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**“A Toxic Dose of Water”**

*(October/November 2017 Issue)*

**Teacher’s Guide**



**Teacher's Guide for**

***“A Toxic Dose of Water”***

**October/November 2017**

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# Connections to Chemistry Concepts

|  |  |
| --- | --- |
| **Chemistry Concept** | **Connection to Chemistry Curriculum** |
| **Ionic compounds** | During the study of ionic compounds, use the information in this article to show how anions and cations play an essential role in maintaining the health of organisms. |
| **Electrolytes** | When discussing conductivity and ions in class, refer to how electrolytes like Na+ are responsible for transmitting electrical impulses through the nervous system. In hyponatremia, low Na+ can disrupt these signals. |
| **Concentration units** | While chemists usually describe solution concentrations in molarity (M), other units are also used (e.g., molality [*m*], parts per thousand [ppt], parts per million [ppm], etc.); and biologists often use percent by mass (g solute/100g water). |
| **Energy of evaporation (Kinetic Energy of water molecules)** | The endothermic phase change from liquid water (sweat) to gaseous water during evaporation requires energy sufficient to increase the kinetic energy of water molecules until the hydrogen bonds between the molecules break, removing heat from the body. |

# Teaching Strategies and Tools

## Standards

* Links to **Common Core Standards for Reading**:

**ELA-Literacy.RST.9-10.1:** Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

**ELA-Literacy.RST.9-10.5**: Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).

**ELA-Literacy.RST.11-12.1:** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

**ELA-Literacy.RST.11-12.4:** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.

* Links to **Common Core Standards for Writing**:

**ELA-Literacy.WHST.9-10.2F**: Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

**ELA-Literacy.WHST.11-12.1E:** Provide a concluding statement or section that follows from or supports the argument presented.

* Links to **Next Generation Science Standards**

**HS-LS1-2**: Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

* + **Disciplinary Core Ideas:**
* LS1.A: Structure and Function
  + **Crosscutting Concepts:**
* Systems and system models
* Scale, proportion, and quantity
  + **Science and Engineering Practices:**
* Developing and using models
* Constructing explanations and designing solutions
  + **Nature of Science:**
* Scientific knowledge assumes an order and consistency in natural system

## Vocabulary

**Vocabulary** and **concepts** that are reinforced in October 2017 issue:

* + Equilibrium
  + Solute and solvent
  + Electrolyte
  + Ions
  + Lipids
  + Osmosis
  + Metallic and nonmetallic
  + Igneous, sedimentary, metamorphic rocks
  + Composting
  + Aerobic and anaerobic
  + Carcinogen
  + Heavy metals
  + Amalgam
  + Polymerization
  + Composites

# Reading Supports for Students

The pages that follow include reading supports in the form of an Anticipation Guide, Reading Strategies, a Graphic Organizer, and Student Reading Comprehension Questions. These resources are provided to help students as they prepare to read and in locating and analyzing information from the article.

The borders on these pages distinguish them from the rest of the pages in this Teacher’s Guide—they have been formatted for ease of photocopying for student use.

* **Anticipation Guide (p. 8:** The Anticipation Guide helps to engage students by activating prior knowledge and stimulating student interest before reading. If class time permits, discuss students’ responses to each statement before reading each article. As they read, students should look for evidence supporting or refuting their initial responses.
* **Graphic Organizer (p.9):** The Graphic Organizer is provided to help students locate and analyze information from the article. Student understanding will be enhanced when they explore and evaluate the information themselves, with input from the teacher, if students are struggling. Encourage students to use their own words and avoid copying entire sentences from the article. The use of bullets helps them do this.

If you use the **Anticipation Guide** or **Graphic Organizer** to evaluate student performance, you may want to develop a grading rubric such as the one below.

|  |  |  |
| --- | --- | --- |
| **Score** | **Description** | **Evidence** |
| 4 | Excellent | Complete; details provided; demonstrates deep understanding. |
| 3 | Good | Complete; few details provided; demonstrates some understanding. |
| 2 | Fair | Incomplete; few details provided; some misconceptions evident. |
| 1 | Poor | Very incomplete; no details provided; many misconceptions evident. |
| 0 | Not acceptable | So incomplete that no judgment can be made about student understanding |

