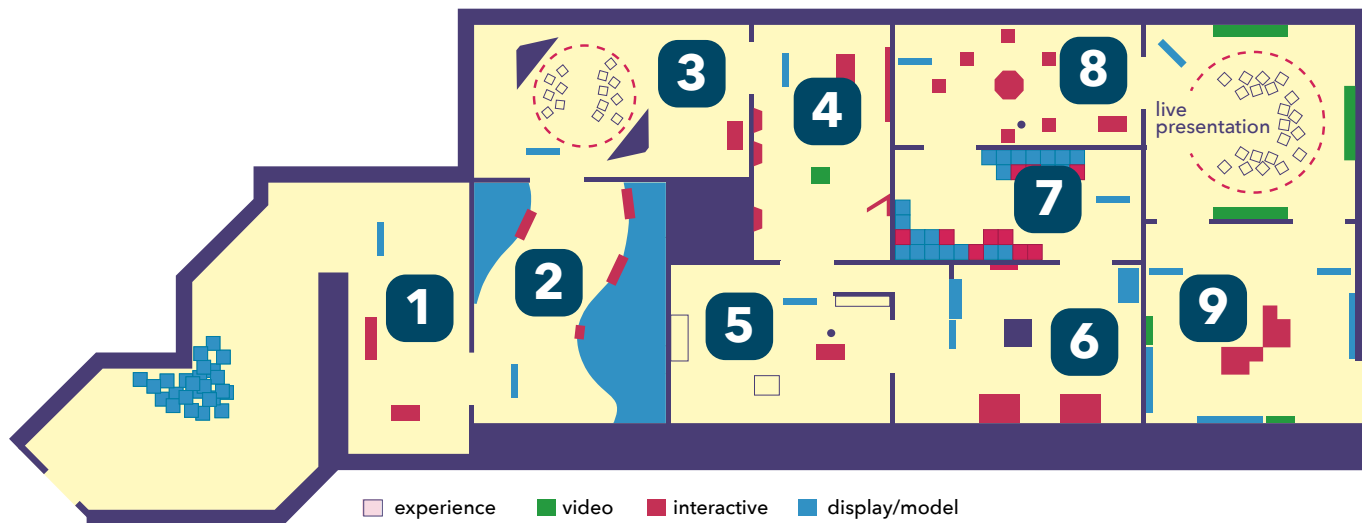


Student Worksheet: Page 1

Name: _____

ANSWER KEY

In the *Our Senses: An Immersive Experience* exhibition, you will explore the connection between the senses and perception and **collect information** for classroom discussion. On a blank piece of paper, **write down** any further observations, questions, or wonderings.



1. SEEING	<p>In this room, the walls are covered with images printed in three different colors of ink (yellow, cyan, magenta). When the light in the room changes from red to green to blue, what you perceive changes. Focus on a particular area of the wall. Describe what happens as the light changes.</p>		
	<p><i>Note: As the light changes, different sets of animals on the wallpaper become visible. All the images are there all the time, but only some of them are visible in each light. Depending on what part of the wall students are viewing, the sets of animals they see and describe may vary.</i></p>		
	<p>Use the flashlight to shine white light on the wall. What do you see?</p>		
	<p><i>Sample answer: Under white light, the wallpaper looks like a mix of images printed in three different colored inks.</i></p>		
	<p>Walk over to the "How Does It Work?" interactive. How many different types of cones do these animals have?</p>		
	<p>humans <i>Answer: three</i></p>	<p>seals <i>Answer: one</i></p>	<p>whales <i>Answer: one</i></p>

