Science Unit: Marine Biodiversity: Global Ocean to the Salish Sea
Lesson #1 Adaptation Card Game

Summary:	Students will attempt to match marine creatures to their habitats based on the adaptations that are listed and the habitat characteristics.
Lesson type:	Matching paper lab
Grade level:	Presented to grade 3; appropriate for grades 2 – 10 with age appropriate modifications
Duration of lesson:	75 min
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Developed for:	Lord Kitchener Elementary
School Year:	*2016-2017*

Connections to BC Curriculum

Living things are diverse, can be grouped, and interact in their ecosystems, demonstrate curiosity about the natural world, make predictions based on prior knowledge

Objectives

Students will learn about the conditions for life in various ocean biomes on earth and attempt to match organisms to these biomes based on their listed adaptations.

Materials

- Print sets of ocean biomes cards, one set per student group
- Print sets of marine creatures, one set per student group

Background Information for the Teacher

While there is only one global ocean, the conditions throughout the ocean basins can vary dramatically. Water properties, such as temperature, salinity, dissolved oxygen, pressure, nutrient availability, and light (among others), all encourage organisms to develop specific adaptations to their local habitat. Some organisms may be more cosmopolitan and are well adapted to wide ranges of conditions, while others may be so highly specialized that they fill a niche only located in a region as small as an island.

This lesson encourages students to examine conditions in six ocean biomes (polar, coastal, tropical, open, deep, and benthic) and the adaptations that selected organisms have to those environments as a way to explore marine biodiversity. Some of the most common ocean adaptations that are addressed include: strength in numbers, broadcast spawning, bioluminescence, camouflage (and counter-shading), and venoms.

While the cards should have enough information about the different biomes and organisms to enable students to draw the connections, if you would like to speak more about the individual organisms, read about their life histories and more by searching the internet for their common or Latin names.

Vocabulary

- **Habitat** – the natural home or environment of an animal, plant, or other organism
- **Adaptation** – a change or the process of change by which an organism or species becomes better suited to its environment
- **Pressure** – the force exerted on an organism by the mass of ocean above it. For every 10 m deeper in the ocean, the pressure increases by 1 atmosphere, the unit of pressure based on the pressure exerted at sea level by all the air between sea level and space. The average depth of the ocean is around 4000 m deep where pressures would be around 400 atmospheres!
- **Temperature** – Since water is denser than air, it has a much higher heat capacity and therefore changes to the temperatures in different habitats occur much more slowly and over a much narrower temperature range than in the atmosphere. Students can be led through an inquiry exploration of marine sea surface temperatures by looking at world map and thinking about where it is colder on the planet and where it is warmer. These land temperatures also apply to the ocean.
- **Salinity** – The salinity of the ocean is a measure of how many free ions are present in the seawater and changes globally based on the local and regional amounts of evaporation and precipitation. Students can be led through an inquiry exploration of marine sea surface salinity by looking at a true color satellite image of the world and thinking about where the land surface is green, these are places with more precipitation than evaporation and the ocean will reflect this with lower salinity. Where the land surface is brown (deserts), evaporation dominates precipitation and the ocean reflects this with higher salinity.
- **Oxygen** – Oxygen dissolves in seawater through wind driven mixing. While this happens globally, except where sea ice covers the surface, oxygen only gets into the deep ocean at select subpolar locations where the conditions are right for deep mixing events in the wintertime. If you are interested in learning more about this process, search for “thermohaline circulation” or “ocean conveyor belt.” A large low oxygen environment exists below the depth where light allows photosynthesis to occur and respiration dominates. Most of the deep ocean is oxygenated thanks to deep ocean circulation and low rates of respiration.
- **Nutrients** – the basic chemicals that marine organisms need to survive. While abundant in the deep ocean, large areas of the surface open ocean are lacking in micronutrients that are necessary for phytoplankton to grow and thrive. Nutrients also go through a seasonal cycle which can be different depending on the latitude similar to nutrient availability in soils.
- **Light** – Due to scattering, sunlight does not penetrate far into seawater. Different colours penetrate to different depths which can lead to opportunities for camouflage and limitations photosynthetic organisms.

Classroom Set-up

- Arrange students into groups of 2-4 at their desks

Lesson Detail

Introduction

The global ocean has different biomes based largely on: temperature, salinity, pressure, dissolved oxygen content, nutrients, light, substrate, and current speed. These different factors create countless niches for life to take advantage of and to adapt. By this age, students know that the sun creates warmth and that a lack of sun makes temperatures colder. Using this basic information, students can be led to understand that the sun also warms the surface ocean and these temperature differences can lead to different adaptations in many creatures.

Similarly, students can be led through some of the other factors that create the unique habitats of the ocean. Certain adaptations can help creatures survive in different environments, such as sleek body shape for those ocean going fish that undertake long migrations, bioluminescence for those deep sea fish and jellies that need to attract prey or distract predators, venom for slow moving creatures both in defense and to kill their prey, broadcast spawning as a reproductive strategy for slow moving/stationary organisms, and camouflage that can help creatures go undetected. Each of these adaptations serves a purpose to the organism and it is possible to use the types of adaptations that an organism has to suggest in which environment the organism lives.

Activity

In teams, students are asked to carefully read each of the habitat cards and the organism cards. Based on the adaptations of the organism, and the conditions of the habitat, students should be able to pair the organism with the habitat. There are six organisms that pair with each habitat. Allow for about 30 minutes for the students to debate each other and explore their reasoning when making the organism assignments. If possible, be flexible with the time allotted for this segment as more time may allow further probing of misconceptions and guided learning.

When groups have their organisms assigned to the habitats ask groups how they classified the different organisms into groups. Was there a key adaptation that gave them clues to things that grouped together? For animals incorrectly grouped, what was the thinking that led to that association? Is there a learning opportunity when addressing the misconceptions? Did different groups assign organisms the same, but with different logic? Are there creatures that can be found in multiple habitats?

Eventually, reveal which organisms belong in which habitat and the telling adaptations where appropriate.

Closure Discussion

Examples of questions to help students share their results and observations…

1. What are some of the common adaptations the organisms are employing in each habitat?
2. What types of adaptations are useful in all habitats?
3. Is it possible to be both incredibly specialized/adapted and also widely distributed? Why or why not? Can you think of an example that supports your argument?

Extensions of Lesson

1. Have students conduct further investigations into a particular organism.
2. Investigate a particular adaptation or habitat
3. Go further investigating the adaptations of a particular phylum.

References

This lesson used more websites than was possible to keep track of, but all images used have a creative commons license. Generally, internet searches were conducted using both common and scientific names to research the life history and adaptations of the organism. YouTube videos are also available for all of the species listed if you would like to expose students to more than just a picture of each organism. In some cases, the common name was abbreviated to not give a clue as to the habitat (ex. Arctic cod is listed as simply "Cod") but the Latin name is correct for the adaptations listed.

Coastal Ocean (Page 1)

Tufted Puffin	*Fratercula cirrhata*
Lingcod	*Ophiodon elongates*
Blue Mussel	*Mytilus edulis*
Purple Sea Urchin	*Strogylocentrotus purpuratus*
Sea Palm	*Postelsia palmaeformis*
Dungeness Crab	*Metacarcinus magister*

Polar Ocean (Page 2)

Harp Seal	*Pagophilus groenlandicus*
Emperor Penguin	*Aptenodytes forsteriaa*
Ribbon Worm	*Parborlasia corrugatus*
Krill	*Euphausia superba*
Cod	*Arctogadus glacialis*
Sea Spider	*Pycnogonida spp.*

Open Ocean (Page 3)

Bluefin Tuna	*Thunnus thynnus*
Blue Shark	*Prionace glauca*
Blue Glaucus	*Glaucus atlanticus*
By-the-wind Sailor	*Velella velella*
Sargassum	*Sargassum spp.*
Storm Petrel	*Hydrobatidae spp.*

Tropical Ocean (Page 4)

Frogfish	*Antennariidae spp.*
Barracuda	*Sphyraena spp.*
Lionfish	*Pterois spp.*
Brain Coral	*Mussidae spp.*
Fur Seal	*Arctocephalus galapagoenis*
Giant Clam	*Tridacna spp.*

Deep Ocean (Page 5)

Vampire Squid	*Vampyroteuthis infernalis*
Pacific Barreleye Fish	*Macropinna microstoma*
Oarfish	*Regalecus glesne*
Atolla Jellyfish	*Atolla wyvillei*
Comb Jelly	*Ctenophora spp.*
Angler Fish	*Ceratiidae spp.*

Benthic Ocean (Page 6)

Hagfish	*Myxini spp.*
Black Coral	*Antipatharia spp.*
Tripod Fish	*Bathypterois grallator*
Vent Mussel	*Bathymodiolus thermophiles*
Sea Lily	*Bathycrinidae spp.*
Palm Worm	*Ridgeia spp.*