Developing Models for Sensory Receptors

Ann Moriarty
Joanna Snyder
FOSS Curriculum Developers

FOSS is a K-8, modular, research-based, NGSS-aligned curriculum developed at the Lawrence Hall of Science (UC Berkeley) with support from the National Science Foundation.
FOSS Next Generation

FOSS Next Generation is a research-based science curriculum designed to support the Framework and Next Generation Science Standards for grades K-8.

Each course provides instructional sequences and pedagogical strategies to support three dimensional instruction.
NGSS Three Dimensions
<table>
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<tr>
<th>Grade</th>
<th>Integrated Middle Grades</th>
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<tr>
<td>6–8</td>
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<td>Heredity and Adaptation*</td>
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<td>Planetary Science</td>
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<td>Human Systems Interactions*</td>
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*Half-length courses  
Physical Science content  
Earth Science content  
Life Science content  
Engineering content  

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Features of FOSS Next Generation

- Notebooking embedded in curriculum
- Embedded assessment including three-dimensional performance assessments
- Benchmark assessments online
- Student Resource Book with embedded strategies to support Common Core ELA
- FOSSweb:
  - Online activities, simulations, videos
  - Digital Teacher Guide and eSRB
  - Modifiable teacher slides
  - Teacher prep videos

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Systems Connections prompts students to solve a mystery—a disease mystery. On the path to diagnosis, students encounter the levels of complexity in humans: cells form tissues, tissues form organs, organs form systems, and systems form a multicellular organism, the human. They discover how organ systems interact, each dependent on all the others for its functions.
Investigation 2: Supporting Cells

In *Supporting Cells*, students fatigue their muscles and learn how their cells obtain the food and oxygen they need via the digestive, respiratory, and circulatory systems. They model how *aerobic cellular respiration works in cells*. They find out how cells eliminate the wastes produced during aerobic cellular respiration via the circulatory, respiratory, and excretory systems.

MS-LS1-3
MS-LS1-7
Investigation 3: The Nervous System

In *The Nervous System*, students explore the different senses to understand **how humans gather information from the environment**. They engage in a “neuron relay” to model how sensory information travels to the brain for processing and how information returns to the body for action. Finally, students turn their attention to their own **learning and memory formation**.
NGSS Performance Expectations in Investigation 3

**MS-LS1-3**: Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.

**MS-LS1-8**: Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.
Human Systems Interactions
Teaching Slides, 3.1
Review organ-system interaction

1. How do we as living organisms interact with the world around us?
2. How do we know what is going on around us?
3. What are the senses?
Think about what it would be like if you couldn’t sense the environment around you. One student in each group should imagine you do not have sight, hearing, smell, taste, or touch. Write a short paragraph and then share.

Talk with a partner instead!
Focus question

• How does the sense of touch work in humans?

Record ideas about what kind of information about the world the sense of touch gives you.
Investigate the phenomenon…

Work with a partner. Do 5 fingertip trials each, then 5 knuckle trials each.
Sensory receptors

Anything that causes an action, or response, in an organism is a stimulus.

When something presses on the skin, the stimulus is pressure.

The skin has cells called sensory receptors that respond to the pressure.
For Step 6, write these words on the word wall illustrating the "cause-and-effect" relationship, e.g., stimulus → response. Add the word pressure under stimulus. When introduced, add the word mechanoreceptors.

Point out the Greek origin of the suffix "mechano" meaning machine or mechanical and the Latin root word "receptor" meaning receive.
FOSSweb

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Human Systems Interactions
Next Generation | Grades 6-8
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Middle School Second Edition | Grades 6-8
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Human Systems Interactions
Next Generation
*Resources by Investigation*

**Investigation 1: Systems Connections**

**Investigation 2: Supporting Cells**

**Investigation 3: The Nervous System**

Students explore the different senses to understand how humans acquire information from the environment. They engage in a “neuron relay” to model how sensory information travels to the brain for processing and how information returns to the body for action. Students turn their attention to their own learning and memory formation.

**Investigation 3, Part 1: The Sense of Touch**

**Investigation 3, Part 2: Sending a Message**

**Investigation 3, Part 3: Other Senses**

**Investigation 3, Part 4: Learning and Memory**
Students explore the different senses to understand how humans acquire information from the environment. They engage in a “neuron relay” to model how sensory information travels to the brain for processing and how information returns to the body for action. Students turn their attention to their own learning and memory formation.