* **Student Reading Comprehension Questions (p. 10-11):** The Student Reading Comprehension Questions are designed: to encourage students to read the article (and graphics) for comprehension and attention to detail; to provide the teacher with a mechanism for assessing how well students understand the article and/or whether they have read the assignment; and, possibly, to help direct follow-up, in-class discussion, or additional, deeper assignments.
* **Additional Reading Supports:**
* This issue supports the 2017 National Chemistry Week theme of “Chemistry Rocks!”
* Most of the articles in this issue provide opportunities for students to consider how understanding chemistry can help them in their personal lives.
* Consider asking students to read “Open for Discussion: Sports Drinks” on page 4 to extend the information in “A Toxic Dose of Water” on pages 5-7.
* The infographic on page 19 provides more information to support the article “Making Water Safe to Drink” on pages 14-16.
* To help students engage with the text, ask students which article **engaged** them most and why, or what **questions** they still have about the articles.
* You might also ask them how information in the articles might affect their health and/or consumer choices. Also ask them if they have questions about some of the issues discussed in the articles.
* To help students engage with the text, ask students which article **engaged** them most and why, or what **questions** they still have about the articles. Some of the articles in this issue provide opportunities, references, and suggestions for students to do further research on their own about topics that interest them. The “Web Sites for Additional Information” section of the Teacher’s Guide provides sources for additional information that might help you answer these questions.

“A Toxic Dose of Water: How Much is Too Much?” *ChemMatters*, October/November 2017 Issue)

Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

## Anticipation Guide

“A Close-up Look at the Quality of Indoor Air” (*ChemMatters*, April/May 2016 Issue)

**Directions:**  ***Before reading the article*,** in the first column, write “A” or “D,” indicating your agreement or disagreement with each statement. As you read, compare your opinions with information from the article. In the space under each statement, cite information from the article that supports or refutes your original ideas.

|  |  |  |
| --- | --- | --- |
| **Me** | **Text** | **Statement** |
|  |  | 1. Cells can shrink or swell depending on the amount of water inside. |
|  |  | 1. Most of the water in our bodies is within our cells. |
|  |  | 1. The most plentiful positive ion inside our cells is sodium ion (Na+). |
|  |  | 1. Potassium, sodium, and chloride ions move as freely as water between cells. |
|  |  | 1. Medications, including ibuprofen, can contribute to hyponatremia (too much Na+ inside the cell). |
|  |  | 1. Drinking too much water can dilute the Na+ concentration in your blood. |
|  |  | 1. Sports drinks are unsafe for athletes to use in any amount in hot weather. |
|  |  | 1. The semipermeable membranes in our bodies are composed of lipids. |
|  |  | 1. Electrolyte solutions conduct electricity. |
|  |  | 1. The symptoms of dehydration and hyponatremia are the same. |

## Graphic Organizer

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

“A Toxic Dose of Water: How Much is Too Much?” *ChemMatters*, October/November 2017 Issue)

**Directions**: ***As you read***, complete the graphic organizer below to compare different air pollutants.

|  |  |
| --- | --- |
| **What is it?**  **Osmosis** | **How does it affect electrolyte balance?** |
| **What is the role of lipids in osmosis?** | **What causes hyponatremia?** |

**Summary:** On the bottom or back of this paper, write a short email (about 3 sentences) to a friend who wants to know how drinking too much water can affect your body.

## Student Reading Comprehension Questions

“A Toxic Dose of Water: How Much is Too Much?” *ChemMatters*, October/November 2017 Issue)

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Name

**Directions**: Use the article to answer the questions below.

* 1. What was the cause of Zyrees’s death?
  2. What happened to Cynthia at mile 22 of the Boston Marathon?
  3. What causes (a) dehydration, and (b) hyponatremia?
  4. What happens when the amount of water inside body cells (intracellular) is (a) too low, or   
     (b) too high?
  5. Why is the constant exchange of water between intracellular and extracellular areas critically important?
  6. (a) How do chemists usually report the concentration of a solution? (b) How is molarity defined?

**Student Reading Comprehension Questions, cont.**

“A Toxic Dose of Water: How Much is Too Much?” *ChemMatters*, October/November 2017 Issue)

* 1. Complete the following table: Use Table 1 and information in the article to identify the ion in each column that has the largest concentration, and state the ion’s location (extracellular or intracellular).

|  |  |  |
| --- | --- | --- |
| **Highest Concentration** | **Ion** | **Location** |
| **Cell (M)** |  |  |
| **Blood (M)** |  |  |

* 1. (a) Why is a cell membrane considered semipermeable? (b) What does the process of osmosis describe?
  2. In addition to consuming too much water that can result in hyponatremia, what medications can play a role in bringing on this condition?
  3. What happens when the sodium level in blood plasma falls below 0.135M?
  4. What probably killed Zyrees and Cynthia?
  5. Describe the symptoms of dehydration. Why is it especially important to watch for these?

