Shape of Life

Molluscs: Gastropod

Middle School Student Edition
Lab Activity: The Gastropods

Lesson by Kevin Goff

SNIPS AND SNAILS AND GASTROPOD TAILS

Molluscs are a clan of closely related animals that includes snails and slugs, clams and oysters, and even squid and octopi. The name comes from the Latin *mollus*, meaning "soft," for these animals all have a soft and boneless body – though some are armored with a stony shell. Phylum Mollusca encompasses more than 150,000 species that have carved out niches in nearly all of Earth's habitats, from freshwater lakes to dry land, from the ocean's sunlit surface waters to its darkest depths, from hot tropical forests to frigid polar seas. Some are sedentary filter-feeders that spend their whole lives anchored to the same spot (oysters and mussels). Others are among the world's speediest predators (squid). Some snails drift in the sea as tiny plankton, barely visible to the naked eye, while the giant squid grows longer than a school bus. Most are utterly brainless, but octopi are the most intelligent invertebrates on the planet. Some live only a year, others are older than you or I will ever be.

Despite their spectacular variety, most molluscs belong to one of only three classes: **gastropods**, **bivalves**, and **cephalopods**. Today we'll focus on gastropods – the snails and slugs.

Snail Trails

Gastropod means "stomach-foot" – a good name for an animal that crawls belly-down on a single, muscular **foot**. Get a pond snail, garden slug, or other gastropod from your teacher. Place it in a clear container. If it's an underwater species, add water from its natural habitat. With luck it'll soon become active. Use a magnifying glass or binocular microscope for a closer look. Can you observe its underside through the clear container (you might have to hold it overhead)? Can you see wave-like motions in the foot? How about a trail of slippery mucus? Remember these!

Sketch a side view of your gastropod and label it with these 4 terms: **anterior** (its head), **posterior** (its trailing end), **ventral** (its belly or underside), and **dorsal** (its back).

Sketch with labels

Look for **sensory tentacles** at the anterior end. These have sense receptors for touch and taste, and at the tips are simple eyes. They can't see crisp images, but they can detect shadows and movement. Examine a tentacle and eye under magnification. An interesting thing to do is to (gently!) touch its eye. ***How does it react?***

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Walk like a Water Balloon

When you touched your slug or snail's eye, it probably retracted its tentacle. After a few seconds it probably telescoped back out. This motion is similar to turning a sock inside out! It's driven by **fluid pressure**, like squeezing the end of a tube of toothpaste or blowing into a curly New Year's Eve horn. Molluscs can move this way because they their bodies are boneless and filled with blood. Your blood gets pumped through pressurized pipes (arteries). But snails don't have many blood vessels. Their blood just soaks into spongy spaces in their tissues.

In other words, a snail is built like a spongy water balloon and this serves as a **hydrostatic skeleton**. Your own muscles work by tugging on your bones, but molluscs don't have bones. Instead, a snail's muscles coil around its blood-filled tissues. By squeezing these, it can twist, turn, curl up, or extend a tentacle.

You can mimic this way of moving with a water balloon. Fill a long balloon about 2/3rds with water and tie it off. Imagine this is a slug's body. Now let your hands be its muscles. Set it on the table and squeeze it at different angles. ***Can you make it turn, twist, or stretch out?***

