Shape of Life
The Story of the Animal Kingdom

Fantastic Flatworms

A Body Blueprint for Success

Overview

Students explore flatworm adaptations through short Shape of Life videos and student-centered activities in the 5E Instructional Model. They watch a short video about the flatworm body plan and its other characteristics. Then they identify adaptations that relate to a predatory lifestyle with the support of one or more video segments and the Flatworms Fact Sheet. Students will record notes about physical and behavioral adaptations, then create a flatworm illustration, labeling its structures and adding annotations to describe their functions. Students compare and contrast flatworm anatomy with human anatomy, leading them to understand that these simple creatures' ancestors were revolutionary in animal evolution. Enrich / Extend activities are listed at the end of the lesson.

Subjects
Science, Environmental Education, Writing, and Art

Grades 6–12

Time
45–90 minutes

Vocabulary
Adaptations, bilateral symmetry, central nervous system, cilia, coelom, evolution, hermaphrodite, marine, pharynx, planarian, natural selection, stereo senses

Objectives

- Students will explore body structures of flatworms and theorize how those structures relate to the evolution of hunting and other predators alive today.
- Students will describe flatworm adaptations orally and in writing.
- Students will create labeled illustrations of flatworms.

A blue Pseudoceros flatworm *(Pseudoceros bifurcus)* hunts in its marine environment.
Image: Etienne Gosse CC BY 2.0

Standards		Middle School / High School
Next Generation Science Standards	Performance Expectations	MS-LS1-3. Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells. [Clarification Statement: Emphasis is on the conceptual understanding that cells form tissues and tissues form organs specialized for particular body functions. MS-LS1-4: Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively. MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. MS-LS4-2: Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships. HS-LS4-1: Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
	Disciplinary Core Ideas	LS1: From Molecules to Organisms: Structures and Processes LS1.A: Structure and Function LS1.B: Growth and Development of Organisms LS4: Biological Evolution: Unity and Diversity LS4.C: Adaptation
	Crosscutting Concepts	• Cause and Effect • Structure and Function • Systems and System Models
	Science & Engineering Practices	• Developing and Using Models • Engaging in Argument from Evidence • Obtaining, Evaluating, and Communicating Information

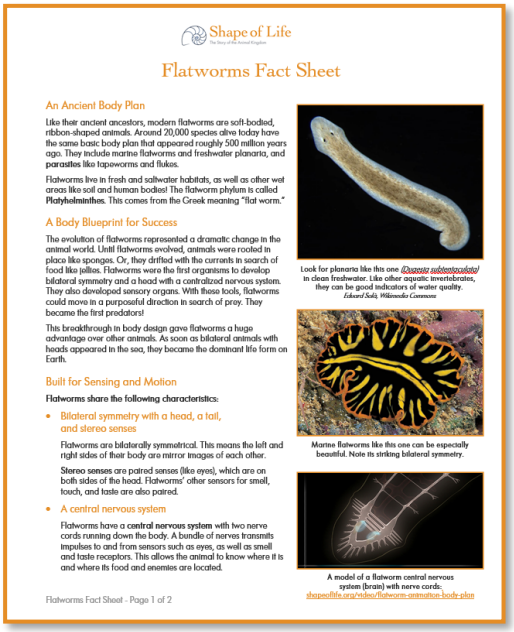
Common Core ELA	Writing	7
	Speaking & Listening	4, 6
	Language Standards	1, 2, 3, 6

Teacher Background

See the Flatworms Fact Sheet for details about their key characteristics and reproduction: shapeoflife.org/factsheets.

A marine flatworm shows off its striking bilateral symmetry.
Photo: Shape of Life

Materials + Preparation


Shape of Life

Flatworms Fact Sheet

An Ancient Body Plan

Like their ancient ancestors, modern flatworms are soft-bodied, ribbon-shaped animals. Around 20,000 species alive today have the same basic body plan that appeared roughly 500 million years ago. They include marine flatworms and freshwater planaria, and **parasites** like tapeworms and flukes.

Flatworms live in fresh and saltwater habitats, as well as other wet areas like soil and human bodies! The flatworm phylum is called **Platyhelminthes**. This comes from the Greek meaning "flat worm."

