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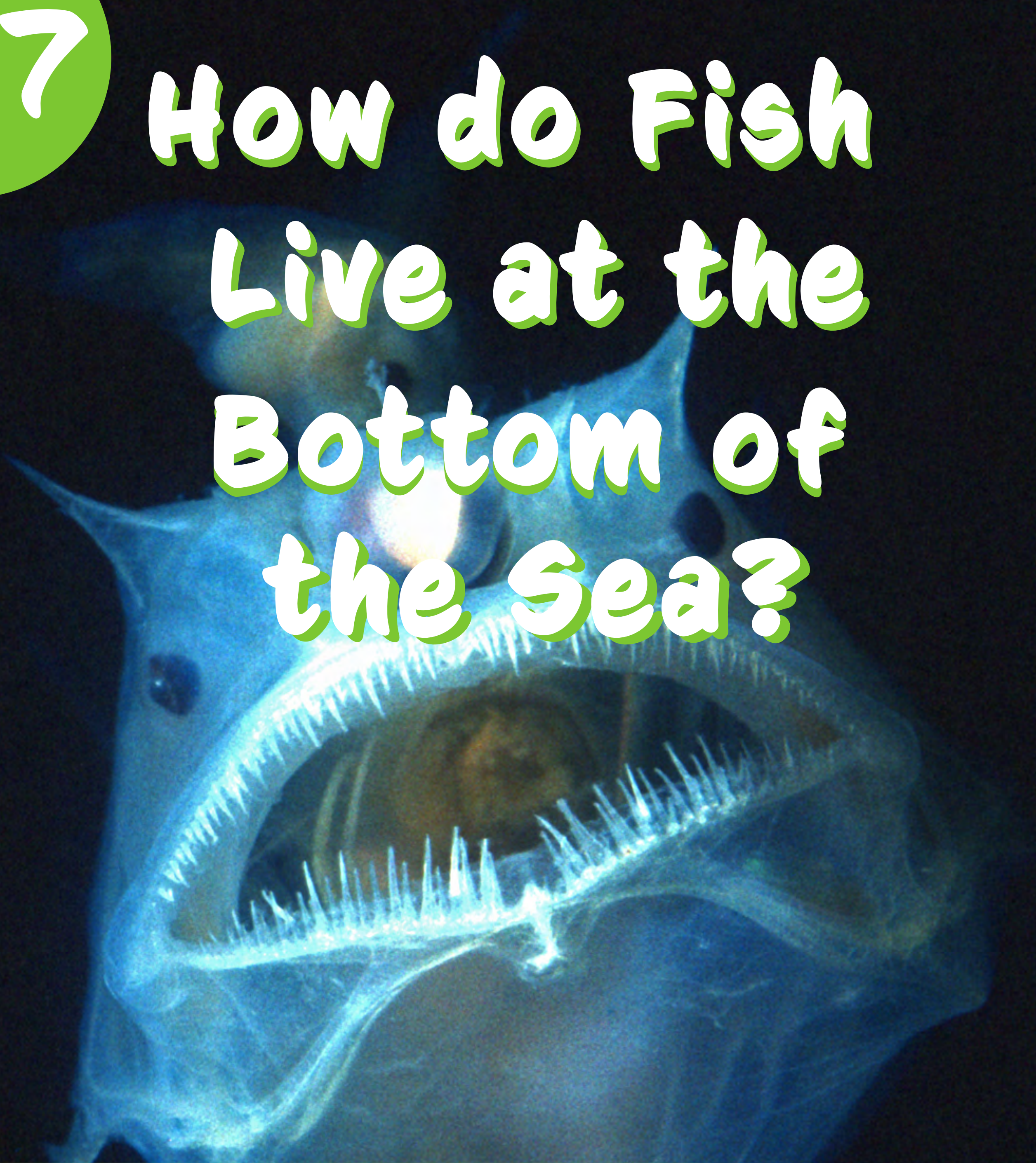
How do Fish Live at the Bottom of the Sea?