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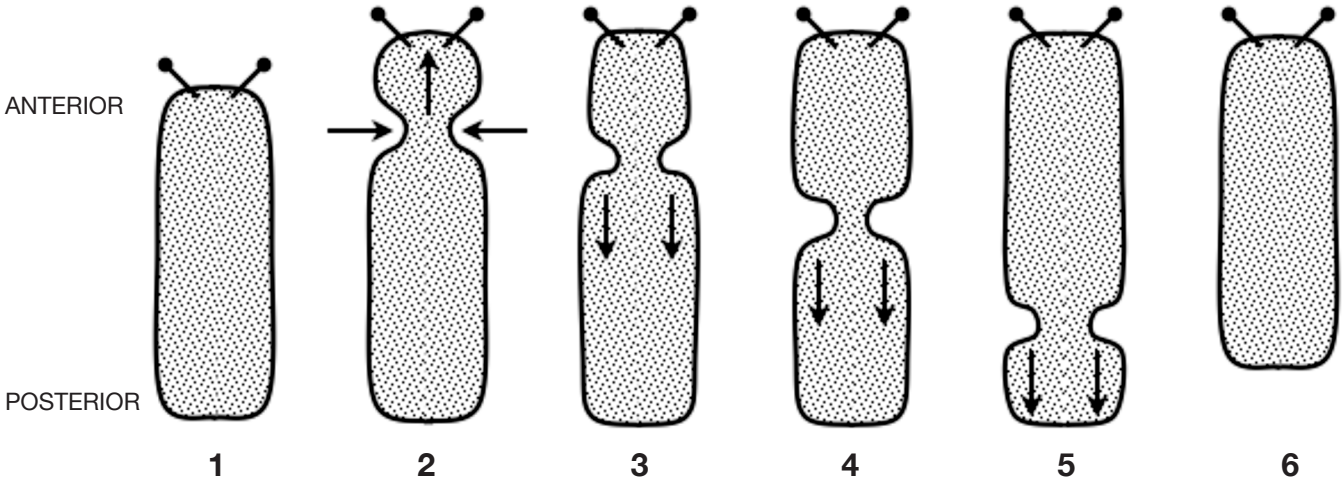
Many gastropods crawl using a **retrograde wave**. The animal squeezes its muscles in a BACKWARDS sequence, and this results in FORWARD movement! The first contraction causes the head to stretch forward. A second contraction then squeezes more fluid forward, to fill in the space behind the head. Next, a third

contraction squeezes more fluid forward. And so on. As the muscle contractions migrate backwards, the blood and body are squeezed forward! The snail also makes a trail of slimy mucus [say “MYOO-kiss”] to grease its way.



You can model this with your water balloon. Wrap a hand around it near the front end. Squeeze to make its “head” stretch forward (see step #2 above). Now wrap your other hand just behind the first. Relax your first hand as you squeeze your second hand, pushing more water forward (step #3). Now slowly work your way hand-over-hand toward the REAR, squeezing water FORWARD as you go. ***Can you get your homemade slug to creep along, a few inches at a time?***

A Very Special Bathrobe

Another special trait of molluscs is the **mantle**. This is a blanket of soft tissue that covers its body like a bathrobe. (In days of old, a “mantle” was a sleeveless cloak that people draped over their clothes.) The mantle has a very important function: It creates the shell. It does this in two stages: First, tiny glands lay down a web of protein fibers. Next, the glands release a calcium paste onto the web, and it hardens like plaster.

VIDEO TO WATCH

To see the mantle’s handiwork, visit the Shape of Life website and watch “Mollusc Animation: Shell Repair” (1.5 min; under Animations). The scientist is Gary Vermeij. Blind since birth, he studies fossil seashells not with his eyes but with his hands!

Vermeij’s research shows that the oldest fossilized shells were simple domes, shaped like an umbrella. But later, a tremendous variety of more complicated shapes appear in the fossil record: coils, cones, and tall twisting towers. These are often decorated

with spikes and spines. ***Why do you think gastropod shells gradually "diverged" from a simple dome into so many complex shapes?***

Chainsaws and Crossbows

Gastropods also have a long tongue coated with teeth, called a radula ["RAD-joo-luh"]. It works like a chainsaw to scrape plant matter or meat into the mouth. Some predatory snails use it to drill holes in other molluscs' shells! And in cone snails, the radula has become a hunting dart armed with deadly venom. The sting of some cone snails can be lethal to any human foolish enough to try adding one to his seashell collection!

The abalone is a gastropod. Which special molluscan traits does it exhibit in the Shape of Life footage?