## Answers to Student Reading Comprehension Questions

* + 1. **What was the cause of Zyrees’s death?**

*The cause of Zyrees’s death was consuming too much water.*

* + 1. **What happened to Cynthia at mile 22 of the Boston Marathon?**

*Cynthia passed out at mile 22 of the Boston Marathon (and died 3 days later of hyponatremia).*

* + 1. **What causes (a) dehydration, and (b) hyponatremia?**
       1. *Dehydration can be caused by not drinking enough water.*
       2. *Hyponatremia can be caused by drinking too much water.*
    2. **What happens when the amount of water inside body cells (intracellular) is (a) too low, or (b) too high?**

1. *When the water content inside body cells is too low, cells can shrink.*
2. *When the water content inside body cells is too high, cells can swell and burst.*
   * 1. **Why is the constant exchange of water between intracellular and extracellular areas critically important?**

*The constant exchange of water between intracellular and extracellular areas …”is critically important for hydration, nerve impulses, muscle function (including the heart) and pH level.”*

* + 1. **(a) How do chemists usually report the concentration of a solution? (b) How is molarity defined?**
       - 1. *Chemists usually report the concentration of a solution in terms of molarity (M).*
         2. *Molarity is defined as the number of moles of solute divided by the volume of the resulting solution in liters.*
    2. **Complete the following table: Use Table 1 and information in the article to identify the ion in each column that has the largest concentration, and state the ion’s location (extracellular or intracellular).**

|  |  |  |
| --- | --- | --- |
| **Highest Concentration** | **Ion** | **Location** |
| **Cell (M)** | *K+* | *Intracellular (within cells)* |
| **Blood (M)** | *Na+* | *Extracellular (outside cells)* |

* + 1. **(a) Why is a cell membrane considered semipermeable? (b) What does the process of osmosis describe?**

1. *A cell membrane is considered semipermeable because water molecules freely pass through the cell membrane, while movement of ions (Na+, K+, and Cl–) is partially blocked.*
2. *The process of osmosis “describes water molecules moving from an area of low-solute concentration to an area of high-solute concentration.”*
   * 1. **In addition to consuming too much water that can cause hyponatremia, what medications can play a role in bringing on this condition?**

*Medications that can play a role in bringing on hyponatremia include diuretics, antidepressants, Ecstasy, and painkillers such as ibuprofen.*

* + 1. **What happens when the sodium level in blood plasma falls below 0.135M?**

*When the sodium level in blood plasma falls below 0.135M, hyponatremia can occur.*

* + 1. **What probably killed Zyrees and Cynthia?**

*Zyrees and Cynthia probably drank too much water, which diluted the Na+ concentration in their blood and, through osmosis, too much water rushed into their brain cells.*

* + 1. **Describe the symptoms of dehydration. Why is it especially important to watch for these?**

*Some signs or symptoms of dehydration are nausea, muscle weakness, dizziness and confusion.*

*It is especially important to watch for these because the symptoms of dehydration are identical to those of hyponatremia.*

# Possible Student Misconceptions

1. **“While running, I need to be certain that my body stays hydrated, so I think of “more is better” and drink as much Gatorade as possible.”** *Drinking as much as possible can be dangerous. Proper hydration is important, but consuming too much water, or fluids containing mostly water, too quickly, can lead to a sodium (Na+) imbalance and hyponatremia.*
2. **“I’ve heard that all athletes can benefit from drinking sports drinks while exercising.”** *Sports drink will not be beneficial until you have lost a considerable amount of Na+ during a long hard workout, one that lasts for more than an hour; until then, water is probably sufficient.*
3. **“I read that ‘carbo-loading’ is important before a marathon.”** *“Carbo-loading” is a running tradition. Runners flock to Italian restaurants for pasta the night before competition. It was believed that carbohydrate storage provided energy needed for long races. Studies now show that the best preparation for distance running is a healthy diet throughout the year and drinking water only when thirsty. For triathlon and longer events, eating salty snacks should be used to replenish Na+—after a marathon or during a triathlon.*
4. **“My cousin told me that when running a marathon, I should hydrate before I am thirsty and continue to drink at least one cup of water every 30 minutes.”** *This was the advice years ago, until it was discovered that one-third of the Boston Marathon runners had low sodium levels. The U.S. Track and Field Association have revised their guidelines and they now advise runners to skip regulated times to hydrate and just drink when they are thirsty.*
5. **“Since sports drinks contain electrolytes, drinking them should keep me from getting hyponatremia.”** *Not necessarily. Sports drinks also contain a lot of water so the sodium in the drink is quite dilute. If you drink them too quickly, there will not be enough time for your body to process the additional water.*

