



# E/V Nautilus

## ACTIVITY BOOK

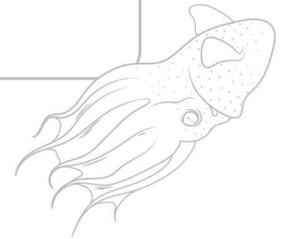
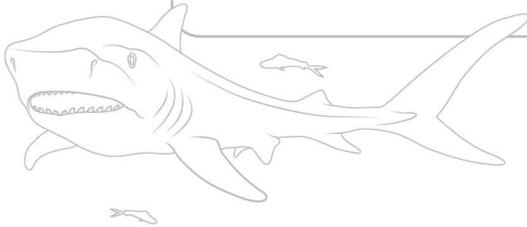




# NAUTILUSLIVE.ORG

## OCEAN EXPLORATION TRUST

this book belongs to:



## Introduction

The deep sea is a fascinating place with clues to help understand the formation of the planet and incredible life adapted to live in the high-pressure of the deep, dark ocean.

Our team at Ocean Exploration Trust works from our ship Exploration Vessel *Nautilus* on expeditions all around the world. We help scientists study our living planet, engineers develop new technologies, and students grow into careers in science, technology, engineering, art, and mathematics fields. We believe your creativity and curiosity can carry you anywhere your dreams take you... even the bottom of the ocean!



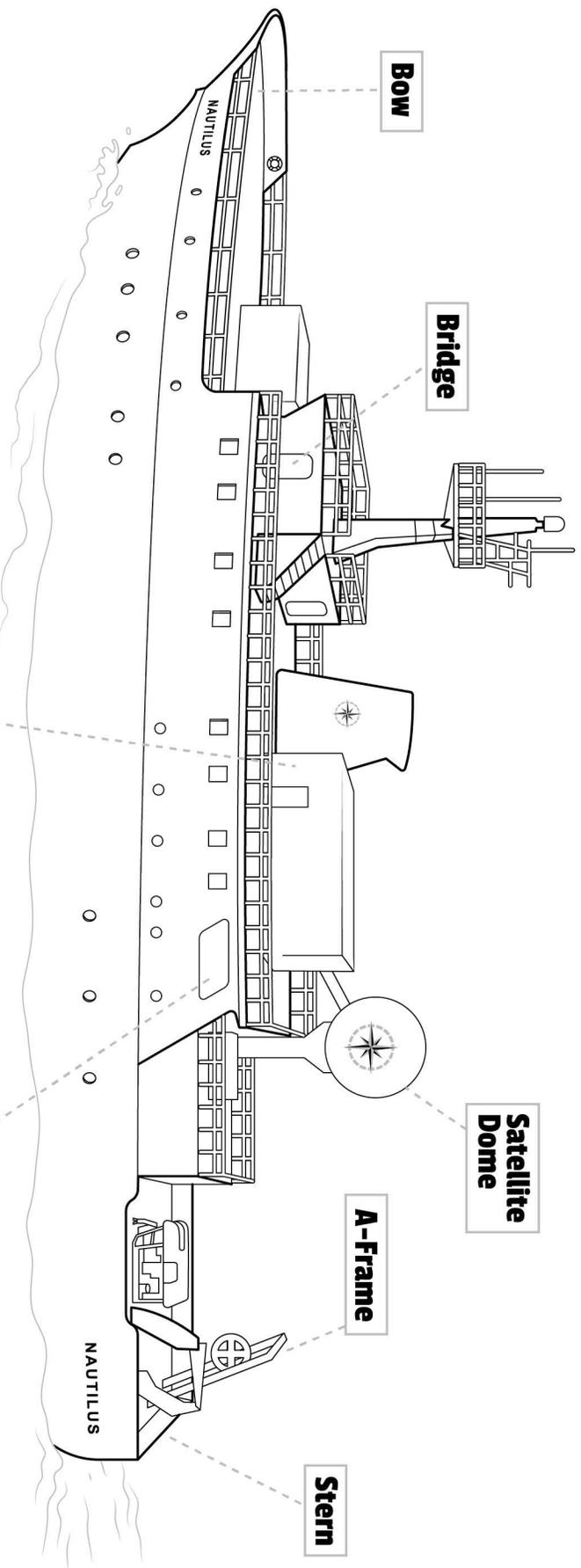
## Ready to learn more?

Explore more fun activities (with an adult's permission) at [www.NautilusLive.org/education](http://www.NautilusLive.org/education) and share your work with friends and fellow explorers using [#InspiredByNautilusLive](https://twitter.com/InspiredByNautilusLive) on social media.

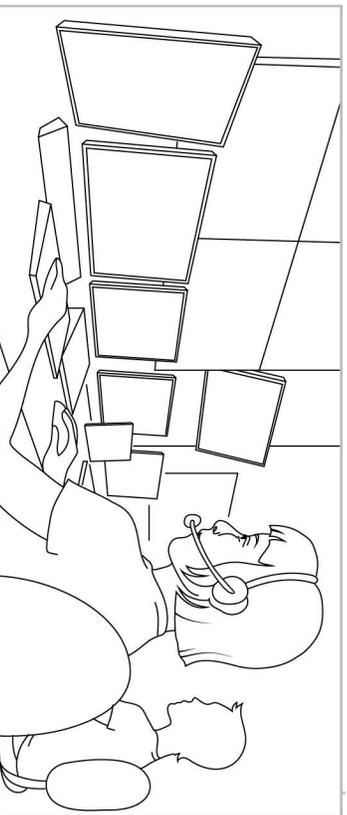
Answer key available at <https://nautiluslive.org/resource/nautilus-activity-book>

# E/V Nautilus Coloring Page

Research vessels carry explorers into the ocean to learn about the 71% of the planet covered by water. *E/V Nautilus* is the floating home to 50 scientists, engineers, educators, and crew and is equipped especially for exploring the oceans with a laboratory and control room for ROVs.



**ROV Control Room**

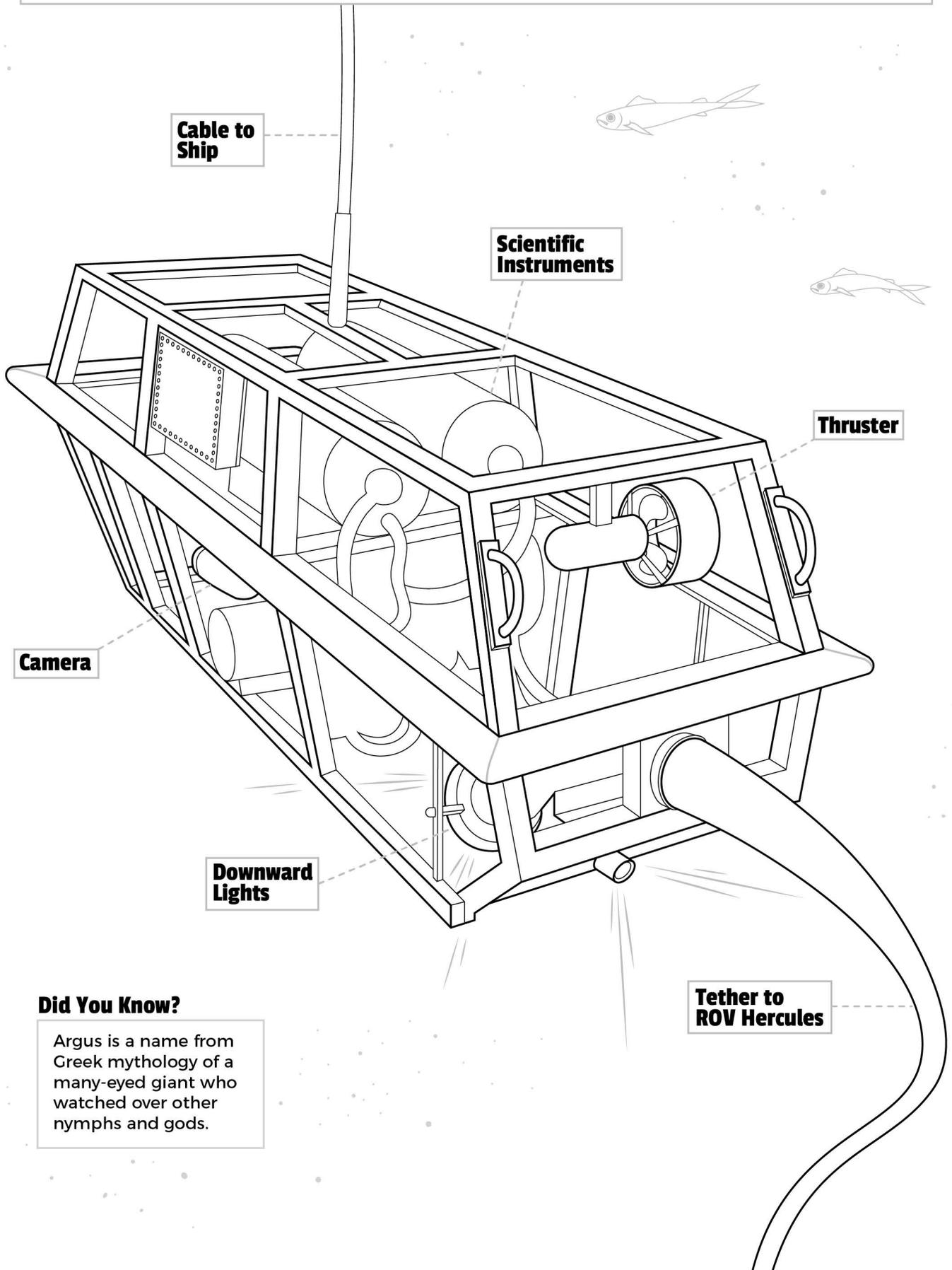


**Laboratory**



# ROV Argus

ROV *Argus* hangs on the cable between E/V *Nautilus* and ROV *Hercules* shining down light and giving an eyes-in-the-sky perspective on all the team's discoveries.



**Cable to Ship**

**Scientific Instruments**

**Thruster**

**Camera**

**Downward Lights**

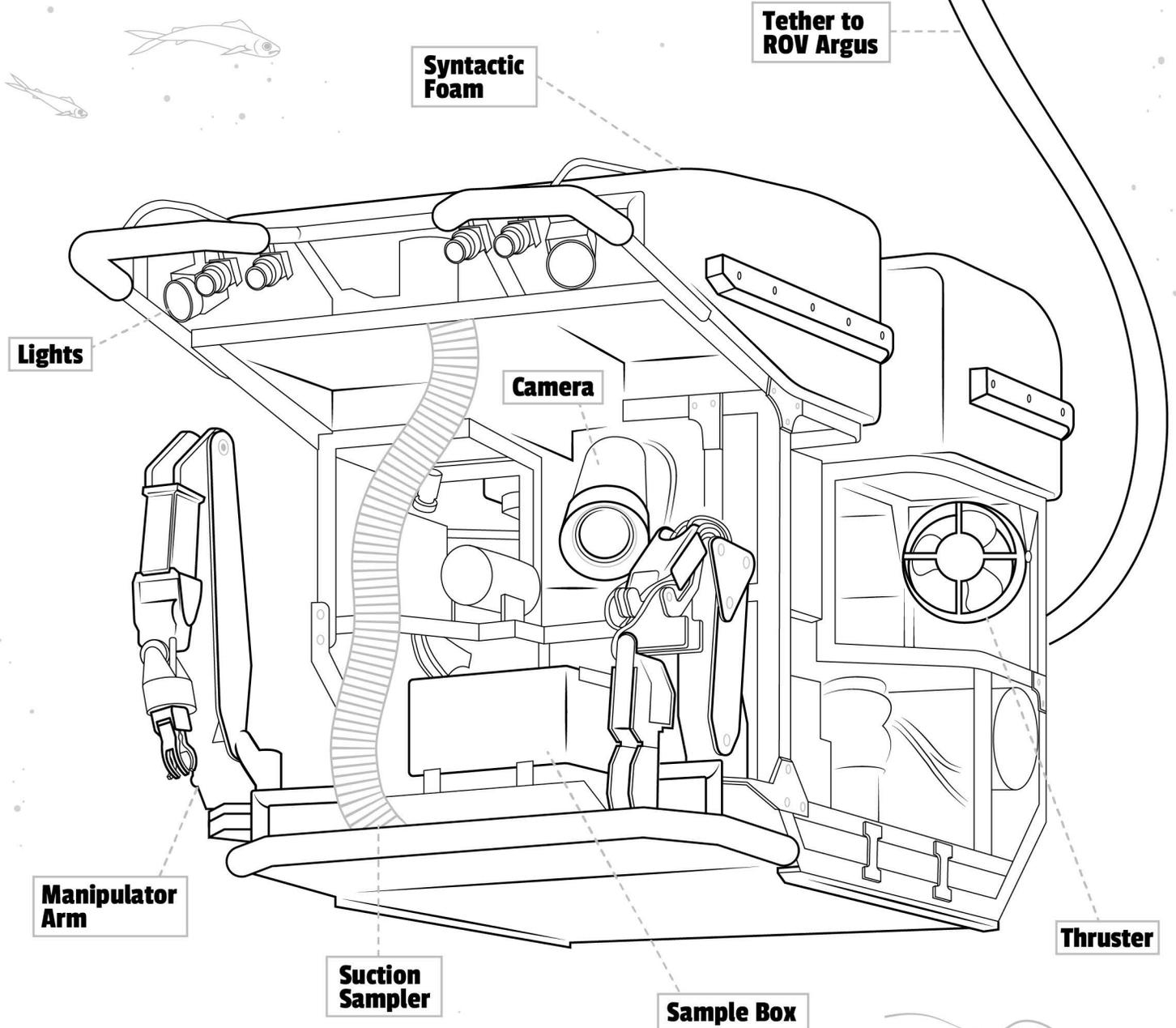
**Tether to ROV Hercules**

## Did You Know?

Argus is a name from Greek mythology of a many-eyed giant who watched over other nymphs and gods.

