

**April/May 2017 Teacher's Guide**

**for**

***Don’t Let Cortisol Stress You Out!***

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# About the Guide

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

E-mail: bbleam@verizon.net

Susan Cooper prepared the anticipation and reading guides.

Patrice Pages, *ChemMatters* editor, coordinated production and prepared the Microsoft Word and PDF versions of the Teacher’s Guide.

E-mail: chemmatters@acs.org

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>.

# Student Questions

**Don’t Let Cortisol Stress You Out!**

* 1. Name a region of the brain and two different glands that produce stress hormones.
	2. What is CRH, and where in the body is it produced?
	3. Why is the pituitary gland called the master gland?
	4. What hormone triggers the release of cortisol?
	5. Describe the carbon skeleton of steroid molecules.
	6. Describe how the cascade of stress occurs in the body.
	7. Describe three functions of cortisol.
	8. Long term overstimulation of cortisol causes a wide range of negative effects on the body, such as the breakdown of muscle, bone, and connective tissue. What molecule is the product of the breakdown of these tissues?
	9. What part of the brain is important for memory?
	10. Describe four ways to prevent stress.
	11. What did one in five teens identify as a cause of stress?

# Answers to Student Questions

**(taken from the article)**

**Don’t Let Cortisol Stress You Out!**

1. **Name a region of the brain and two different glands that produce stress hormones.**

*A region of the brain that produces stress hormones is the hypothalamus. Two glands that produce stress hormones are the pituitary gland and the adrenal glands.*

1. **What is CRH, and where in the body is it produced?**

*CRH is the corticotropin-releasing hormone, and it is produced by the hypothalamus.*

1. **Why is the pituitary gland called the master gland?**

*The pituitary gland is called the master gland “because it orchestrates many of the body’s hormonal responses, including stress.”*

1. **What hormone triggers the release of cortisol?**

*The adrenocorticotropic hormone (ACTH) which is released by the pituitary gland triggers the release of cortisol by the adrenal glands.*

1. **Describe the carbon skeleton of steroid molecules.**

*The carbon skeleton of steroids contain three six-membered rings and one five-membered ring.*

1. **Describe how the cascade of stress occurs in the body.**

*The cascade of stress occurs as follows: “A neural signal from the brain triggers release of CRH from the hypothalamus, which triggers the release of ACTH from the pituitary gland, which triggers release of cortisol from the adrenal glands.”*

1. **Describe three functions of cortisol.**

*Cortisol increases the amount of glucose in the bloodstream, which supplies sugar to muscles, it inhibits inflammation, and it suppresses the immune response.*

1. **Long term overstimulation of cortisol causes a wide range of negative effects on the body, such as the breakdown of muscle, bone, and connective tissue. What molecule is the product of the breakdown of these tissues?**

*Glucose is produced as a result of the breakdown of muscle, bone, and connective tissue.*

1. **What part of the brain is important for memory?**

*The hippocampus is the part of the brain that is important for memory.*

1. **Describe four ways to prevent stress.**

*Cutting back on coffee, getting adequate sleep, bundling up when it is cold, and including more omega-3 fatty acids in the diet can all help prevent stress.*

1. **What did one in five teens identify as a cause of stress?**

*One in five teens identified a lack of sleep as a cause of their stress.*

# Anticipation Guide

Anticipation guides help to engage students by activating prior knowledge and stimulating students’ 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.

**Directions: *Before reading***, 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. Cortisol is released in the brain.
 |
|  |  | 1. The pituitary gland orchestrates many of the body’s hormonal responses.
 |
|  |  | 1. Steroids are organic molecules containing four rings.
 |
|  |  | 1. Cortisol reduces the amount of glucose in the bloodstream.
 |
|  |  | 1. Too much cortisol can reduce muscle mass.
 |
|  |  | 1. Caffeine can reduce cortisol secretion.
 |
|  |  | 1. Chronic stress can damage the brain.
 |
|  |  | 1. Lack of sleep can increase cortisol production.
 |
|  |  | 1. Omega-3 fatty acids found in fish and nuts can increase cortisol secretion.
 |
|  |  | 1. The practice of meditation can reduce cortisol production.
 |

# Reading Strategies

These graphic organizers are provided to help students locate and analyze information from the articles. Students’ 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 articles. The use of bullets helps them do this. If you use these reading strategies 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 |

***Teaching Strategies:***

* 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.
* **Vocabulary** and **concepts** that are reinforced in this issue:
	+ Chemical reactions
	+ Macro- and micronutrients
	+ Personal and community health
	+ Proteins
	+ Structural formulas
	+ Biochemistry
	+ Consumer choices
	+ Recycling
* Some 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” on page 4 to extend the information in “Growing Green on the Red Planet” on pages 5-7.
* The infographic on page 19 provides more information to support the article “Espresso, Café Latte, Cappuccino…A Complex Brew” on pages 10-12.
* 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.
* The Background Information in the *ChemMatters* Teachers Guide has suggestions for further research and activities.

