Teacher Notes

Themes

- Human anatomy and physiology
- Robotics
- Medicine
- Engineering

Key learning outcomes

- Features of the human body help us survive by performing a variety of important functions
- Technology can mimic functions seen in the natural world, including the human body
- Robotic technology has applications throughout society, including in our own homes and workplaces

Key curriculum areas (years 4 to 8)

- **Science:** Science Understanding (Biological sciences), (Chemical sciences), (Physical sciences); Science as a Human Endeavour
- **English:** Language; Literature
- **Digital Technologies:** Knowledge and understanding

Publication details

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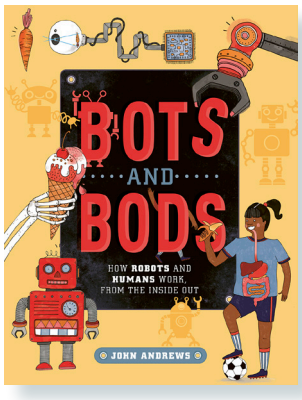

Bots and Bods

How Robots and Humans Work, from the Inside Out

John Andrews

About the book

Bots and Bods explores the differences and the similarities between humans and robots. You'll see the basic features of human bodies and how they are copied in bots. You'll learn how movement happens, how the world is seen and sensed, and how humans and robots think it all through. And you'll look to a future where bots will be helping bods more than ever.

Packed with detailed illustrations and fun facts, *Bots and Bods* takes you on a fascinating tour of the human – and robot – body.

So come on in and discover your inner robot!

Recommended for

Readers aged 8 to 12

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Teacher Notes

About the author

John Andrews is a bod, not a bot. He has edited and written dozens of adult and children's books on history, sport, music, science and a host of other subjects. His recently published work includes *Timeline of World History* and *The Beautiful Game: The Infographic Book of Soccer*.

Pre-reading activities

Stretch a large sheet of paper (at least 1 metre wide and 2 metres long) on the floor and invite a student to lay down on it. Trace their silhouette out on the paper with a thick marker.

Ask other students to draw and label parts of the body they know the names of, including various bones, organs and appendages. Discuss with students how long a person might live for without specific body parts.

Invite students to come up with pieces of technology that function a little like various body parts. For example, they might suggest a computer is like a brain, or a camera is like an eye.

Discussion questions

Science

1. In *Bots and Bods*, students learn that robots do tasks considered too dirty, boring or dangerous for humans. Write the words 'dirty', 'dull' and 'dangerous' on a board or sheet, creating three columns. Invite students to come up with tasks for each that would be much better suited to a robot than a human.
2. Robots might perform many tasks of living things. Ask the students to consider whether robots might be considered alive. What features would they need to become part of the living world?
3. Creating a robot to perform a task in place of a human means choosing the right materials to build it from. Some will be better than what nature gives us! Instruct students to read bits of Chapter 1: Body Basics, from *Bots and Bods*. Ask them to suggest materials that could be used to form various parts of a robot, such as its covering, its limbs or its sensors. Discuss advantages and disadvantages of each material, comparing it with the organic material making up human body parts.

4. Instruct students to read pages 30–31 of *Bots and Bods*. Discuss with them how prosthetic body parts have developed over the centuries to become lighter, more comfortable and more durable. With sensitivity and inclusion for any students utilising prosthetics (including glasses and hearing assistance), ask students to share how they might feel if they were to lose a sense or a part of their body and have it replaced with technology. Ask them to propose how various forms of assistive technology might be improved further in the future.
5. Discuss with students the way computers have improved over time in speed and storage. Ask them to imagine how computers might be in the future. Do they think computers could ever think like humans? If so, how might they know they're talking to a human? Can they think of ways they could 'trick' a robot into telling them it wasn't human?

English

1. The word 'robot' is common in English yet had its origins in another language. Read the introduction to *Bots and Bods* with the students, and discuss how the word 'robot' has evolved since it was first used in 1920. Invite them to share or research other words now used in English that have their origins in another language.
2. A method used by writers to emphasise a word – either because it is unusual, metaphorical or possibly new to the reader – is to place it in between a set of quotation marks. Invite students to find terms inside quotation marks in *Bots and Bods* and discuss why the author wanted the word to stand out.

Digital Technologies

1. Read the section titled Sending Signals on pages 38 and 39 in *Bots and Bods*, comparing brains with circuits. Ask the students to compare and contrast nervous systems and computers, in terms of materials they're made from, speed and functions.
2. To make digital technologies work, we issue simple commands into something called an interface. Discuss with students the different ways they tell machines, computers and other devices how to operate. Ask them how this compares with ways we affect the actions of other humans, plants and animals.

