Exploring the deep sea
Lesson 1: Invertebrate adaptations for the deep sea

In this lesson, students will

1. Learn about diversity and adaptations in deep-sea organisms
2. View deep-sea video footage from Canadian oceans and recognize adaptations in unfamiliar animals

This lesson contains
-Lesson plan
-2 exercises

Extra supplies needed
Computer with internet to view videos and websites. Exercise 1 can also be done with an Invertebrate Biology textbook

Background knowledge
Basic invertebrate biology

Vocabulary
Deep sea
Photosynthesis
Photic/aphotic/twilight
Food web
Phyto/zooplankton
Marine snow
Sessile/motile
Suspension feeder
Detritus/detritivore
Predator/scavenger
Hydrothermal vents
Symbiotic bacteria
Camouflage
Bioluminescence
Counter-illumination
Pelagic/benthic
Abyssal plains
Biogenic habitats

A world without light

Organisms living in the **deep sea** (deeper than about 200 m) live in a much different environment than organisms from shallow, coastal waters. Sunlight can easily penetrate the subtidal zone**,** making the parts of the ocean down to about 200 m a good habitat for organisms that use **photosynthesis**, like kelp, phytoplankton, and corals with symbiotic algae. The top part of the ocean where light can reach is called the **photic zone.**

There are no plants outside the photic zone. The segment between about 200 m to 1000 m is called the disphotic or **twilight zone**, where only very small amounts of blue and green light can reach down. Sunlight cannot reach deeper than about 1000 m, making this part of the ocean totally dark (**aphotic**).

➔ Read more about the deep sea at http://marinebio.org/oceans/deep/ (Be sure to scroll down for lots of information)

Sources of food

Photosynthetic organisms are at the base of **food webs** in marine ecosystems, just like on land. In the photic zone, tiny photosynthetic **phytoplankton** are abundant and provide food for small **zooplankton,** which are eaten by small carnivores like fish, which are eaten by larger carnivores like sharks. Phytoplankton cannot live in the aphotic deep sea. However, when surface-dwelling phytoplankton die, they slowly drift down to the bottom of the ocean and provide energy for deep-sea animals. Dead animals, from zooplankton to whales, also eventually sink to the bottom of the ocean. These food falls can be an important food source for benthic organisms. The rain of dead organic material from the surface is called **marine snow.**

Many **sessile** (non-moving) deep-sea animals like corals and sponges are **filter** or **suspension feeders** that use fan-like structures to capture marine snow from the water. **Motile** (moving) animals may eat **detritus** from the sediment (**detritivores**) or hunt live prey (**predators**). Because food is scarce in the deep sea, many animals are **scavengers** that eat anything, dead or alive, that they can find.

Hydrothermal vents and methane seeps are special deep-sea habitats where animals use **symbiotic bacteria** to convert toxic chemicals like sulphur and methane into usable energy. Unlike most ecosystems on earth that depend on the sun for energy, vents and seeps are **chemosynthetic,** meaning they get their energy from the chemicals.

➔ Read more about hydrothermal vents at http://www.divediscover.whoi.edu/vents/

Avoiding predators

Camouflage is an important way that organisms use to hide from predators. Octopuses are specialists at camouflage and can actively change their color, shape, and texture to blend in with any kind of surrounding. Many pelagic invertebrates (those that live in the open ocean) are transparent. Most animals that use camouflage can't change their color, but are specialized for certain habitats.

In the deep sea, there is no red light because it gets absorbed at the surface of the ocean. Many deep-sea animals take advantage of this and are colored red or purple as a type of camouflage**.** Because there is no red light present for their bodies to reflect, they are almost invisible.

➔ To see examples of deep-sea camouflage, watch http://youtu.be/lXRaaHxshWg

(Remember that in any pictures or videos from the deep sea, the animals are visible to us because of the bright lights from the underwater cameras)

Bioluminescence

Many different deep-sea organisms are **bioluminescent,** meaning they are able to produce light from chemicals stored inside their bodies. Some animals contain symbiotic bacteria to produce light, while others are able to do it themselves. Animals that can produce their own light include some crustaceans, jellyfish, squid, echinoderms, worms, corals, and fish.

Bioluminescent light can help predators hunt, either by luring prey towards them or by using their light as headlights to make prey visible. Species-specific light displays can help animals find mates. Bioluminescence can also help defend against predators. Some species of shrimp can release clouds of bioluminescent light into the water to distract predators. Other animals, like some jellyfish, flash their lights brightly when they are attacked, making a kind of "burglar alarm" that can attract bigger predators that will attack the first attacker.