Student Worksheet: Page 2

Name: _____

ANSWER KEY

2. DETECTING	We can only sense a tiny fraction of the information around us, but other animals have evolved various ways of sensing beyond what humans can. List two examples of animals and their senses that can detect stimuli humans can't.	
	Animal: <i>Platypus</i>	Additional Info: <i>This ability is more common in fish. The duck billed platypus has about 40,000 electro-receptors in its long flat bill.</i>
	Sense: <i>Detect Electric Fields</i>	
	Animal: <i>Snake</i>	Additional Info: <i>Some snakes have infrared vision: the ability to see prey by the heat they generate. Snakes have the advantage of being able to see their warm-blooded prey in the darkness. Humans can't see infrared.</i>
Sense: <i>Infrared vision</i>		

3. HEARING	Walk around the room. What sounds grab your attention the most? What did they make you think of or feel?	
	<i>Answers may vary.</i>	
	Explore the "How Does It Work?" interactive. What are the smallest bones in the human body and what is their evolutionary origin?	
<i>Smallest bones in the human body are the hammer, anvil, and stirrup. These bones used to be part of the jaw in our distant evolutionary ancestors millions of years ago.</i>		

Student Worksheet: Page 3

Name: _____

ANSWER KEY

4. SELECTING

Pick one of the senses and compare it among the dolphin, human, and coyote.

Sense: *Answers may vary.*

Observations: *Answers may vary.*

Explore the interactives in the “Mind Control” section. Provide an example of how your brain can control what you see.

Answers may vary.

5. BALANCING

How did it feel to walk in the wavy room?

Answers may vary.

Explore the “How Does It Work?” interactive. How does your brain keep you balanced?

Sample answer: To keep you balanced, the brain combines what you see and feel with information you receive from organs in the inner ears. These organs track your movements and relay signals to the brain, eyes, and other parts of the nervous system, helping you adjust your body so you don't fall.

Student Worksheet: Page 4

Name: _____ **ANSWER KEY**

6. CORRECTING	Describe one example from this section of how the brain corrects our senses.
	<i>Answers may vary.</i>

7. TOUCH	Our skin has specialized nerve endings for detecting different sensations. In this room you can explore several of these nerve endings that contribute to your sense of touch. Pick your favorite nerve ending and describe it.
	Nerve ending name: <i>Answers may vary.</i>
	Sensation: <i>Answers may vary.</i>
	Description: <i>Answers may vary.</i>

8. SMELLING	Often, what we experience as a single scent is made up of many different component scents that our brain integrates to produce a familiar scent like that of chocolate. Go around the room to test different smells and guess if they are found in chocolate. Write down your observations.
	<i>Answers may vary.</i>

Student Worksheet: Page 5

Name: _____ **ANSWER KEY**

Examine the wall graphics. Describe two of them and list the method used to generate it.

Answers may vary.

9. EXTENDING

POST-VISIT ACTIVITY CLASSROOM DISCUSSION

Back in the classroom, engage your students in discussion about what they saw in the *Our Senses* exhibition. The goal is to help students process what they learned and refine their thinking about the content.

Students have collected many facts in the exhibition. A post-visit discussion will give them an opportunity to reflect on their experience, to explain some of the underlying phenomena, and to generate novel questions for further research. Students can use the information they learned while visiting the exhibition (referring to the notes they took on their worksheets) to have peer-to-peer and whole-group discussion.

Below is a suggested structure for facilitating discussion around the content of the exhibition.

Teacher Tips:

- You might opt to use this structure with additional questions as well, but this sequence is intended to facilitate small and large group conversation around one question at a time.
- Sample answers are meant to assist you in providing clarity to students during discussion as needed.

1. Select one of the following questions to focus on initially.

- **Q1: Why did some of the images appear/disappear in different colored lights?**
The images on wallpaper are printed with colors that appear as yellow, magenta, and cyan to the human eye in white light. When we shine red light the images printed in cyan absorb it, making the animal visible and appear dark brown to black. Other images that are printed in yellow and magenta reflect red light and are thus invisible in red light. The images printed in magenta are visible under green light and images printed in yellow are visible in blue light.
- **Q2: Why do you think animals have different numbers of types of cone cells?**
Animals have adapted to their environments and color perception is subject to evolutionary selection pressures. Animals that are able to recognize their food source will have an evolutionary advantage. Since food sources will vary under different environmental conditions, the ability to see color might be more important to some animals than to others.
- **Q3: Why do you think different animals have different sensory abilities?**
As different animals adapt to different environmental conditions they will exhibit sensory differences. This is most easily explained within the context of evolutionary theory, especially adaptation. (Prompt students to give specific examples from the exhibition.)

