

# SeaKeepers Digital Lesson Plans

## Lesson 12: Pip Hare - The Deep Ocean



**This activity was created in partnership with Pip Hare Ocean Racing for educational engagement on virtual platforms.**

**Activity:** The Deep Ocean

### **Preface:**

Our oceans face many threats today, including climate change and pollution. In order to protect and preserve our oceans, we need to understand these threats and how the oceans respond to them. The International SeaKeepers Society supports marine research and education by connecting scientists with yacht owners, creating research opportunities for scientists to better understand our oceans – and to create plans to protect them.

Through partnering with Pip Hare Ocean Racing, this lesson aims to educate students on the deep ocean and what it takes to succeed in challenging conditions, focusing on the topic of resilience in an understudied environment. Students will investigate why we know so little about such an abundant habitat before designing their own deep ocean creature and discussing the adaptations that would enable it to survive in extreme environments. This lesson will introduce students to the mysterious deep ocean, giving them the opportunity to discuss why we know so little about it and challenge them to think about the importance of resilience in physically demanding conditions.

**Objectives:** Students participating in this lesson should see improvement in the following areas:

- Understand why the deep ocean is a challenging environment for organisms to survive in and why we know very little about it.
- Identify adaptations that enable organisms to survive in the deep ocean.
- Understand why it is important to be resilient in challenging conditions.

**Age Group:** Key Stage 3

**Estimated time:** 70+ minutes

### **Required Materials:**

Students do not need any background knowledge of deep ocean environments and ecosystems to take part in this lesson, but some knowledge of animal and plant adaptations would be useful. The information provided should provide enough background information to present this lesson, but you can use any resources available to you to teach the students.

For the main activity, students will need:

- Pencils/pens (for drawing the design)
- Paper
- Coloured pencils/pens (for decorating the design)

- Erasers (optional)
- Rulers (optional)
- Crafting materials (optional - if students wish to create their creatures)

### Lesson Breakdown:

- Introduction to Pip Hare and the deep ocean ecosystems and environment (20 minutes)
- Main Activity: Design a deep sea creature that is adapted to the deep ocean environment (30+ minutes depending on available time)
- Wrap up discussion (15 minutes)
- Clean up (5 minutes)

### Lesson Vocabulary:

- **Abyssal plain** - a large, level areas of the ocean floor, occurring at depths of more than 10,000 feet (3,000 metres) and covered with a thick layer of sediment.
- **Adaptation** - the evolutionary process whereby an organism becomes better able to live in its habitat or habitats.
- **Aphotic** - lacking light; especially not reached by sunlight.
- **Benthic** - anything associated with or occurring on the bottom of a body of water.
- **Bioluminescence** - the biochemical emission of light by living organisms such as glow-worms and deep-sea fish.
- **Chemosynthesis** - the process by which sugar is made by bacteria using chemicals as the energy source, rather than sunlight.
- **Demersal** - living close to the floor of the sea or a lake.
- **Hydrothermal vents** - an opening in the sea floor out of which heated mineral-rich water flows.
- **Pelagic** - relating to the open sea.
- **Photosynthesis** - the process by which green plants and some other organisms use sunlight to synthesise nutrients from carbon dioxide and water.
- **Resilience** - the capacity to withstand or to recover quickly from difficulties.

### Lesson Introduction/Overview:

#### Why is the deep ocean an extreme environment?

Beneath our ocean surface lies the challenging environment of the deep ocean, where much remains a mystery to us. As the ocean becomes deeper, sunlight dissipates until no light remains and the ocean becomes immersed in total darkness. Solar rays are also the predominant source of heat for the ocean, so as light decreases with depth, as does the water temperature. As such, almost all organisms that are able to survive at the ocean surface would not survive in the deep ocean, in particular those that are heavily reliant on sunlight for photosynthesis, such as phytoplankton. Photosynthesis is the process where specific organisms convert sunlight, water and carbon dioxide into oxygen and sugars, which in turn can be used as a source of energy. Phytoplankton represent the base of the surface-water marine food web, providing a source of energy for all organisms, from microscopic animals to blue whales. However, at depth, these organisms cannot survive and photosynthesis does not occur. As such, energy resources are almost always sparse.

Organisms that reside in the deep ocean must be highly resilient to survive in these harsh conditions, while also under the intense physical pressure of thousands of litres of water above. In particular, this physical pressure prevents humans from accessing this environment without assistance from a manned submersible, deep sampling tools or robotic vehicles. This equipment is expensive and as such, the deep ocean remains largely unexplored and the creatures that live within remain greatly understudied.