# Anticipating Student Questions

1. **“Does it matter which sports drink I choose?”** *Yes, sports drink ingredients differ. It is important to read the ingredient labels to determine which is best for you and for your activity level. Also, check with your health care provider if you are using prescription medications.*
2. **“Do sports drinks really work?”** *It is important to drink when you are thirsty, but drinking plain water will hydrate as well as sports drinks and it doesn’t contain sugar. Endurance athletes need to replenish sodium ions lost in sweat. Eating potato chips can do this as well as sports drinks.*
3. **“When I run, I sweat a lot, so I need to keep hydrated, but I don’t want to get hyponatremia. How can I hydrate safely?”** *Sports physicians recommend that you drink water when thirsty and snack on salty foods like potato chips or pretzels to replace sodium ions lost in sweat.*
4. **“What makes me feel thirsty?”** *The hypothalamus located in the brain has sensors that monitor the concentration of sodium in the blood. When the sodium concentration increases to a certain level because there is a lack of water, the brain sends thirst signals.*
5. **“How can taking Ecstasy increase the risk of hyponatremia?”** *Ecstasy disrupts the normal release of the hormone arginine vasopressin* **(***ADH) from the brain. This is the hormone that signals the kidneys to either excrete water in the urine or absorb and keep it to prevent dehydration. Ecstasy increases the release of ADH. This signals the kidneys to retain water, which may lead to hyponatremia.*

# Activities

**Labs and Demos**

**“Electrolytes and Non-electrolytes” lab (1 class period):** Students test the conductivity of various solutions including soda and Gatorade. This lab could be extended to include testing other sports drinks. (<http://www.sciencegeek.net/Chemistry/chempdfs/Electrolytes.pdf>)

**“The Energy of Evaporation – A Lab Investigation” (45–50 min.):** Students measure evaporation rates of water, acetone and isopropyl alcohol. This data and structural formulas are used compare and explain the strength of the intermolecular forces between molecules of each substance. (<http://highschoolenergy.acs.org/content/hsef/en/how-can-energy-change/energy-of-evaporation/_jcr_content/toparticleparsys/columnsbootstrap/column1/acscontainer/containerPar/download/file.res/Teachers_Key.pdf>)

**Media**

**Two Khan Academy videos:** These presentations are designed to enhance student understanding at the particle level. Videos are accompanied by complete text transcripts.

* + “LeBron asks: “Why does sweat cool you down?” (5:39) A question from basketball star LeBron James leads to an explanation of molecular collisions, average kinetic energy of molecules, and phase changes involved in evaporative cooling. (<https://www.khanacademy.org/science/biology/water-acids-and-bases/water-as-a-solid-liquid-and-gas/v/lebron-asks-why-does-sweating-cool-you-down>)
  + “Osmosis, Membranes and Transport” (8:03) Particle-level diagrams show osmosis through a semipermeable membrane as water moves from low to higher solute concentrations. (<https://www.khanacademy.org/science/chemistry/states-of-matter-and-intermolecular-forces/mixtures-and-solutions/v/boiling-point-elevation-and-freezing-point-supression>)

**“Introduction to homeostasis”, YouTube video (4:07)** Students will enjoy this well-done, partially animated presentation that clearly explains homeostasis, the negative feedback loop, and how the hypothalamus controls the body’s response to hot or cold in the outside environment. (<https://www.youtube.com/watch?v=-W7kAyUQT0E>)

**Lessons and Lesson Plans**

**A debate, “Rise and Sell: The Energy Drink Business and What They’re Really Offering” (90 min.)** This lesson, with complete instructions, is designed for a debate class but would fit well as a chemistry debate. A major goal is for students to recognize beliefs and assumptions regarding energy drinks. (<https://teachers.net/lessonplans/posts/4258.html>)

**Lesson plan for an experimental design, “Is Gatorade® the Only Source of Electrolytes?” (60–90 min.)** Students are asked to consider Gatorade advertisements and plan an investigation designed to provide evidence of the presence of electrolytes. (<http://alex.state.al.us/lesson_view.php?id=34677>)

**Projects and Extension Activities**

**Group research project and poster presentation:** Students will identify the ingredients in a sports drink, determine the rationale for each addition and prepare a classroom poster that illustrates and describes the purpose of each chemical ingredient (beyond basic carbohydrates). This Web site (for teacher use only) may help in poster evaluation: (<http://www.myhealthwire.com/news/diet-nutrition/345>).