# ROV Hercules

ROV *Hercules* acts as the eyes and hands on the seafloor for explorers aboard *Nautilus* and around the world. Equipped with samplers, sensors, cameras, and lights, *Hercules* has surveyed ancient shipwrecks, discovered hydrothermal vents, and helped to identify marine species new to science.



## Did You Know?

In Greco-Roman mythology, Hercules is a hero famous for his incredible strength, stamina, and far-reaching adventures.



# Acrostic Poem

Acrostic poems spell out a phrase or word and feature one characteristic per line to describe the poem phrase in more detail. Together, the lines of the poem describe the main topic of the acrostic and combine to form a message. **Add one descriptive word that starts with the BOLD letter and describes explorers or the ocean.**

**E**  
**X**  
**P**  
**L**  
**O**  
**R**  
**A**  
**T**  
**I**  
**O**  
**N**

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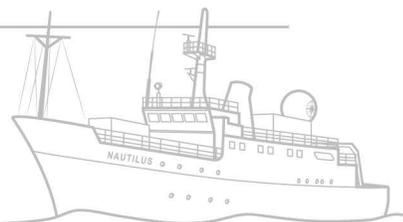
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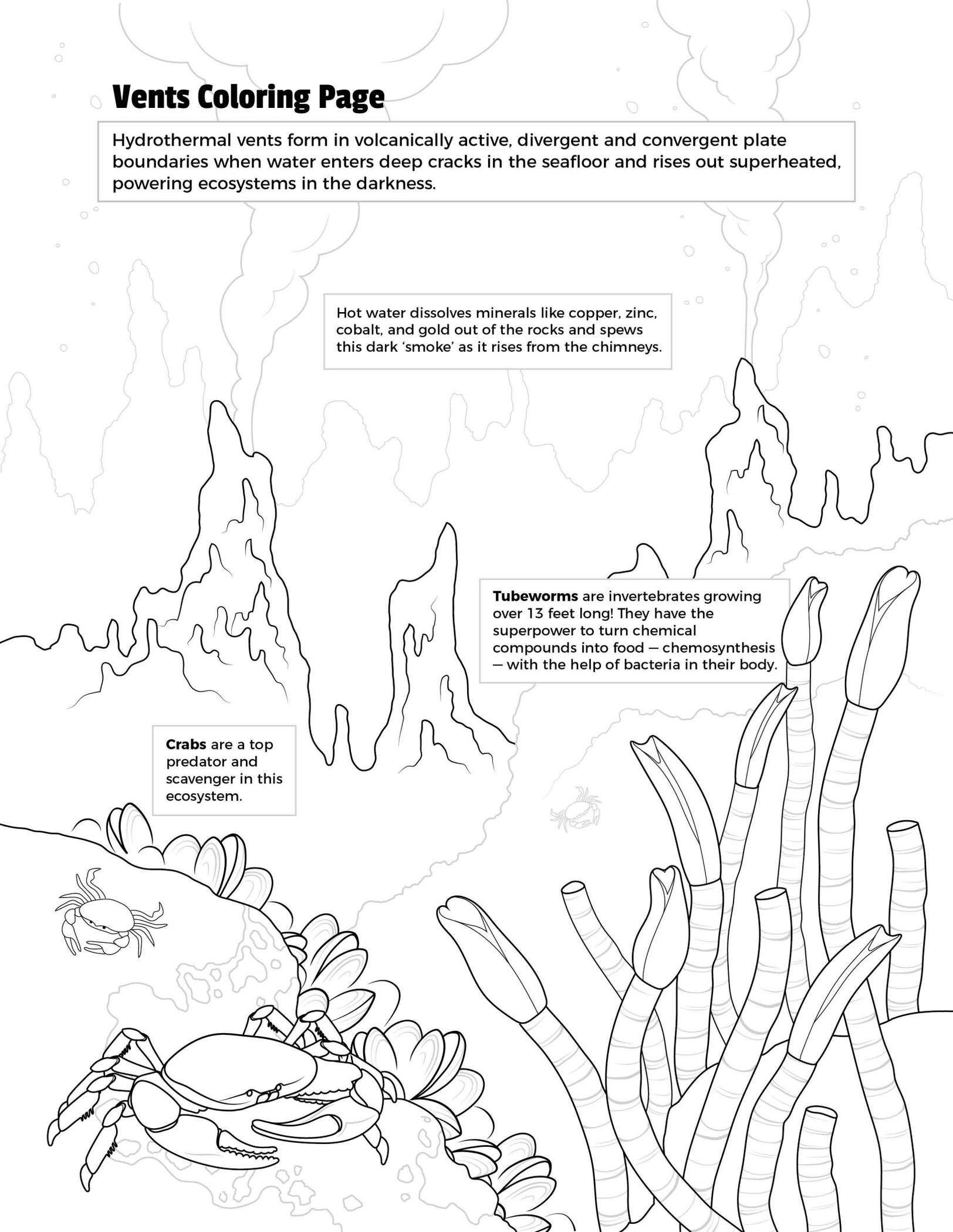
# Vents Coloring Page

Hydrothermal vents form in volcanically active, divergent and convergent plate boundaries when water enters deep cracks in the seafloor and rises out superheated, powering ecosystems in the darkness.

Hot water dissolves minerals like copper, zinc, cobalt, and gold out of the rocks and spews this dark 'smoke' as it rises from the chimneys.

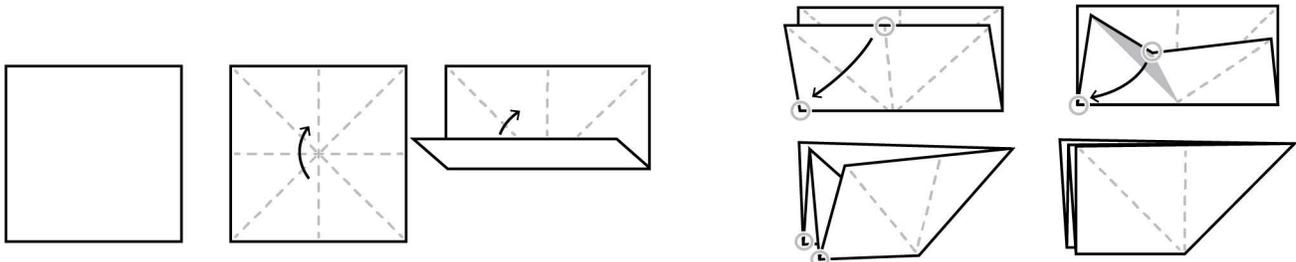
**Tubeworms** are invertebrates growing over 13 feet long! They have the superpower to turn chemical compounds into food – chemosynthesis – with the help of bacteria in their body.

**Crabs** are a top predator and scavenger in this ecosystem.



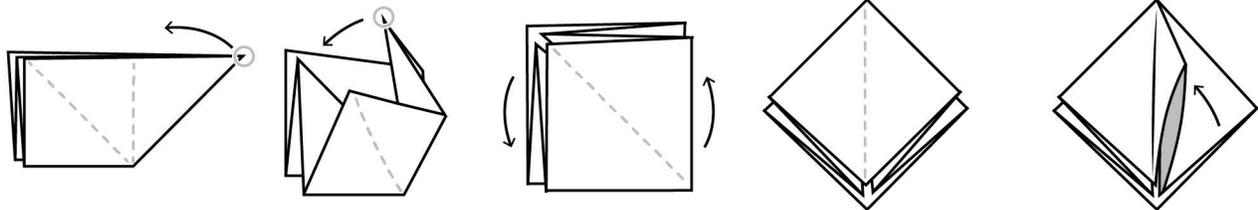
# Octopus Origami

You will need: a square piece of paper + scissors



**1** Crease paper as shown and fold bottom half upward as shown

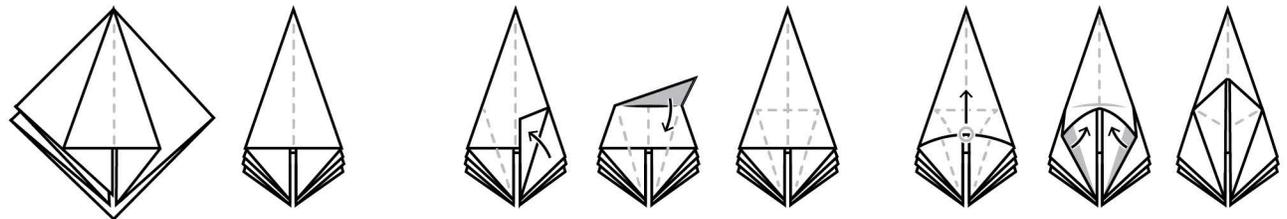
**2** Fold two circled points together



**3** Fold circled point inward

**4** Rotate so open side faces down

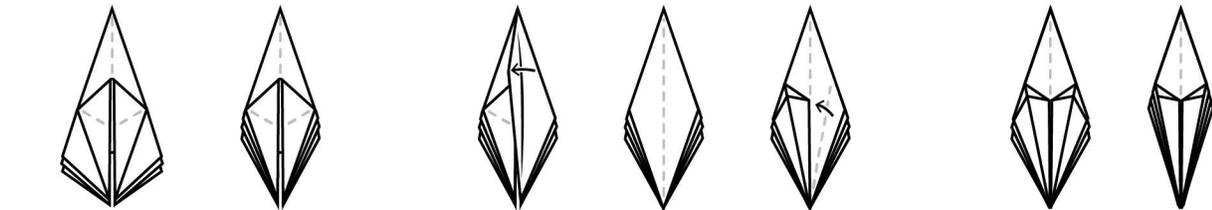
**5** Turn one flap so it points upward



**6** Flatten flap as shown and repeat for remaining flaps

**7** Fold creases as shown

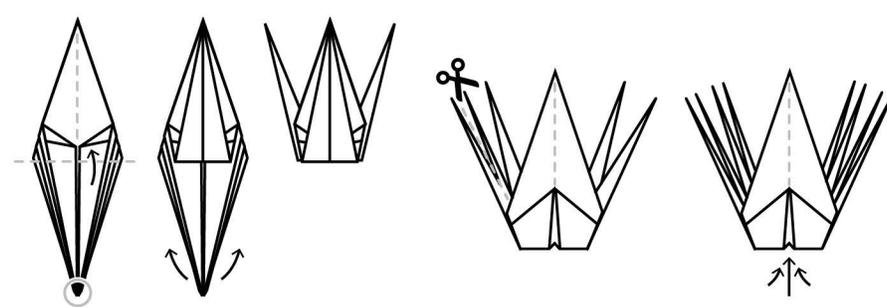
**8** Lift circled point and fold upward along new creases



**9** Repeat steps 7 + 8 on remaining 3 flaps

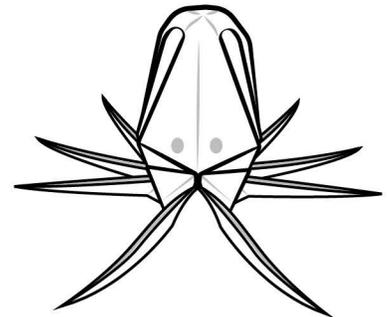
**10** Fold one flap over to show a 'blank' side, then fold as shown

**11** Repeat step 10 on 3 remaining 'blank' sides



**12** Fold circled point up and repeat for remaining 3 points

**13** Cut the 4 points in half and blow air into the bottom hole to inflate



**14** Fold tentacles out and draw 2 eyes (optional)

# Methane Seeps Coloring Page

Methane seeps are places where methane gas leaks out of the ocean floor and they're home to many creatures who can turn chemicals into energy. Types of methane seeps include: gas hydrate seeps, oil/gas seeps, brine pools, and mud volcanoes.