Key Concepts

There are four different habitat zones in the ocean.

Marine animals in the abyssal zone have special adaptations to help them survive their extreme environment.

Water pressure is the force of water pressing down on objects.

Before You Begin

Soak the water beads in about 2 cups of water overnight. They should take 6-24 hours to fully expand. Drain the excess liquid before using. You may also want to make the play dough, following the recipe on the right.

Materials

- 1 teaspoon dry water beads K
- thumbtack K
- masking tape K
- toothpick K
- rubber band K
- water
- empty tall plastic water bottle
- sink
- plastic produce or grocery bag
- a bowl of water (that can fit your hand)
- play dough (store bought or homemade, recipe on the side of this page)
- small plastic bag
- dinner plate
- 3-4 books for weight
- How do Fish Live at the Bottom of the Sea? Test Data Chart P

Play Dough

The play dough must be soft for this experiment. Use this recipe if you need some that will squish well.

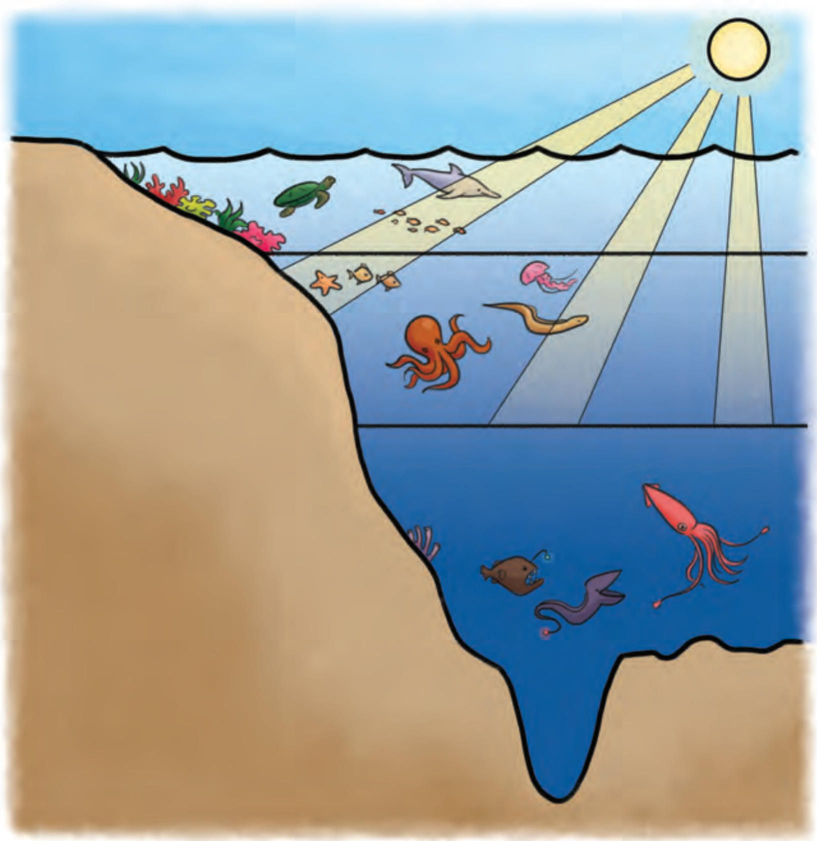
Mix together 1/2 cup flour, 1/4 cup salt, and 3/4 teaspoon cream of tartar. Add 1/2 cup boiling water and 1 1/2 teaspoon vegetable oil and carefully mix. Sir until a dough starts and it remains sticky, knead in small amounts of flour until smooth.

Introduction

Scientists have discovered more than 1 million different species of plants and animals living in the ocean. They believe there may be millions more yet to be discovered, but because the ocean is so vast, deep, and dark we may never know about everything that lives in it.