## **Why should we learn more about the deep ocean?**

Learning more about the deep ocean could provide humans with undisturbed resources and unknown knowledge that could support development of technologies in multiple different disciplines. For example, since 1969, 17 drugs have been developed using marine-derived resources, including bacteria, fungi and halophytes (salt-tolerant plants). Since different microorganisms live in the surface waters compared to the deep ocean, these populations have the potential to provide us with components that could be used to treat human and/or animal diseases. In contrast, the deep ocean floor is rich in minerals that are essential for the creation of many modern-day technologies, including mobile phones and laptops, while under the surface lie reserves of crude oil that can be refined and exploited as a fuel for transportation and heating systems. However, obtaining these products involves drilling into the ocean floor, where multiple unique species live. These organisms are particularly vulnerable as they lack the energy to rapidly move elsewhere. Increasing our knowledge of a) where these resources can actually be found, and b) where deep ocean habitats are most prolific, could help drilling operations target areas that are rich in crude oil without harming vulnerable ecosystems.

The deep ocean and the species living within have the untapped potential to provide multiple benefits to human populations, as so much remains unknown. Increasing our knowledge of this environment could be hugely beneficial for human civilisation both for current and future developments.

## **How do organisms survive in the deep ocean?**

The ocean is split into 5 zones, each classified by a specific depth range: epipelagic, mesopelagic, bathypelagic, abyssopelagic and hadal. The epipelagic zone represents the region at the ocean surface, where light penetrates fully and the most well-known organisms reside, including many sharks, whales and vibrant fish. Although this aspect of the ocean is highly accessible and therefore more researched, it represents very little of the entire ocean, as the remaining 4 zones collectively comprise the deep ocean.

The deep ocean supports a highly diverse array of marine life due to the large variety of habitats that exist within. For example, the Abyssal plains are a large area of mostly flat land that cover approximately 40-50% of the deep ocean floor. As light does not reach this dark expanse, life is limited to microorganisms, soft-bodied fish and crustaceans. However, a particularly distinctive adaptation of species within this habitat is bioluminescence. Bioluminescent creatures have the ability to create light within themselves that they can emit from different parts of their bodies. Organisms use this feature to both attract prey and deter predators, depending on their feeding preferences. For example, Anglerfish (like that seen in Finding Nemo) have a protrusion extending out from the spine of their dorsal fin that resembles a light bulb, which they use as a lure to attract other fish. In contrast, Brittle Stars use bioluminescence to deter predators by producing intense flashes to startle them, giving the star the ability to escape, or by using light to misinform predators that they are toxic.

As another example, hydrothermal vents are dotted across the global oceans and provide a highly nutritious habitat for multiple deep ocean species. These naturally-formed structures are found along tectonic plate boundaries and release large volumes of hot water and associated nutrients into the deep ocean environment. This input of nutrients enables unusual and often unique creatures to survive where they otherwise wouldn't. For example, specialised microscopic organisms called chemosynthetic bacteria rely on these nutrients and increased temperatures to create energy in a similar process to photosynthesis, and provide a source of food for larger organisms. Often referred to as the "Furry Lobster", Yeti Crabs are covered in bristles (setae) that help them collect these food sources and enhance their senses as they are fully blind. Whereas Giant Tube Worms are benthic (floor-dwelling) organisms that store chemosynthetic bacteria inside their bodies to keep themselves well fed. One species that doesn't rely on bacteria as a food source is the Vent Octopus, as it feeds on crabs and other small crustaceans. With unusually large quantities of suckers on their tentacles to increase their movement ability, semi-transparent white bodies to hide them from

predators, and a lack of ink sacs as camouflage is no longer required in their completely dark habitat, these octopi have evolved to successfully exploit the deep ocean environment.

The wide array of organisms that live within the deep ocean have successfully adapted to tolerate these extreme conditions. Shifts away from what might be considered “the norm” have enabled them to survive where others would not, maximising their success in a hostile world. Their resilience has allowed them to react, respond and continue to thrive, preventing the deep ocean from becoming a barren landscape. Resilience is required in many different situations to enable us to succeed where otherwise we might not. By better understanding deep ocean creatures, we provide ourselves with a unique perspective on the importance of being adaptable and resilient during difficult periods. Pip Hare relied on these skills during the Vendee Globe, where she was faced with many challenges while racing across the global oceans.

