Body systems and Bots. What's the connection?

3 to 4 weeks

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SUBJECT/GRADE LEVEL

Subject Area: Science

Grade Level: Middle School

Materials

- Card sort game
- Projector or a computer with internet access
- Video: Crash course: Cells
- Microscopes
- Microscope slides of living and nonliving things
- Model home
- Handouts: Linked to each section
- Images of: (Prokaryotic cell, Eukaryotic cell, Animal cell , Unicellular eukaryotic cell)
- Computers and internet access
- Access to Ai tools (ChatGpt, Google Gemini, Canva Ai tool)
- Trivia games (I should have known that, Disney Trivia, Trivia pursuit)
- TinkerCAD account: www.tinkercad.com
- Google Gemini access: gemini.google.com
- Internet-enabled device
- Optional: 3D printer access
- Computer with internet access

STANDARDS

Next Generation Science Standards

- MS-ETS1-1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

Mathematics Standards | Common Core State Standards

- 7.G.A.1 Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.
- G.MG.A.2 Apply geometric methods to solve real world problems.

English Language Arts Standards | Common Core State

- RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).
- RST.6-8.8 Distinguish among facts, reasoned judgment based on research findings, and speculation in a text.

LESSON OBJECTIVE(S)

Students will investigate and model how biological systems in the human body process and respond to stimuli, and will draw connections to how robots and AI tools simulate these systems through sensors, processors, and outputs. Through hands-on stations, AI interaction, 3D design, and coding activities, students will analyze, compare, and communicate how input → processing → output works in both living organisms and intelligent machines.

CAREER CONNECTION(S)

Mentor Background: Dr. Benjamin D. Nye is the Director of Learning Sciences at the University of Southern California, Institute for Creative Technologies. His research interests include modular intelligent tutoring system (ITS) designs, modeling social learning and memes, cognitive agents, and educational tools for the developing world and low-resource/low-income contexts. He received his Ph.D. in Systems Engineering from the University of Pennsylvania in 2011. Ben currently leads projects focused on areas such as mobile adaptive learning ecosystems (PAL3), open-source and user-authorable tutoring chat dialogs (OpenTutor), a studio for career mentors to self-record their own virtual mentors (CareerFair.ai).

STEM Careers: Artificial Intelligence Engineer, Computer Vision Engineer, Machine Learning Engineer, Robotics Engineer, Software Engineer, Analytics Consultant, Business Analyst, Data Scientist

ENGAGEMENT Part 1

Brief Description: Students will rotate through 4 interactive stations designed to activate background knowledge, introduce key vocabulary and spark inquiry about the complexity of living organisms and cells.

Time: Approximately 2 days

Day 1:

Materials:

- Card sort game
- Projector or a computer with internet access
- Video: Crash course: Cells

- Microscopes
- Microscope slides of living and nonliving things
- Model home
- Handouts: Linked to each section
- Images of:
  - Prokaryotic cell
  - Eukaryotic cell
  - Animal cell
  - Unicellular eukaryotic cell

Procedures:
What Makes Something Alive?

Station 1: Living vs. nonliving sort

Objective: Students classify images and justify their choices.

Materials:

- Card sort game

Task:

- Students work in pairs to sort the cards into two categories: LIving or Nonliving.

Prompt Questions:

- What do all living things have in common?
- Are there any items you disagree with?
- Can you think of something that was once living but now it is not?

Station 2: Slide Challenge and Video Clip

Objective: Students will observe microscope slides and begin identifying characteristics of life.

Materials:

- Video: Crash course: Cells- The building blocks of life
- Microscopes
- Microscope slides of different living and nonliving things

Task:

- Have students watch the 4-5 minute video (play it on a loop)
- Have students view the images in the microscopes and write their guesses as living or nonliving and why.

Station 3: Describe your home

Objective: Connect everyday items to biological systems.

Materials:

- Model of a house with all its rooms and appliances
- Station 3 model and handouts

Task:

- Have students in groups list rooms/ appliances/etc. and describe how each part contributes to the function of the home.