The average depth of the ocean is 12,460 feet deep—that's 8 1/2 Empire State Buildings stacked on top of each other! The Earth's oceans are also home to the tallest mountains and the deepest valleys. Scientists have divided the open ocean into "zones" or layers. These zones are characterized by temperature, amount of sunlight, and water pressure. The deeper the ocean gets, the less light from the Sun is able to penetrate through the water. This means that the deeper the water gets, the darker and colder the environment becomes. Each ocean layer creates a different habitat, which means many different animal species can live in the various layers of the ocean. The number of different types of creatures that live in an area is called **biodiversity**. Biodiversity can be used as a measurement to determine how healthy an area is. If an area has higher biodiversity (or a higher number of different types of animals) then that area is considered healthy.

The abyssal zone is the deepest zone and is a harsh environment for any creature. The temperatures are so cold, the water pressure is so great, and the darkness is so deep that plants can't grow and many creatures would be crushed by the water pressure. In fact, the water pressure is enough of a problem that it keeps people from diving into the deep ocean waters too. To go very deep, scientists need special pressure-resistant dive suits and vehicles to explore the deeper parts of the ocean. And yet, some creatures call this environment home. Today you will explore how one creature, the blobfish, is able to survive in this environment.



Before we talk more about the blobfish, let's first explore what this deep sea habitat is really like. One of the key characteristics of the deep sea is the immense water pressure. But what is water pressure? And why is it a problem for people, the deeper we go in the ocean? Let's find out.

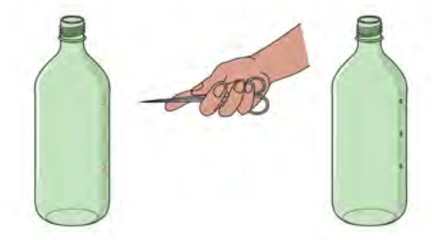
Make a Prediction

If we poke three holes in the side of a water bottle to let the water spill out, which hole will let a stream of water shoot out the farthest? The top, middle, or bottom hole? Mark your prediction on the **How do Fish Live at the Bottom of the Sea? Test Data Chart**.

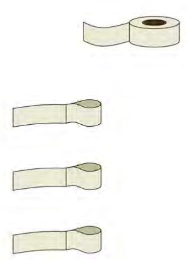
Investigate

What is Water Pressure?

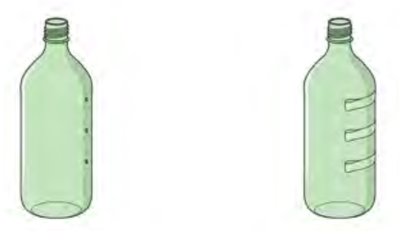
1. **Parents:** Use a thumbtack to poke 3 holes in the bottle vertically, in a line. Move the thumbtack in a circle to make each hole slightly larger, or use a toothpick to enlarge the holes.



2. Pull three pieces of tape off of the roll and fold one end down on each piece, to make a small, non-sticky tab.

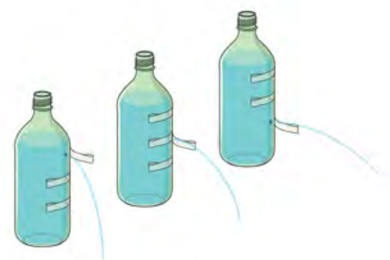


3. Use the tape to cover the holes, like small doors.



4. Fill the bottle with water. Set it on the edge of a sink with the holes facing into the sink.

5. Pull the tab to open each tape door. What happens? Draw what you see in the space provided on the Test Data Chart.



Tip: Feel free to refill the bottle and watch what happens a couple of times. You may need to use new tape to cover the holes if you do.

Tip

If the tape is too sticky or difficult to stick and remove, you may cover up each hole with a finger and release as needed.

6. **Parents:** Close the holes again with new tape and fill the water bottle one more time before you continue with the discussion. If the bottle leaks even with tape, refill it in a minute when your students need to hold it to feel its mass.

