



DON'T LET CORTISOL STRESS YOU OUT!

WEST HIGH SCHOOL SECOND BASEMAN CRAIG HAWKSON knows as soon as he swings his bat that it's going to be a strike. The ball lands in the catcher's mitt and Craig turns and heads ingloriously back to the dugout. He runs the implications through his mind: It's the third strike, which makes it the third out, which means the men on second and third won't score, which means his team won't retake the lead in the game.

But Craig's mind is even more occupied with thoughts of the *really* big game with Central High, which is coming up in three weeks, when a talent scout from the state university will watch him play. If he doesn't hit the ball—and hit solid balls that get him on base each time at bat—he can kiss his college scholarship goodbye.

Craig shuffles into the dugout and grabs his mitt, ready to trot out and take his defensive position at second base. The coach comes up to him.

"Focus, Craig. Remember to focus. You can hit those pitches. You want to get your swing back by the big game."

"Thanks, coach."

"What's been getting in your way?"

"I don't know. I just need more practice, I guess."

"OK. Now get out there and play ball."

Craig runs out to second base. He *does* know what is getting in the way—he's just been too stressed out to play well. He's feeling overwhelmed with his heavy load of high school honors and Advanced Placement classes, his part-time work schedule at a hardware store, his baseball schedule, and, on top of all that, performing ongoing fix-it projects on his aging 1993 Chevrolet Camaro. The stress is playing havoc with his concentration, with his energy level—even, he thinks, with his coordination when he swings his bat.

Standing by the well-worn canvas bag on second base, waiting for the visiting team's player at home plate to take his first swing of the new inning, Craig makes a decision. He knows that stress is messing up his game, so he decides to do something about all this stress. With the solid, unflagging determination of a Hawkson, Craig vows that by the time the big game with Central High arrives, he is going to relax and swing like a pro.

By John P. Roche

Stress and hormones

That evening after dinner, Craig asks his mother, who is a physician, if he can talk to her. They go to her study, and he asks her to tell him about stress and how to reduce it. He knows that he is in for a scientific lecture because, in his mother's world, it is all about education. But he decides to endure her lecture because he needs all the help he can get.

His mother explains that stress is the activation of a cascade of hormones in the body, beginning with a region of the brain called the **hypothalamus**, moving on to a gland in the brain called the **pituitary gland**, and ending up with the secretion of a hormone, known as **cortisol**, from the **adrenal glands** that sit on top of the kidneys (Fig. 1).

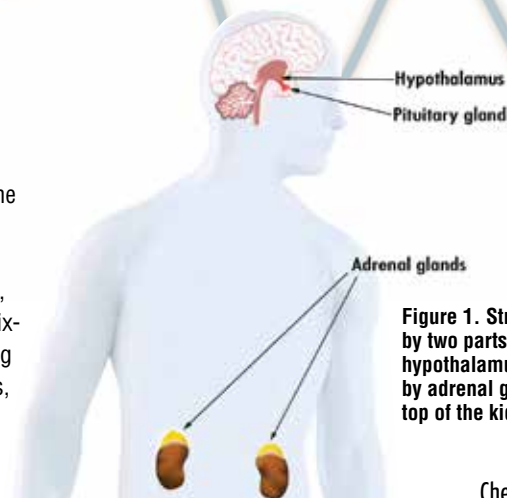


Figure 1. Stress hormones are produced by two parts of the brain, called the hypothalamus and the pituitary gland, and by adrenal glands, which are present on top of the kidneys.

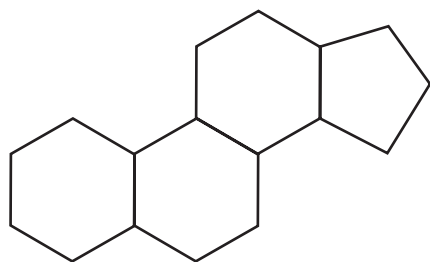


Figure 2. The four-ring core structure of a steroid molecule. Carbon atoms are located at the corners of every ring.

Craig already knows that his stress begins in his brain. When Craig's brain recognizes, say, an upcoming exam in honors biology, nerve signals go to the hypothalamus in his brain. In response to these nerve signals, his hypothalamus releases a molecule called **corticotropin-releasing hormone (CRH)**, which travels to Craig's pituitary gland.

The pituitary gland is the master gland of the body, because it orchestrates many of the body's hormonal responses, including stress. CRH from the hypothalamus causes the pituitary gland to release another hormone, called **adrenocorticotropic hormone (ACTH)**. When ACTH is released, it circulates throughout the body in the bloodstream, and when it reaches the adrenal glands, it triggers the release of a hormone called cortisol.