Prompt Questions:

- “Describe your house. What parts does it have? What does each part do? What would happen if one part stopped working?
- These will be completed in a handout.

Station 4: Cell Image Comparison

Objective: Begin recognizing diversity in cell types and structures.

Materials:

- Station 4 handouts
- Images of:
  - Prokaryotic cell
  - Eukaryotic cell
  - Animal cell
  - Unicellular eukaryotic cell

Task:

- Have students observe the different types of cells and complete the handout. In the hand out students will compare and contrast each of the images they observe.

Day 2:

Procedures:

Exploring AI tools. Students will rotate between stations, interacting with AI tools.

Brief Description: Students will rotate through 4 interactive stations designed to activate background knowledge, introduce key vocabulary and spark inquiry about the complexity Ai tools and engagement on how they function.

Objective: Students will interact with AI tools to explore how it answers questions, generates content, or solves problems.

Materials:

- Computers and internet access
- Access to AI tools (ChatGpt, Google Gemini, Canva AI tool)
- Trivia games (I should have known that, Disney Trivia, Trivia pursuit)

Station 1: Talk to AI

Materials:

- Computers and internet access
- Access to AI tools (ChatGpt, Google Gemini, Canva Ai tool)

Task:

Students will:

- Ask AI to write a poem about a burger, a pizza or cheese fries.
- Ask AI tool to write a short story about a dog, a cat or a mouse.
- Ask AI tool to write a social media post for a zebra that has escaped the zoo, a lion that has escaped the zoo or a sloth that has escaped the zoo.

Student Questions:

- Does the response sound like a human made it?
- What surprised you?

Station 2: Brain Battle

Materials:

- Computers and internet access
- Access to AI tools (ChatGpt, Google Gemini, Canva Ai tool)
- Trivia games (I should have known that, Disney Trivia, Trivia pursuit)

Task:
Students will:
Pick a trivia game:
a. Pick a card from trivia game
b. One student will take a stopwatch and time how long it takes their partner to answer the trivia question
c. Do the same but with the AI tool you have decided to utilize
Student Questions:
- ➢ Who was faster?
- ➢ Who was more accurate?
- ➢ Who was more creative with the answer?

Station 3: Picasso time!
Materials:
- ➢ Blank piece of paper
- ➢ Colored pencils
- ➢ Crayons
- ➢ Pencils
- ➢ Erasers
- ➢ Computer with internet access
- ➢ Ai tool (ChatGpt, Google Gemini, Canva Ai tool)

Task:
Students will:
- ➢ Sketch a picture out of one of the Picasso cards
- ➢ Utilize a picture Ai tool and ask them to create the same picasso card

Student Questions:
- ➢ How is your art different from the Ai tool?
- ➢ What choices did you make and what are the choices your Ai tool makes?

EXPLORATION Part 1

Brief Description: Deepen understanding of how both humans and robots process and respond to stimuli using systems of communication and control.

Procedures:
Part 1: The Amazing Human Brain: Your Body's Control Center
Presentation Check for Understanding

Part 2: EXPLORE: THE ROBOTIC BRAIN
Objective: Students will create a basic model of a neural network to understand data processing.

- Materials Needed:
  - Beads or colored blocks (variety of colors)
  - String or yarn (to connect beads)
  - Graph paper or poster board for diagram/drawing
  - Markers for labeling

- Instructions:
    - Group Formation: Divide students into small groups of 3-4.
    - Assign Roles: Each group member can take on a specific role (e.g., Designer, Builder, Recorder, Presenter) to encourage collaboration.
    - Building the Model: Slides to use while explaining model activity
    - Each group receives a set of beads representing different neuron types:
        - Input Neurons (Green): Represent sensory data (e.g., images, sounds).
        - Hidden Neurons (Yellow): Process the information.
        - Output Neurons (Red): Represent the final decision or output.
    - Students will connect the beads using string to illustrate how input data flows through the network. They should create at least one hidden layer between the input and output layers.