Investigation 3, Part 1: The Sense of Touch

Students think about how humans sense the environment around them and then turn their attention to the sense of touch. They compare touch sensitivity between fingertips and knuckles to learn about pressure receptors and receptive fields.

- Investigation 3 - Teacher Prep Video
- Important Course Update: Notebook sheet 7: Touch Receptors Diagram Labels
- Focus Question 3.1
- Teaching Slides, Inv 3.1 (Modifiable PPT)
- Teaching Slides 3.1 (PDF)
- Notebook Sheet No. 7
- Notebook Sheet No. 7 for Display
- Teacher Master C
- Teacher Master D
- Teacher Master E
- Online activity: Hearing Menu
- Online activity: Touch Menu
- Embedded Assessment Notes
Welcome to the Touch Menu!

- HOW THE SKIN WORKS
- RECEPTORS
- RECEPTIVE FIELDS
- HOW TOUCH WORKS
- SENSORY PATHWAY
- HOW THE SKIN LOOKS
- 3D FINGER
- WHAT CAN GO WRONG
- MORE...

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Pressure receptors are called **mechanoreceptors**.

“mechano” means machine.
“receptor” means receive.
Read “Sensory Receptors” on page 55.

Sensory Receptors

Mmm, I smell doughnuts! I can picture which one I want before I even see them. Why does that smell bring up images and memories in my brain?

One of the jobs of your nervous system is to take in information, decide what is meant, and respond to it in some way. For many, the smell of doughnuts means something more. The brain connects the smell to prior experiences. The smell evokes a memory of a doughnut, a warm, chocolatey scent. The brain recognizes desire and responds by sending the body to find the doughnut and eat it.

Our senses all rely on the ability of sensory receptors to take in information and send it to the brain. Each sense has receptors that respond to certain inputs: mechanical, chemical, or others even magnetic.

We experience the world around us through our senses, which work together to collect information and send it to the brain. How might all five senses help you enjoy a doughnut?
ELA Connections from Common Core

<table>
<thead>
<tr>
<th>Sensory Receptor</th>
<th>Function</th>
<th>Stimuli</th>
<th>Location</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanoreceptors</td>
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<tr>
<td>Chemoreceptors</td>
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<tr>
<td>Photoreceptors (Electromagnetic)</td>
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**Determine the central idea:**
When students finish reading the page, have them write one sentence, make a simple drawing, or use a graphic organizer to...

**ELA CONNECTION**

These suggested strategies address the Common Core State Standards for ELA for literacy.

- **RST 2:** Determine the central ideas or conclusions of a text; provide an accurate summary.
- **RST 10:** Read and comprehend science/technical texts independently and proficiently.

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Touch

Your sense of touch develops before you are born. It is the first sense to develop. Next to vision, touch is perhaps our most important sense for gathering information about the world.

Sense of touch includes several major types of sensation. Each type has its own or more specific receptors. The receptors stimuli can be a mechanical or thermal signal.

Receptors

Pressure is a mechanical stimulation of the skin. Some pressure receptors respond to brushing and light touch. Some respond to deep, steady indentation of the skin. Others respond to vibration. Hair follicle receptors are the base of the hair and are triggered by movements of the hair.

Thermal receptors respond to sensations related to temperature. Cold receptors are no longer stimulated when the temperature drops too low, so a bundle full of ice may start to feel warm.

Your fingertips are especially sensitive to touch.
Discuss pressure sensory receptors

• Why are your fingertips better able to discriminate the number of small dots in a braille code?
What is your model?

Each sensory receptor cell has a receptive field, an area from which it gathers information.

- A few large receptive fields
- Many small receptive fields
Collect data on receptive fields
Collect data on receptive fields

1. What was the difference between feeling the points with your fingertips and with your knuckles?
2. What does that tell you about the receptive fields and the sensory receptors in the fingertips?
What is your model?

What data could you collect to develop evidence to support the overlapping or nonoverlapping model?

Many small receptive fields

Many small receptive fields

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Sense-making discussion

Write in your notebook:
• your test, the data you gathered, and your claim and evidence.