Craig's mother mentions that cortisol, the stress hormone, is a steroid hormone. Craig interrupts his mother at the mention of the word "steroid." "Aren't steroids illegal drugs responsible for giving athletes huge muscles?" His mother explains that the steroids he is thinking of are synthetic versions of human hormones that were originally developed to help promote muscle growth in individuals whose muscles had atrophied from lack of use following surgery.

Steroids are organic molecules that contain three six-membered rings and one five-membered ring (Fig. 2). This structure is called a carbon skeleton. It is common to all steroid molecules, but each of these molecules differ in the identity and location of the atoms attached to this carbon skeleton. The chemical structure of cortisol is shown in Fig. 3.

Craig summarizes how the cascade of stress occurs in the body: "So, a neural signal from the brain triggers release of CRH from the hypothalamus, which triggers the release

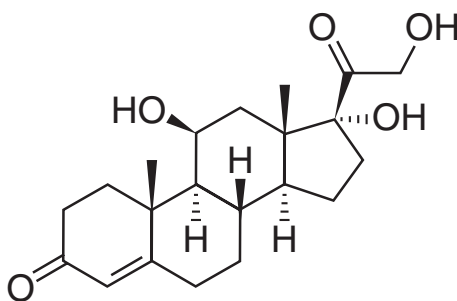


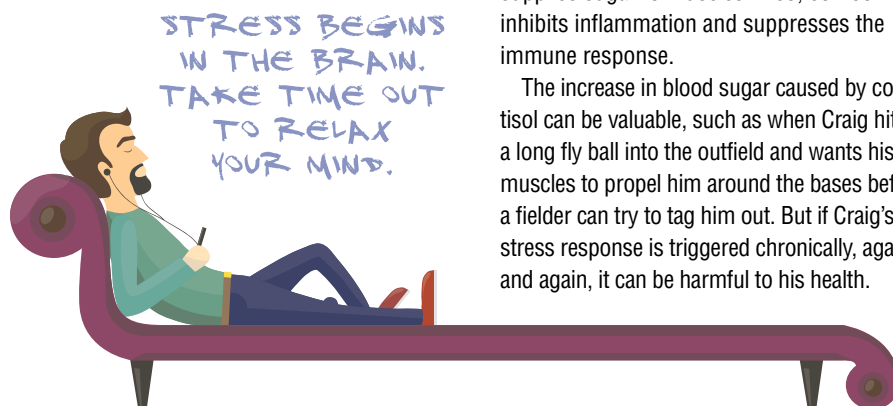
Figure 3. The chemical structure of a cortisol molecule

of ACTH from the pituitary gland, which triggers release of cortisol from the adrenal glands. But what happens next? What effects does cortisol have on my body?"

The downside of too much stress

Craig's mother explains that cortisol triggers the release of the sugar glucose into the bloodstream. So cortisol increases the amount of glucose in the bloodstream, which supplies sugar to muscles. Also, cortisol inhibits inflammation and suppresses the immune response.

The increase in blood sugar caused by cortisol can be valuable, such as when Craig hits a long fly ball into the outfield and wants his muscles to propel him around the bases before a fielder can try to tag him out. But if Craig's stress response is triggered chronically, again and again, it can be harmful to his health.



Tips to Manage Anxiety and Stress

- ▶ **Take a time-out.** Practice yoga, listen to music, meditate, get a massage, or learn relaxation techniques.
- ▶ **Eat well-balanced meals.** Do not skip any meals.
- ▶ **Limit alcohol and caffeine.**
- ▶ **Get enough sleep.**
- ▶ **Exercise daily.**
- ▶ **Take deep breaths.**
- ▶ **Count to 10 slowly.** Repeat, and count to 20 if necessary.
- ▶ **Instead of aiming for perfection, which isn't possible, be proud of however close you get.**
- ▶ **Accept that you cannot control everything.**
- ▶ **Welcome humor.**
- ▶ **Maintain a positive attitude.**
- ▶ **Volunteer or find another way to be active in your community.**
- ▶ **Learn what triggers your anxiety.** Is it work, family, school, or something else you can identify? Write in a journal when you're feeling stressed or anxious, and look for a pattern.
- ▶ **Talk to someone.** Tell friends and family you're feeling overwhelmed. Talk to a physician or therapist for professional help.



SOURCE: TIPS TO MANAGE ANXIETY AND STRESS. ANXIETY AND DEPRESSION ASSOCIATION OF AMERICA: <https://www.adaa.org/tips-manage-anxiety-and-stress> [accessed Feb 2017].

