 

**ELEMENTARY SCHOOL**

**Sustainable Science**

**Desalination Design Challenge**

**Lesson 2: How Do Animals Conserve Water?**

**Teacher Background and Overview:**

When scientists and engineers look for safe, sustainable solutions to different problems, they often turn to nature for inspiration. *Biomimicry* is the art and science of taking inspiration from nature in the design of new technologies. Though humans cannot deal well with salty water, nature has evolved to deal with salt in several different ways to help animals and plants thrive in high-saline environments.

If scientists and engineers are to create long-term solutions to global environmental challenges, they must consider the sustainability of their innovations and inventions. *Sustainability* is broadly defined as meeting the needs of our current population without sacrificing the needs of the next generation. With sustainability, it is important to consider three major areas: environment, economics, and social equity. Similarly, green chemistry provides scientists and engineers with criteria to create sustainable products. For a technology to be considered green chemistry, it must perform just as well or better, cost the same or less, and have less impact on human health and the environment than the existing product or process. Green chemistry and biomimicry are tools that can be used together to create sustainable solutions that meet the challenges of society.

This lesson builds off of Lesson 1 and students’ prior knowledge of water. Students will learn about adaptations found in nature for both conserving and removing salt from water, in reading and in class discussion. Later in the unit, students will use what they learn in Lesson 2 to help them design a water filter and a desalination device.

**Time Required:**

30 minutes (designed for ELA time)

**Learning Objectives:** Students will…

* Explain how adaptations enable animals to conserve water.
* Describe how nature removes salt from water.
* Understand that scientists derive inspiration from nature for technological innovation.

**Standards:**

***Massachusetts Standards***

*ELA & Literacy*

**RSIT.5.1** Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text.

**RSIT.5.2** Determine two or more main ideas of a text and explain how they are supported by key details; summarize the text.

**RSIT.5.3** Explain the relationships or interactions of two or more individuals, events, ideas, or concepts in a historical, scientific, or technical text based on specific information in the text.

**WS.5.2** Write informative/explanatory texts to examine a topic and convey ideas and information clearly.

**SL.5.1** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others’ ideas and expressing their own clearly.

**SL.5.2** Summarize a written text read aloud or information presented indiverse media and formats, including visually, quantitatively, and orally.

**Materials:**

* Copies of articles or access to computer/tablet

**Procedure:**

1. Review the need for fresh water from Lesson 1.
2. Watch the Crash Course video *The Basics of Freshwater* (4:15) <https://www.youtube.com/watch?v=oaQCiwzjnCM>.
3. Introduce and discuss sustainability. Sustainable development is broadly defined as meeting the needs of our current population without harming the needs of the next generation. Sustainability is comprised of three overarching themes: environment, economics, and social equity. As we move toward sustainable development, fields such as biomimicry and green chemistry are key players.
4. Ask students to define biomimicry by breaking up the word into “bio” and “mimic” and defining those terms. Biomimicry is the science of deriving inspiration from nature to develop better technologies.
5. Create a class KWL chart using the guiding question, “How do animals conserve water?” Fill out the K (know) and W (want to know) columns.
6. Have students find a partner, or assign partners. Assign each pair two animals from the article *20 Amazing Animal Adaptations for Living in the Desert* <http://mentalfloss.com/article/57204/20-amazing-animal-adaptations-living-desert>.
7. Instruct students to compare and contrast the adaptations of their two animals.

**Wrap-Up/Assessment:**

1. Have partners write down 1–2 ideas of how their animals’ adaptation could be used by humans to innovate a product or process to conserve water; save these for Lesson 3.
2. Final assessment is to finish the KWL chart with the whole class by filling in what they learned in the L column.

**20 Amazing Animal Adaptations for Living in the Desert**

**BY** [**CRAIG S BAKER**](http://mentalfloss.com/authors/56758/Craig-S-Baker) **JUNE 13, 2014**

<http://mentalfloss.com/article/57204/20-amazing-animal-adaptations-living-desert>.