A Body Blueprint for Success

The evolution of flatworms represented a dramatic change in the animal world. Until flatworms evolved, animals were rooted in place like sponges. Or, they drifted with the currents in search of food like jellies. Flatworms were the first organisms to develop bilateral symmetry and a head with a centralized nervous system. They also developed sensory organs. With these tools, flatworms could move in a purposeful direction in search of prey. They became the first predators!

This breakthrough in body design gave flatworms a huge advantage over other animals. As soon as bilateral animals with heads appeared in the sea, they became the dominant life form on Earth.

Built for Sensing and Motion

Flatworms share the following characteristics:

- Bilateral symmetry with a head, a tail, and stereo senses

  Flatworms are bilaterally symmetrical. This means the left and right sides of their body are mirror images of each other.

  Stereo senses are paired senses (like eyes), which are on both sides of the head. Flatworms' other sensors for smell, touch, and taste are also paired.

- A central nervous system

  Flatworms have a **central nervous system** with two nerve cords running down the body. A bundle of nerves transmits impulses to and from sensors such as eyes, as well as smell and taste receptors. This allows the animal to know where it is and where its food and enemies are located.

Look for planaria like this one (*Dugesia subtentaculata*) in clean freshwater. Like other aquatic invertebrates, they can be good indicators of water quality.
Edward Kelly, Wikimedia Commons

Marine flatworms like this one can be especially beautiful. Note its striking bilateral symmetry.

A model of a flatworm central nervous system (brain) with nerve cords:
shapeoflife.org/video/flatworm-animation-body-plan

Flatworms Fact Sheet - Page 1 of 2

- Make copies of the "Flatworms Fact Sheet," one for each student or pair of students, and/or share it with them electronically: shapeoflife.org/factsheets
- If you have access to a projector, prepare to show one or more beautiful images of flatworms, such as the one at the top of the Flatworms page from Shape of Life: shapeoflife.org/resource/about-flatworms.
- Shape of Life video "Flatworms: The First Hunter" (9:54): shapeoflife.org/video/flatworms-first-hunter

  Decide if you will show the video to the whole class and/or have partners view the video and take notes about flatworm adaptations.

  Note: Depending on the maturity level of students, you might omit segment 5:11–7:43, which includes information on sexual reproduction and the phenomenon known as "penis fencing."
- Computer with Internet connection and data projector if you plan to show all or part of the video(s) to the whole class
- Science notebook and pencil or pen for each student
- Whiteboard or chart paper and markers
- Colored pencils and/or markers for students to share
- *Optional:* Review the "Getting A Head: The First Hunter" chapter from Shape of Life and/or make copies for students: shapeoflife.org/sites/default/files/global/The-First-Hunter.pdf.

Teaching Suggestions in the 5E Model

Engage

1. Options to "hook" students and introduce the lesson. (3–5 min.)

   - Ask students to turn to a partner and discuss: What are the basic characteristics of a predator? What body structures and capabilities would you need to find, catch, and eat your prey?
   - Give students 3–5 minutes to write down ideas in science notebooks and/or draw a simple predator.
   - Then ask the groups to share their best ideas with the whole class and discuss.

Explore

2. Students explore flatworms and their behaviors. (10 min.)

   - Ask students to watch the first few minutes of the "Flatworms: The First Hunter" video (9:54) from Shape of Life with the audio and closed captioning turned off: shapeoflife.org/video/flatworms-first-hunter.
   - Cue the video to start after the title, so students are not cued to what the animals are doing.

Screenshot from "Flatworms: The First Hunter" from Shape of Life

- Ask students to think about how to describe what they're seeing. Invite them to record their ideas in science notebooks, including anything they may have already learned about sea creatures like these.
- When you stop the video clip, invite them to turn to a neighbor to discuss their ideas. Ask them to record additional brainstormed ideas in science notebooks. After a minute or two, invite the partners to share their best ideas with the class.