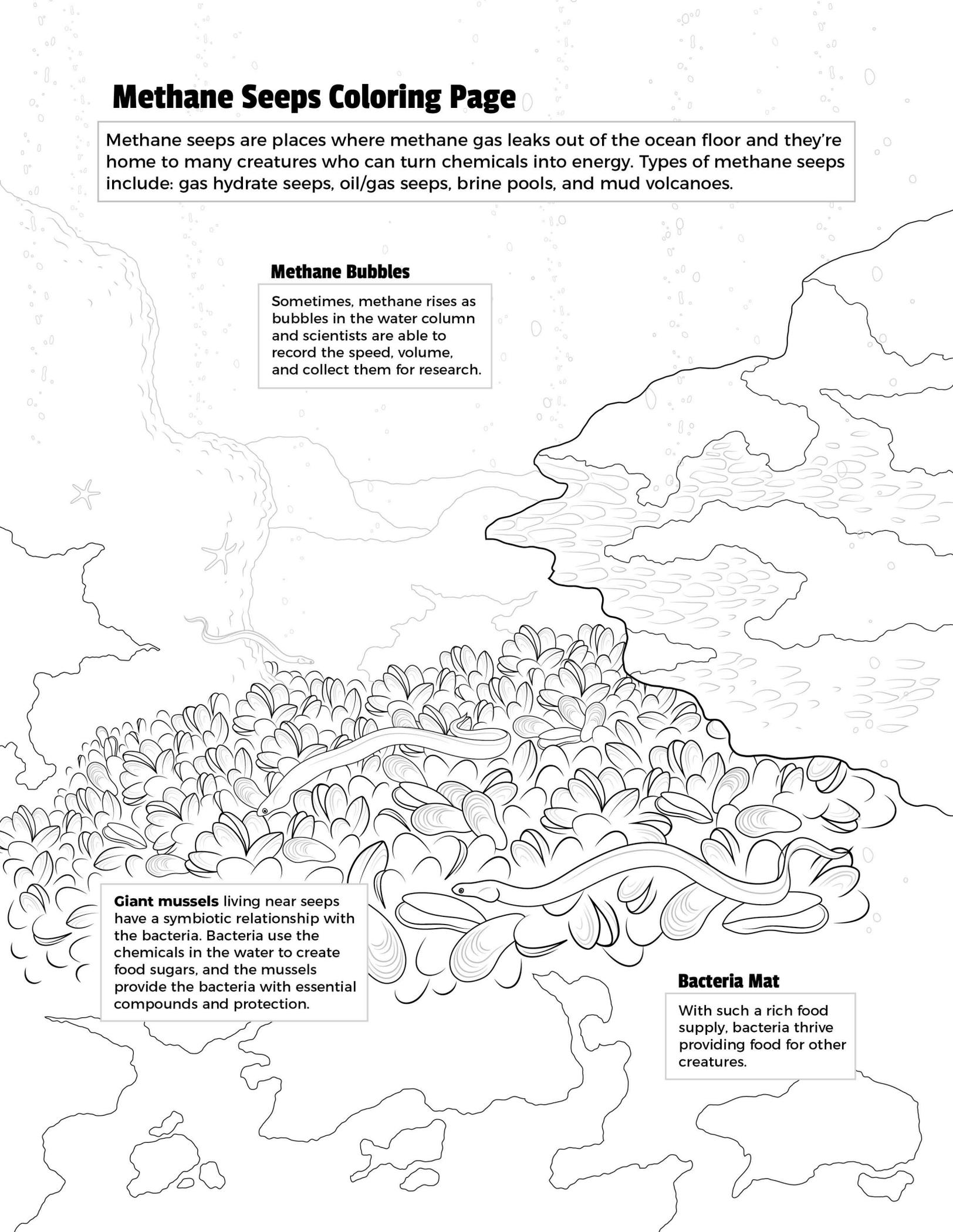
## Methane Bubbles

Sometimes, methane rises as bubbles in the water column and scientists are able to record the speed, volume, and collect them for research.

**Giant mussels** living near seeps have a symbiotic relationship with the bacteria. Bacteria use the chemicals in the water to create food sugars, and the mussels provide the bacteria with essential compounds and protection.

## Bacteria Mat

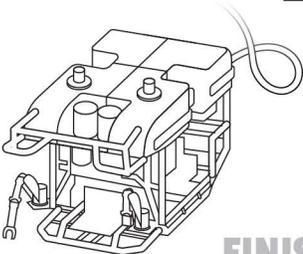
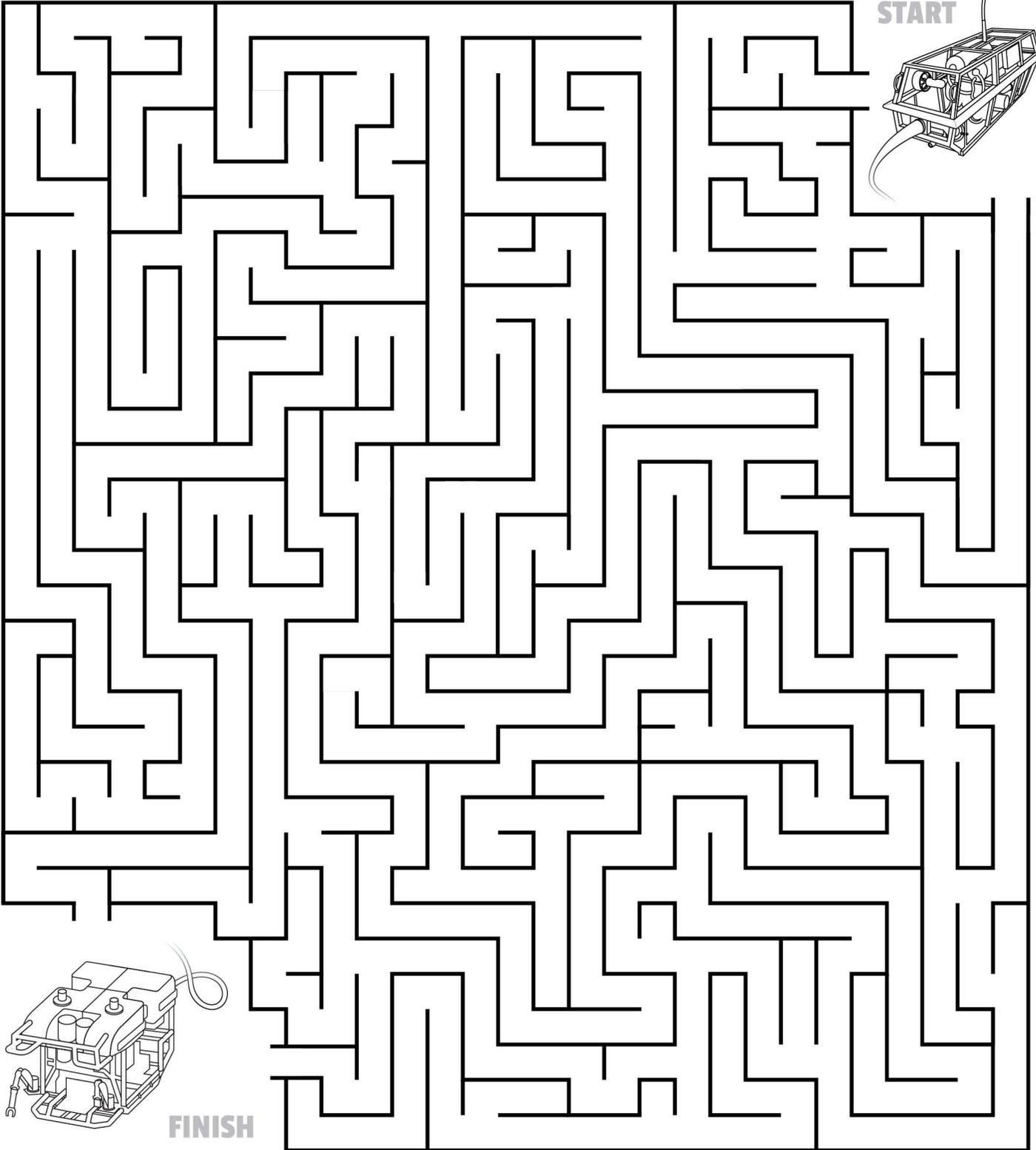
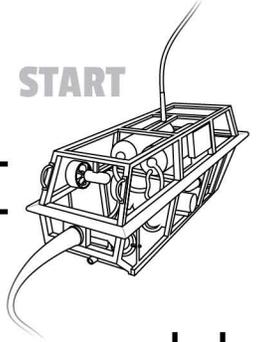
With such a rich food supply, bacteria thrive providing food for other creatures.



# Nautilus Maze

Help a data signal travel from E/V *Nautilus* to the seafloor transferred through the tether from ROV *Argus* to ROV *Hercules*!

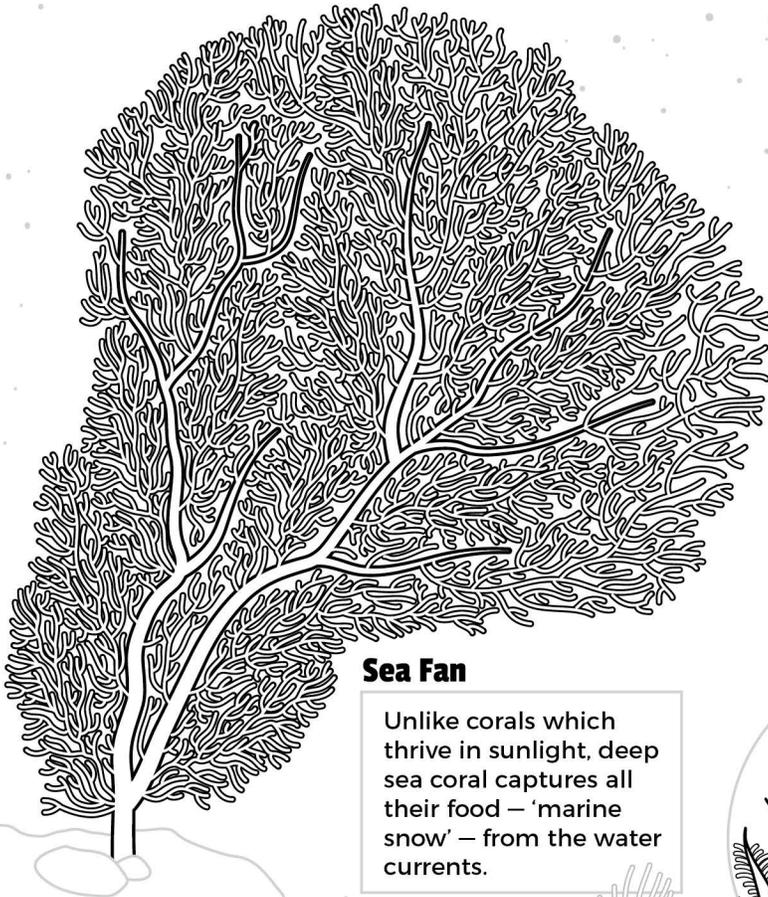
START



FINISH

# Coral Garden Coloring Page

Deep water corals live on rocky outcroppings from 150 feet to the deepest parts of the ocean. These corals don't normally form reefs, but by growing tall create habitats for other organisms. Some corals can grow up to 4000 years old!

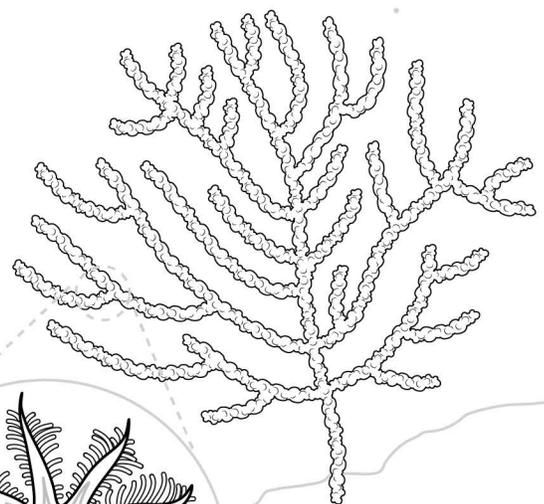


## Sea Fan

Unlike corals which thrive in sunlight, deep sea coral captures all their food – 'marine snow' – from the water currents.