Be prepared to:
• draw your model and provide the evidence you gathered to support your conclusions.
### SENSE-MAKING DISCUSSION PLANNING GUIDE

**Course** | Human Systems Interactions  
---|---  
**Investigation** | Inv. 3 The Nervous System  
**Guiding question:** | How do humans detect, process, and use information about the environment?  
**Focus question:** | How does the sense of touch work in humans?  

### NEXT GENERATION SCIENCE STANDARDS

<table>
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<tr>
<th>Focus DCI(s)</th>
<th>Focus SEP(s)</th>
<th>Focus CCs</th>
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<tr>
<td>L51.A: Structure and function</td>
<td>Developing and using models, Planning and carrying out investigations, Analyzing and interpreting data, Constructing explanations, Engaging in argument</td>
<td>Systems and system models, Structure and function, Scale, proportion, and quantity</td>
</tr>
<tr>
<td>L51.D: Information processing</td>
<td>Obtaining, evaluating, and communicating information</td>
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### Questions and Intended Responses

**Step 15**

**What to ask**

- What data could you collect to develop evidence to support the overlapping or nonoverlapping model for receptive fields? (Step 15)
- What was your test?
- What was the data you collected?

**What to listen for**

- Receptive fields are arranged in both size and overlapping or nonoverlapping model.
- We thought about size in the prior test; if smaller receptive fields, we always feel the correct number; if larger, we can’t always tell.

**Scaffolding questions**

- How are the overlapping and nonoverlapping models for pressure receptive fields different?
- If there were tests where you didn’t feel the paper clip, what does that tell you?
- If you always felt the paper clip, what does that tell you?

**Application questions**

- Do you think the number of pressure receptors and model of pressure receptive fields are the same in all parts of the body that have skin? (Back, arms, legs, feet, etc.) (this is looking forward to Step 17)
- We thought about pressure receptive fields. What about other receptors in your fingers and knuckles? Might they follow the same model?
- Do you think pain receptor receptive fields might be large or small? What might be the pros and cons of large or small?
Who is doing the talking?

This diagram shows the interactions that might take place between the teacher, students, and the class notebook in a sense-making discussion.
16. Assess progress: notebook entry

After the sense-making discussion, give students the opportunity to draw a line of learning and record any changes they would like to make to their original claim. Then, collect a small sample of notebooks and check for depth of understanding of the model students are developing for pressure receptive fields.

What to Look For

- Students describe a reasonable and appropriate paper-clip test.
- Students clearly describe the data they collected from their test.
- Students use the data to develop evidence to construct an explanation to support one of the models, such as, if they always sensed the paper clip, that supports the overlapping model; or if there were times they did not sense the paper clip, that supports the non-overlapping model.

Plan to spend 15 minutes reviewing the selected student responses. Using Embedded Assessment Notes as a tool, review the responses, record any alternative concepts that are evident, and decide if any next-step strategies are required before moving forward.
Introduce the homunculus

Teacher master E, Homunculus
Review vocabulary

Spend a few minutes reviewing the vocabulary for this part. Update the vocabulary index and table of contents in your notebook.
Answer the focus question

• How does the sense of touch work in humans?
Homework

Read “Hearing” in FOSS Science Resources on page 64
NGSS Three Dimensions

- Models
- Investigations
- Data
- Explanations
- Argument from Evidence
- Information

LS1.D Information Processing
LS1.A Structure/Function

- Scale/proportion
- Structure/Function

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3. Your lips are more sensitive to touch than your forehead. What is different about the touch receptive fields in the lips compared to the forehead?

(Mark the one best answer.)

- A  There are more touch receptive fields in the lips.

- B  The touch receptive fields are bigger in the lips.

- C  The touch receptive fields are more sensitive in the lips.

- D  The touch receptive fields are used more often in the lips.
INVESTIGATION 3 – The Nervous System

14. Display alternative models

Project teacher master D, Present Receptive Fields Models B. Ask students how these models for the pressure receptive fields are the same and different from the previous models. They should notice that these fields are large and small but they do not overlap. Ask students how they could gather data to determine which models (overlapping or nonoverlapping) better describe the pressure receptors and receptive fields on their hands. Have them discuss this in their groups.