**Directions:** As you read the article, complete the graphic organizer below to describe how cortisol is related to stress.

|  |  |
| --- | --- |
|  | **Chemicals involved** |
| **HOW does stress affect cortisol production?** |  |
| **WHAT is cortisol?** |  |
| **WHY is too much cortisol a bad thing?** |  |
| **HOW can cortisol production be reduced?** |  |

**Summary:** On the back of this page, summarize the information about cortisol production in a sentence (20 words or less).

# Connections to Chemistry Concepts

**(for correlation to course curriculum)**

1. **Organic chemistry: structural formulas and molecular shapes**—In discussion of structural formulas, hybridized carbon atoms and molecular shapes of organic compounds, steroids and cortisol ring structures can make good examples of slightly more complex molecules showing these concepts.
2. **Organic chemistry: functional groups**—In the study of functional groups in organic chemistry, hormones can be used as examples of molecules containing various functional groups (e.g., the hydroxyl, carboxyl, amine, and keto functional groups).
3. **Cascade reactions**—In a more advanced chemistry class, a discussion of cascade reactions (e.g., the copper(II) one pot reaction) can include a discussion of the cascade of stress reactions that occur in the body. This stress cascade might even introduce the chemistry concept.
4. **Acids and bases**—The study of acids and bases can include a discussion of amino acids, molecules containing both acid (–COOH) and base (–NH2) groups, as well as the production of proteins from amino acids reacting with each other via hydrolysis. Amino acid-derived hormones also provide a real-life example of acid-base chemistry.

# Possible Student Misconceptions

**(to aid teacher in addressing misconceptions)**

***Possible Student Misconceptions (to aid teacher in addressing misconceptions)***

1. **“Stress doesn’t bother me, I’m used to it.”**

*Rather than “getting used to stress,” one has to learn to reduce stress. As long as stress is present, our bodies respond by producing stress hormones such as epinephrine and cortisol. These hormones increase blood pressure, heart rate, and blood glucose, as well as cause anxiety, fatigue, and other symptoms. Being used to chronic stress will not prevent your body from making stress hormones. In order to reduce the level of stress hormones in the blood, you have to prevent the stress. Eating well balanced meals, exercising daily, getting enough sleep, and maintaining a positive attitude are some of the ways to manage stress.*

1. **“Exercising will not relieve my stress, because it is a physical stress.”**

*Yes, exercise is a physical stress, and it does cause a short term elevation of cortisol. But shortly after exercising, cortisol levels in the blood decrease and produce health benefits, such as feeling more relaxed, improving mood, and improving quality of sleep.*

# Anticipating Student Questions

**(answers to questions students might ask in class)**

1. **“Can the negative effects of chronic stress such, as diabetes, high blood pressure, and impaired memory be reversed?”** *It may take a long time to relieve the stress, but by changing some behaviors, yes. Getting adequate sleep, eating well balanced meals, avoiding caffeine and alcohol, and exercising daily may help.*
2. **“If I can manage anxiety and stress with a positive attitude and practicing yoga, then is stress more of a psychological disease than a hormone imbalance?”** *Our bodies need a restoration phase after a stress event in order for the cortisol levels to return to normal. These is evidence to show that stress, caffeine, and sleep deprivation cause the body to make higher levels of cortisol, and it is the cortisol, not attitude, that causes the negative effects of stress.*

# Activities

**Labs and Demos**

1. **“Kaleidoscopical Activity” demonstration:** This demonstration explores optical isomers that are able to twist light waves in different directions. (<https://www.flinnsci.com/globalassets/flinn-scientific/all-free-pdfs/dc91417.pdf>)
2. **“One pot copper(II) reactions” experiment:** Students perform a series of reactions in one pot, or vessel. This can be related to the cascade reactions that are discussed in the article. (<http://dwb5.unl.edu/CHEM/SmallScale/SmallScale-061.html>)
3. **“Identification of an unknown amino acid” from its titration curve experiment:** Amino acids in solution at neutral pH are zwitterions. The point at which zwitterions form is called the isoelectric point and can be used to identify an unknown amino acid.