### **Pip Hare and Medallia**

Pip Hare is a global ocean racing yachtswoman who is only the 8th woman ever to finish the Vendee Globe; a non-stop solo race spanning approximately 24,000 nautical miles across the world. With a professional career of over 25 years, Pip has made sailing her life. Her passion, determination and hard work have enabled her to succeed where others might struggle. After racing through the world’s toughest environments and overcoming many challenges along the way, Pip uses her experiences and accomplishments to inspire others to aim high and strive to achieve their goals. Her story shows one of grit, determination and resilience beyond what some may say is humanly possible. Having achieved her life-time goal of completing the Vendee Globe at 46, and in a male dominated environment, Pip proves what is possible when you are determined, ambitious and resilient in the face of adversity.

When faced with unforeseen obstacles, Pip’s ability to adapt under pressure has allowed her to think clearly, find a solution and continue to achieve success. Her ability to cope in any scenario enables her to do things differently and hit targets that others wouldn’t even consider. This resilience provides her with the capacity to both withstand changeable weather conditions in the open ocean when aboard her vessel *Medallia*, and disregard the status quo to become an inspirational changemaker. Pip shows why it is important to think beyond the norm and be resilient in all walks of life, navigating the challenge of achieving your goals in order to become the best version of yourself.

### **What is resilience?**

Resilience is defined as “the capacity to withstand or to recover quickly from difficulties”. Resilience is required in many situations that people face, whether these be in their daily lives or during extreme challenges, like the Vendee Globe. In both, two forms of resilience are most commonly used: Mental and Physical.

Mental resilience refers to someone’s ability to cope with difficult events and situations, and how they recover from them. For example, trying to have a positive mindset can help to process a challenging circumstance. When Pip experienced obstacles during her many global ocean races, she relied on her mental resilience to keep her focused and allow her to succeed in her voyages.

Physical resilience focuses on someone or something’s ability to resist external physical pressures without becoming damaged or broken, and the subsequent ability to adapt to these challenges. For example, a creature residing within the deep ocean has to be able to resist physical pressure from the thousands of litres of water above, extremely cold temperatures and the lack of light at depth. These organisms have also had to adapt to find a way to survive and thrive in this hostile environment. Examples of these adaptations include reducing movement and slowing metabolic activity to limit heat loss and energy consumption, and becoming invisible to avoid detection by predators that have limited visibility due to the lack of light.

Creatures living in the deep ocean heavily rely on their physical resilience to survive on a daily basis. Without resilience, this habitat would be a barren landscape as no species would be able to live here. These creatures are an extreme example of the need for resilience in order to cope with challenging circumstances. They emphasise the importance of being able to adapt in both positive and negative scenarios, in order to create a more effective solution, in this case: survive. We can similarly use resilience to become better problem solvers in our daily lives, increasing our ability to be successful when faced with adversities.

### **Activity Instructions:**

#### **Introduction:**

1. Present the introduction and attached images to the students to provide them with background information about Pip Hare and the deep ocean environment, focusing on the adaptations of those organisms that live within and the importance of resilience.
2. Check understanding of the deep ocean environment, adaptations and resilience by asking the questions:
  - a. Why is it so difficult for humans to access the deep ocean?
  - b. If it's so difficult to access, how do we know anything about the deep ocean?
  - c. Do the organisms in the deep ocean face the same challenges as we do at the surface?

#### **Main Activity:**

3. Provide each student with sufficient materials and direct them to design their own deep sea creature. They should think about how it has adapted to survive in the deep ocean environment, considering questions such as:
  - a. Is the creature a plant or animal?
  - b. Where does the creature live?
  - c. What does the creature look like?
  - d. How big or small is the creature?
  - e. How will the creature breathe, move and eat with these new adaptations?
4. After the allotted activity time, bring the group back together.
5. Students take turns to present their creature to the class and describe the adaptations that would enable their creature to survive in the deep ocean environment.
6. The aim of this part of the lesson is for students to consider why it is important for organisms to be well adapted to their specific environment, and how all organisms need to be resilient to survive in challenging conditions.
7. End by highlighting how the students have all created very different creatures, yet all of them have adaptations that would enable them to survive in the deep ocean environment. Finish with the wrap-up discussion.

#### **Wrap up Discussion:**

At the end of the session, have the students turn to the person next to them and discuss what they think is the main challenge that prevents humans from accessing the deep ocean. Ask the students to present their answers and why. Then ask the students to return to their partner and discuss whether a creature living in the deep ocean would face that challenge. Again, ask the students to present their answers. Finally ask the students: How can they survive in the deep ocean when we can't? Their answers should highlight the importance of adaptations, which the educator can then relate back to the examples given in the lesson introduction.