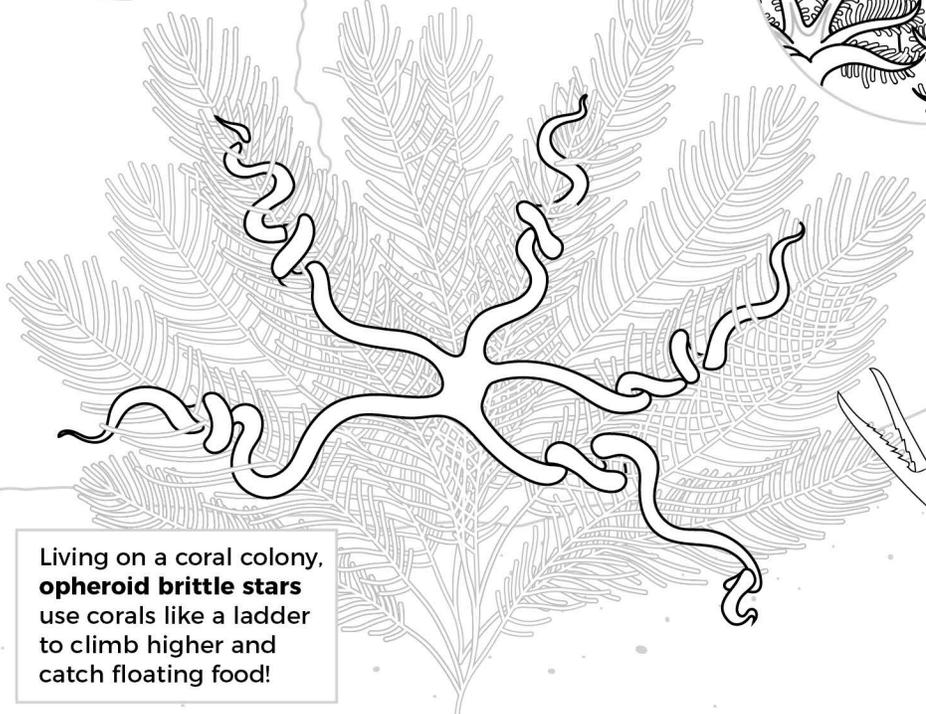


**Marine snow** contains tiny pieces of particles of debris, animal parts, and even animal poop.

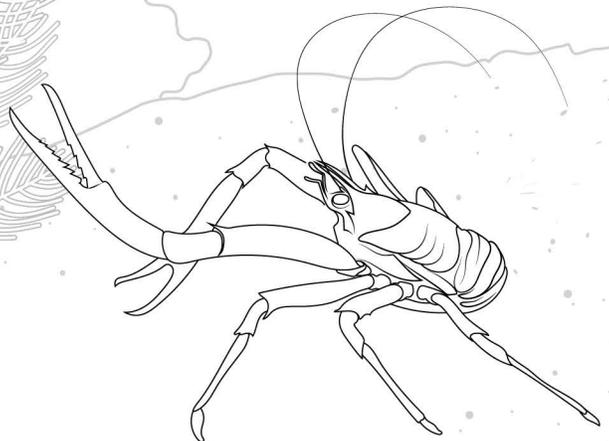


## Octocoral

These coral colonies are made up of 100's or 1000's of tiny polyps, each one with 8 tentacles.



Living on a coral colony, **ophiroid brittle stars** use corals like a ladder to climb higher and catch floating food!



# Fill-in-the-Blank Word Game

Play this word game with a parent or friend! Fill in the blanks below with each type of word. Once you're finished, add your words into the story on the next page!

1 **Plural Noun:**

11 **Verb:**

2 **Past Tense Verb:**

12 **Adjective:**

3 **Number:**

13 **Number:**

4 **Adverb:**

14 **Another Number:**

5 **Adjective:**

15 **Musician:**

6 **Item of Clothing:**

16 **Type of Food:**

7 **Adjective:**

17 **U.S. State:**

8 **Number:**

18 **Type of Transportation:**

9 **Type of Sea Creature:**

19 **Adjective:**

10 **Another Type of Sea Creature:**

# So many samples to process!

(Add in your words from the previous page to complete the story)

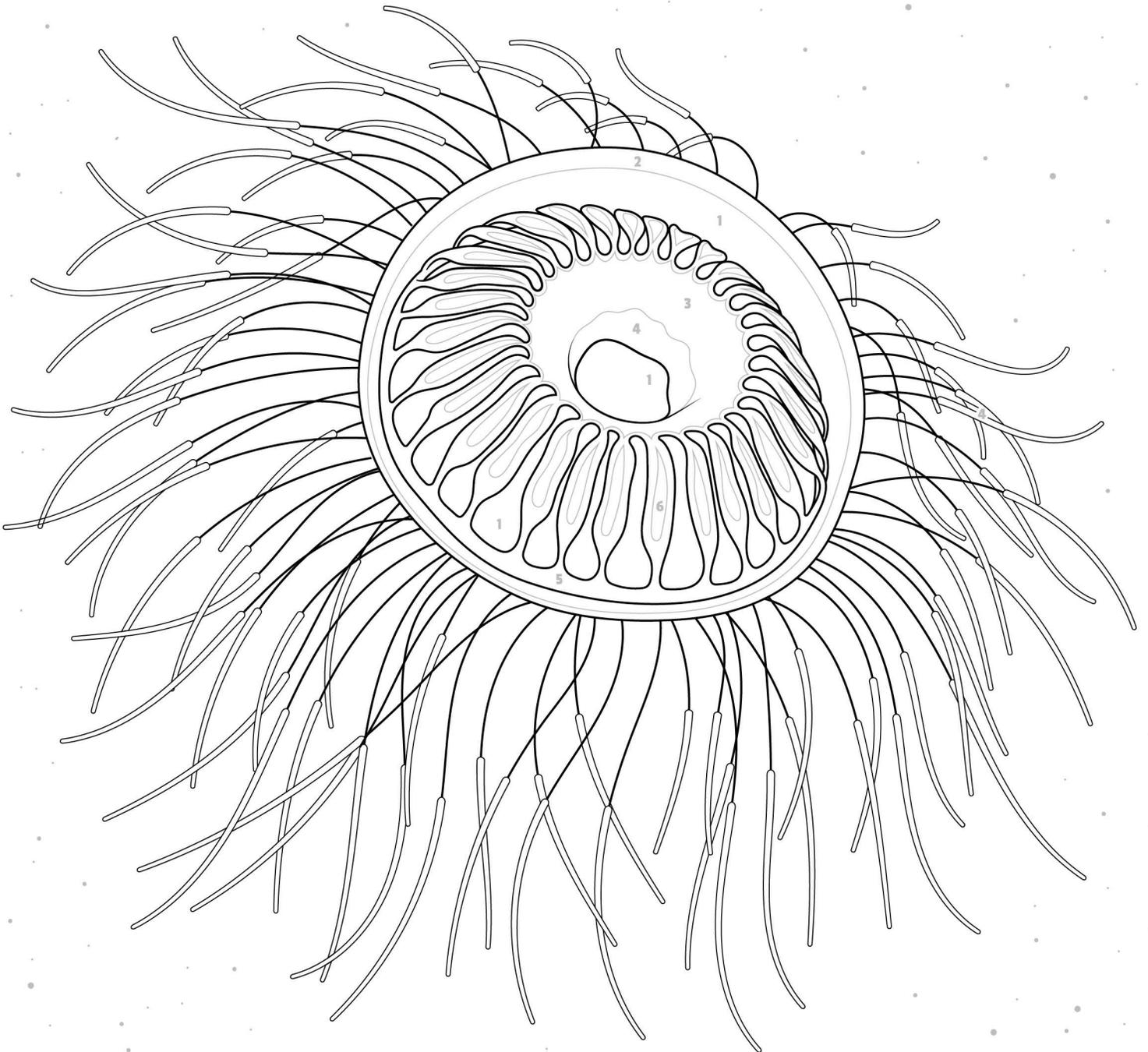
Wow! What an exciting dive with the \_\_\_\_\_<sup>① plural noun</sup> onboard E/V Nautilus. ROV Hercules and ROV Argus have just \_\_\_\_\_<sup>② past tense verb</sup> from the seafloor after \_\_\_\_\_<sup>③ number</sup> hours. The team is waiting \_\_\_\_\_<sup>④ adverb</sup> to see what's returned! All the samples must be removed from the sample boxes and taken into the lab to be examined.

The \_\_\_\_\_<sup>⑤ adjective</sup> Science Manager makes sure everyone is wearing \_\_\_\_\_<sup>⑥ item of clothing</sup> and gloves; safety first! As the bio boxes open, the first thing the team sees is a \_\_\_\_\_<sup>⑦ adjective</sup> rock and \_\_\_\_\_<sup>⑧ number</sup> types of animals, including \_\_\_\_\_<sup>⑨ type of sea creature</sup> and \_\_\_\_\_<sup>⑩ another type of sea creature</sup>.

The team works together to \_\_\_\_\_<sup>⑪ verb</sup> all of the samples into the lab where scientists take pictures, write \_\_\_\_\_<sup>⑫ adjective</sup> labels, and pack each sample for shipment when the ship gets back to shore. ROV Hercules has \_\_\_\_\_<sup>⑬ number</sup> different sample boxes. Working together with the team, sample processing can take a record \_\_\_\_\_<sup>⑭ number</sup> hours to finish! Thankfully the team has the music of \_\_\_\_\_<sup>⑮ musician</sup> and can take breaks for their favorite snack \_\_\_\_\_<sup>⑯ type of food</sup> to keep the energy up! Some of the samples will be kept at a Zoology Museum in \_\_\_\_\_<sup>⑰ U.S. state</sup> and the sand, sediment, and rock samples are shipped via \_\_\_\_\_<sup>⑱ type of transportation</sup> to the Marine Geology Lab in Rhode Island. Detailed research and discoveries will be made for years to come, leaving scientists curious and \_\_\_\_\_<sup>⑲ adjective</sup> for more deep sea exploration!

# Firework Jelly Color-By-Number

Select colors for your key, then follow the paint by number clues to create a bright firework jellyfish like the *Halitrephes maasi* spotted in the waters of Mexico more than 1,200 meters deep.



# Sampling Tool Matching Game

ROV *Hercules* has many tools to collect scientific samples from the seafloor. Some tools have very specific functions, but all work so samples are not damaged in the process. Since space can be limited aboard the ROV, some tools work for multiple situations. **Which of *Hercules*' tools is the best match for the samples below? Connect them with a line.**

**Slurp Suction Hose**



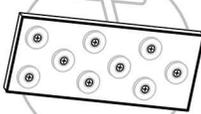
sucks up water, sediment, and small or delicate fauna

**Niskin Bottle**



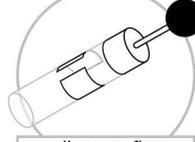
large cylinders for capturing water samples during a dive

**Magnet Board**



used to collect rare earth elements from sediment surface

**Push Core**



collects seafloor sediment while also preserving layers

**Scoop**



collects loose fauna or sediment off of the seafloor

**Manipulator Claw**

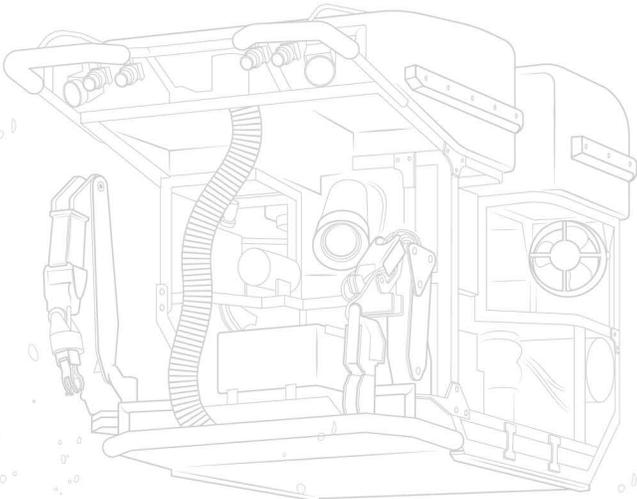


powerful jaws at the end of an arm, used for gripping

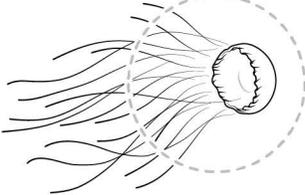
**Gas-Tight**



Samples gasses from sources like methane seeps



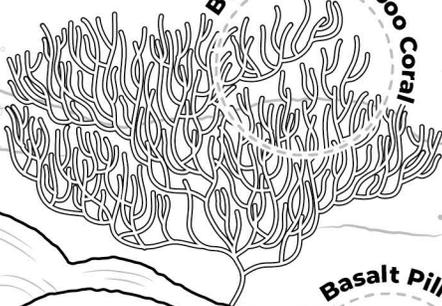
**Jellyfish**



**Methane Bubbles**



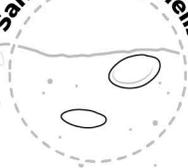
**Bendable Bamboo Coral**



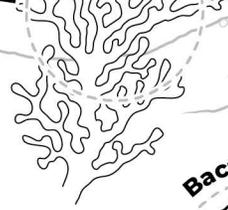
**Water**



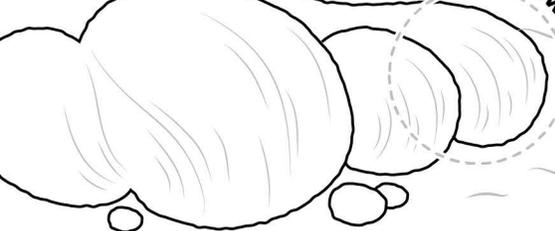
**Sand & Small Shells**



**Fragile Lophelia Coral**



**Basalt Pillow**



**Deep Muddy Sediment**



**Bacteria Mat**



# Sea Creature Word Search

Find all the animal words listed below! Words can be found in all directions.



E	B	S	J	E	B	A	J	G	A	K	E	P	A	D	U	Y	X
A	D	E	E	L	S	L	E	H	J	E	L	L	Y	F	I	S	H
V	E	A	L	X	A	C	L	O	K	E	D	A	Y	I	O	D	O
S	E	C	B	A	T	H	Y	M	O	D	I	O	L	U	S	G	P
E	P	E	A	F	I	S	H	J	E	S	O	B	O	N	P	A	T
A	S	R	R	E	T	S	A	N	U	B	H	T	A	R	V	P	U
R	E	A	S	H	A	R	P	R	A	N	M	C	I	V	U	U	B
O	A	L	H	P	H	S	H	A	R	K	A	K	P	B	R	C	E
A	C	K	A	R	P	H	A	V	E	W	O	S	Q	O	E	N	W
E	O	T	R	T	O	A	O	O	D	Q	P	L	W	P	B	B	E
S	R	H	O	D	A	I	Y	S	H	U	J	E	E	R	M	G	A
C	A	O	T	P	D	F	U	M	A	Z	A	A	O	S	U	A	T
A	L	R	U	G	U	T	L	L	I	O	I	W	I	Q	C	P	H
R	A	E	B	U	R	S	H	N	P	P	E	A	M	O	U	M	R
O	P	H	E	R	O	I	D	O	M	B	D	R	F	E	C	S	U
W	O	R	K	U	B	A	T	P	U	R	N	M	R	P	A	E	O
T	O	P	S	O	S	H	X	T	B	O	N	T	P	V	E	A	P
S	E	A	H	P	H	O	R	E	S	P	H	N	S	I	S	A	S

**Octopus:** a soft bodied, eight tentacled mollusc

**Deep Sea Coral:** not all corals need sunlight to survive. In the deep sea corals capture their own food as it floats by with polyps

**Tube Worm:** rifting tubeworms have a bright red plume to take in chemicals filled with hemoglobin, the same chemical that makes human blood cells red

**Jellyfish:** free swimming marine animals with umbrella shaped bodies and trailing tentacles

**Shark:** a type of fish related to skates and rays with a long body and cartilaginous skeleton

**Sea Cucumber:** holothurian sea cucumbers recycle food out of the sediments and seafloor mud

**Bathymodiolus:** mussels that thrive at hydrothermal chimneys

**Rathbunaster:** 20-armed sea stars found throughout the Pacific

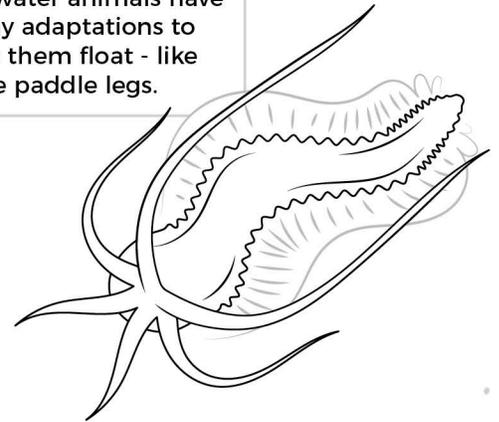
**Opheroid:** brittlestars which spend their lives perched on branches of a coral colony capturing marine snow

# Midwater Coloring Page

The water between the surface and seafloor – the midwater – is home to animals with many adaptations to find food, protection, and navigate the dark expanse. When exploring with ROVs, each dive begins and ends with a journey through the midwater where sunlight fades away on the way down.

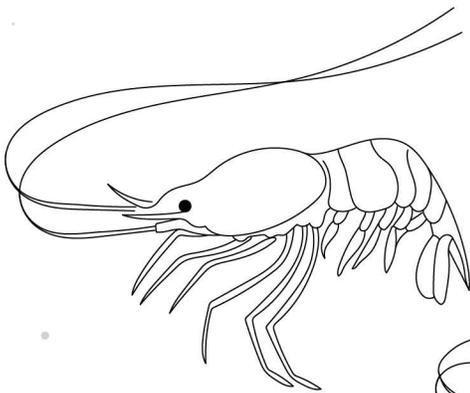
## Squid Worm

Midwater animals have many adaptations to help them float - like large paddle legs.



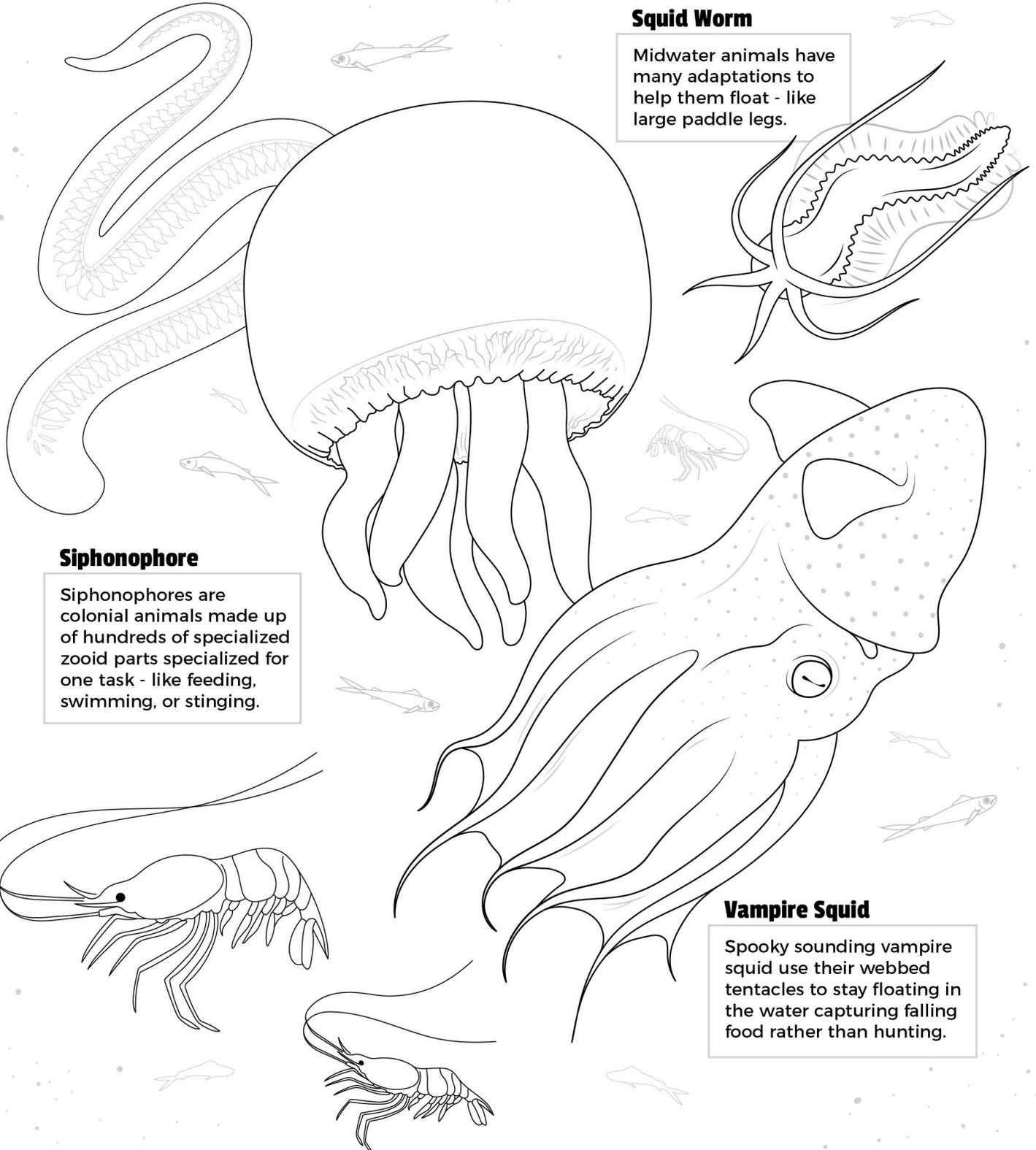
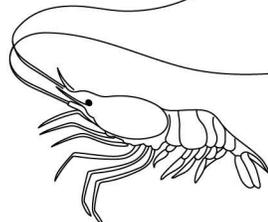
## Siphonophore

Siphonophores are colonial animals made up of hundreds of specialized zooid parts specialized for one task - like feeding, swimming, or stinging.



## Vampire Squid

Spooky sounding vampire squid use their webbed tentacles to stay floating in the water capturing falling food rather than hunting.



# Geology Word Search

Find all the geology words listed below! Words can be found in all directions.



**Basalt:** igneous rock formed from the rapid cooling of magma

**Trench:** a narrow depression in the seafloor formed where one tectonic plate sinks under another

**Pillow Lava:** pillow shaped lava structures, usually a spherical or tubular shape

**Hydrothermal Vent:** a fissure where superheated, chemically rich water rises from the seafloor building up chimneys near tectonic plates moving apart

**Seep:** an area on the ocean floor where hydrogen sulfide, methane, and other chemicals gurgles out of sediments

**Volcano:** usually located along mid-ocean ridges, underwater volcanoes account for up to 75% of the magma output on Earth

**Brine Pool:** super salty, or briny, water formed from salt deposits in Earth's crust that pools in depression on the seafloor

**Sediment:** naturally occurring material that is broken down over time. This material can be made up of pebbles, sand, decaying matter, organic material, and chemicals

**Seamount:** a mountain over 1000 meters tall rising from the seafloor but not breaking the surface

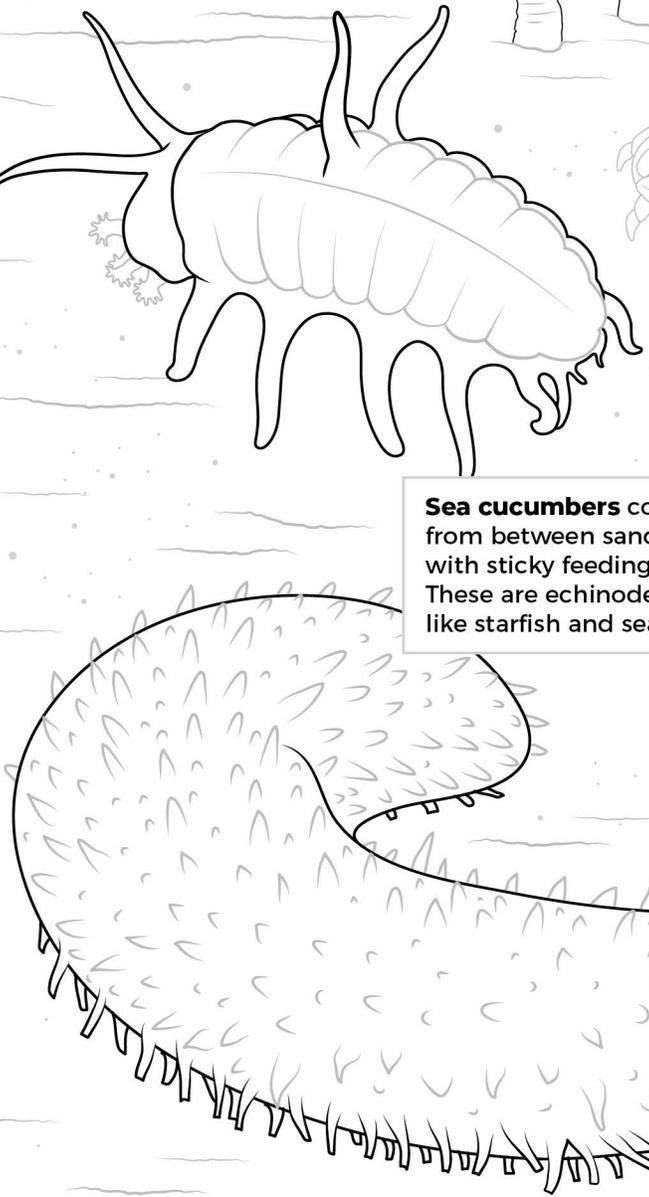


# Abyssal Plain Coloring Page

Covering more than 50% of the Earth's surface, the abyssal plain is the mostly flat, sediment-covered areas on the deep seafloor. These plains are typically located between 3,000 and 9,000 meters deep! Many animals here capture food floating down from above or recycle food found along the seafloor.



Because many creatures live in sediment - like these burrowing **Sipunculid worms** - the biodiversity of the abyssal plain can seem hidden.



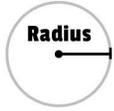
**Sea cucumbers** collect food from between sand grains with sticky feeding pads. These are echinoderms, just like starfish and sea urchins!



**Microbes** – single-celled organisms too small to be seen without high-powered microscopes – are the most abundant deep-sea organisms with more than a billion cells per milliliter of abyssal plain sediment!

# Guyots: Find the Area

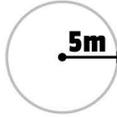
Find the area of the tops of these guyot. The area of a circle is the product of the radius squared ( $r^2$ ) and pi ( $\pi$ ). The radius is half of the diameter. A squared number is the number times itself.



$$\pi = 3.14$$

$$r^2 = r \times r$$

Example:



$$\text{Area} = \pi \times r^2$$

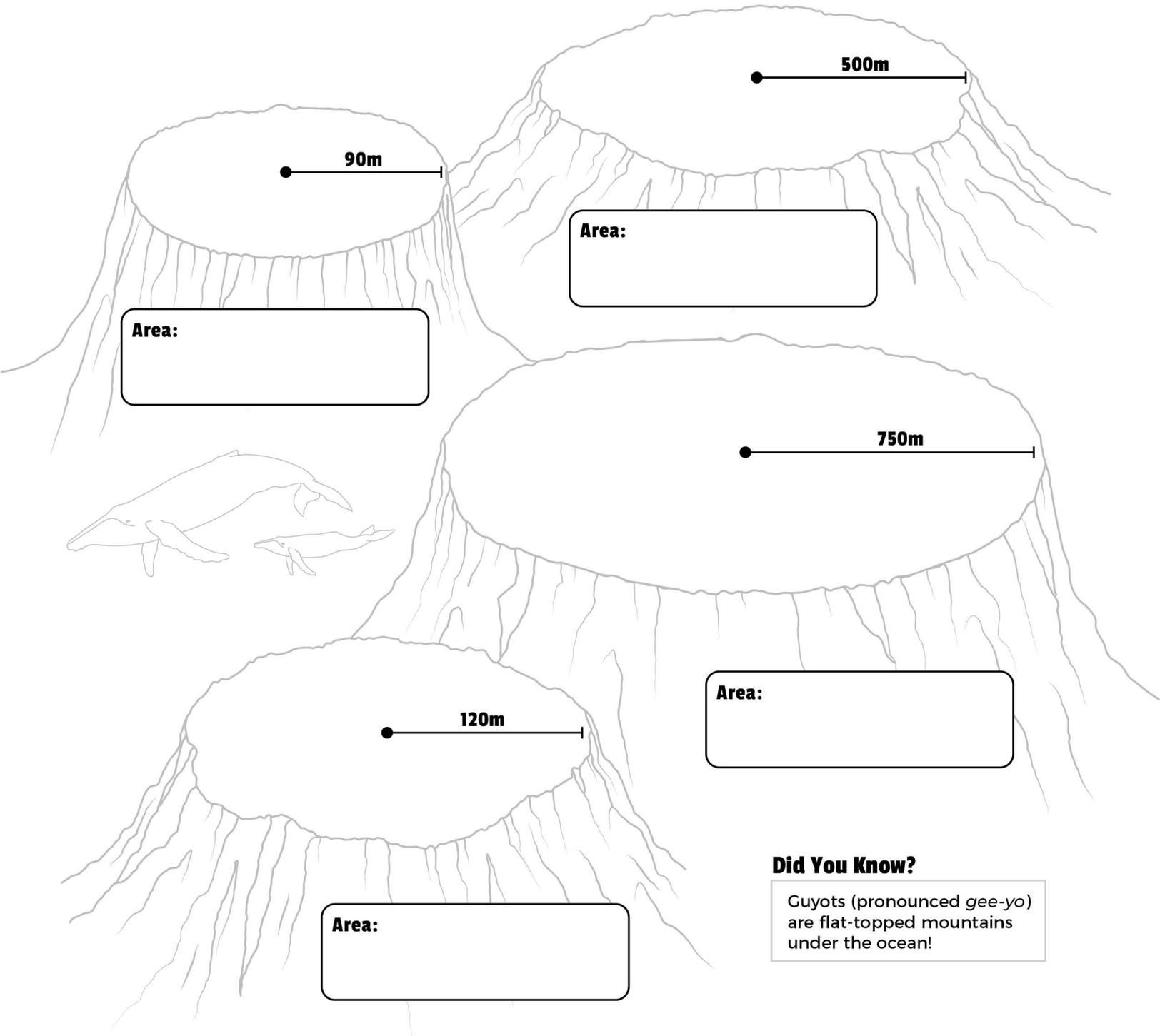
$$\text{Area} = \pi \times 5^2$$

$$\text{Area} = 3.14 \times (5 \times 5)$$

$$\text{Area} = 3.14 \times 25$$

Answer:

**78.5**  
meters<sup>2</sup>



Area:

Area:

Area:

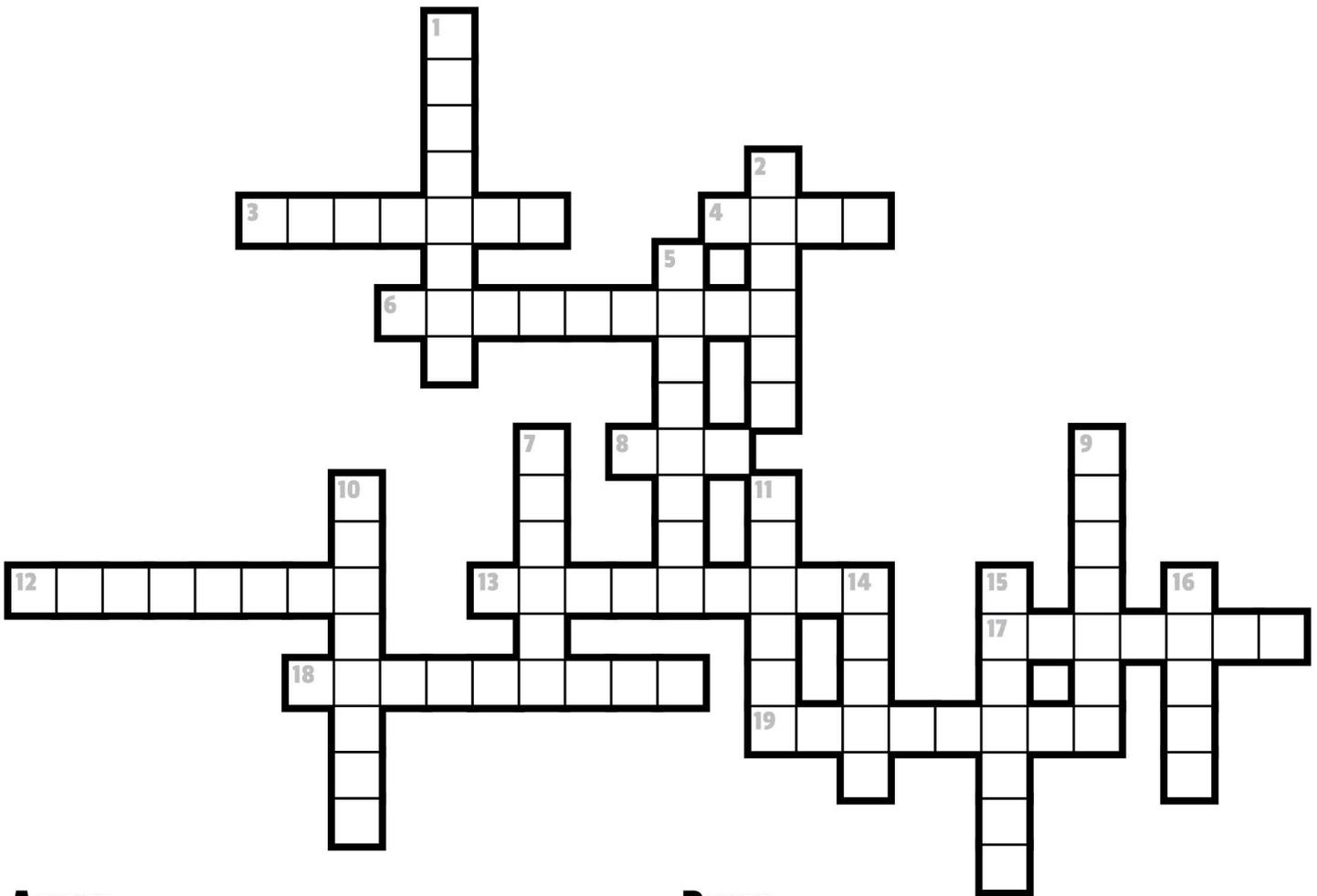
Area:

### Did You Know?

Guyots (pronounced gee-yo) are flat-topped mountains under the ocean!



# Ocean Exploration Crossword



## Across

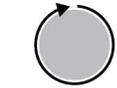
- 3** The most common gas found bubbling out of the seafloor at seeps
- 4** Team members who make sure the ship runs smoothly
- 6** Gelatinous organism often with long tentacles that sting to capture prey
- 8** Remotely Operated Vehicle
- 12** Tiny organisms that consume chemicals
- 13** What powers ROV *Hercules* through the water
- 17** Investigating something new
- 18** A type of brittle star which lives symbiotically wrapped around deep sea coral branches
- 19** Greco-Roman mythological hero known for his super strength

## Down

- 1** Water between the seafloor and ocean surface
- 2** Spiky round creatures that move around on the seafloor
- 5** Tiny single-celled organisms too small to be seen without high-powered microscopes
- 7** Cable connecting ROV *Hercules* and *Argus* to *E/V Nautilus*
- 9** Animal with 8 tentacles that has the ability to change color
- 10** An underwater mountain that does not reach the surface
- 11** Long, narrow depression in the seafloor
- 14** This type of fish has a cartilaginous skeleton
- 15** The scientific study of rocks, minerals, and sediments
- 16** Colonial animal that creates habitat for other animals and uses polyps to catch food

# Glass Sponges: Find the Circumference

Find the circumference of these glass sponges! The length through the middle of a circle is a diameter. The perimeter of a circle is called the circumference. To find the circumference of a circle, multiply the diameter by pi ( $\pi$ ).



Circumference

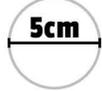


Diameter

$$\pi = 3.14$$

Pi

Example:



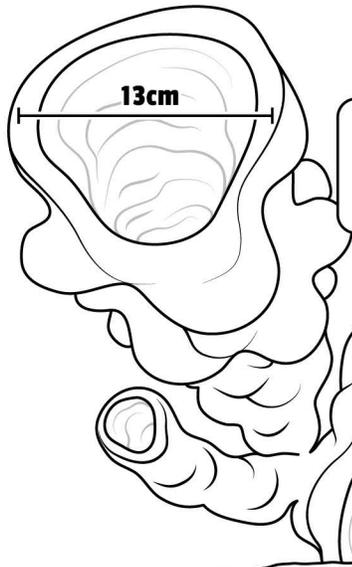
$$\text{Circumference} = \pi \times \text{Diameter}$$

$$\text{Circumference} = \pi \times 5$$

$$\text{Circumference} = 3.14 \times 5$$

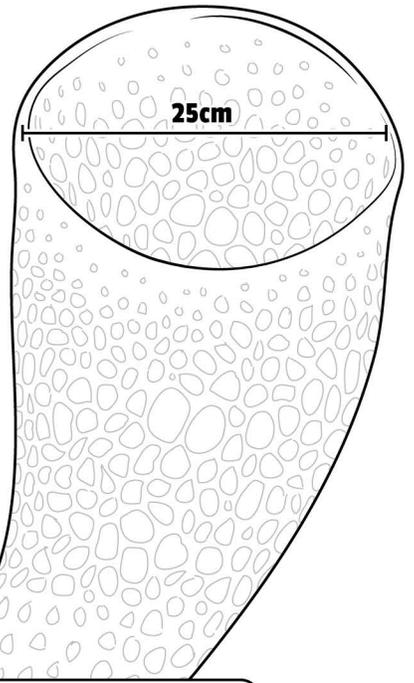
Answer:

**15.7**  
centimeters



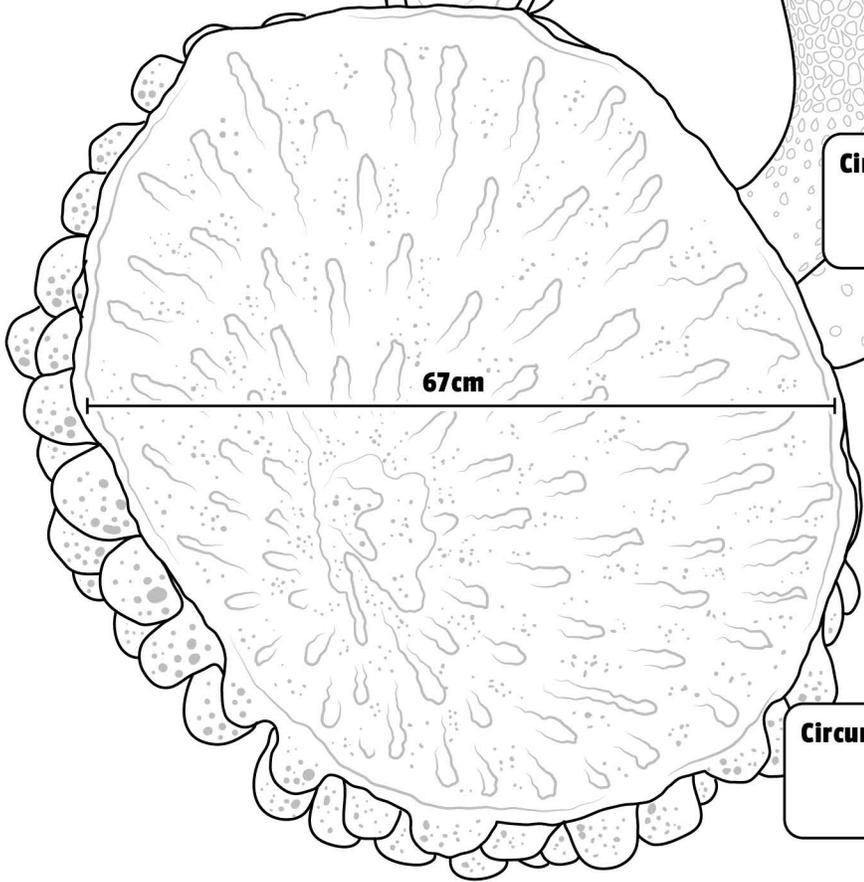
13cm

Circumference:



25cm

Circumference:



67cm

Circumference:

## Did You Know?

Although they look like intricate vases, glass sponges are serious colonial predators, filtering billions of gallons of water a day to capture their microscopic food.

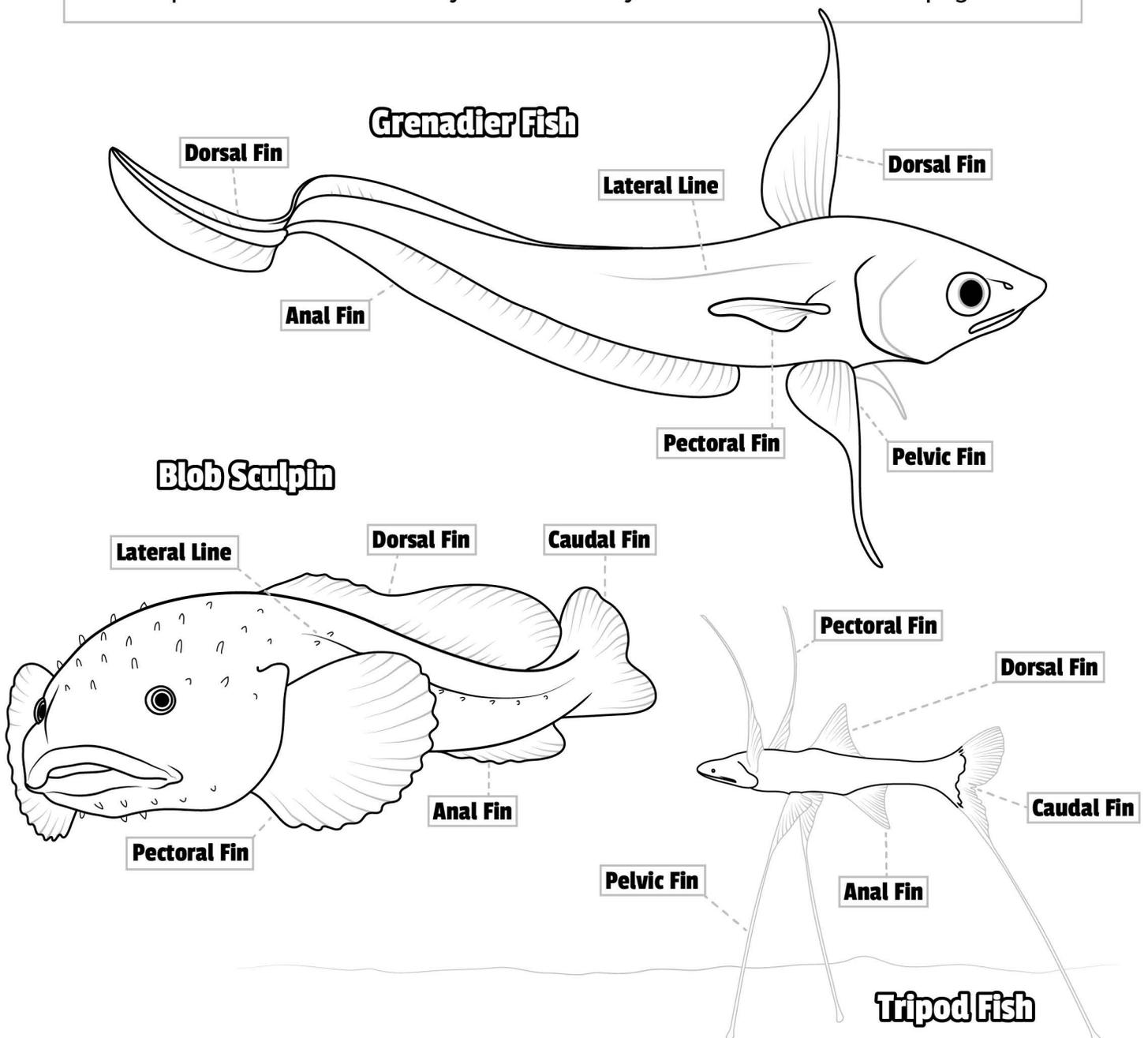
# Fish Anatomy & Adaptations

**Fins** evolve into many different shapes - small for maneuverability, large for fast speed, and even into points like stilts or lobes like suction cups.

**Body shapes** and **mouth parts** vary based on how fish find their food, like a flat body for low lying creatures, large mouths for large prey, and skinny bodies for creeping into small spaces.

**Colors** and **textures** of scales can help fish to camouflage, communicate like glow in the dark, or even attract other fish to them.

Below are some deep-sea fish with labeled anatomy. Study their parts and consider the adaptations listed above so you can create your own fish on the next page.



# Create-A-Fish

Draw a fish that lives close to the seafloor, eats smaller fish species, and needs to blend in with the sediment for protection. Label or describe what makes your fish a good match for the environment.

Draw a fish that lives in complete darkness, attracts its own food, and can swim really fast to get away from predators. Label or describe what makes your fish a good match for the environment.

Draw a fish that can eat food much larger than itself and disguise as another animal on the seafloor. Label or describe what makes your fish a good match for the environment.

# Design A Career Badge

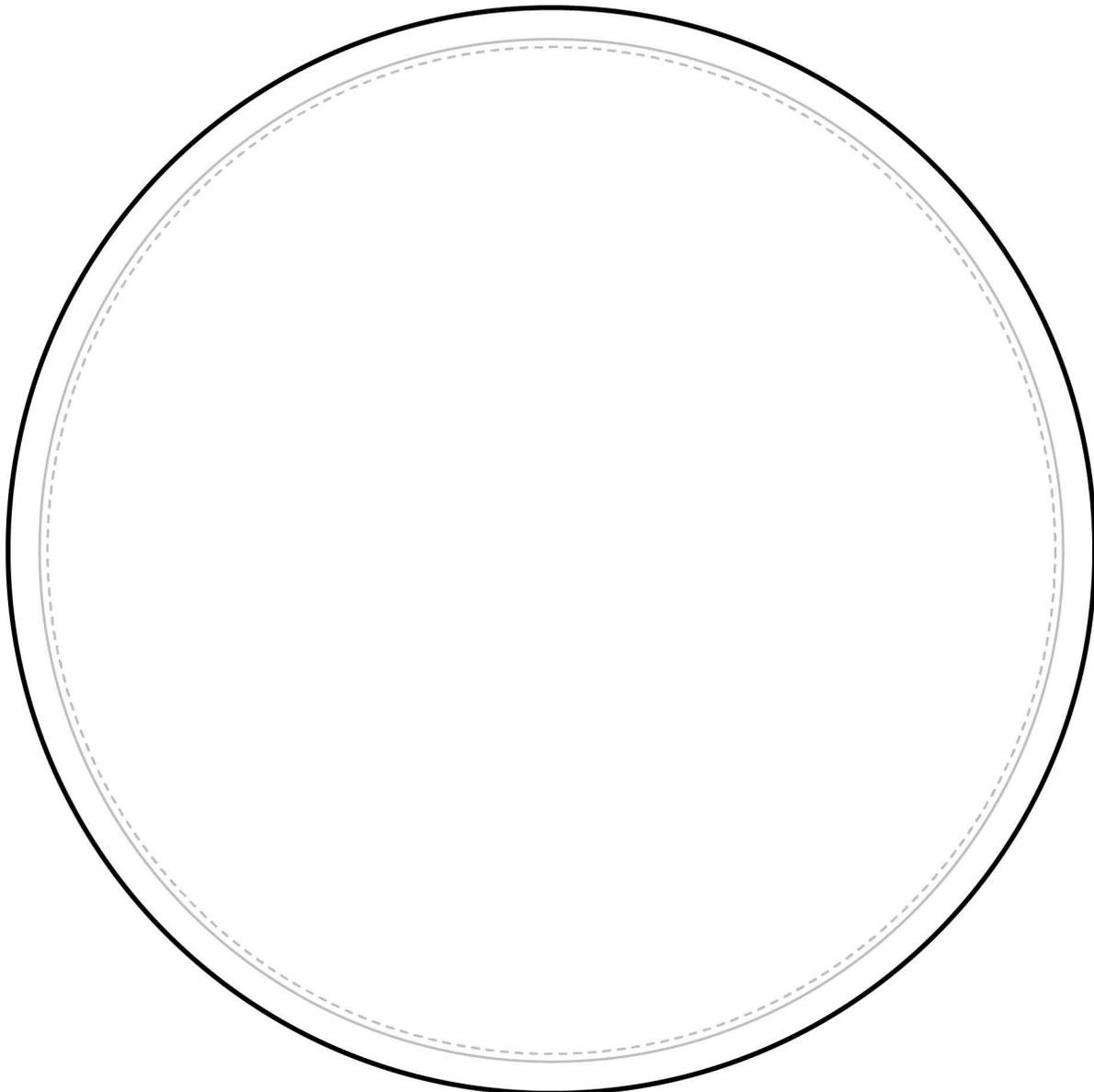
Draw, paint or design your own career patch showing the kinds of tools, skills or workplace you see in your future! Use your imagination or find inspiration from our team below to get started!