OPTIONS FOR NEURAL NETWORKS (ONE PER GROUP)

    - Recording Observations: handout linked here
    - Each group should record their process, noting:
        - Their assigned neural network
        - The connections made between the neurons.
        - Any challenges faced during construction and how they overcame them.
        - A brief description of what each layer represents in terms of data processing.
    - Visual Representation:
    - Using graph paper or poster board, students will sketch the layout of their neural network model, labeling each type of neuron and describing its function.
- Class Share-Out:
    - Once the models are complete, each group will present their neural network to the class. They will explain:
    - The flow of information through their model.
    - How their design represents a simplified version of a neural network.
    - Any real-life examples of how neural networks are utilized (e.g., image recognition, voice assistants).

Reflection Questions:

    - How did your model help you understand the concept of neural networks?
    - What similarities did you notice between your model and actual neural networks used in technology?

Part 3:
Time: 1 day of about 45–60 minutes

Objective: By the end of this lesson, students will be able to: (1) Describe basic features of a neural network. (2) Observe how AI tools make predictions based on patterns. (3)Recognize how data inputs influence outputs in AI models.

Materials:

- Internet-connected devices (laptops/tablets)
- Printed or digital "AI Neural Network Model" (simplified diagram of layers: input, hidden, output)
- Access to free AI tools like:
  - Quick, Draw! (https://quickdraw.withgoogle.com/)
  - Teachable Machine (https://teachablemachine.withgoogle.com/)
  - ChatGPT or other large language models if allowed
- Student handouts for observation and reflection

Opening work (5 min):
Briefly visit the phenomenon: "How can AI generate art, answer questions, or recognize faces like a human can?"
Ask students:

- "What do you think happens inside an AI's 'brain' when it makes a decision or prediction?"

Explore (35–40 min):
Part 1: Investigating AI Behavior (15–20 min)
Option A – Use "Quick, Draw!"

- Students take turns drawing prompts.
- Observe how the AI predicts what they're drawing.
- Discuss:
  - What do you think the AI is looking for in your drawing?
  - Did it get your drawing right away? Why or why not?

Option B – Teachable Machine

- In groups, students create their own mini image classifier.
- Train the model using simple images (like hands up vs hands down).
- Test it with classmates.
- Discuss:
  - How did the AI learn the pattern?
  - What data did it need?

Option C- ChatGpt, Google Gemini or any other LLM available

- Students take turns asking the Ai tool to:
  - Draw a picture of…(have them create an imaginary image that they would like the Ai tool to create)
  - Answer questions: These questions cannot be about the class. They should be about material they know the answer to.
- Discuss:
  - Did the Ai tool draw what you were expecting? How could you have made it draw what you wanted?
  - Did the Ai tool answer as you expected? Did you find out something new?
  -

Part 2: Model the Neural Network (15–20 min)

- Hand out or project a basic diagram of a neural network
- In small groups, students simulate being parts of a neural network:
  - Each student plays the role of a "neuron."
  - "Input" students get a data card (e.g., color, shape).
  - Pass it through the "hidden" neurons (students must decide how much of the signal to pass forward using yes/no or point values).
  - "Output" neuron decides the final category.

Debrief with Questions:

- How did the “neurons” decide what to pass on?
- How does this relate to what AI does with your images or text?
- What might happen if we gave it unclear or wrong data?

Wrap-Up Discussion (5–10 min):

Ask:

- What surprised you about how AI learns?
- What are some limitations or biases you noticed in the way AI made decisions?

Have students record a short reflection or complete a sentence stem like:

“Today I discovered that neural networks…”

*This is to be done in their science journal.

EXPLANATION Part 1

Brief Description: Deepen understanding of how both humans and robots process and respond to stimuli using systems of communication and control.

Procedures:

Whole-Class Discussion & Visual Modeling (10–15 min)

Review Exploration Observations:

- Ask: How would you know what to do when you touch something hot?
- Ask: “How would a robot know what to do when it sensed something?”
- Guide students to see parallels in stimulus → processing → response in both humans and machines.