With long-term overstimulation, cortisol causes a wide range of negative effects. It causes deposition of fat in the stomach and face and promotes the breakdown of muscle, bone, and connective tissue to create glucose. Long-term overstimulation can therefore cause a reduction in body muscle mass—not something Craig wants with the physical demands of playing baseball and moving crates of supplies at the hardware store.

Various scientific studies have shown that chronic stress can also increase the risk of high blood pressure, type 2 diabetes, and elevated lipid levels. Stress also impairs memory and interferes with learning. If Craig waits until the night before an exam to start studying, this strategy can be doubly counterproductive—it leaves him with less time to study, and the stress of preparing at the last minute makes it more difficult for him to learn. Chronic stress can even cause damage to an area of the brain called the **hippocampus** that is important for memory—another outcome that Craig definitely wants to avoid.

There are other triggers, which can be controlled. For example, consumption of caffeine has been found to increase cortisol secretion. Also, a lack of adequate sleep can cause an increase in cortisol. Another trigger is a drop in body temperature, which can lead to a secretion of cortisol and a suppression of the immune system.

Preventing stress

“So what do I do?” Craig asks. As usual, his mother tells him. “I’ve provided you with a lot of information. Sort through it, make decisions, and I will support you.”

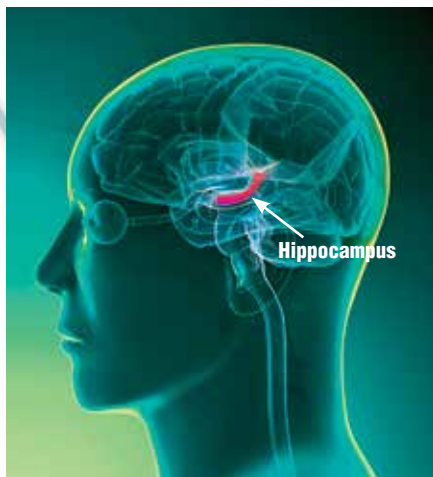
Craig decides that he would start with easy changes: He would try cutting back on coffee, getting adequate sleep, and bundling up when it is cold—all steps that can help reduce his cortisol secretion. He also decides to include more omega-3 fatty acids in his diet, which are abundant in many kinds of fish and nuts, because these fatty acids can inhibit CRH secretion.

He also tries a meditation class at the local yoga studio. Scientists found that the practice of meditation can reduce the secretion of CRH from the hypothalamus, reducing stress. Other researchers discovered that when practiced over long periods of time, meditation improves memory and increases the amount of gray matter in some areas of the brain.

Teens and Stress

According to a survey published in February 2014 by the American Psychological Association, **30% of teens said they felt depressed or sad because of stress.** Also, 36% of them reported feeling tired, and 23% of them reported skipping a meal due to stress. **Nearly one in five teens said that when they do not get enough sleep, they are more stressed.**

SOURCE: AMERICAN PSYCHOLOGICAL ASSOCIATION SURVEY SHOWS TEEN STRESS RIVALS THAT OF ADULTS (PRESS RELEASE). FEB 11, 2014: <http://www.apa.org/news/press/releases/2014/02/teen-stress.aspx> [accessed Feb 2017].



Chronic stress can cause damage to an area of the brain called the hippocampus (shown here in red), which is important for memory.

Because physical exercise can be a great de-stressor, Craig decides to increase the number of times per week that he performs noncompetitive physical activity. Exercise itself is a stress to the body, causing a short-term elevation of cortisol, but it also has several health benefits that reduce stress after the exercise is complete. These health benefits include feeling more relaxed, elevating one's mood, and improving one's quality of sleep.

Three weeks later, when his big game arrives, Craig takes his place at home plate, choking up a little on the bat, feeling rested and full of energy and confident that whatever happens, he will have done his best.

The first pitch flies past him in the strike zone before he can react. Strike one. The next pitch is a ball, low and outside. The next pitch is another fastball and he swings hard and misses. Strike two. Three weeks ago, he would be panicking. But today, he glances up at the bleachers, checks on the college scout in the fifth row, and then stares out at the pitcher.

He sees the ball spinning toward him, as if in slow motion, and he digs the balls of his feet into the dirt. He swings the bat with a concentrated burst of power and swat! The ball soars past the fence, he jogs around the bases, and as he passes third, he sees the scout give him a thumbs-up sign. Craig feels a rush of relief, and then he experiences the glimmer of a new and welcome kind of stress—he wonders what he is going to choose as a major in college. CM

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John P. Roche is an author and science writer who lives in Massachusetts. This is his first article in *ChemMatters*.