**Tools:** Hardhat, Computer, Video camera, Map, Crane, Blueprints, History Book, Wrench, Paints, Ruler, Forceps, Joystick, Drone

**Workplaces:** Stage, Classroom, Ship Bridge, Laboratory, Shipyard

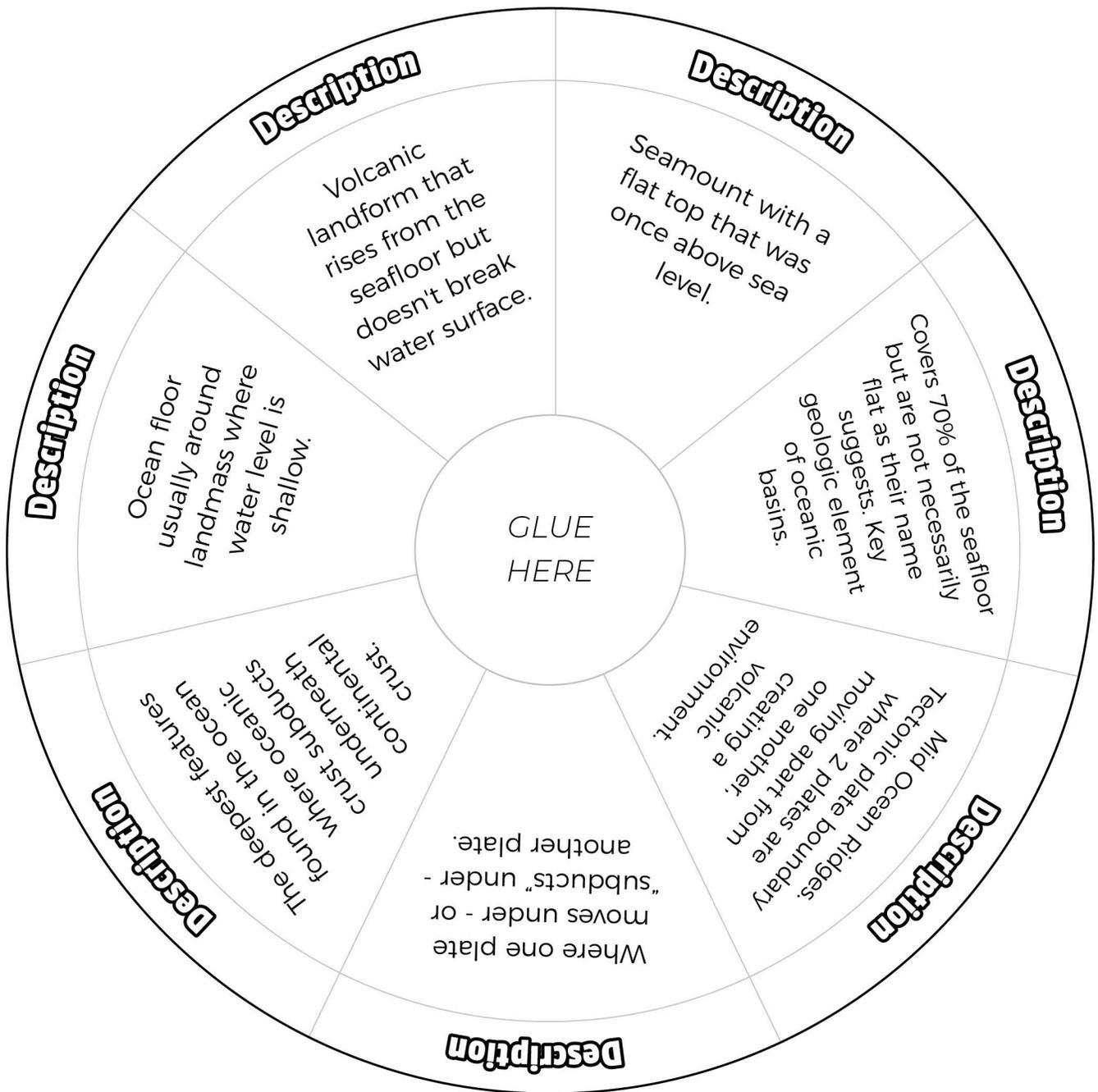
**Skills:** Teamwork, Communication, Social media, Coding, Mechanics, Good at puzzles, Writing, Drawing or Painting

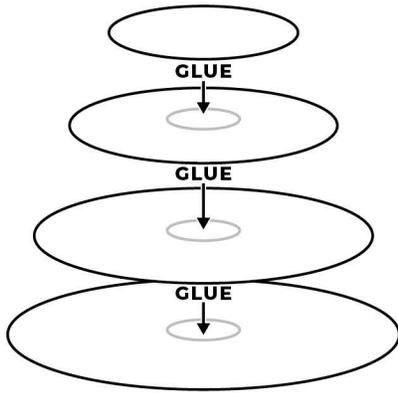
## My Future Career:



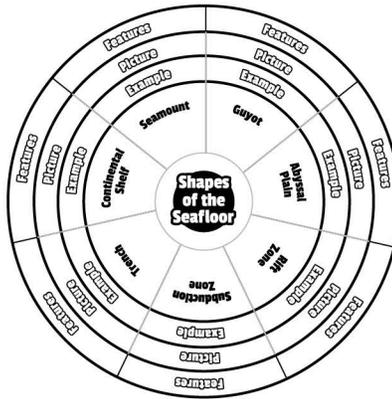
# Shapes of the Seafloor Foldable Wheel

Color and cut out the circles on these three pages. Cut the dotted lines between sections, except on the largest circle (shown below). Glue the wheels together by placing a dot of glue where it says *glue here*. Line up all circles with 'Glue Here' upright to make sure all sections are aligned correctly. The biggest circle will be on the bottom and the smallest circle will be on top. A visual guide is provided on the next page if you need help!

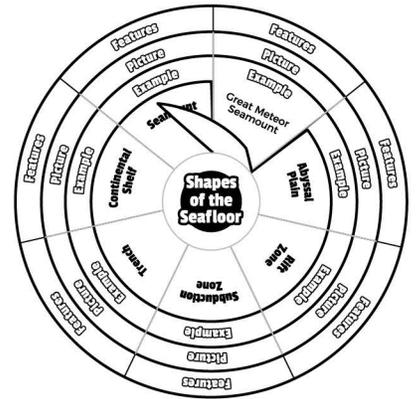




Glue together each circle as shown, from largest to smallest.

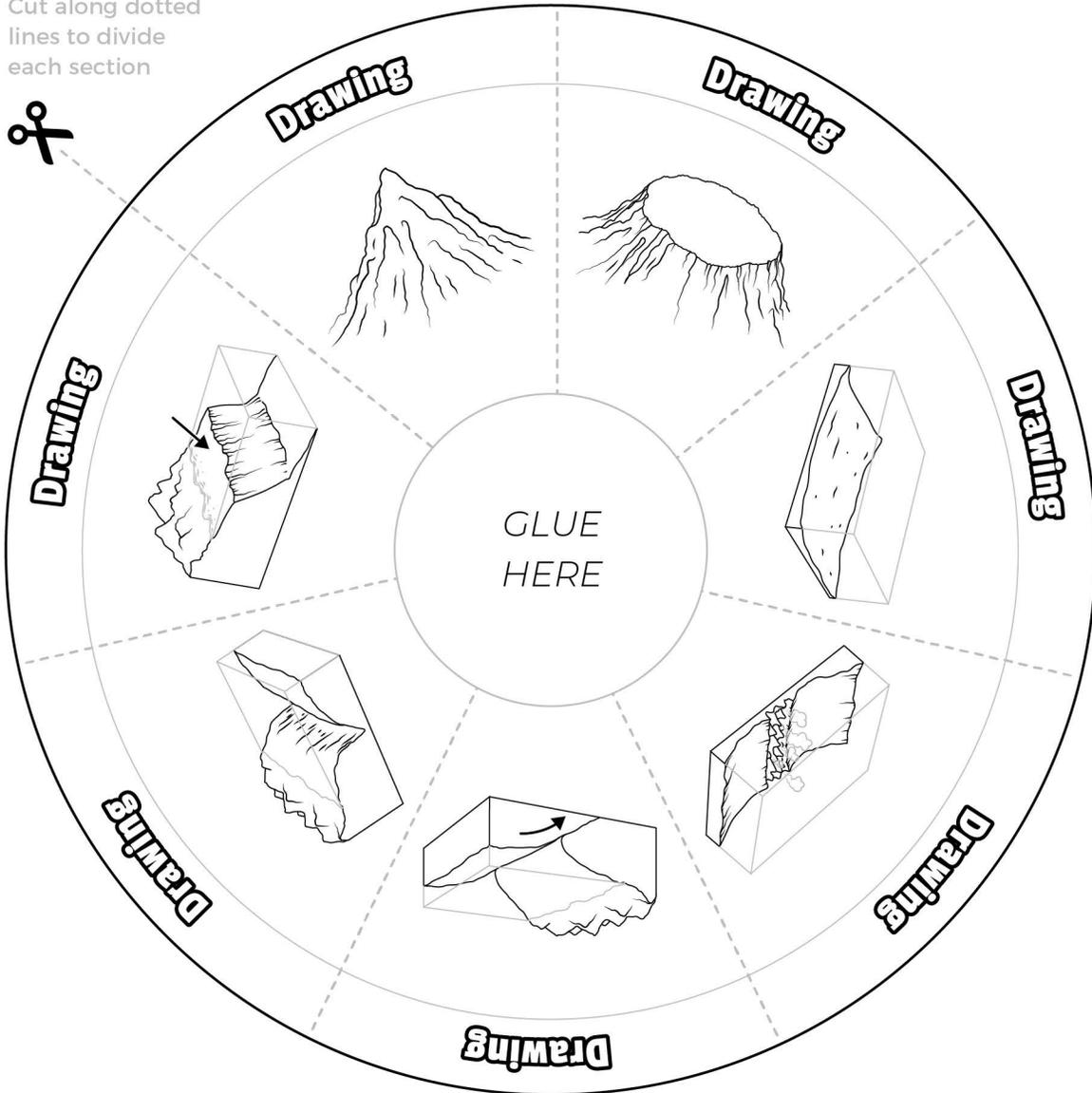


Your completed wheel will look like this once assembled.

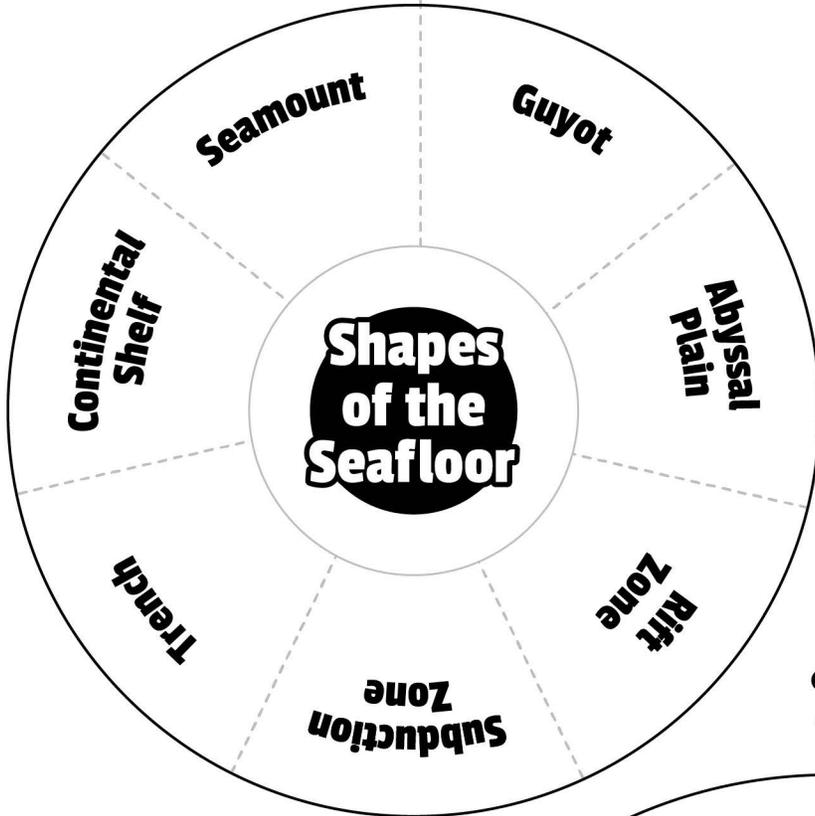


Quiz yourself! Flip over sections to reveal the examples, pictures, and features of each type of shape.

Cut along dotted lines to divide each section



Cut along dotted lines to divide each section



Cut along dotted lines to divide each section

