a place of mind

FACULTY OF EDUCATION

Department of
Curriculum and Pedagogy

Earth & Space Science

Exploration of Extreme Environments: Deserts

Science and Mathematics
Education Research Group

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Deserts

Deserts I

The Earth is made up of many biomes, such as grasslands, rainforests, deciduous forests, and deserts.

What characteristic classifies deserts, one of the Earth's biomes?

A. They are all located close to the Equator

B. Plants and animals have adaptations to survive there

C. Animals in them interact closely with those in nearby biomes

D. The soils are not abundant with nutrients

Solution

Answer: B

Justification: **Biomes** are ecosystems that share common features. Desert biomes all have extreme temperatures and weather conditions. They all have arid climates (dry air), little shelter, and harsh winds. There are many locations on Earth where these conditions are present – not just at the Equator, where we usually think of deserts being located.

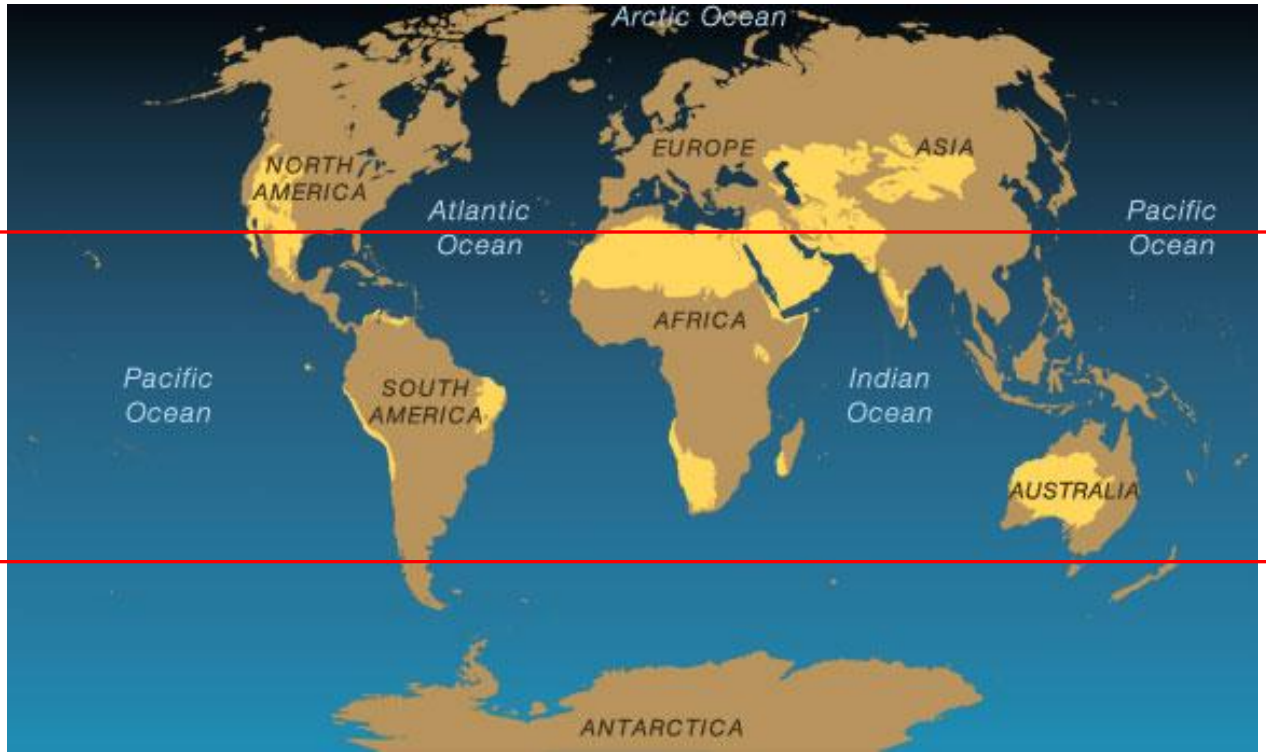
Animals and plants that live in the desert have developed special adaptations that allow them to survive in these harsh conditions. The adaptations that allow them to survive in the desert make it difficult for plants and animals to survive in other biomes.