POST-VISIT ACTIVITY CLASSROOM DISCUSSION

- Q4: Why do you think humans prioritize certain sounds over others?

Conscious choice to focus on one sound over another is one reason. Other reasons might be sudden movement or loud sounds since they could indicate danger and therefore it is evolutionarily advantageous to hear them. Yet another reason is that sometimes the brain only notices the sounds it expects to hear.

- Q5: Why do you think it would be important to understand the phenomenon of selecting when giving a testimony in a court of law, etc.?

The human brain selects certain information based on many factors such as social context, prior experience, and so on. Two individuals who witnessed the same event may remember different details based on the way their brain selected information in the moment. This has implications for testimony in a court of law; it is possible that two different individuals' testimonies may conflict while each is giving an honest account of what they remember experiencing.

- Q6: Can you think of any equipment you use or have used to extend your senses?

Telescope, microscope, hand lenses, ultrasound, x-ray, cat scan, satellite images.

2. Set up your classroom for discussion.

Divide students into groups of four. Then, if possible, ask students to form one large circle with their chairs, making sure to sit next to their group members. This set-up will ensure a smooth transition between small group and whole group conversation.

3. Establish norms.

If you have already established a set of norms or agreements for discussion in your classroom, remind students of those norms.

Teacher Tip: Explicitly demonstrate appropriate body language and effective talk moves. To do this, you might model what a productive conversation looks like with a colleague and ask students to study your behavior and conversational moves. This is often called the "fishbowl" strategy.

Possible Norms for Discussion

- One voice at a time
- Stay on the current topic until the group is ready to move on
- Practice active listening: eyes on the speaker
- Students call on one another

POST-VISIT ACTIVITY

CLASSROOM DISCUSSION

4. Small group talk.

Explain that groups will have five minutes to discuss each question before transitioning into a six- to eight-minute whole class discussion.

The goal during small group discussion is for students to run an academic discussion as independently as possible. The following strategies will support them in reaching this goal.

- Provide each group with a copy of the discussion questions and the conversational prompts they can use to keep the discussion going.
- Invite each group to select a moderator to gently remind the group that each person needs to have the opportunity to speak, helping to ensure equity of voice.
- Invite each group to select a note taker to record key ideas as well as wonderings that emerge during the conversation.
- Use a timer that is visible to students to help them manage their time.
- Listen in to conversations to assess student thinking and coach; note particularly insightful ideas and ask students to repeat them in the whole group discussion.

5. Whole Group Talk.

Have students arrange their chairs in one big circle (if possible) to maximize engagement and help maintain eye contact with the speaker.

Facilitate a whole class discussion about the same question students just talked about in small groups. Again, the goal is for students to run the discussion as independently as possible with strategic but minimal teacher support. See suggested strategies below:

- Use a timer that is visible to students and to you.
- Act as a participant and a guide:
 - Clarify content as needed.
 - Coach students to communicate effectively and make their thinking public.

POST-VISIT ACTIVITY

CLASSROOM DISCUSSION

- Students can use the same conversational prompts that they used during small group talk (have them posted). You can lean into individual students and quietly coach them to use these prompts.
- If students struggle to sustain conversation, use partner talk (“think-pair-share”) to fuel the discussion. This can be used in the moment when students are grappling with a difficult concept. Listen in on conversations and encourage selected student(s) to share; select students who you have heard make comments that will likely lead to additional discussion and idea building.