(<http://www.colby.edu/chemistry/CH367/laboratory/expt1.pdf>)

1. **“Disturbing an Equilibrium System” experiment:** In this hands-on activity, students will study factors that can disturb an equilibrium system and make predictions about how a reaction will shift when a stress is applied. (<http://dwb5.unl.edu/CHEM/LABS/LABS-14.html>)
2. **“Preparation of Cholesteryl Ester Liquid Crystals” experiment:** In this experiment, a series of liquid crystals from cholesteryl esters will be prepared and their properties to change color at different temperatures will be examined. The novelty mood rings that were popular in the 1970s contained liquid crystals. (<http://www.chymist.com/Liquid%20Crystals.pdf>)
3. “**Preparation of liquid crystals**” **experiment:** This activity contains the directions for purchasing and preparing the cholesteryl ester solutions needed for the “Preparation of Cholesteryl Ester Liquid Crystals experiment (<http://education.mrsec.wisc.edu/274.htm>)
4. **“Color changes and mood rings” experiment:** The causes of color changing rings are investigated. ([https://sciencewithtoys.wikispaces.com/Mood+rings](https://sciencewithtoys.wikispaces.com/Mood%2Brings))

**Simulations**

1. **“Equilibrium”:** This ChemCollective site includes concept tests to be used for class discussions, scenario based activities, and tutorials related to equilibrium concepts. (<http://chemcollective.org/equilib>) Note: Java Virtual Machine must be installed on your computer to run this software.
2. **“Le Châtelier’s Principle—Concentrations”** Students play with the simulation to see and understand on a particle level why equilibrium shifts when put under a stress of changing concentration. (<https://phet.colorado.edu/en/contributions/view/3858>)

**Media**

1. ***National Geographic* presents “The Science of Stress”:** (55:50). The video discusses how stress hormones were designed to help us survive. But we now know that chronic stress is dangerous and has many negative effects on our bodies. (<https://www.youtube.com/watch?v=ZyBsy5SQxqU>)
2. **“A Video Review of How Hormones Use G-protein Signaling Pathways”:** This video (9:49) summarizes how water soluble hormones function in target cells.

 (<https://www.youtube.com/watch?v=wC2_7Ror3qY>)

1. **“A Video review of mechanisms of steroid hormones”:** This short video (1:26) explains how steroid hormones function in target cells.

([https://www.youtube.com/watch?v=m9jOXiYdMeYhttps://www.youtube.com/watch?v=m9jOXiYdMeY](https://www.youtube.com/watch?v=m9jOXiYdMeY))

**Lessons and Lesson Plans**

1. **“Geometric Isomers of Alkenes”:** Students will work in cooperative groups to complete this POGIL activity on pages 11–15 to study *cis*- and *trans-* isomers. (<http://www.cognella.com/pdf/abrahamson_sneak_preview.pdf>)
2. **“Guided Inquiry Activity—Equilibrium and le Châtelier’s Principle”** After completing this guided inquiry activity, students will be able to explain chemical equilibrium, identify factors that disrupt a system at equilibrium, and explain the effects of the shift on the original equilibrium.

(<https://pogil.org/uploads/media_items/equilibrium-and-le-chatelier-s-principle.original.pdf>)

**Projects and Extension Activities**

1. **Students make hormone-receptor models** to understand how hormones bind to specific receptors before initiating a cellular response. (<https://www-tc.pbs.org/wgbh/nova/education/activities/pdf/3313_03_nsn.pdf>)

# References

**(non-Web-based information sources)**

**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”*.**

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This article discusses various hormones of the endocrine system. In particular, it discusses the sex hormone and relates form to function. (Tinnesand, M. Your Body Under Construction. *ChemMatters*, 2011, *29* (4), pp 14–16)

The Teacher’s Guide for the December 2011 article above provides additional information on the endocrine system and hormones, in particular the sex hormones, and their receptors.

This 2014 article discusses performance enhancement drugs such as anabolic steroids, which mimic the hormone testosterone. (Wendel, J. Performance Enhancement Drugs. Is Winning Everything? *ChemMatters*, 2014, *32* (3), pp 9–11)

There is useful information in this article about chiral molecules. The article defines chiral molecules, explains enantiomers, and discusses how chirality affects how these molecules function. (Warmflash, D. Left Life? Right Life? Chirality in Action. *ChemMatters*, 2015, *33* (2), pp 5–7)

# Web Sites for Additional Information

**(Web-based information sources)**

**Hormones**

“Healthline” provides this site that describes the hypothalamus and the hormones produced by this gland. (<http://www.healthline.com/human-body-maps/hypothalamus>)

This site describes the hypothalamus, homeostasis, and the feedback mechanisms that maintain homeostasis. (<http://www.braintheinsidestory.co.uk/hypothalamus-section/>)

This concept review of amino acids, the precursors of hormones, describes their isomeric forms and polarity. (<http://www.phschool.com/science/biology_place/biocoach/bioprop/landd.html>)

This Web site describes the synthesis, transport, and endocrinology of thyroid hormones: <http://people.upei.ca/bate/html/notesonthyroidfunction.html>.

**Receptors**

This site includes information about hormone receptors: <http://e.hormone.tulane.edu/learning/docking-receptor-binding.html>.

**Stress**

This site discusses the role of CRH in chronic stress: <https://breakingmuscle.com/learn/what-you-dont-know-about-crh-can-kill-you>.