Finish the discussion by asking questions about how both people and deep ocean organisms need to be resilient to survive the challenges they face:

- Why is it important to be resilient when faced with extreme challenges?
- How can resilience help people and organisms survive in tough environments?
- How can resilience help people to achieve their goals?
  - If the students are struggling with these questions, focus their thoughts by highlighting Pip Hare's experiences, using the questions:
    - How important was resilience to Pip Hare's success in ocean-wide races?
    - Without resilience, do you think she would've been as successful?
    - Why?

For more information, here are some useful websites:

Pip Hare:

- <https://www.piphare.com/>
- <https://www.vendeeglobe.org/en>

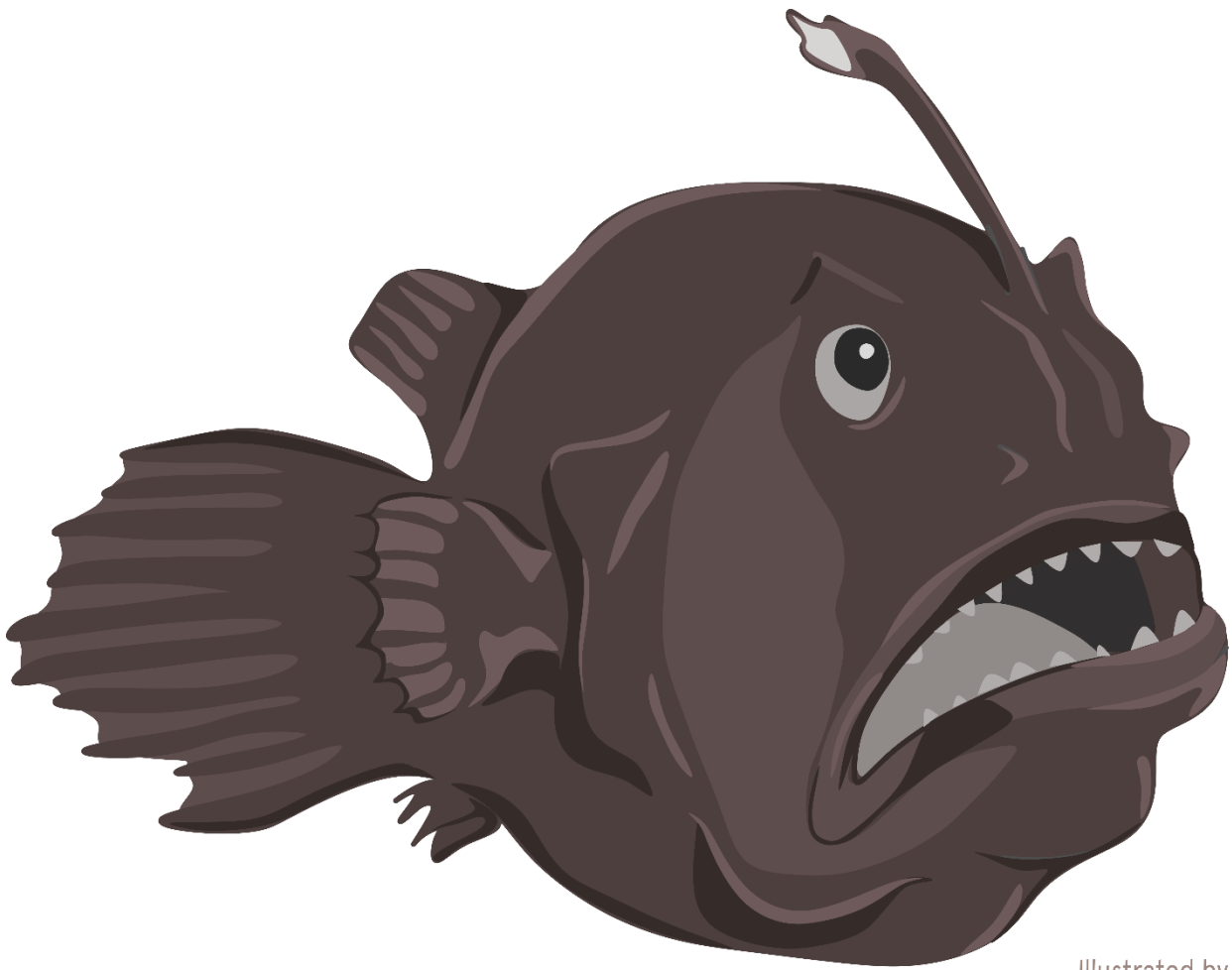
Deep Oceans:

- <https://ocean.si.edu/ecosystems/deep-sea/deep-sea>
- <https://www.marinebio.org/oceans/deep-sea/>
- <https://letstalkscience.ca/educational-resources/backgrounders/life-in-deep-sea>
- <https://www.montereybayaquarium.org/stories/deep-sea-animal-adaptations>

Resilience:

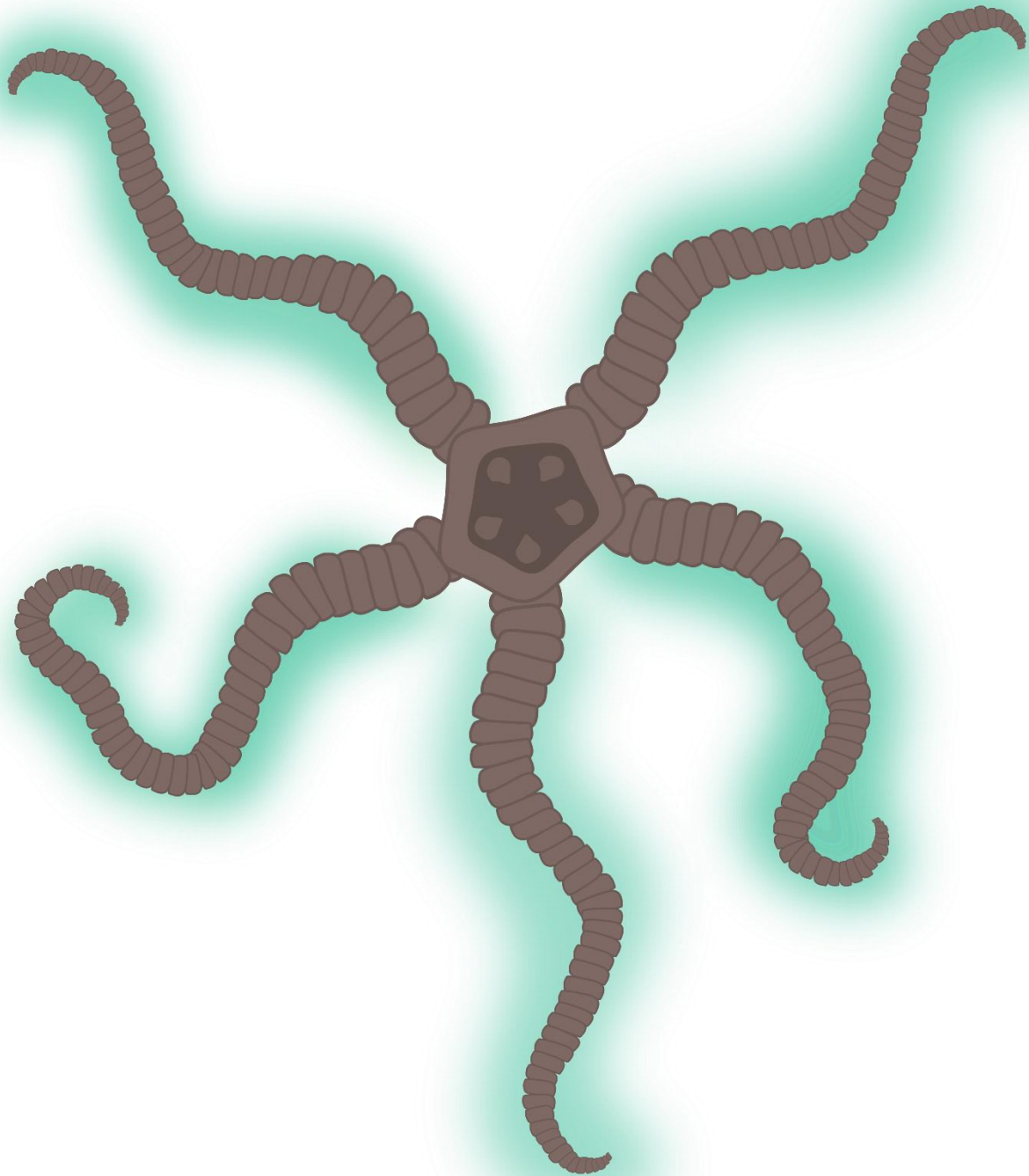
- <https://www.mind.org.uk/information-support/types-of-mental-health-problems/stress/managing-stress-and-building-resilience/>
- <https://www.redcross.org.uk/get-help/get-help-with-loneliness/wellbeing-support/resilience-building-activities>

**Media:**



Illustrated by Georgia Wells

**Anglerfish**



Illustrated by Georgia Wells

**Brittle Star (surrounded by bioluminescence)**





**Yeti Crab**

Illustrated by Georgia Wells



Illustrated by Georgia Wells

**Tube Worms**



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