VIDEO TO WATCH

For vivid footage of all these traits –foot, mantle, shell, radula, hydrostatic skeleton, and retrograde waves – visit the *Shape of Life* website and watch the first 8 minutes of "Molluscs: The Survival Game" (under Phyla; stop at the nautilus).

Early in their evolutionary history, gastropods used only their foot for crawling. And they used their radula to graze on algae or scrape up food. But in modern moon snails – as seen on the Shape of Life – the foot and radula "diverged" for NEW functions and a NEW lifestyle. ***What is the moon snail's new lifestyle? Describe how the moon snail's foot and radula adapted for this.***

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You Go Your Way, I'll Go Mine

In the *Shape of Life* video, the narrator says, "When they first appeared over half a billion years ago, molluscs were but tiny creatures inching around under a protective shell. How did the struggle for survival create so many variations on their original body plan?" He is describing **divergent evolution**: the branching of a SINGLE group of ancestors into NEW and DIFFERENT body forms. Molluscs evolved new body features and new behaviors for new functions and new lifestyles.

It may be hard to believe that a snail, squid, and clam are close kin. But if you examine their major body features, you'll see they have much in common! ***Let's do a little "painting by numbers" with colored pencils to help you understand how all modern molluscs "diverged" from the same original body plan:***

- ❑ **Mantle and shell** – Again, the mantle is a soft blanket of tissue that produces the shell. Outline these in a dark color, using the same color for all four animals.
- ❑ **Mantle cavity** – This is an open space under the shell and mantle where water circulates across the **gills**. Dashed arrows show the flow of water. Shade in this cavity with a light blue color on all four animals.
- ❑ **One-way gut** – Jellyfish, sea anemone, and flatworms all have a dead-end stomach, with only one opening. But molluscs were among the first animals to evolve a one-way gut, with a **mouth** at one end and **anus** at the other. Shade this on all four in the same color.
- ❑ **Head/foot region** – This contains the mouth, sense organs, and muscles for movement. Shade with a light color.
- ❑ **Visceral mass** – This is a spongy region that houses the internal organs of digestion, circulation, excretion, and reproduction. Shade with a light color.

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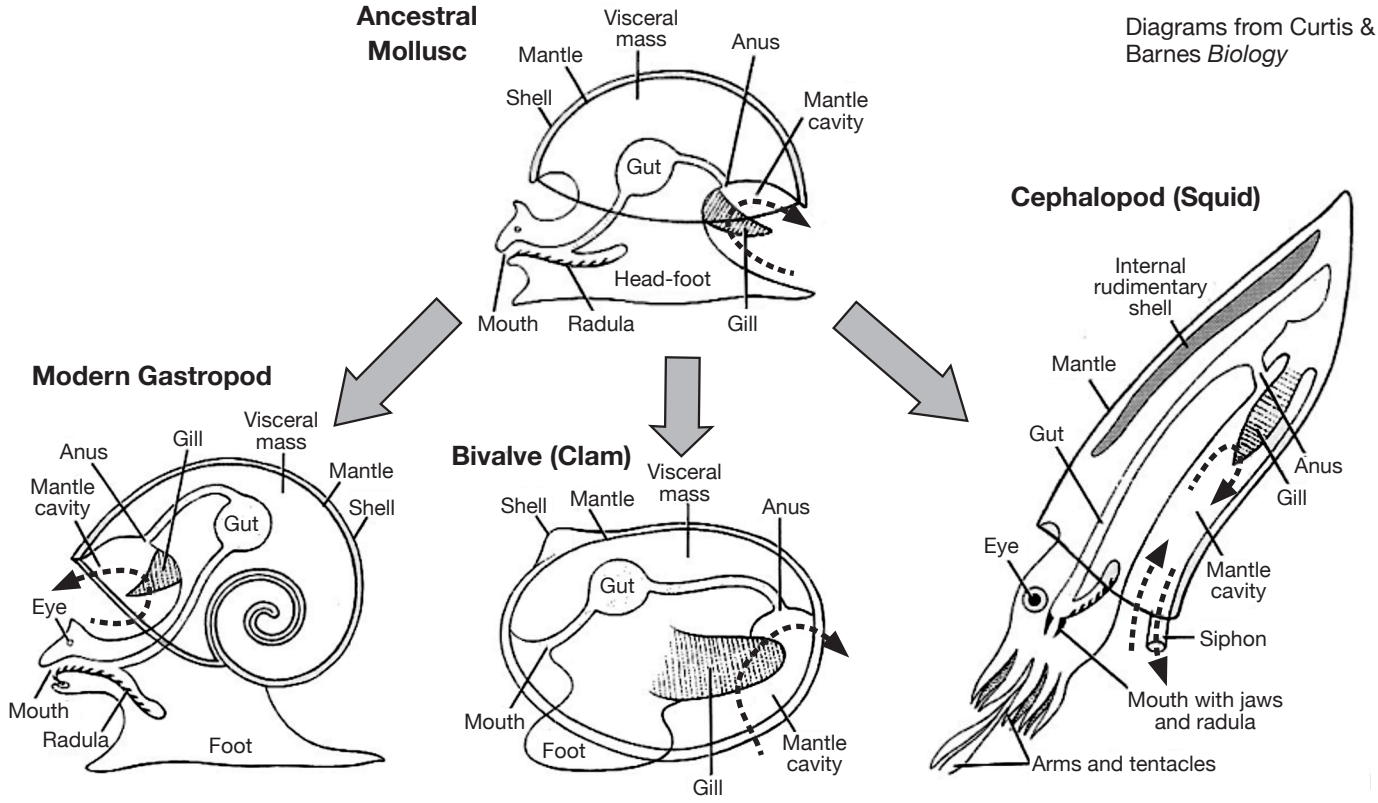