6. Post-Discussion Exit Slip.

To conclude the discussion, have students respond to the following questions and submit it as an exit slip.

- Is there anything about the senses that you understand in a deeper way as a result of the discussion?
- Are there any wonderings that emerged in the small or large group discussion that you would like to explore further?

For additional support in facilitating discussion:

https://inquiryproject.terc.edu/shared/pd/TalkScience_Primer.pdf

STUDENT HANDOUT

RACCOON PHOTOGRAPHY

In Mr. Randu's photography class, two students, Jay and Adriana, are discussing a black and white photograph taken by their classmate Dionne. The title of the piece is "Raccoon Paws."

Jay: I think Dionne took a picture of a raccoon pushing on some material from behind because it looks like the paws are popping out.

Adriana: I think this is a picture of raccoon paw prints in some soft material like mud. Oh wait, now I see it popping out too... What is going on?



INSTRUCTIONS

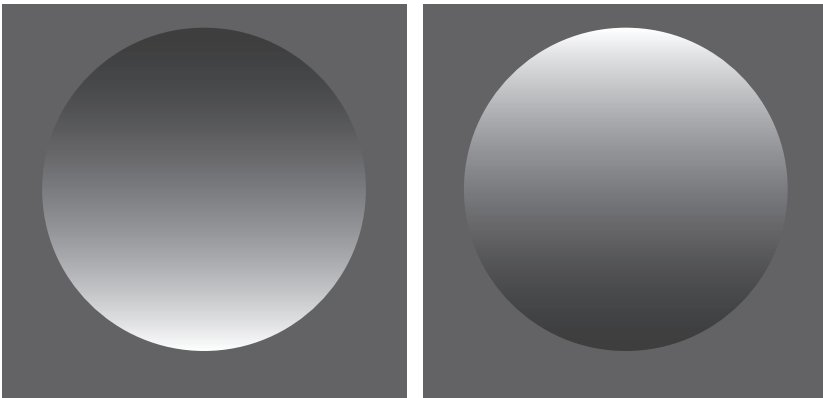
- Observe the picture for 30 seconds. What do you see? Are the paws "pressed in" or "popping out"?
- Rotate the picture 90 degrees and observe it for another 30 seconds. Now what do you see?
- What do you think is happening?

STUDENT HANDOUT
RACCOON PHOTOGRAPHY

ANSWER

Dionne took this photograph when she was walking through the woods in the spring. It shows raccoon footprints pressed into soft muddy bank of a river. But the prints appear to be popping out, like a relief. Why? As the brain processes the black and white image it “corrects it” to make the footprints pop out because the brain is used to seeing things lit from above.

To test this look at these two dots:



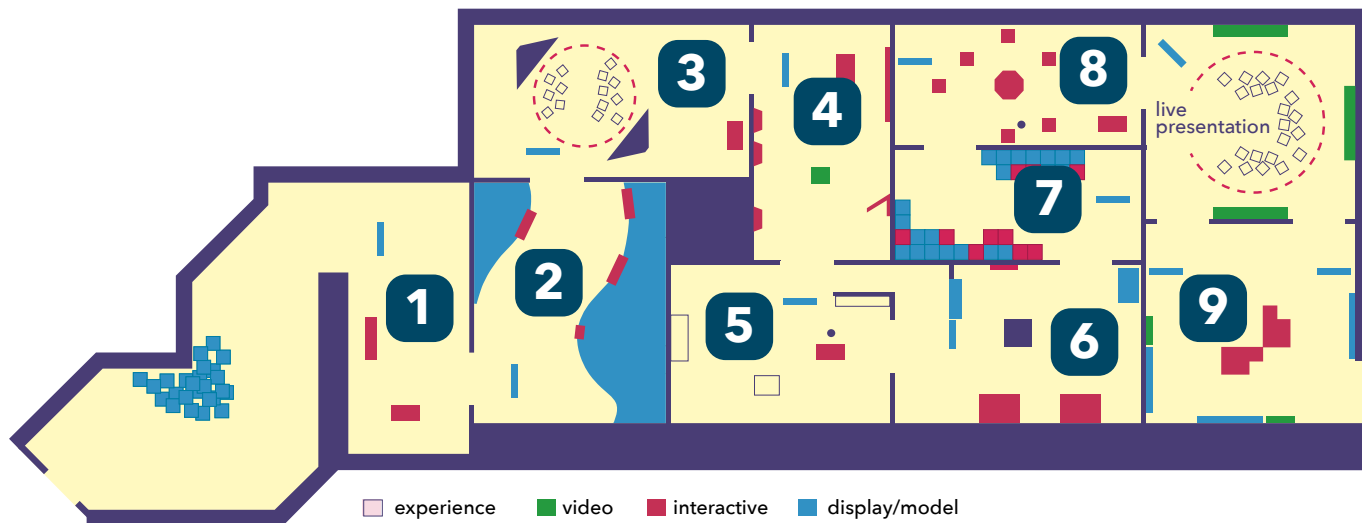
Which is convex (popping out)? Which is concave (going in)?