**Design and advertise a new sports drink:** Research possible formulas for known sports drinks. Design a sports drink with specialty ingredients. Use information about the additives you choose to convince your audience that your new drink is a “must-buy”. Name the new drink and prepare an advertisement in the format of your choice (brochure, Prezi, video, live presentation, etc.).

# References

**The references below can be found on the *ChemMatters* 30-year DVD, which includes all articles   
published from the magazine’s inception in October 1983 through April 2013; all available Teacher’s Guides, beginning February 1990; and 12 *ChemMatters* videos. The DVD is available from the American Chemical Society for $42 (or $135 for a site/school license) at this site:** [**http://ww.acs.org/chemmatters**](http://www.acs.org/chemmatters)**. Click on the “Teacher’s Guide” tab to the left, directly under the “*ChemMatters Online"* logo and, on the new page, click on “Get the past 30 Years of *ChemMatters* on DVD!” (the icon on the right of the screen)**

**Selected articles and the complete set of   
Teacher’s Guides for all issues from the past three   
years are available free online at the same Web site, above. Click on the “Issues” tab just below the logo, *“ChemMatters Online”*.**



***30* Years of *ChemMatters !***

Available Now!

Consuming sports drinks is one way to restore electrolytes and sugar lost during endurance activities; however sports drinks are not beneficial for exercise under an hour. This article mentions athletes becoming dehydrated but not hyponatremic. (Graham, T. Sports Drinks: Don’t Sweat the Small Stuff. *ChemMatters*, 1999, *17* (1), pp 11–13)

The “Drinking Bird” toy works similarly to the way evaporation of sweat cools the skin. Author Rohrig provides an explanation of how the toy works in this article. (Rohrig, T. The Amazing Drinking Bird. *ChemMatters,* 2005, *23* (3), pp 10–11)

This article discusses the ingredients in energy drinks, the physiological effects of each additive, and how the combined effect of several of the added substances may be harmful. (Rohrig, B. Are Energy Drinks Good for You? *ChemMatters*, 2008, *26* (4), pp 10–11)

Diagrams in this article compare normal cells (balanced osmolarity between interstitial and intracellular fluids) with shrunken cells and bursting cells (too much salt). (Eboch, C. Shaking out the Facts about Salt. *ChemMatters*, 2016, *34* (1), pp 11–13.)

# Web Sites for Additional Information

**Invention of sports drinks**

Long before Gatorade, there was Glucozade. Rebranded as Lucozade, it is still the best selling sports drink in the UK. This site provides more of the history and backstory of this early sports drink. (<http://www.campaignlive.co.uk/article/superbrands-case-studies-lucozade/232378?src_site=brandrepublic>)

Concern over heat effects on University of Florida “Gators” football players prompted the production of Gatorade, designed to replace water, electrolytes and energy lost during practice and games. Find more about Gatorade here: <https://www.gatorade.com/company/heritage>.

**Sports drink ingredients**

While the basic composition of all sports drinks is the same, individual manufacturers add their own colors, flavors and preservatives. Ingredients of various drinks are listed on a table at this URL:

<https://www.sportsdietitians.com.au/wp-content/uploads/2015/04/Sports-Drinks.pdf>.

This Web site explains how to calculate the efficiency of oxidizing glucose for quick energy during sports. (<http://www.tiem.utk.edu/~gross/bioed/webmodules/ATPEfficiency.htm>)

**Sports drinks vs energy drinks**

When *Consumer Reports* magazine analyzed the caffeine content in 27 top-selling energy drinks available in U.S. markets, they found that many companies underestimated the amount of caffeine in their products, by as much as 20%. Results are published in a table at <http://www.consumerreports.org/cro/magazine/2012/12/the-buzz-on-energy-drink-caffeine/index.htm>.