What's Happening

What happened to the water in the bottle when you opened the tape doors that covered the holes? (Water streams out of the holes.)

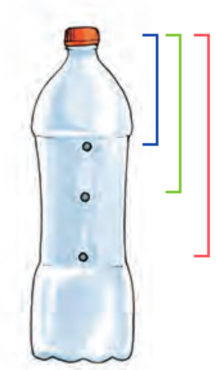
Out of which hole does the water squirt the furthest? (The bottom hole.)

Why do you think this happens?

Our bottle is somewhat like the layers of the ocean. **Gravity** is a **force** that pulls everything toward the center of the earth. Gravity pulls the water in the bottle toward the center of the Earth—or "down." If you tip the bottle over so the opening is at the bottom, gravity pulls the water out of the hole. Gravity also pulls water downhill into the lowest part of land—which is where we find the ocean.

Mass is the word scientists use to describe the amount of matter in something. Water has mass. The more water in a container, the more mass the container has. Gravity pulls on mass. The greater the mass, the more gravity pulls.

When water piles on top of itself, like in the ocean, water's mass increases, and gravity has more to pull on. We call the force of gravity pulling water down **water pressure**. Water has mass. The deeper the water is, the more mass presses down on objects underneath it.



At the top of the bottle, above the first hole, there's only a little water. If we put this much water in a bag and you held it in your hand, it wouldn't feel very heavy. There isn't much water (or mass) for gravity to pull on, so it doesn't push down on you very hard.

More water sits in the bottle above the middle hole. If we put this much water into a bag and let you hold it in your hand, it would feel heavier than the first bag of water. There would be more water for gravity to pull on, and you would feel more force pushing down on you.

The greatest amount of water sits above the bottom hole. Hold the water bottle for a minute. Do you feel that it's a little bit heavy? That's gravity pulling on all the mass of all the water in the bottle, pushing it down on you.

As we open the tape doors on our bottle, gravity pulls the water down and the water pushes out of the holes. Since there isn't a lot of water above the first hole, there's not a lot of pressure pushing the water down, so the water doesn't squirt out of the top hole very far.

At the middle hole, more water sits above, so there is more pressure pushing down. This greater pressure pushes water out of the hole with more force, so the stream we see squirts out of the bottle a little farther.

At the bottom hole, the greatest amount of water sits above, so a lot of pressure pushes the water down. The stream of water pushes out of the bottom hole with the most force, so it squirts the farthest.

? In the ocean, what do you think happens to water pressure the deeper you dive? (There is more water pressure.)

Water pressure increases the deeper you go because more water is above you, pressing down on you. In the deepest parts of the ocean, this pressure is huge.

While water pressure does push down, it doesn't only push down. It also pushes against anything that's in the water, from all sides.

? Put your hand in a produce bag. If you put your hand in the bag into the water, what do you think will happen? (Possible: Your hand will stay dry; the water will squish in on your hand, etc.)

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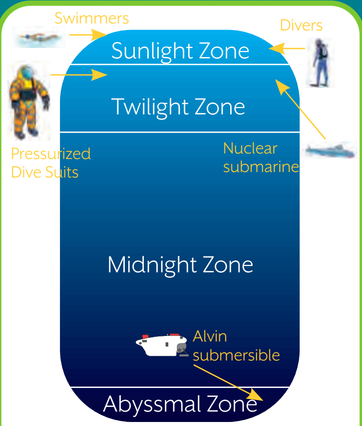
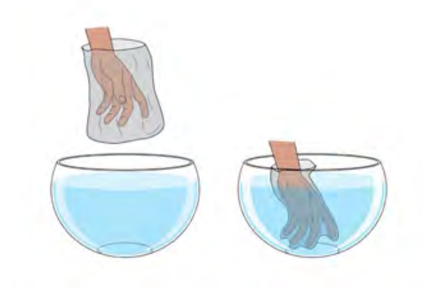


Without equipment, swimmers can dive about 20 feet deep. Scuba divers can dive to 130 feet if they're careful how they return to the surface. Workers use pressurized dive suits to dive to 1000 feet.

Nuclear submarines can go down about 984 feet, which is still part of the twilight zone. Special pressure-resistant scientific vehicles, like the Alvin submersible can go as deep as 14,800 feet deep.

Now think carefully for a minute: What else is in the bag, besides your hand? (Air!)

Air is in the bag, along with your hand. Put your bagged hand in a bowl of water.



What happens? (The water pushes in on your hand.)

Under the water level, is there any more air in the bag? (No, the water pushed the air out of the top of the bag.)

Water pressure pushed the bag toward your hand until it pushed the air out of the bag. In this small amount of water, your hand is able to withstand the force of water pressure, so it pushes back against the water.

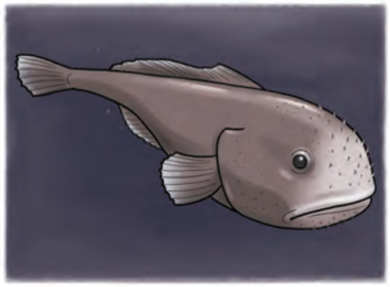
As people dive in the ocean, water pressure increases. It grows strong enough to push the air out of our lungs the way it pushed the air out of the bag. As people dive, they need not only air to breathe but more and more protection from water's pressure. While people can dive with swimsuits and scuba gear closer to the surface, deeper in the ocean we need equipment like strong submarines to keep the water pressure from squishing us.

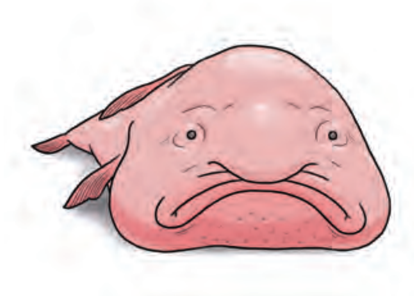
And yet, some creatures are able to live deep in the ocean without being squished by water pressure. But how?

Let's begin by talking about why our bodies have shape. Inside our bodies we have bones. Run your hand on the front of your shin. The hard part you feel is a bone. You can feel another bone on the side of your forearm. Bones are hard and their strength helps them perform a few specific jobs for our bodies. Bones support our bodies and give us shape. They protect our insides and support the weight of our bodies. Bones also give our muscles something to pull on, which helps us move.

Fish have bones too, and their bones also give them shape, protect their insides and help them move. But one fish, the blobfish, doesn't have many bones. Instead, its body is gelatinous, which means it is made of something like the texture of jelly. A blobfish doesn't have many bones or muscles either. But why? How is it able to survive this way? And how is it able to survive in an environment with immense water pressure?

Blobfish are deep-sea fish found only in Australia, Tasmania, and New Zealand. Blobfish live in the dark and cold parts of the ocean. They spend their lives in a depth range of 2,000 to 3,900 feet where the water pressure is 60 to 120 times higher than the pressure at sea level. This unusual fish is very rare and is currently listed as endangered. Blobfish can grow up to 12 inches long and weigh 20 pounds. A blobfish's lifestyle lives up to the fish's name. Much like the robot-vacuums of the sea, blobfish tend to float along near the bottom, eating whatever floats in front of it and can fit into its mouth. As drifters, blobfish don't need to have many bones or muscles. But how does a blobfish's body hold its shape?





Blobfish look quite different deep under water (top picture). Scientists believe they suffer tissue damage when fishing nets pull them to the surface (bottom picture).

Next, let's make two fish models—one of a typical surface fish and one of a blobfish—and see how well they hold up under pressure.

Fish Under Pressure

We will use play dough to mimic the texture of muscles found in a typical fish that lives near the surface. We will use a toothpick to represent fish bones.

Did you know?

Doctors call your shin bone a **tibia**, and call the small bone on the outside of your arm that leads to your pinky finger the **ulna**.

Did you know?

A blobfish's body is made of a jelly-like substance that turns into a floppy mass when it is taken out of the water, hence the name blobfish.

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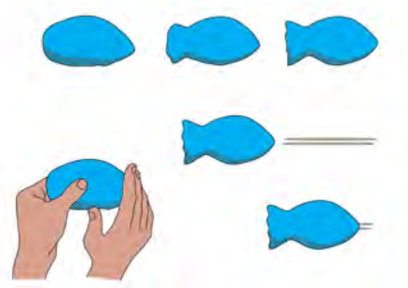
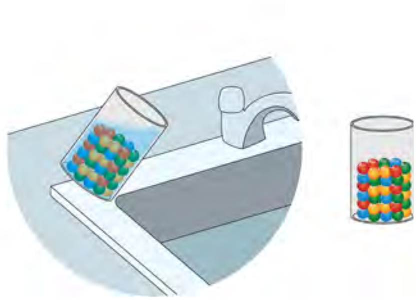
1. Use play dough to mold a simple fish shape. Push a toothpick inside the fish's body to mimic its bones.

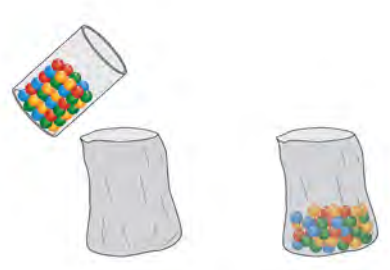


Next we will make a model blobfish. Water beads are gelatinous. They are like the texture of a blobfish's body.

2. Drain the excess water off the water beads.

3. Pour the beads into a small plastic bag.





4. Push as much air as you can out of the bag, twist it, and secure it with the rubber band.

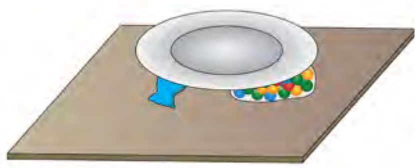
5. Optional: Draw a face on the bag so it looks like a fish.

Explore the two fish you made for a minute.

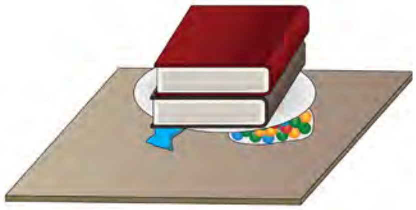
Make a Prediction: If we apply pressure to these two fish, which will be able to resist a squishing force better? Record your prediction on the Test Data Chart.

Test

1. Set both fish on the counter and lay a plate on top. If the plate is uneven, you may wish to do one fish at a time.



2. Crouch down so you can better observe the fish and start setting books on top of the plate (or ask a parent to help). The books represent the greater and greater water pressure that pushes on fish deep in the ocean. What do you observe with the books on the fish?



3. Remove the books. Which fish held up better under the pressure of all the books? Draw a picture on the Test Data Chart under "Fish Under Pressure—Test" to record your observations.

What's Happening

Remember, water pressure pushes in from all sides. On land, air pushes on us too—with a force called air pressure. We are adapted to living with air pressure—so well, in fact, that we usually don't think about it. At sea level, air pushes with a force of about 14.7 pounds per square inch. Scientists call this amount of pressure 1 atmosphere. Water pressure increases about 1 atmosphere for every 10 meters of depth. So even 20 meters down (about 66 feet), water pressure is already twice as great as the air pressure at the surface of the sea. (And remember, blobfish live between 2,000-4,000 feet down!)

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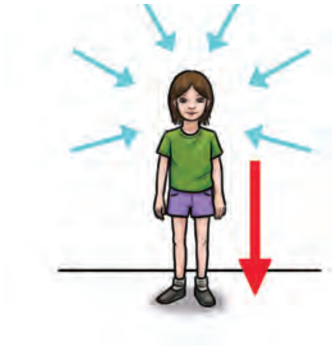
On land, gravity pulls "down" on us, and air pressure pushes in on us, but not nearly with the same amount of force as the force of water pressure at the bottom of the sea. Our bones are good at holding us up against gravity, and our muscles and tissues are strong enough to withstand the force of air pressure. But we are not built well to withstand the great pressure of water.



Like our playdough fish, our bodies would squish from the water pressure deep under the ocean. Our bones help our bodies stay upright against gravity's downward pull, but they can't help us much when water pressure pushes in on all sides. Blobfish, on the other hand, have gelatinous tissues, more like the water beads. The water pushes in on them from all sides, but their jellylike tissues are stronger all over—in every direction, and therefore able to resist the pressure much better than ours. Blobfish bodies are specially able to survive the immense water pressure at the bottom of the ocean where they live.

Draw Conclusions

Today we used a bottle with three holes in it to help us understand water pressure.

Which hole allowed the water to shoot out the farthest? Why? (The bottom hole, because it had the most water pushing down on it.)

The bottom hole in the bottle allows water to squirt out the farthest, because the water pressure is the greatest at the bottom of the bottle. Our water bottle is like a mini model of the ocean. The deeper the water gets, the stronger the water pressure is. Deep in the ocean, water pressure is so great people can't survive there without special equipment.

You also submerged your hand in a bag in a bowl of water. This showed how water pressure pushes all around on something, and not just straight down.

Then we built two model fish.

Why did we build a fish out of playdough and a toothpick? (The playdough fish was a model of other typical fish and how our bodies would respond under increased water pressure.)

Why did the water beads help us model a blobfish? (Because the tissues in a blobfish are jelly-like, like the water beads.)

Why didn't we add a toothpick to the model of the blobfish? (We didn't add a toothpick to the model of a blobfish because blobfish don't have many bones.)

Which fish held up better under a large amount of water pressure, the big stack of books? Why? (The blobfish didn't squish. It's jelly-like body was able to push out against the pressure equally in all directions.)

Takeaway

Water has mass. Water's mass, when gravity pulls on it, creates a force scientists call water pressure. When water piles up on itself, the way it does in the ocean, the amount of force in water pressure increases as the water depth increases. Water pressure is so great at the bottom of the ocean, many types of fish and people can't survive.

Blobfish don't have many bones or muscles, since they tend to float along at the bottom of the ocean, eating whatever passes by, and they are able to do this in very deep water because they don't have many bones or muscles. Their bodies are made of a gelatinous tissue that helps their bodies resist the force of water pressure pushing on them from all sides. Their special body tissues help them survive the conditions deep in the ocean where they live.

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Make Connections

Darkness is also a key characteristic of deep sea habitats. If you sit on the bottom of a pool and look up, you'll notice how light the sky is compared to where you are. That's because the water above filters the light until it can no longer reach through the water. In the deep parts of the ocean, the water is a slightly lighter color looking up toward the surface than looking in any other direction. Predators hide below in the darkness looking up for the shadows of fish against the lighter water. The lanternfish has **bioluminescence**, which means they produce their own light. Special photospheres on the lanternfish's belly make a dim light. This light helps them to hide against the lighter backdrop of the surface above.

Go Further

Make a fish out of construction paper. Use a hole punch to punch holes in the fish's underside. Activate a glowstick and tape it inside the fish's body. Lay on the ground outside at twilight and hold the fish above you. Does its glow help it to blend in with the light color of the sky?

Develop a practical use for your water beads. Can they help protect something from being squished? Can they keep a door from slamming into a wall? How can you make use of their squishy structure?

Make Connections

The deepest place on earth is in the Mariana Trench (located in the Pacific Ocean near Japan). It is 7 times as deep as the Grand Canyon. At its bottom, it is almost 7 miles below sea level.

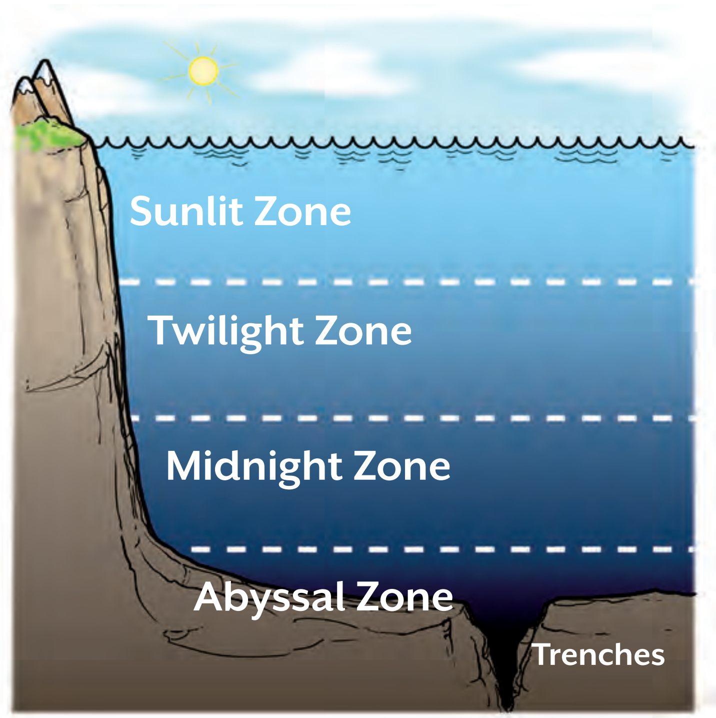
Epilogue: More about Ocean Depths

Scientists identify several different habitat zones in the ocean. The first zone is called the **sunlit zone**. It extends from the surface to about 600 feet down in the ocean. In this zone, there is plenty of sunlight, relatively low water pressure, and temperatures are relatively warm. Because sunlight can filter through the water in this layer, plants can grow. The plants provide an excellent food source for the animals that live in this zone. Sharks, tuna, mackerel, jellyfish, sea turtles, sea stars, stingrays, and whales all live in the sunlight zone.

The **twilight zone** (approx. 600–3,000 feet) is directly below the sunlit zone. Here temperatures are colder and there is more water pressure. Very little, if any, sunlight reaches into the twilight zone. Animals like squid, octopus, and hatchet fish live here.

Below the twilight zone is the **midnight zone** (approx. 3,000–13,000 feet). As the name suggests, there is no sunlight in this zone. Here the water pressure is about 2 tons per square inch and temperatures are near freezing. Only a few animals can live in this extremely harsh environment. Some animals that live here use bioluminescence, which means that they produce their own light. Bioluminescence creates light without making heat.

Below the midnight zone is the **abyssal zone** (approx. 13,000 feet and below), which is similar to the midnight zone, but colder and with even greater water pressure.



See the Bigger Picture

When gelatin is soaked in a liquid, it takes in moisture and swells. When it is heated, the particles melt and help to thicken the liquid. Gelatin is most commonly used in the food industry. It is used to thicken foods, make candies and molded desserts, and to stabilize some foods like ice cream and marshmallows. Pharmaceutical companies also use gelatin to make capsules for medication, make-up, lotions, ointments, and lozenges.

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How do Fish Live at the Bottom of the Sea? Test Data Chart

What is Water Pressure?

Make a Prediction

When you fill the bottle with water, water will squirt out of the holes in the side. Circle the hole on the bottle you think will allow water to squirt out the farthest.

Observation

Draw what you see when you pull open the tape doors.

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Fish Under Pressure

Make a Prediction

Which fish will resist a squishing force better? Playdough fish Blobfish

Test

Draw a picture of your observations here.