15. Engage in argument from evidence in a sense-making discussion

a. What data could you collect to develop evidence to support the overlapping model or the nonoverlapping model?

Let groups plan their investigations and then give them a few minutes to collect the data. Conclude among the groups and see how they approach the problem. They should be using the paper clip to test the tongue, lips, and feet. They should also record their findings in their notebooks.

b. Present Receptive Fields Models B. Ask students to select which model they can support with evidence and to describe that evidence. Ask them to write in their notebooks 1) the text, 2) the data they gathered, and 3) the reason why they support that claim. They should include information on both the size of the receptive field and the overlapping aspect.

This is a good time for students to engage in a sense-making discussion. They should be prepared to draw their models and provide the evidence they gathered to support their conclusions as they share them with the rest of the class.

Assess progress: notebook entry

After the sense-making discussion, give students the opportunity to form three groups and record any changes they would like to make to their original claim. Then, they will be able to share their results with the rest of the class.

What to Look For

- Students describe a reasonable and appropriate paper clip test.
- Students correctly describe the data they collected from their test.
- Students explain their conclusions in a sense-making discussion.

Part 1: The Sense of Touch

- Students use the data to develop evidence to support one of the models, such that, if they always arched the paper clip, that supports the overlapping model; if these were times they did not use the paper clip, that supports the non-overlapping model. Plan to spend 15 minutes reviewing the selected student responses.
- Using Embedded Assessment Notes as a tool, review the responses, record any alternative concepts that are evident, and decide if any next-step strategies are required before moving forward.

17. Introduce the human nervous system

Project teacher master E, Human body. Say: Scientists represent the number of touch receptors in different parts of the body using a diagram called a human nervous system (HNS), which is Latin for “nerve person.” Ask your partner about what you notice about this image. Focus on the structure and function of each body part portrayed here and why some are exaggerated.

Confirm that the image exaggerates different parts of the body to show how touch sensitive they are. Then hold a class discussion using the following questions. Students can also use the concept of scale and proportion to interpret and explain the diagram.

- Which parts of the body are best equipped to gather information through the sense of touch and which are poorly equipped? (The lips, tongue, hands, and feet are best; the ears, legs, and arms are poorly equipped.)
- Why might it be important to have certain parts of the body be very sensitive to touch and other parts not? (We use certain parts of our body to interact with the world. These parts should have more sensory receptors.)

18. Review vocabulary

Give students a few moments to review the vocabulary developed in this part. Have them update their vocabulary indexes and tables of contents if they haven’t already done so.

19. Answer the focus question

Tell students to write a response to the focus question. They should include what they have learned about sensory receptors and receptive fields.

- How does the sense of touch work in humans?

Once students have completed their own responses, ask a few to share their thoughts with the class.

CROSSCUTTING CONCEPTS
- Scale, proportion, and quantity
- Structure and function

TEACHING NOTE

This is a structural relationship. Structures such as tendons, ligaments, and muscles help us maintain our body’s movement. The skin on our back does not provide as much important sensory information that you need to respond to, therefore, it is not important that you be as sensitive to touch as other parts are.
FOSS Next Generation

- FOSS supports three dimensional instruction, and provides detailed pedagogical support for notebooking, assessment, literacy, and engineering.
- FOSS courses **build concepts** through a course and across grades with a conceptual framework for grades K-8.
- FOSS integrates scientific knowledge with the **practices** of science and engineering.
Connections to the Framework

Specific connections to the K-12 Framework **Disciplinary Core Ideas**, **Scientific and Engineering Practices**, and **Crosscutting Concepts** can be found in multiple locations:

- Overview Chapter
- Framework Chapter
- Online at [www.FOSSweb.com](http://www.FOSSweb.com)

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What do you get?

- Investigations Guide
- Materials for 5 classes
- FOSSweb - Multimedia
- Student Books with ELA and ELL support
- Teaching Slides (modifiable)
- Teacher Prep Videos

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• Log on to **FOSSweb** to explore the courses using your temporary access code

• Check out **FOSSSConnect**, our online newsletter, at [www.deltaeducation.com/FOSSSconnect](http://www.deltaeducation.com/FOSSSconnect)