Along with warnings about the effects of consumption of excess caffeine (sleeplessness, heart palpitations, headaches, nausea, jitters and death), the World Anti-doping Agency (WADA) has added caffeine to its Monitoring Program for 2017. (<https://www.washingtonpost.com/news/early-lead/wp/2017/03/08/caffeine-could-be-headed-to-world-anti-doping-agencys-prohibited-substance-list/>)

**Sweat glands**

This research paper published by the U.K. *Journal of the Royal Society* compares the activity of hunter-gatherers to modern athletes to explain our need for apocrine glands. These are the sweat glands that secrete an oily solution through hair follicles. (<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1281456/>)

Eccrine glands, the major human sweat glands, secrete an odorless, water-based electrolytic fluid though pores all over the body. This site contains an illustration of sweat glands and discusses how sweat glands work. (<http://health.howstuffworks.com/skin-care/information/anatomy/how-sweat-works2.htm>)

**Homeostasis**

This site includes diagrams that illustrate how negative feedback loops reduce the effect of a stimulus, stabilize the system and return the system to homeostasis—the body’s ability to maintain stable internal conditions necessary for survival (e.g., regulation of normal body temperature in response to hot or cold external stimuli), or response to changes in blood glucose levels. (<https://www.khanacademy.org/science/biology/principles-of-physiology/body-structure-and-homeostasis/a/homeostasis>)

This Rice University site describes the differences in (and confusion about) the terms: homeostasis, steady state, and chemical equilibrium. Definitions and examples of each situation is provided, including a description of the two major differences between homeostasis and equilibrium. (<http://www.ruf.rice.edu/~bioslabs/studies/invertebrates/steadystate.html>)

**Thermoregulation**

This Web site explains the role of the hypothalamus in regulating body temperature. Diagrams illustrate mechanisms to show how this is accomplished. (<http://www.bbc.co.uk/schools/gcsebitesize/science/add_ocr_pre_2011/homeostasis/bodytemprev4.shtml>)

This Web site describes the chemical composition of human sweat, our body’s mechanism for regulating our internal temperature, including ion concentrations. (<https://www.thoughtco.com/chemical-composition-of-human-sweat-or-perspiration-604001>).

**Balancing electrolytes**

The University of Utah defines osmosis as the process responsible for maintaining the electrolytic balance in the body. This site provides a 25-page slide show of the osmotic balance in various types of animals: (<http://www.sci.utah.edu/~macleod/bioen/be6000/notes/L17-osmotic-balance.pdf>.

This site contains nice illustrations, plus a description of the three terms used to describe the concentration of a solution in comparison to the concentration of the interstitial fluid. (<http://www.dummies.com/education/science/anatomy/the-cell-membrane-diffusion-osmosis-and-active-transport/>.

**Water’s role in electrolyte balance**

The focus of this chapter is on water’s important physiological role in the transport of electrolytes and nutrients (biochemical molecules), maintaining osmotic and temperature balance, and as a medium for chemical reactions. Guidelines for determining the replenishment needs of weekend athletes, teens and children, videos on dehydration and osmosis and a link to U.S. Centers for Disease Control and Prevention (CDC) data are included. (<https://2012books.lardbucket.org/books/an-introduction-to-nutrition/s11-nutrients-important-to-fluid-a.html#zimmerman_1.0-ch07_s01_s01_s01_n01>)

Normal kidney function and its essential role in regulating the concentration of water in blood plasma are explained. A detailed diagram shows how the brain signals release of the hormone (ADH) to direct the process of adjusting the concentration of water excreted in the urine. (<http://www.bbc.co.uk/schools/gcsebitesize/science/add_ocr_pre_2011/homeostasis/waterbalrev3.shtml>)

**Hyponatremia**

This clear description of the causes of, and dangers present in, our “over-hydrated culture” includes a discussion of the physiological effects of drinking too much water. (<https://www.scientificamerican.com/article/strange-but-true-drinking-too-much-water-can-kill/>)

Emphasis is placed on overhydration presenting a greater risk than dehydration in this Web site. Discussion includes tips on how much liquid runners should drink, and the best times for runners to drink liquids. (<https://runnersconnect.net/overhydration-dangers-drinking-too-much-water-while-running/>)

# About the Guide

Teacher’s Guide team leader William Bleam and editors Pamela Diaz, Steve Long and Barbara Sitzman created the Teacher’s Guide article material.

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Articles from past issues of *ChemMatters* and related Teacher’s Guides can be accessed from a DVD that is available from the American Chemical Society for $42. The DVD contains the entire 30-year publication of *ChemMatters* issues, from February 1983 to April 2013, along with all the related Teacher’s Guides since they were first created with the February 1990 issue of *ChemMatters*.

The DVD also includes Article, Title, and Keyword Indexes that cover all issues from February 1983 to April 2013. A search function (similar to a Google search of keywords) is also available on the DVD.

The *ChemMatters* DVD can be purchased by calling 1-800-227-5558. Purchase information can also be found online at <http://tinyurl.com/o37s9x2>.