Activities

Science

A camera for an eye

You will need

- A small box (such as a shoebox)
- Black paint and brush
- Scissors
- Baking paper
- Sticky tape
- A large nail

What to do

1. Coat the inside walls of the box completely in black paint. Leave it in a warm, dry space until it's dry enough to be touched.
2. Cut a 'window' from one end of the box. The exact size doesn't matter, though the larger the better.
3. Cut a piece of baking paper large enough to cover the window. Place this piece of baking paper inside the box against the window, and tape it in place.
4. Use the large nail to pierce a hole in the wall of the box that is opposite to the window. The hole should be just a millimetre or two across.
5. Stand in front of a window that faces a bright, daylight scene outside. Hold the box up with the hole facing the scene outside, and the box's baking paper window facing you.
6. Can you see an image on the baking paper? What does it look like?

What's happening?

This box represents a very simple device called a camera obscura. It works by allowing a very small amount of light reflecting from a bright scene to enter a darkened space, where it creates an image on a flat surface.

You might notice the scene looks upside down. Light rays pass through the small hole in a straight line, with some reflecting from the top part of the scene and ending at the bottom part of the box, and others reflecting from lower down in the scene and ending at the top of the box.

Your eyes focus light in a very similar way, with an image falling 'upside down' on the tissue inside the back of your eyeball. Your brain then fixes this image to make it look the right way.

A 'living' circuit

You will need

- 4 × citrus fruit (e.g. lemons or oranges)
- 4 × zinc-coated nails (look in the nail section of your local hardware store)
- 4 × small copper strips (look in the plumbing section of your local hardware store)
- 10 × alligator clips (hobby electronics stores will have these)
- 5 × short lengths of insulated wire (hobby electronics stores will have these)
- 1 × red LED (hobby electronics stores will have these)

What to do

1. Connect an alligator clip to each end of the 5 short lengths of insulated wire.
2. Place each citrus fruit on a bench and press it with your palm, rolling it back and forth to break up the inside a bit.
3. Insert a zinc-coated nail into each citrus fruit, pushing it far enough to pass through the skin and into the flesh.
4. Insert a copper strip into each citrus fruit roughly two to three finger-widths away from the zinc-coated nail, pushing it far enough to pass through the skin and into the flesh.
5. Attach the alligator clip of one wire onto the zinc-coated nail of one citrus fruit. Attach the other alligator clip of the same wire to the copper strip of a second citrus fruit.
6. Connect all four citrus fruit in this manner using two other wires, forming a row of connected fruit.
7. Attach the last two leads to each leg of the LED. Clip one of these leads to the remaining copper strip. Attach the other lead to the remaining zinc-coated nail. (If it doesn't glow, try swapping the leads around.)

What's happening?

Like most living things, citrus fruit contain a mix of chemicals inside them that include some with positive charges and others with negative charges.

These are called electrolytes, and are similar to the chemicals inside a battery cell. Together with two different metals, they help produce an electric current.

The two metals in this case are zinc and copper. Zinc is very reactive; combined with the mix of chemicals in the citrus juice, it reacts easily, releasing electrons.

These move through the wire into the copper, which isn't very reactive. It passes the electrons into other chemicals in the juice, ensuring they keep flowing. As this electric current flows through the LED, it causes it to glow.

In our body, similar mixes of positively and negatively charged materials are responsible for causing our nerves to send messages, and our muscles to move.

Bony levers

You will need

- A large model skeleton (articulated Halloween decorations work fine)
- Blu-tac
- Red wool
- Scissors

What to do

1. Discuss with the class what constitutes a lever. Explain how it is an example of a simple machine, and it comes in a variety of forms.
2. Ask students to point out bones on a skeleton that move around a joint, lifting or pulling like a lever.
3. Use Blu-tac and lengths of red wool to connect bones that pivot around a shared joint. Discuss how they operate as levers.

What's happening?

Bones rely on the contraction and relaxation of opposing groups of muscles to move the body. This mechanical process turns the skeleton into an assortment of levers. Ask the students to research the names of some of these muscles and show how they work on the skeleton.

English

The metaphor machine

Science often relies on a literary device called a metaphor to explore or communicate ideas. These are figures of speech that compare distinct objects or events based on characteristics they happen to share.

Sometimes we see this in the development of scientific or medical language. The word 'cancer', for instance, comes from a word that means 'crab', thanks to early observations of branching tumours. Crab is a metaphor for how cancers can look.

Come up with a list of organs and body functions and write them onto cards. Hand these cards out to individual students, or students working in groups. Ask them to describe their part of the human body using only a metaphor. For example: this organ is a computer (the brain), or this organ is a camera (the eye).