Some bioluminescent organisms that live in the twilight zone use a kind of camouflage called **counter-illumination**. Because there is a small amount of light in this zone, swimming animals cast a shadow when seen from below. Some fish, crustaceans, and squid have lights on the bottom of their bodies that cancel out this shadow to hide them from predators below.

➔ Read more about bioluminescence at http://www.lifesci.ucsb.edu/~biolum/

Habitat

There are several types of habitat in the deep sea. Organisms that live in the open ocean are called **pelagic,** while those that live on the sea floor are called **benthic.** Most of the sea floor is part of the **abyssal plains,** which are vast areas with soft sediment (mud and silt) bottoms. Some areas of the ocean have hard, rocky structures like cliffs, seamounts, boulders, and gravel.

Many organisms are specialized for a certain type of substrate. Sessile organisms like many corals and sponges need rocky substrate to anchor to, but others, like sea pens, are specialized to live on soft substrates. Some motile organisms like sea star, sea cucumbers, and crustaceans burrow in soft sediment to find food, while others will crawl around on harder substrates.

Some organisms like corals and sponges are called **biogenic habitats** because they themselves are habitats for other organisms**.** The best-known example of biogenic habitats are tropical coral reefs, where many corals grow together to provide shelter for a wide diversity of fish and invertebrates. In the deep sea, cold-water corals and sponges have a similar function. Because the ocean is vast and primarily soft-bottomed, there are few places for animals to hide from predators. Corals and sponges act like cities in the deep sea, giving places for many other animals to live, feed, and hide. Many filter-feeding animals (like basket stars and sea anemones) will attach themselves to the tall parts of corals to catch food, and animals like fish and crabs seek shelter underneath their branches.

➔ Read more about biogenic habitats at http://www.gulfofmaine.org/habitatprimer/biogenichabitats.pdf

In the following two exercises, you will watch videos from the deep sea. When watching these videos, think about the adaptations of the invertebrates you see. Where are they living? What do they eat? How are they avoiding predators? Can they move?

Exercise 1: Deep-sea invertebrate profiles INSTRUCTIONS

Pick **two** invertebrates from this list, or choose your own. Answer the questions below for your species.

Crab	Shrimp	Deep-sea coral		Sea spider	Sea star
Jellyfish	Octopus	Sponge	Snail	Sea anemone	Sea cucumber (sea pig)

Use the following websites, or use the resources your teacher provides.

http://www.montereyinstitute.org/noaa/

- Lesson 3: Deep-sea corals
- Lesson 6: Deep-sea benthos
- Lesson 15: Seamounts as habitats for invertebrates

http://www.youtube.com/user/MBARIvideo

- Hide and seek in the deep (http://youtu.be/lXRaaHxshWg)
- Challenges of the deep (http://youtu.be/IeXUuhLGBCQ)
- Do the locomotion in the deep (http://youtu.be/gtj_JSlKXgY)
- Coral-devouring sea stars (http://youtu.be/OxuGalZUeYY)
- Feast in the deep (http://youtu.be/rdI3eFrTGs8)

Exercise 1: Deep-sea invertebrate profiles **Your name_____**

Name of deep-sea invertebrate #1 _____

Is this animal sessile or motile? If it moves, how does it move?

Describe its habitat (benthic, pelagic, mud, rock).

How does it use camouflage? If it doesn't, how does it avoid predators?

What kind of food does it eat? How does it catch food?

What else is interesting about this animal?

Exercise 1: Deep-sea invertebrate profiles **Your name_____**

Name of deep-sea invertebrate #2 _____

Is this animal sessile or motile? If it moves, how does it move?

Describe its habitat (benthic, pelagic, mud, rock).

How does it use camouflage? If it doesn't, how does it avoid predators?

What kind of food does it eat? How does it catch food?

What else is interesting about this animal?

Exercise 2: Recognizing adaptations in unfamiliar animals
Watch the video clips of deep-sea remotely operated vehicles from
Newfoundland (http://youtu.be/pbGAMe0DfR0) **OR** British Columbia (http://youtu.be/d5Ya_2NauPs)

As you watch, pause the video and look closely at the animals. Do you recognize any of the animals? What adaptations to deep-sea life can you see? This can include **feeding, habitat, movement, defenses, coloration, camouflage, or anything else.**

In the following table, list as many adaptations as you can for the invertebrates in the video. If you don't know what the animal is, describe it and write down the time in the video you saw it. There are two examples to get you started.

Time	Animal or description	Possible adaptations
3:51 (Newfoundland)	Tall fuzzy yellow thing	Has many branches- could be used for feeding?
1:56 (British Columbia)	Sea star	Lots of starfish on the mud. Do they eat things that live in the mud? They're also red, like the corals. This could be camouflage.