3. Invite students to draw and explain adaptations for hunting. (25 min.)

- Pass out the "Flatworms Fact Sheet" and ask students to watch the "Flatworms: The First Hunter" video with the sound and closed captioning turned on.
- Using what they learned in the video and on the fact sheet, ask students to draw and label the anatomy of a flatworm in science notebooks, on separate paper, or with a computer or tablet. Encourage students to use the ABCDEs of good scientific illustration: calacademy.org/educators/lesson-plans/introduction-to-scientific-sketching.
- For each body feature, ask students to describe its function and how it relates to being a predator. They can include the details as annotations on their illustrations and/or on separate paper or with a computer.
- If time allows, students can color their flatworms with their vivid and striking colors. You might provide colored pencils, markers and/or other art supplies, or students could complete this step outside of class time.
- Circulate through the room, answering questions and providing feedback, as necessary.

Explain

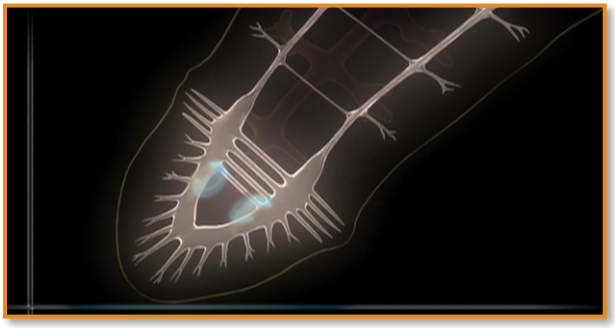
4. Ask students to share one or more of their illustrations. (1–5 min.)

- This can be done with a document camera and data projector, if available.

5. Discuss other key concepts with the support of the "Flatworms: The First Hunter" video and Flatworms Fact Sheet. (5–15 min.)

- Bilateral symmetry with a head, a tail, and stereo senses
  - Flatworms are bilaterally symmetrical: the left and right sides of their body are mirror images.

- **They have stereo senses** (paired senses like eyes), which are on both sides of the head. Flatworms' other sensors for smell, touch, and taste are also paired. This allows the animal to know where it is and where its food and enemies are located.



A model of a flatworm central nervous system (brain) with nerve cords: shapeoflife.org/video/flatworm-animation-body-plan

1. A central nervous system

- Flatworms have a **central nervous system** with two nerve cords running down the body.
- A bundle of nerves transmits impulses to and from sensors such as eyes, as well as smell and taste receptors.

2. No coelom (body cavity)

- Flatworm bodies do not have a central cavity like most other animals. Instead, they have a layer of tissue in which their organs, nerves, and sensors are embedded in separate pockets.
- Their bodies have only a single opening, which serves both as a mouth and also ejects waste.
- Many flatworms eat by extending a tube called a **pharynx** out of the opening and into their prey. The lining of the pharynx secretes enzymes, which soften the bits of food that the pharynx then passes into the flatworm's body. The meal passes through its body in a gut that is not a central channel, but more like a network of branches. The branches distribute food directly to the rest of the body.

3. No circulatory system

- Why are flatworms so flat? They lack specialized organs (circulatory and respiratory organs) to take in and move gases, especially oxygen and carbon dioxide. Instead, gases pass into and through their bodies by **diffusion**. Diffusion is the movement of a substance from an area of higher concentration to an area of lower concentration. Because of this flatworms don't need a circulatory system and blood to distribute oxygen.
- A flattened shape allows oxygen to diffuse to all parts of the body and carbon dioxide to exit.

4. Cilia for movement

- Some flatworms have **cilia**, which are hair-like growths on the outside of their body. When cilia are present in large numbers, they can produce currents to move water.
- Small flatworms use waves of ciliary action to move over surfaces. Larger species use muscular movements of their entire body to move along a surface or swim.

5. Regeneration – the power to replace

- When flatworms are wounded, special cells called neoblasts quickly move toward the site of the damage and grow new tissue.
- Flatworms can regrow body parts or even, in the case of planarians, regrow an entire organism.

- Ancient trails in the fossil record

- Scientists have discovered ancient soft-bodied organisms indirectly – through the tracks they left behind in mud roughly 500 million years ago. *Optional:* Show the "James Hagadorn, Paleontologist: Traces of Early Animal Life" video (6:11) from Shape of Life (or a clip): shapeoflife.org/video/james-hagadorn-paleontologist-traces-early-animal-life.
- These tracks told scientists the organism that made them could move in a purposeful direction. Having this ability meant the ancient organism could pursue prey.