See if other students can guess the organ or body part.

Digital Technologies

Robot friends

You will need

- Clipboard
- Paper
- Pen
- 20 cards featuring a complex arrangement of lines and shapes (such as a triangle over a square with a circle inside and a wavy line at the top)

What to do

1. Divide students into pairs. Ask them to decide who will be the robot and who will be the programmer.
2. The robot holds the clipboard with the paper and a pen, the programmer holds a card with shapes on it, keeping it hidden from their robot.
3. Instruct each pair to sit back-to-back.
4. Explain that the programmer will describe to their robot how to draw the shapes as they are on their card, without using any words specific to any one shape, such as square, circle or triangle.
5. Robots aren't allowed to make any noise or gesture; they can only follow instructions to draw the shapes as they're being described.
6. Once all partners have completed the activity once, ask them to compare the robot's drawing with their own. How closely do they match?
7. Repeat the activity with different pairs or different cards.

What's happening?

Lists of instructions in computing are referred to as algorithms. In programming computers – and robots – algorithms use languages just as we do in communicating.

But computing languages are often simpler, and require precise descriptions of how to complete tasks.

Discuss with students how they improved their 'programming' as they went along, and how they got around an inability to use words for shapes.

Australian curriculum links (Primary)

Year level	Learning area: Science	Other learning areas
Year 4	**Science Understanding: Biological sciences** • Living things have life cycles (ACSSU072) **Chemical sciences** • Natural and processed materials have a range of physical properties that can influence their use (ACSSU074)	**English** • Understand that Standard Australian English is one of many social dialects used in Australia, and that while it originated in England it has been influenced by many other languages (ACELA1487) • Incorporate new vocabulary from a range of sources into students' own texts including vocabulary encountered in research (ACELA1498) **Digital Technologies** • Recognise different types of data and explore how the same data can be represented in different ways (ACTDIK008)
Year 5	**Science Understanding: Biological sciences** • Living things have structural features and adaptations that help them to survive in their environment (ACSSU043) **Physical sciences** • Light from a source forms shadows and can be absorbed, reflected and refracted (ACSSU080)	**English** • Understand that the pronunciation, spelling and meanings of words have histories and change over time (ACELA1500) • Understand the use of vocabulary to express greater precision of meaning, and know that words can have different meanings in different contexts (ACELA1512) **Digital Technologies** • Examine the main components of common digital systems and how they may connect together to form networks to transmit data (ACTDIK014)
Year 6	**Science Understanding: Biological sciences** • The growth and survival of living things are affected by physical conditions of their environment (ACSSU094) **Physical sciences** • Electrical energy can be transferred and transformed in electrical circuits and can be generated from a range of sources (ACSSU097)	**English** • Understand how to use knowledge of known words, word origins including some Latin and Greek roots, base words, prefixes, suffixes, letter patterns and spelling generalisations to spell new words including technical words (ACELA1526) **Digital Technologies** • Examine the main components of common digital systems and how they may connect together to form networks to transmit data (ACTDIK014)

Australian curriculum links (Secondary)

Year level	Learning area: Science	Other learning areas
Year 7	**Science as a Human Endeavour** • Solutions to contemporary issues that are found using science and technology, may impact on other areas of society and may involve ethical considerations (ACSHE120)	**English** • Understand the way language evolves to reflect a changing world, particularly in response to the use of new technology for presenting texts and communicating (ACELA1528) • Understand and explain how the text structures and language features of texts become more complex in informative and persuasive texts and identify underlying structures such as taxonomies, cause and effect, and extended metaphors (ACELA1531) • Understand how to use spelling rules and word origins, for example Greek and Latin roots, base words, suffixes, prefixes, spelling patterns and generalisations to learn new words and how to spell them (ACELA1539)

Year level	Learning area: Science	Other learning areas
Year 8	**Science Understanding: Biological sciences** • Multi-cellular organisms contain systems of organs carrying out specialised functions that enable them to survive and reproduce (ACSSU150) **Physical sciences** • Energy appears in different forms, including movement (kinetic energy), heat and potential energy, and energy transformations and transfers cause change within systems (ACSSU155) **Science as a Human Endeavour** • Solutions to contemporary issues that are found using science and technology, may impact on other areas of society and may involve ethical considerations (ACSHE135)	**English** • Understand the influence and impact that the English language has had on other languages or dialects and how English has been influenced in return (ACELA1540)

Related books from CSIRO Publishing

More Hands-On Science (2020)
Ready, Set, Code! (2020)
The Physics of Popcorn (2020)
Hands-on Science (2016)
Imagining the Future (2016)

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