Then turn the page 90 degrees and look again. Your brain assumes the light is coming from above and makes assumptions about the shape of the object.

Student Worksheet: Page 1

Name: _____

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	<p>Use the flashlight to shine white light on the wall. What do you see?</p>		
	<p>Walk over to the "How Does It Work?" interactive. How many different types of cones do these animals have?</p>		
<p>humans</p>	<p>seals</p>	<p>whales</p>	

Student Worksheet: Page 2 Name: _____

2. DETECTING	We can only sense a tiny fraction of the information around us, but other animals have evolved various ways of sensing beyond what humans can. List two examples of animals and their senses that can detect stimuli humans can't.	
	Animal:	Additional Info:
	Sense:	
	Animal:	Additional Info:
Sense:		

3. HEARING	Walk around the room. What sounds grab your attention the most? What did they make you think of or feel?	
	Explore the "How Does It Work?" interactive. What are the smallest bones in the human body and what is their evolutionary origin?	

Student Worksheet: Page 3

Name: _____

4. SELECTING

Pick one of the senses and compare it among the dolphin, human, and coyote.

Sense:

Observations:

Explore the interactives in the "Mind Control" section. Provide an example of how your brain can control what you see.

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How did it feel to walk in the wavy room?

Explore the "How Does It Work?" interactive. How does your brain keep you balanced?

Student Worksheet: Page 4 Name: _____

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Describe one example from this section of how the brain corrects our senses.

Our skin has specialized nerve endings for detecting different sensations. In this room you can explore several of these nerve endings that contribute to your sense of touch. Pick your favorite nerve ending and describe it.

7. TOUCHING

Nerve ending name:

Sensation:

Description:

8. SMELLING

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Student Worksheet: Page 5

Name: _____

Examine the wall graphics. Describe two of them and list the method used to generate it.

9. EXTENDING

STUDENT HANDOUT
CONVERSATIONAL PROMPTS

Use these sentence frames to help sustain discussion:

To Clarify:

- "What made you think that?"
- "Can you say more about that?"
- "Can you explain . . .?"
- "I still have questions about . . ."
- "Can you give an example?"
- "Let me see if I understand what you're saying . . . Are you saying (paraphrase in your own words) . . .?"

To Elaborate on an Idea:

- "I want to add on to the idea that . . ."
- "Based on what I saw/read in the exhibit, I think . . ."
- "What you are saying reminds me of . . ."

To Question:

- "I disagree with the idea that . . . because . . ."
- "What (in the exhibition display/ on your worksheet) made you think that?"

STUDENT HANDOUT
POST-DISCUSSION EXIT SLIP

1. Is there anything about the senses that you understand in a deeper way as a result of the discussion?

2. Are there any wonderings that emerged in the small or large group discussion that you would like to explore further?