- Benefits of having a head
  - Scientists believe ancient flatworms were the first organisms to have a head. Having a head meant they could move in a purposeful direction.
  - The head became the area where the primitive brain and sense organs are located. These sense organs allowed organisms to detect changes in the environment to avoid threats to survival and also find food and mates.
  - Organisms without a head that evolved before flatworms could only drift in the ocean or were rooted in place (like sponges and cnidarians). Because they could move purposefully using their senses, ancient flatworms could actively search for prey.

6. Ask students:
   - Why do you think scientists think flatworms were the first predator?
   - Why does having a head give animals an advantage?
   - What are the benefits of having stereo senses?
   - What senses do flatworms have that help them hunt?
   - Why might some flatworms be so colorful? What purpose(s) might that serve? You might ask them to think about other colorful organisms they know and how color might help them survive and reproduce. (scaring away predators, attracting mates, etc.)
7. Discuss how many flatworms are **parasites**. They live in and harm other organisms, called hosts, which provide food and shelter. Parasitic flatworms include flukes (trematodes) and tapeworms (cestodes).
8. Invite students to add more details, labels and annotations to their illustrations. (10 min.)
   - Ask students to add final details to their scientific sketches and/or computer-generated diagrams of flatworms. Encourage students to label the individual structures and add written annotations that explain their functions and how the adaptations help the flatworms to hunt and survive.
   - Illustrations can be completed with the support of reference materials such as books and reputable sources on the Internet.
   - Again, ask students to share one or more of their illustrations with the additional details. They should show both external and internal structures.
9. Students compare and contrast the flatworm body with the human body. (5–15 min.)
   - Show the animation of the human body plan from Shape of Life: shapeoflife.org/video/human-body-plan.
   - You might also show and discuss the animation of the flatworm body plan: shapeoflife.org/video/flatworm-animation-body-plan.
   - Using a Venn diagram, another graphic organizer, or in writing, ask students to compare and contrast a flatworm's body with the human body.
     - What features do they share in common?
     - What are their differences?

Evaluate

10. Students present their illustrations and/or other projects to the class.

- Provide a rubric such as the one at the end of the lesson so students know how they will be assessed.
- Completed projects can be displayed on classroom and/or school walls.

11. Review completed student illustrations and science notebooks.

- Review student illustrations, labels, and annotations.
- Check that they have explained flatworm structural and behavioral adaptations, including ways they are able to catch food.

12. Closing discussion / reflection (5 – 15 min.)

- Ask students to use arguments based on empirical evidence and scientific reasoning to support an explanation for how flatworm structures affect the probability of successful reproduction. (Adapted from MS-LS1-4)
- Ask how flatworm adaptations, such as a body with a head, bilateral symmetry, central nervous system, and stereo senses relate to the evolution of animals. Discuss student ideas and how similar structures and behaviors are found in other animal groups.
- Ask students to reflect on what they learned in the lesson, including about flatworm adaptations, orally and/or in writing. Ask them to reflect on what you, as the teacher, might do to improve the lesson next time.

Extend / Enrich

- Conduct a field study into flatworms found in your area. This could include freshwater ecosystems, as well as the ocean. (Will vary)
  - Visit the animals in their natural ecosystems, if possible, such as tidepools, coral reefs, or clean rivers. Flatworms are common in clean tidepools, reefs, and streams in crevices and on the undersides of rocks.
  - Students can record observations of them in field notebooks. Questions can be written down and researched later.
  - You might contact local wildlife agencies for the best places to find them.
- Students dive deeper into flatworm research. (5 – 20 min.)
  - Students can learn more about different species' lifestyles (e.g. parasitism), prey consumed, relatives, and biology by watching other Shape of Life videos and/or doing additional research. A good source with details such as species that flatworms hunt is the chapter "Getting A Head: The First Hunter" from Shape of Life: shapeoflife.org/sites/default/files/global/The-First-Hunter.pdf.
  - Students can present their findings about a specific species to the class. Provide a rubric so students know how they will be assessed, such as the one at the end of the "Science in Action!" lesson: shapeoflife.org/lesson-plan/sol/science-action.
- Observe flatworms under magnification. (1 – 20 min.)
  - If you have access to live or preserved flatworms, students can view them and/or their body structures under magnification via a microscope, hand lens, and/or macro lens to better see their unique adaptations.