As the summer temperatures continue to climb, you may find yourself spending more and more time indoors enjoying the comforts of central air conditioning. But without the benefit of modern technology, animals that make their home in the heat have had to come up with their own ways of staying cool and hydrated. We caught up with San Diego Zoo Ambassador and Zookeeper Rick Schwartz between television appearances in New York City to talk about the incredible ways that some creatures have adapted to survive in the desert.

***1. The Thorny Devil Drinks with Its Skin.***

In the Australian Outback, pooled water can be extremely hard to come by. To deal with this issue, the thorny devil has developed skin that can absorb water like blotter paper (called “capillary action”). According to Schwartz, “the way the scales on the body are structured, it collects dew and channels it down to the corners of the mouth," where the lizard drinks it. You can actually watch the lizard’s skin darken as it soaks up whatever liquid remains from even the muckiest of puddles.

***2. The African Pyxie Frog Can Hibernate in a Water-Soluble Mucus Sac for Years.***

Schwartz says it was previously believed that these animals died off during every dry season, but what was actually happening was far more interesting. When the rainy season ends on the African savannah, the second largest frog in the world burrows 6 to 8 inches underground and seals itself in a mucus membrane that “essentially hardens into a cocoon.” The frog can “hibernate” in this sac for up to seven years waiting for rain, which, when it comes, causes the mucus sac to soften, signaling to the frog that it’s time to wake up. The South African lungfish benefits from a similar method of hibernation.

#### 3.“Sidewinding” May Look Funny, But It’s Actually Highly Efficient.

This unusual method of locomotion is used by two species of venomous snake—the Mojave Desert sidewinder in the southwestern United States and the Namib Desert viper in Africa. Not only does it help the serpents keep traction on shifting sands, but it ensures that only two points of the animals’ bodies are touching the hot ground at any given time.

#### 4. The Chuckwalla Is the Puffer Fish of the Desert.

When facing a predator, this large lizard will scurry under a rock crevice and inflate the loose folds of skin along its body, making it difficult to pull from its hiding place—a perfect escape plan in the rocky deserts of the U.S. and northern Mexico that the chuckwalla calls home.

#### 5. Big Ears Act Like Radiators.

The fennec fox of North Africa has large ears which Schwartz points out “serve a dual purpose”: they are great for listening for bugs to eat that may be moving around underground, but they are also loaded with blood vessels, allowing the animals to dissipate excess body heat. Schwartz points out that while big ears are wonderful radiators during hot days, the fox’s thick fur coat also acts as insulation during cold desert nights.

#### 6. The Cape Ground Squirrel Takes Shade Everywhere It Goes.

Native to the driest areas of southern Africa, this borrowing rodent can actually use its bushy tail as a sort of parasol—a function I think we all envy from time to time.

#### 7. The Camel Is a Living Desert Adaptation.

No discussion of desert survival is complete without a mention of the camel. You know that the hump stores fat, which can be used as both a food and water source for the animal when the going gets tough. But Schwartz points out that camels also have thick hairs in their ears for keeping out sand, and the same can be said of their eyelashes—“there’s not a model out there that wouldn’t want eyelashes like that,” Schwartz says. Camels also sport closable nostrils, a nictitating eye membrane, and wide feet that act like snowshoes in the sand.

#### 8. Camels Aren’t the Only Animals That Store Fat for Desert Survival.

The Gila Monster—one of only two venomous lizards in the world—spends most of its life underground and can go months between meals by living off of fat stored in its tail. This is a handy little survival trick during the dry season in their Sonoran Desert habitat.

#### 9. Can’t Find Food? Toughen Up!

The peccary, or javelina, has a tough mouth and specialized digestive system which enables it to chomp down on prickly pear cactus pads (one of their favorite foods) without feeling the effects of the plant’s thousands of tiny spines. “I can’t imagine biting into the paddle of a cactus, but these animals definitely have found ways to do that,” Schwartz says. As an added bonus, using cactus as a food source is a great way to supplement water intake as the spiny succulents are absolutely loaded with the stuff.