Direct Instruction with Interactive Modeling:
Use a chart, diagram, or animated slide showing how signals travel through the nervous system vs. a robot circuit.

Human Body	Ai tool	Robot
Brain	Neuron	Processor (CPU)
Sensory organs (eyes, skin, ears)	Sensors	Sensors (camera, touch, sound)
Nerves	Processor	Wires or circuit paths
Muscles	Output	Motors or actuators

Vocabulary Development (with sentence frames or word wall):

- Stimulus – a change in the environment that causes a reaction
  - "When I touched the hot stove, the heat was the stimulus.
  - Response – the action taken after processing a stimulus
  - Neuron / Signal / Processor / Sensor / Actuator

ELABORATE part 1

Brief Description: Apply understanding of input → processing → output through a creative design challenge that mirrors biological systems in a robot or simulation.

Procedures:
Project: Build or Simulate a Command Center System

Objective: Design and present a system either biological or robotic that detects a stimulus and produces a logical response.

Paper Logic Flow / Comic Strip (No-Tech or Low-Tech)

- Students choose a stimulus (e.g., light, touch, loud sound).
- They create two side-by-side flowcharts or comic strips:
  - One shows how a human would react using the nervous system.
  - One shows how a robot could be programmed to react using sensors and a processor.

*Possible differentiation: Offer templates with "starter boxes" or sentence stems like:

- "If the stimulus is ___, then the [brain/CPU] will tell the [muscle/motor] to ___."

Extension: Human-Robot Roleplay

- Students act out being neurons/sensors/actuators in response teams.
- One student is the "stimulus," another is the "processor," others are "effectors" like hands or wheels.
-

Presentation & Reflection (1-2 days)

Have students:

- ➢ Present their model/system to the class or in small groups.
- ➢ Explain the path of input → processor → output in both human and robotic systems.
- ➢ Compare which system might be faster, more accurate, or better suited for different environments.

ENGAGEMENT Part 2

Brief Description: Have students assume the role of mission planners and engineers for Rover's expedition.

Procedures:
Part 1:
Have students assume the role of mission planners and engineers for Rover's expedition.

Part A: Mission Briefing
Materials: A Rover's Story, Part Two, Chapter 39
Prompt:
"NASA just received a message from a Mars rover. Something's gone wrong… but they only got fragments of the message."
Read this partial, fictional "transmission" on the board:
...terrain unstable... need alternative route... equipment status: 78% functional... mission time running low... awaiting input...

Student will be listening to the story and they will be taking notes on:
(Just play the audio it is not necessary to show the woman reading)

- ➢ The Rover's current mission goals
- ➢ Obstacles or challenges
- ➢ Instrument or tools that are used

After video is over give students time to write down their findings, write on the board the prompt:
Based on what we heard, what's the rover's mission objectives and what are the challenges it faces?

Part B: Creature Report
Prompt: You are the rover. You've just faced a new challenge during your mission on Mars. Write a mission log entry explaining:

- ➢ What happened today?
- ➢ How did you feel (if you could feel)?
- ➢ What decisions did you have to make?
- ➢ What do you hope will happen next?

Part C: Blueprints
Materials:

- Blue copy paper
- Graph paper
- Colored pencils
- Pencils
- Ruler

Students will be working on several designs:

- Drawing a simple design of rovers terrain
- Drawing a simple design of a rover capable of handling the terrain they drew
- Draw tools their robot would need for their mission goals (the same as the rover story they heard)

Part 2: Breaking News!
Objective: Students will be journalists and you must prepare for a press conference
Prompt for the students: "You are a journalist at the Mars Rover Mission Control center. News have come and you must inform everyone through a press conference."

Part A: Student task

- Draft 2-3 headline questions you would ask the rover
- student handout
- Predict the answer you might hear
- Sketch your reporter badge

Part B: Listening to the chapter

- Have students listen to chapter 48 and hear what the rover has to reveal.
- A Rover's Story, Chapter 48
- Encourage students to jot down any answers they get from their drafted questions and anything that they find important for the press conference.

Part C: Have students create a script of what they would need to say in their press conference about what happened to the rover.

EXPLORATION Part 2

Brief Description: Students will explore TinkerCAD to create a personalized 3D keychain while learning the basics of 3D design, shapes, alignment, and grouping.

Time 1–2 class periods (45–60 min total)

Procedures: Explore with Tinkercad and Gemini
Materials Needed:

- TinkerCAD account: www.tinkercad.com
- Google Gemini access: gemini.google.com
- Internet-enabled device
- Optional: 3D printer access

Task: Design a personalized keychain in TinkerCAD. Use Google Gemini as your virtual assistant to help you:

- ➢ Learn new TinkerCAD tools
- ➢ Get design advice
- ➢ Troubleshoot problems
- ➢ Explore creative ideas

Step-by-Step Instructions:

1. Intro to Gemini & TinkerCAD (10 min)

a. Launch both TinkerCAD and Google Gemini in separate tabs.
b. Ask Gemini:
"What is TinkerCAD and what can I make with it?"
c. Follow up with:
"How do I get started with a keychain design in TinkerCAD?"

*Teacher Tip: Demonstrate one or two Gemini queries and their answers for the class.

2. Keychain Design Challenge (30–40 min)

Design Goal: Create a custom keychain with your name, initials, or favorite shape.

Student Tasks:

a. In TinkerCAD, drag a rectangle or rounded shape to start the keychain base.
b. Add text (your name, nickname, initials).
c. Add a hole for a keyring (use a cylinder "hole" shape).
d. Align and group the objects.

Ask Gemini for Help (examples below):

- ➢ “How do I align shapes in TinkerCAD?”
- ➢ “How do I make a hole in my design?”
- ➢ “What are some creative keychain ideas?”
- ➢ “Why can’t I group my text with the base?”

Students should record 2–3 helpful things they learned from Gemini.

Student Reflection Prompt (End of Activity in notebook)

"How did Gemini help you during the design process? What’s one thing you created or changed because of an idea or solution from Gemini?"

EXPLANATION Part 2

Brief Description: Provide a concise overview of the proposed activity.

Procedures:

Get ready to Code!

Time: 30 minutes

Goal: Students learn the key vocabulary and language of coding through a choice of Edpuzzles. After learning the technical language and process of coding, they will return to their original plan for their bee bots. They will rediagram the bot's code and label it with the appropriate vocabulary (ex. algorithm, bug, debug, variable, loop, if-statement/conditional statement, function, input, output, program)..

Teachers have the option to divide class into groups to have each group watch a different Edpuzzle then have students share what they learned. Option to differentiate based on Edpuzzle length and/or number of questions.

Students can record 3 facts about their video, 2 new things they learned, and 1 question they still have.

- Brainpop Coding - Week 1: Introduction to Programming ~6minutes
- Introduction to Coding (Young Kids) ~5minutes
- Why You Should Learn To Code - Is a Software Developer Career Worth It? ~9minutes
- Introduction to Coding for Beginners ~11minutes
- 14-Year-Old Prodigy Programmer Dreams In Code ~14minutes
- Introduction to Coding ~14 minutes

Tinkercad Extended

Time: 15–20 minutes

Goal: Students explain how sensory input is processed in both humans and robots, and compare the systems.

1. Quick Review & Share-Out

Have a few students share their Tinkercad rover model and one journal insight (e.g., "What triggered your rover's reaction?").

2. Mini-Lesson (5 min)

Use a simple diagram or drawing to show:

- How sensory input travels in humans (receptor → nerve → brain → response).
- How it travels in a robot (sensor → wires → CPU → motor).
- Highlight: Both systems process and prioritize information.
-

3. Diagram + Writing Response (graphic organizer)

Students label their flowchart or Tinkercad sketch with:

- The type of input
- Where it's processed
- What the output/action is

Prompt: “How does your rover model mimic the human sensory system?”

4. Exit Ticket (Wrap-Up)
Ask students to answer:

- ➢ What was one thing your rover did that reminded you of a human body system?
- ➢ What’s one way your rover is different from the way humans respond?

ELABORATE Part 2

Brief Description: Provide a concise overview of the proposed activity.

Procedures:

Elaborate in Code! (continuation of Get ready to Code!)
After students share, they will return to their groups to rediagram their bee bot program to include key vocabulary. They have the option to do a different program altogether as long as the diagram/model reflects the new vocabulary/terminology.

Coding Handout

Exit Ticket: Describe the experience you had in creating the bee bot program. Include successes and failures and use as much key vocabulary in your response.This is your opportunity to show what you learned and what you know!

Build Your Own Responsive Rover
Objective: Students apply what they've learned by building a physical rover model that mimics how the human body senses, processes, and reacts to information.

Activity Summary: In small teams, students design and construct a low-tech prototype rover using materials like cardboard, pipe cleaners, and markers. Their rover must:

- ➢ Include at least 2 labeled sensors (input)
- ➢ Have a CPU/control center (processing)
- ➢ Show an output response (movement, signal, etc.)
- ➢ Use arrows to show how data flows from sensor → brain → action
  Compare rover parts to human body systems

What Students Will Do:

- ➢ Revisit a moment from *A Rover Story* where Res responds to something (e.g., sandstorm). Generate a drawing/sketch of their model before building. Rover Diagram & Labels Template
- ➢ Build their rover model using classroom supplies (30 min).
- ➢ Fill out a Rover Function Log Sheet:
  - What does it sense?
  - What’s the brain?
  - What’s the action/output?
  - What human body parts does it match?

** Teacher: Walk around the room to view other teams’ designs and leave feedback.

EVALUATION

Brief Description: Students will demonstrate and reflect on their understanding of how humans and machines sense, process, and respond to input. Evaluation will include their 3D design process, AI interaction reflections, neural network models, coding vocabulary usage, and comparisons between robotic and biological systems. This phase ties together their exploration, explanation, and elaboration through artifacts, reflection, and presentation.

Procedures:

1. Reflection Journal Prompts (Individual)

Purpose: Assess personal understanding and insight.

Task: Students respond to the following prompts in their science journals:

- ➢ How does your rover model mimic a human body system?
- ➢ What did you discover about how AI processes information?
- ➢ How did interacting with AI tools like Gemini help your learning or design process?
- ➢ One thing I changed in my TinkerCAD design because of Gemini was…
- ➢ Today I discovered that neural networks...

Teacher evaluates for use of vocabulary, depth of explanation, and ability to connect ideas across biological and technological systems.

2. Performance Task: TinkerCAD & Rover Presentation

Purpose: Summative assessment of applied learning through hands-on and digital design.

Task: In small groups, students will present:

- Their TinkerCAD rover or keychain (printed or digital).
- The neural network model (from the beads activity).
- The human vs robot comic strip/logic flowchart.

They must explain:

- How input → processing → output works in both designs.
- How sensors (robot) compare to sensory organs (human).
- Where their design was successful and what they'd improve.

Use a presentation rubric with the following categories:

- Accurate vocabulary usage
- Understanding of systems (biological vs robotic)
- Visual clarity of models
- Clarity of explanation
- Collaboration/Participation

3. Coding Vocabulary Integration Check

Purpose: Evaluate vocabulary comprehension and integration into authentic problem-solving.

Task: After coding instruction via Edpuzzle, students:

- Update their Bee Bot diagrams to label inputs, loops, conditionals, etc.
- Complete the Coding Exit Ticket:
  "Describe the experience you had in creating the bee bot program. Include successes and failures and use as much key vocabulary in your response."

Teacher reviews for understanding of core terms: input, output, loop, conditional, debug, etc.

REFERENCES

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