- You can also use a microscope or macro lens connected to a computer and/or data projector to show them to the whole class.

- Students can write fictional stories or poems that incorporate flatworms. (15 min. or more)

  For example, students might write an imaginative piece about a day in the life of a flatworm and its adventurous life as a hunter. Or the piece could be set in a tidepool with other organisms attempting to cope with a warming ocean and ocean acidification.

- Set up learning/exploration centers and offer students a choice of activities.

  Set up classroom centers with other activities related to flatworms and their adaptations, such as those listed above. This would provide more opportunity for student choice and differentiated learning experiences to maximize intrinsic motivation, engagement, and learning.

Expand Knowledge + Skills

Flatworm Background

- "Flatworms." Shape of Life: shapeoflife.org/resource/about-flatworms
- "Getting A Head: The First Hunter." Shape of Life: shapeoflife.org/sites/default/files/global/The-First-Hunter.pdf
- "Worms: Phyla Platyhelmintes, Nematoda, and Annelida." Exploring Our Fluid Earth: Teaching Science as Inquiry (TSI). Univ. of Hawai'i: manoa.hawaii.edu/exploringourfluidearth/biological/invertebrates/worms-phyla-platyhelmintes-nematoda-and-annelida

Related Lesson Plans / Activities

- "Who Was Hunter Eve?" Shape of Life: shapeoflife.org/sites/default/files/2022-12/Who%20Was%20Hunter%20Eve%20.pdf
- "Flatworms: The First Hunter Questions." Shape of Life: shapeoflife.org/lesson-plan/flatworms-first-hunter-questions
- "Question Set: Worms." Exploring Our Fluid Earth: Teaching Science as Inquiry (TSI). University of Hawai'i: manoa.hawaii.edu/exploringourfluidearth/biological/invertebrates/worms-phyla-platyhelmintes-nematoda-and-annelida/question-set-worms

Related Videos

- Explore Shape of Life other videos and information about flatworms: shapeoflife.org/phyla-pages/flatworms/general-info

Standards

- Next Generation Science Standards, including a link to the *Framework for K-12 Science Education* to which this lesson was aligned: nextgenscience.org/framework-k%E2%80%9312-science-education
- Examples of what NGSS looks like for California students can be found in the 2016 Science Framework for California Public Schools: cde.ca.gov/ci/sc/cf/documents/scifwchapter4.pdf
- Common Core State Standards and links to the complete documents: corestandards.org

Shape of Life

The Story of the Animal Kingdom

Appreciation + Thanks

Thank you for using Shape of Life resources and helping to inspire the next generation of thinkers and scientists! We also greatly appreciate all of the scientists who have been collaborating with us to produce the videos and supporting resources. We welcome your questions or comments.

Lesson plan and supporting resources written, designed, and produced by
Rick Reynolds, M.S.Ed. and Krista Reynolds, MLIS, M.Ed.
Engaging Every Student
rick@engagingeverystudent.com

Edited by Nancy Burnett and Natasha Fraley
Shape of Life

Name: _____ Period: ___ Date: _____

Shape of Life
The Story of the Animal Kingdom

Fantastic Flatworms Trivia

Put an "X" or checkmark in front of all that apply.