#### 10. The Sand Grouse Can Carry Water In Its Feathers.

This bird, found mainly in the deserts of Asia and North Africa, has specialized feathers on its belly that are able to soak up small quantities of water. Males of the species will use these feathers like a sponge to carry water back to their nests, which they then share with their female counterparts and offspring.

#### 11. The Dorcas Gazelle Never Has to Drink Water or Urinate.

Though they will drink water when it is available, this small species of North African antelope can get all of the water it needs from the food in its diet. When water is unavailable, the Dorcas gazelle can concentrate its urine into uric acid, which Schwartz describes as “a white pellet” instead of the hydraulically expensive liquid waste. “That’s water conservation,” he says, “and they need to hold on to whatever they get.” As Schwartz points out, the metabolic processes of the body all have outputs which often occur in the form of mineral build up. “Animals that live in an environment where water is readily available will just [get rid of those minerals] through their urine,” he says. “When you have animals that live in these extreme environments where they don’t want to excrete any fluids, the body will find other ways to get rid of those minerals.” The greater roadrunner of North America, which like the Dorcas gazelle can survive its whole life without drinking water, has developed a unique way of dealing with this problem: it secretes excess salt from a gland near its eye.

#### 12. The Fogstand Beetle Drinks Dew Drops.

The Namib Desert in Africa has very little fresh water to speak of, but due to its proximity to the sea, it receives a daily dose of fog in the cool hours of the early morning. Fogstand beetles have learned to stand still in order to let the fog condense on their bodies in the form of water droplets, which they then drink.

#### 14. Delicate Skin Keeps the African Spiny Mouse Protected.

Not only are these animals able to close any wounds through a special process of contraction, but the exceptionally weak skin of these mice means it is also much easier to regenerate, allowing wounded spiny mice to heal from superficial wounds much faster than other species—a process which minimizes blood loss.

#### 15. The Blind Skink Stays Under the Sand.

With subspecies in Africa, Asia, and Australia, this freaky legless lizard has developed an ingenious method of dealing with high desert surface temperatures—simply staying out of them. Blind skinks have lost their legs and eyes through evolution and, like the sandworms from Beetlejuice, prefer to stay hidden underground where they can tunnel in search of creepy crawlies to munch on.

#### 16. Scorpions Can Slow Their Metabolic Rate, Allowing Them to “Hibernate” While Awake.

Scorpions are able to go up to a year without eating thanks to their specialized metabolisms. Unlike other animals that experience a seasonal hibernation, though, a scorpion is still able to react to the presence of prey with lightning quickness even while in this state of nearly suspended animation.

#### 17. Kangaroos Cool Themselves With Spit Baths.

To survive the harsh Australian summers, kangaroos will cool off by licking their forelegs. A special network of blood vessels in the legs allows the animals to reduce their body temperatures quickly through the evaporation of saliva since kangaroos lack regular sweat glands.

#### 18. Meerkats Are Always Game-Ready.

The black circles around the eyes of these social African mammals is often compared to a natural pair of sunglasses, though Schwartz says that the pattern actually functions by “absorbing the sun and preventing it from reflecting back into the eyes.” This means that the pattern works more like the eye black used by professional athletes than actual lenses. Still, says Schwartz, it allows them “to see more clearly” while awake during the day, compared to nocturnal predators such as lions, whose eyes have no special markings whatsoever.

#### 19. The Addax Antelope Changes Color With the Seasons.

Another creature native to the Sahara Desert, the Addax antelope rarely if ever needs to drink water to survive. To cope with the unforgiving desert sun, the Addax sports a white coat in the summer which reflects sunlight, but in the winter the coat turns brownish-gray so as to better absorb heat.

#### 20. The Common Kingsnake Is Immune to Rattlesnake Venom.

What better way is there to silence your competition than by eating them? The common kingsnake is so specialized to that end that not only do they hunt by clamping down on a snake’s jaws before constricting it to death, they have also developed an immunity to rattlesnake venom, making the vipers one of their favorite food sources.