Solution

Looking at the desert ground, it appears dry and sparse. However, this does not mean that it lacks nutrients. For plants to survive, they must be able to get sufficient nutrients from the soil. In many places these nutrients come from organic matter (dead stuff) in the soil. Since there are fewer plants and animals in the desert, there is less organic matter in the soil. This means plants that survive in the desert must be able to get nutrients from the soil itself.

Extend Your Learning: Points of Interest

Although most large, hot deserts are located away from the coast and situated near the equator (occurring in between the Tropic of Cancer and the Tropic of Capricorn), not all hot deserts are found here. The yellow areas show Earth's hot deserts.



Tropic of Cancer

Tropic of Capricorn

Deserts II

Deserts cover about 1/3 of the earth's land surface. Deserts include both hot and dry deserts as well as cold deserts.

Which of the following is a characteristic of cold deserts?

A. There is very little precipitation in summer and winter months

B. Plants are clustered near water sources on the land

C. Organisms find shade under plants in this environment

D. There are no large temperature changes within a 24 hour period

Solution

Answer: D

Justification: Hot and cold deserts have many things in common; after all, they are both part of the desert biome!

In both types of deserts, plants are usually smaller, not allowing for much natural shade for other organisms. In order to find a large enough source of water, root systems spread out in the ground for maximum absorption. This makes it unnecessary for them to be near a direct water source.

The purple saxifrage (pictured right) is the territorial flower of Nunavut. As you can see, it's a low-lying, spread out plant, covering the tundra.

Solution Cont'd

While the average temperature of cold deserts is lower than hot deserts, they both experience large fluctuations in temperature over a 24-hour period (day to night). The hot deserts have larger overall differences in temperature over 24 hours than cold deserts, but they both have significant fluctuations.

There are, however, several differences within the desert biome.

The most obvious difference is that hot deserts have hotter average temperatures than those of cold deserts.

Also, while some cold deserts are dry and have little precipitation, similar to hot deserts, the Arctic (a cold desert) has substantial precipitation; snow in the winter and rain in the summer.

Extend Your Learning: Compare & Contrast

Look at the two pictures below of a hot desert and a cold desert.

What similarities and what differences do you see in these pictures?

What else do you know about each type of desert?

Deserts III

Hot desert temperatures range from extremely low to extremely high within a 24-hour period.

Why is there such a large temperature difference in these environments?

A. The above statement is false; deserts have extremely hot temperatures all the time

B. It cannot be hot at night since the sun is not out to heat the air

C. Since the air has little water in it, deserts will heat up and cool down faster

D. Clouds hold in heat during the day and not at night, allowing the heat to escape

Solution

Answer: C

Justification: The air around us holds water. **Humidity** tells us how much water is in the air: the more water that is in the air, the more humid it is. Water requires a lot of energy to heat up and it cools down slowly. This means humid environments take a long time to heat up and to cool down.

In deserts, the air is very dry (low humidity), so when the sunlight shines down during the day the ground and the air heat up quickly. However, there is no water in the air to hold the heat once the sun goes away. At night, when the sun goes down, the air cools off quickly.

Extend Your Learning: Discussion

Observe the picture below and consider the questions on the following slide.

Extend Your Learning: Discussion Cont'd

There are deserts in Canada – in fact, you may even have visited one! Osoyoos, British Columbia is one of Canada's deserts.

1. What characteristics of a desert do you see in this picture

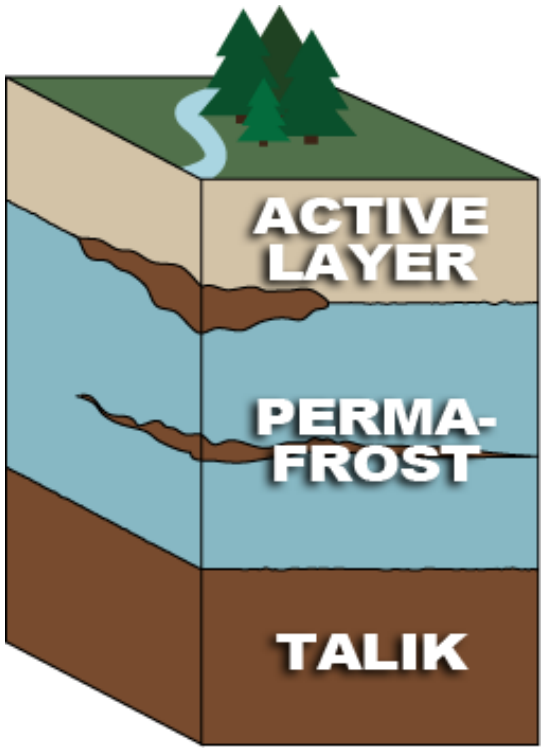
2. Would Osoyoos be considered a hot or cold desert? Why?

3. What other deserts are located in Canada? Where are they located?

4. What other deserts have you visited? What makes them deserts?

Deserts IV

In the cold desert of the Arctic, large portions of the soil can be at or below the freezing point of water (0º C). When a section of soil remains frozen continuously for a span of two or more years it is called permafrost. Unlike the underlying **permafrost**, the uppermost soil layer (called the **active layer**) undergoes a freezing and thawing cycle.



What causes this cycle in the **active layer**?

A. The composition of the soil

B. The amount of water in the soil

C. Seasonal temperature changes

D. None of the above

Solution

Answer: C

Justification: The Arctic experiences summer and winter seasons, but they are likely very different from the seasons you are used to. In the summer months, when the weather is warmer, the soil in the active layer will thaw. It will freeze again once winter begins and temperatures drop below 0º C.

The makeup of the active layer (both the amount of water and the composition of the soil) do not influence this cycle. Only the temperature of the air impacts which direction this cycle is moving in.

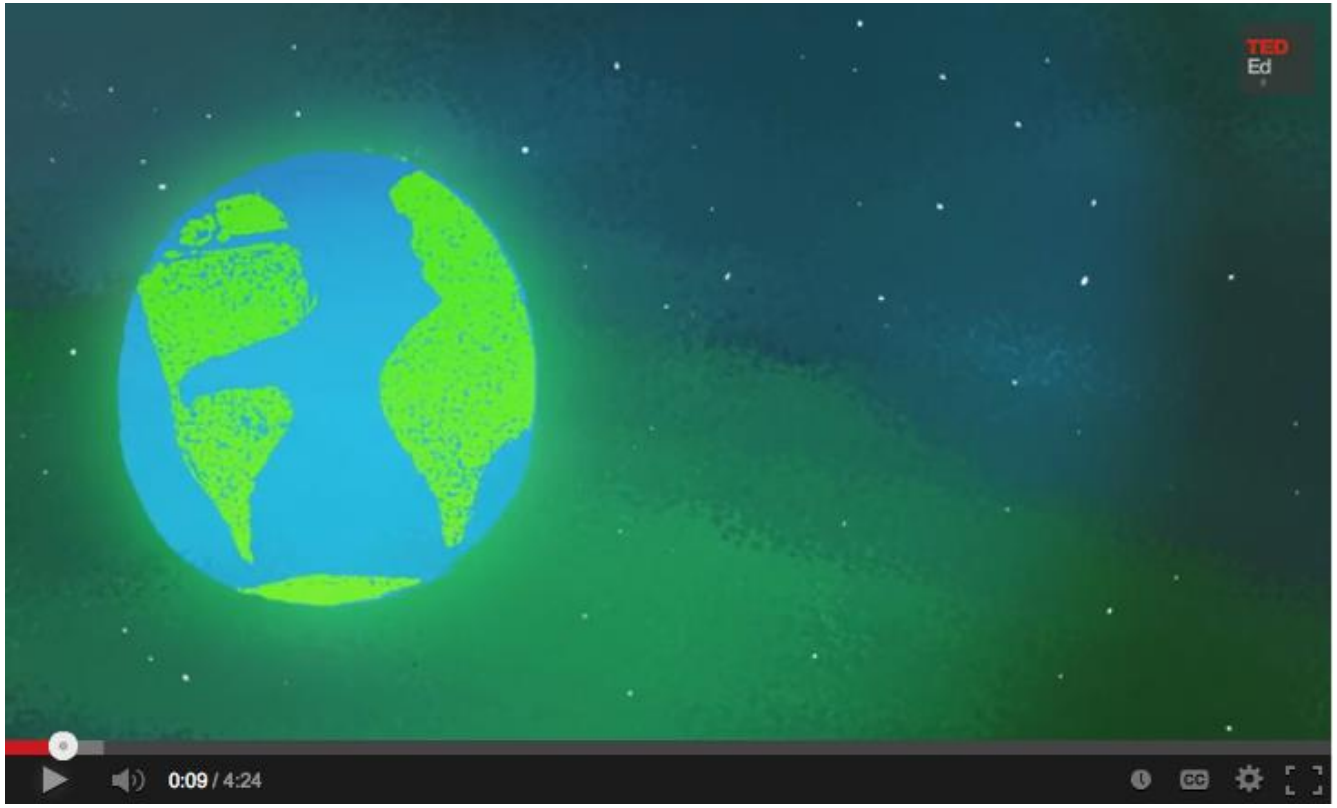
Solution Cont'd

While the amount of water and the composition of the soil do not affect the cycle, they are related closely to the freezing and thawing process.

For example, larger amounts of water take longer to freeze and melt. Also, some minerals in the water (such as salt) will influence the temperature that water freezes at.

Extend Your Learning: Video

Title: The Arctic Vs. The Antarctic



Deserts V

In hot and dry deserts, the climate fluctuates from season to season and day to day. This can make it very difficult for plants to get enough nutrients at all times. In order to overcome this challenge, many plants have adapted.

Which adaptation allows plants to have enough nutrients at all times?

A. Leaves store nutrients for future use

B. A waxy outer shell keeps nutrients in

C. Plants stop photosynthesizing to save energy

D. None of the above

Solution

Answer: A

Justification: In order for plants to absorb nutrients from the soil there needs to be water present. In hot and cold deserts, there is very little water in the soil. This is especially true in winter and summer months, when there is little precipitation to replenish water stores in the ground.

Because of this fluctuation in available water, plants have adapted to absorb lots of nutrients when they can, and to store them in their leaves for future use.

