PHILADELPHIA ZOO

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Anatomy and Physiology (9^{th}-12^{th})

Essential Question: How are anatomy and Physiology related to conservation?

Objectives

1. Be able to describe how bats are impacted by white-nose syndrome
2. Demonstrate knowledge of the link between studying anatomy and physiology and conservation of species

Vocabulary

Anatomy: The branch of science concerned with the bodily structure of humans, animals, and other living organisms

Physiology: the branch of biology that deals with the normal functions of living organisms and their parts

Epizootic disease: a disease that is temporarily prevalent and widespread in an animal population

Classroom Activity

Conservation and Physiology: Have students read the included paper, "Wing pathology of white-nose syndrome in bats suggests life-threatening disruption of physiology" by Paul M. Cryan, *et. al.*

Individually: Have students read the paper individually and highlight what they feel are important pieces of information.

In groups: Students should form groups to discuss in detail the key points of the paper. Students should work together to answer the included questions.

As a class: Go over the entire paper and summary questions as a class. Use the 'Questions for Discussion' to summarize learning and further understanding of the scientific process.

Standards

PA Academic: 3.1 A5, 3.1 A6, 3.1 A8, 3.1.B.C3

Next Generation Science: HS-LS1-2, HS-LS4-1

New Jersey Core Curriculum: 5.1, 5.3E

Common Core: CCSS.ELA-LITERACY.RST.4, CCSS.ELA-LITERACY.RST.7, CCSS.ELA-LITERACY.W.7, CCSS.ELA-LITERACY.SL.1

Conservation and Physiology
Questions for Consideration

Read the entire paper and highlight important information. Work together in a group to answer the following questions.

1. The authors list two major colony-related events that became apparent after white-nose syndrome (WNS) was discovered. What are those two events?
2. What type of organism is responsible for WNS? Do you already know anything about these types of infections in humans or other animals?
3. What is the obvious symptom of WNS in bats? What is the less obvious symptom?
4. Why is this second symptom of great concern?
5. What behavior of bats makes them prime targets for WNS and why?
6. What differences did the authors notice between the wings of healthy bats and those infected with WNS?
7. What is EWL and what does it have to do with WNS?
8. What are the other body functions that may be impaired by WNS?

Questions for Discussion

1. On the first page, the authors mention that over 1 million bats have died. Is this a reliable number to use when discussing WNS in the current year? Why or why not? Hint: look at the year this paper was published, and think about what may have happened since then.
2. The authors note that WNS is also apparent on bats in Europe, but these bats do not die as a result of the disease. Given this information, and the information presented throughout this paper, briefly describe a research project you could complete to help us learn more about how we can protect bats in North America from WNS.

Answer Key

1. 1) losses at affected hibernacula have exceeded 75% and 2) some winter colonies that were stable or increasing in number for decades have all but disappeared (page 1, column 1)
2. A fungus called *Geomyces destructans*. (page 1, column 2) Students will have varying knowledge about fungal infections in humans or other animals, but they should know that they can range from irritating (i.e. athlete's foot) to deadly (*Pneumocycstis* pneumonia), particularly in immunocompromised patients. Fungal infections are also incredibly difficult to treat, and often times the side effects from treatment for fungal infections are worse than the infection itself. In short, fungal infections are pretty bad.
3. WNS is capable of digesting, eroding, and invading the skin of hibernating bats. The bats will exhibit a white muzzle from the fungus, but the true underlying symptom of concern is the degradation of skin in the wing. (page 1, column 2)
4. Bats have four to eight times more exposed skin membrane along their arms, digits, and tail (all these pieces comprise their wings) than other parts of their bodies. These disproportionately large areas of exposed skin play critical roles in homeostasis and thus in day-to-day survival. (page 1, column 2)
5. Hibernation. Hibernating bats cluster very closely together to retain warmth throughout winter, and they typically choose to hibernate in humid areas. This allows for easy passage of WNS from one bat to another. In addition, hibernation reduces immune response, thus making bats less able to fight the infection. (page 2, column 1)
6. Healthy bats have wings that are supple, elastic, and toned. Infected bats have surfaces that may adhere to each other, tear easily, lose tone, strength, and elasticity, and resemble crumpled tissue paper. (page 2, column 1)
7. EWL is evaporative water loss. This occurs in hibernating bats when they lose water through their skin throughout hibernation. Bats can account for this by hibernating in humid areas. The effects of WNS on the wing skin of hibernating bats can exacerbate EWL, thus causing them to experience severe dehydration. This dehydration also leads to emaciation, as the bats will use up fat stores in order to combat dehydration. (page 3-4, columns 2-2)
8. Circulation and respiration (page 4, column 2), thermoregulation (page 5, column 2), and flight (page 5, column 2).

Questions for Discussion

1. No, this is not a reliable number. The current number of deaths due to WNS is actually now nearing 6 million. It is important to look at the publishing date for any research paper to be sure you are using the most accurate numbers possible. If the date exceeds 2 years, while the data is of course still valid, readers should look for a more current piece of research to update their findings.
2. Answers for this question will vary, but students should include a general theme of comparing the anatomy and physiology of European and North American bats. They should take into consideration if and how the disease manifests differently in the two groups of bats, and what (if anything) is protecting European bats from succumbing to the disease.