

Activity 3.4.4: Water Balance

Introduction

Bill’s friends throw a summer picnic to celebrate his 40th birthday. Bill spends the day playing touch football and chasing around after his kids. It’s almost 100°F outside and he is doing what he can to stay cool. Cold beer seems to work so he drinks many over the course of the day. Other than running to the bathroom all afternoon, Bill feels fine. But the next morning when he wakes up, he feels awful. He’s nauseous, dizzy and wishing he had stuck to water at the party. He wonders what is causing this horrific hangover.

Water balance is key to human survival. If you have ever competed in a vigorous athletic event or have been out in the heat for too long a time, you have probably experienced the signs and symptoms of dehydration. You become weak, nauseous, and may even pass out. Your body’s urinary system is designed to help you conserve water, but if no new water is coming in and your body is losing water through exercise or sweat, a balance can not be maintained. The volume of urine that we excrete is a reflection of how much fluid and salt our bodies have to spare. Your body will give you warning signs, but sometimes they come a bit too late!

Like most processes in the body, water balance is regulated by hormones. These chemical messengers help control how much water is retained or removed from the body. In fact, your endocrine system, your nervous system, and your urinary system work together to signal thirst and to effectively manage a water shortage. In this activity, you will explore how the body monitors water levels and calls the kidneys into action. Your job is to help Bill understand how the events of the day affected his ability to maintain homeostasis. Why is poor Bill feeling so bad? What has happened to the water balance in his body? How does this lack of water link to his symptoms and how can he find some relief? Explore the feedback loops in the body that work to keep a water balance and investigate how substances such as alcohol can directly affect the release of hormones.

Equipment

* Computer with Internet access and Inspiration® software
* Anatomy in Clay®Maniken®
* Laboratory journal
* Assorted colors of clay
* Wire tool or wooden knife
* Endocrine system graphic organizer

Procedure

1. Take out the brain map or the data table you created in Project 2.1.3 and locate the area of the brain that senses and controls thirst. The sensation of thirst and your body’s ability to maintain a proper water balance are controlled by communication between the nervous system, the endocrine system and the urinary system.
2. Research the effects of antidiuretic hormone (ADH) on water balance in the blood. Take notes in your laboratory journal. Use the websites found below or other reliable sources you may find.

* Biology Mad Video <http://www.biologymad.com/resources/kidney.swf> - Choose Duct from the dropdown menu and click on the duct wall to see how ADH works.
* Overview of Hypothalamic and Pituitary Hormones- Colorado State University <http://www.vivo.colostate.edu/hbooks/pathphys/endocrine/hypopit/overview.html>

1. Use Inspiration software to create a feedback loop that shows how your body uses ADH to maintain a water balance. Refer to the loops you created in Activities 2.3.1 and 2.3.2 for ideas of how to describe this interaction and to organize your information.

* Start by thinking about how the brain detects high or low levels of sodium or water in the blood.
* Your feedback loop descriptions should include the following words: **thirst, ADH, hypothalamus, neuron, pituitary gland, nephron, kidney, urine, reabsorption, osmoreceptors**.
* Your feedback loop should show the involvement of the nervous system, the endocrine system and the urinary system in restoring a water balance. Make sure to reference key regions in the brain, specific glands and their target organs as well as indicate how the nephron is affected.

1. Research the effects of alcohol on ADH and your body’s water balance. Why did Bill keep running to the bathroom? What is happening to his body since he is producing so much urine? Record your findings in your laboratory journal.
2. Print a copy of your feedback loop. In words, or with changes to your diagram, show and describe how alcohol affects ADH. Make sure you note how changes in this hormone are linked to Bill’s symptoms.
3. Note that another hormone, aldosterone, helps maintain a water balance. However, the way in which this hormone works differs from the mechanism of ADH. Research the way in which aldosterone affects the nephron. Make sure to reference the effect of aldosterone on electrolytes and note the gland that is responsible for the release of the hormone.
4. In your laboratory notebook or using Inspiration, create a Venn diagram that compares and contrasts the action of the two hormones ADH and aldosterone.
5. Add the hormones and glands that help maintain water balance to your endocrine system graphic organizer. Make sure to draw the structures from which the hormones are released and arrows to the target organs or structures.
6. Use the Internet to find answers to the questions listed below. Record your findings in your laboratory journal.

* The kidneys themselves also serve as an endocrine gland. What hormones are produced by the kidney and what function do they serve? What other human body system do these hormones regulate?
* Describe the role of at least two other organs or structures that help the body deal with an influx of alcohol.

1. Answer the conclusion questions.

Conclusion

1. Would blood ADH levels be higher or lower than normal in a person who just completed a three mile run without drinking any water? Explain.
2. Is the ADH feedback loop an example of positive or negative feedback? Explain.
3. How did the events of Bill’s day impact his body’s ability to conserve and balance water?
4. Explain the role of sweating in the body. What effect did sweating have on Bill’s water balance?
5. How could Bill have prevented his horrible hangover? Explain.
6. Diuretics are often prescribed to treat high blood pressure. Given the name of the class of drug, how do you think diuretics affect the kidney, the fluid and electrolyte balance in the body and overall blood pressure?
7. Explain how drinking too much water can throw off the electrolyte balance in your blood. How does this imbalance specifically affect the nervous system and the muscular system? Hint: Think back to what happens at the plasma membrane for a nervous signal to be communicated and to the ions that are required for muscle contraction.
8. Explain how a shortage of water affects the health of your cells. Make sure to use words such as *osmosis, hypertonic solution, hypotonic solution,* or *isotonic solution* in your answer.