The First Snail: A Worm with a Beach Umbrella?

Picture an ancient worm-like animal crawling on a shallow seafloor 600 million years ago. Back then, the sun's ultraviolet radiation was quite ferocious, because Earth's atmosphere was still low in oxygen and the ozone layer was very thin. Over evolutionary time, some of these ancient creatures evolved a hard, dome-shaped shell, perhaps to shield them from the sun – like a beach umbrella! Or maybe it was to fend off predators. Either way, this animal was similar to the ancestral mollusc diagrammed above.

But notice that in modern gastropods, the old beach umbrella shell has now become coiled. Also, the mantle cavity has swung around 180° to the anterior end. ***What might be the benefit of these changes?*** (Hint: how did your live snail react when you handled it?)

Clams use their foot to burrow into the seafloor for safety. The beach umbrella shell has turned into a tightly closing hinged box, with a wedge shape to make burrowing easier. Clams quietly filter food from the water. ***What ancestral body features have they lost? Why?***

In squid, on the other hand, the shell has actually moved INSIDE the body. It has become lightweight and supports a long, streamlined body. ***What does this tell you about the squid's new lifestyle, versus its sluggish ancestors?***

The squid is in fact an active predator. It no longer crawls on the seafloor, but instead uses jet propulsion for fast swimming and hunting fish in open water. ***Besides the shell, what other features of the ancestral mollusc have changed for this new niche? Why?***

Why was there such pressure for so many different types of molllusc body to evolve?

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Divergent Evolution

Again, the snail, clam, and squid represent a case of **divergent evolution**, or what Darwin called "descent with modification." Their similarities show that they share a common ancestor, but their differences show that their bodies later adapted for new functions, new habitats, and new lifestyles as new challenges arose. In future lessons, labs, and episodes of ***The Shape of Life***, you may learn about other molluscan specializations. There's the small but deadly blue-ringed octopus, whose bite delivers one of the world's most toxic venoms. There are cockles that use a giant, twirling foot to spring from their burrows and scramble away from attackers. There's the nautilus – half squid, half snail – that floats itself off the seafloor by filling its chambered shell with gas. As you learn about such amazing animals, bear in mind that they all came from the same ancestor: a simple snail beneath a beach umbrella!