Solution Cont'd

There are many other adaptations plants have developed to survive in the desert, such as a waxy outer shell that keeps water in. However, this waxy shell does not help the plants store nutrients.

Plants also require energy to process these nutrients and continue growing. This energy is produced through photosynthesis. This means a plant must continually photosynthesize.

Extend Your Learning: Did You Know?

The following plants have unique adaptations to hot and dry deserts. Click on each plant to learn more about the plant and its adaptation.

Plant Name	Adaptation
Paddle Cactus	Large, barbed spines that stick to clothing, flesh or animal fur; these spines cause discomfort or injury to animals
Brittle Bush	Hairy leaves and stems protect the plant from the heat by acting like a blanket; the white flowers also reflect the sunlight to keep cool
Turpentine Bush	Leaves are needle-like and give off a foul smell (like turpentine!) when crushed
Tumbleweed	The above-ground part of a plant separates from its root system in order to blow in the wind to disperse its seeds or spores

Deserts VII

Desert animals also have special adaptations to the hot and dry climate.

Which of the following adaptations are **not** present in animals found in hot and dry deserts?

A. Improved night vision
B. Kidneys that concentrate urine
C. Spiky outer shell
D. Ability to go into a dormant state
E. Having a third eyelid

Solution

Answer: C

Justification: A spiky outer shell is an adaptation, but it does not address the specific challenges animals face in desert climates. Instead, a spiky outer shell wards off predators.

Each of the other adaptations specifically address challenges of the hot desert climate.

Many animals that live in hot and dry deserts require good night vision because they are nocturnal (sleep during the day and are active at night). This adaptation allows them to retain more water because it is cooler at night.

The kidneys of desert animals concentrate urine. This is also an adaptation that reduces the amount of water being lost.

Solution Cont'd

Dormancy is when an animal's growth, development and physical activity is temporarily stopped. Animals do this for many reasons, such as difficulty finding a regular food source for a portion of the year. For example, grizzly bears hibernate for 5 – 7 months each year during the cold winters when they cannot properly hunt for food. Where food is plentiful, some grizzly bears skip hibernation all together. This adaptation is common in multiple biomes, including some animals living in the desert.

Some animals (e.g. camels and lizards) have a third translucent eyelid for protection that keeps eyes moist, while still allowing the animal to see. This is called the *nictitating membrane*.

Deserts VIII

The cataglyphis ant is an extremophile that lives in the desert. It moves forward and then rotates 360º in order to locate the position of the sun, then continues on to locate its prey. This is so that it may find the most direct route back to its nest.

What is this type of adaptation called?

A. A physiological adaptation

B. A structural adaptation

C. A behavioural adaptation

D. None of the above

Solution

Answer: C

Justification: This is an example of a behavioural adaptation because there is no change to the ant's physical appearance (also known as structural features) or body systems (physiological features).

A behavioural adaptation is a change in an organism's actions that help it to survive in its environment. Turning around to locate the position of the sun is something that the ant does to survive the intense heat in the desert.

Other behavioural adaptations include bird calls to find a mate or sense danger and the caribou migration to the Canadian arctic.

Extend Your Learning: Video

Title: The Amazing Cataglyphis Ant

Title: BBC Finding The Way: Ants, Moths & Bees

Deserts IX

Animals that live in cold deserts also have special adaptations to the their frigid climate.

Which of the following is **not** an adaptation to the cold desert that an animal might have?

A. Thick layer of blubber

B. Nocturnal behaviours

C. Antifreeze-like solution in body

D. Thick fur coat

Solution

Answer: B

Justification: Animals have many adaptations to help them survive – the key here is which ones help them deal with the cold desert climate.

Being nocturnal helps many animals find prey and in the hot and dry desert because the cooler night air allows them to retain more water. In the cold desert the temperatures are always cold, so this adaptation does not help an animal deal with the climate.

Solution Cont'd

Each of the other adaptations specifically address challenges of the cold desert climate.

Beluga whales and polar bears have a thick layer of blubber in order to withstand the cold Arctic ocean.

Polar bears and some Arctic and Antarctic fish have developed antifreeze proteins in their blood in order to keep them alive in the sub-zero temperatures.

Polar bears also have a thick fur coat for insulation. This coat is made up of different layers of fur that serve different purposes. Guard hairs make up the outer layer and keep air in, while the denser hairs closer to the body act as a warm insulating layer.

Extend Your Learning: Compare vs. Contrast

Blubber is a thick layer of fat, that covers the entire body of marine mammals that live in very cold climates, including seals, whales, manatees, and walruses. Blubber does not cover their fins, flippers, or flukes.

Blubber is an adaptation that serves any purposes for animals in cold climates.

Blubber insulates the body, stores energy, and helps animals float because it is less dense than the surrounding ocean water. Blood can circulate through blubber, and the blood vessels will constrict in cold temperatures, reducing blood flow, and keeping the animal warmer.

Extend Your Learning: Activity

How well does blubber keep an animal warm?

Materials Needed:

- One medium sized plastic bag and one glove (Latex, or for dishes)
- Shortening or butter
- Cold water
- A large bowl

1. Fill the bag with shortening. Fill the bowl with water and ice.
2. Put your gloved hand inside the shortening-filed Ziploc bag
3. Make sure your gloved hand is covered in a layer of shortening
4. Attach the glove and Ziploc together to make sure the shortening does not escape (using tape or an elastic)
5. Submerge the “blubbered” hand in the cold water. Submerge your other, bare, hand in the cold water. What do you notice?

Extend Your Learning: Points of Interest

Polar bears have layers of fur to keep them warm. Guard hairs make up the outer layer, and a denser fur is closer to the body.

- Guard hairs are hollow and very coarse.
- Guard hairs are actually transparent
  - We see white because all colours of light are reflected back through the air between the hairs
  - The transparent hairs focus heat onto the bears' dark skin below the fur
- Guard hairs trap a layer of air against the skin for insulation
- The hollow hairs allow polar bears to dry quickly (through shaking water off) and keep the inner layer of fur dry.

Extend Your Learning: Video

Title: Penguins: Popularity, peril and poop