1. Flatworms are classified as:

   ___ Carnivores ___ Predators

   ___ Herbivores ___ Protists

2. Flatworms have bilateral symmetry and stereo senses.

   ___ True ___ False

3. Flatworms are the most ancient of all animals on Earth.

   ___ True ___ False

4. Flatworms are only found in marine (ocean) ecosystems.

   ___ True ___ False

5. Flatworms have a central nervous system.

   ___ True

   ___ False

6. Flatworms move using the following structures:

   ___ Tube feet ___Fins

   ___ Cilia ___Hyphae

7. Flatworms are **hermaphrodites**, organisms with both female and male reproductive systems.

   ___ True

   ___ False

8. Flatworms can regrow body parts that are damaged.

   ___ True

   ___ False

9. What roles can flatworms play in their ecosystems (places they live)?

A magnificent sea slug
(Chromodoris magnific)
Image: Etienne Gosse CC BY 2.0

Name: _____ Period: ___ Date: _____

Fantastic Flatworms Trivia KEY

1. Flatworms are classified as:

   __X__ Carnivores __X__ Predators

   ____ Herbivores ____ Protists

2. Flatworms have bilateral symmetry and stereo senses.

   __X__ True ____ False

3. Flatworms are the most ancient of all animals on Earth.

   ____ True __X__ **False**

4. Flatworms are only found in marine (ocean) ecosystems.

   ____ True __X__ **False**

5. Flatworms have a central nervous system.

   __X__ **True**

   ____ False

6. Flatworms move using the following structures:

   ____ Tube feet ____Fins

   __X__ **Cilia** ____Hyphae

7. Flatworms are **hermaphrodites**, organisms with both female and male reproductive systems.

   __X__ **True**

   ____ False

8. Flatworms can regrow body parts that are damaged.

   __X__ **True**

   ____ False

9. What roles can flatworms play in their ecosystems (places they live)?

Marine flatworms are mainly carnivores that prey on tiny animals (protozoa, copepods and other worms) or feed on immobile animals such as bryozoans and tunicates. Flatworms play a role in many food chains. Some flatworms are parasites and parasites of all sorts are essential to most food webs and even in some food webs make up the majority of the biomass. But on the other hand, parasitic flatworms can disrupt coral reef ecosystems.

Animals are often used to monitor toxins in the environment. Researchers found that flatworms in estuaries can indicate the health of the ecosystem.

Invasive flatworms are a threat to forest ecosystems in the U.S. These flatworms come into the country on imported garden plants. An invasive flatworm from New Guinea has invaded Europe.

See the video at shapeoflife.org/phyla-pages/flatworms/role-ecosystem.

Flatworms Glossary

adaptation	process in which an organism changes over many generations to better fit its habitat
asexual reproduction	process by which new offspring are produced by a single parent; some flatworm species clone themselves while others produce new offspring by budding
behavioral adaptation	an action of an organism that helps it survive and reproduce
bilateral symmetry	the left and right sides of an organism's body are mirror images of each other
central nervous system	a brain and nerve cords; integrates information and coordinates and influences the activity of all parts of the body
cilia	hair-like growths from a cell that when present in large numbers can produce currents to move water and/or propel an animal across a carpet of mucus
coelom	fluid-filled body cavity; flatworms lack one
evolution	process by which organisms change over time through **natural selection**
hermaphrodite	organism having both male and female sex organs
marine	found in or related to the sea
natural selection	process by which organisms better adapted to their environment survive to produce more offspring
pharynx	A muscular tube used for feeding; in flatworms it also ejects waste
planarian	A group of free-living flatworms that live in marine, freshwater, and terrestrial habitats; some species are able to regenerate entire organisms from cut pieces of an individual flatworm
Platyhelminthes	name of flatworm phylum; "platy" means flat and "helminth" means worm in Greek
stereo senses	paired senses that provide information about distance as well as direction

Name: _____ Period: ____ Date: _____

Model / Presentation Rubric

Title: _____

Presentation Component	Maximum Points Possible	Self-Score (fill out before presentation)	Teacher Score
Part 1: Content			
Subject and purpose of model / presentation clearly introduced	10		
Key concepts identified and clearly explained in well-organized way	10		
All information accurate and obtained from reliable sources	10		
Conclusion summarizes key points in persuasive way; Questions answered thoroughly and accurately	10		
Part 2: Delivery / Audience Engagement			
Speech delivered clearly at appropriate volume and speed (not too fast, slow, loud, or soft)	10		
Speed, volume, and voice inflection are varied to engage audience and emphasize key points	10		
Speaker connects with audience through eye contact and does not spend too much time looking at notes or screen	10		
Speaker demonstrates enthusiasm for topic throughout presentation; audience is persuaded by speaker	10		
Part 3: Visuals			
Visuals help to clearly explain concepts	10		
Part 4: Writing Conventions			
Grammatical and spelling conventions followed	10		
TOTALS:	**100**		

Comments: