

THE POWER OF YOUR ADRENAL GLANDS TO HELP YOU COPE WITH STRESS

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YOUNG REVIEWERS:



CHI LOK
AGE: 11



FURQAN
AGE: 10



JASPER
AGE: 11



LIAM
AGE: 12

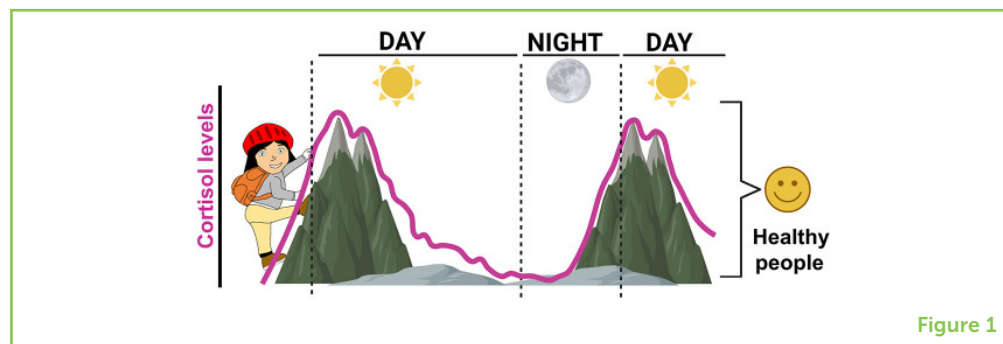
Whenever you face a difficult exam at school, you may feel nervous and stressed. In these situations, your adrenal glands kick in. These glands are located on the tops of the kidneys. The main job of the adrenal glands is to produce hormones, which are molecules responsible for many functions in the body. One of the hormones produced by the adrenal glands is called cortisol. Cortisol helps us manage stressful situations. However, some people's bodies fail to produce cortisol. These people suffer from what is called Addison's disease, and they must be treated with cortisol for life. In this article, we will learn what the adrenal glands are, what they do to help the body to be healthy, and how people with Addison's disease manage that condition.

WHAT IS ADDISON'S DISEASE?

Thomas Addison was a British physician who, while working at Guy's Hospital in London, was the first to observe that some of his patients

Figure 1

Healthy humans have high cortisol in the blood when they first wake up. During the day, cortisol levels decrease slowly and, after going to bed, levels are very low. While sleeping, cortisol starts increasing to restore the high levels needed in the morning, to face a new day (created using BioRender.com).



ADDISON'S DISEASE

An uncommon medical condition affecting the adrenal gland. It occurs when your body does not produce enough levels of certain hormones.

ADRENAL GLANDS

Organs located on top of the kidneys. They produce hormones, including cortisol, that are needed to keep the body healthy.

HORMONES

Substances made by specialized cells and released into the bloodstream. Hormones send messages around the body to help it function properly.

CORTISOL

A hormone that regulates a wide range of processes in the body, including metabolism, the immune response, and the body's response to stress.

were restless and pale, their muscles were losing strength, and they had difficulties concentrating properly. He described his observations in a biomedical journal 1855 and, since then, this condition has been called **Addison's disease**. Addison's disease sometimes comes on very quickly, but more frequently it proceeds slowly, taking several months for the symptoms to become noticeable [1]. Addison observed that his patients were not feeling well due to the improper functioning of organs called the **adrenal glands**.

THE ADRENAL GLANDS MAKE CORTISOL

The adrenal glands are two small, triangular-shaped organs located on top of the kidneys. All animals have adrenal glands. In humans, the adrenal glands are about the size of a peanut, while smaller animals, like rats, have pea-sized adrenal glands. The main function of the adrenal glands cells is to produce **hormones**. Hormones are substances produced by several glands, including the adrenal glands, that control many essential bodily functions. One of the hormones produced by the adrenal glands is called **cortisol**.

Cortisol controls several essential functions, including regulating the way the body uses the nutrients in food to gain energy. Cortisol also helps us fight bacteria and viruses to stay healthy, and it controls the flow of blood through our veins and arteries, especially when we are sick. Another essential role of cortisol is helping us cope with challenging, stressful situations that make us feel nervous or overwhelmed [2]. Last, cortisol helps us decide when it is time to sleep and when it is time to wake up. In the morning, when we are most active, our cortisol levels are the highest. As the day goes by, cortisol levels gradually drop, becoming lowest in the middle of the night after we go to bed. During the night, the body restores its levels of cortisol, like charging a cell phone's battery (Figure 1). This process prepares the body to face the new day with energy.

How does the body recognize the moments when cortisol is needed? To produce the right amount of cortisol, several organs work together

Figure 2

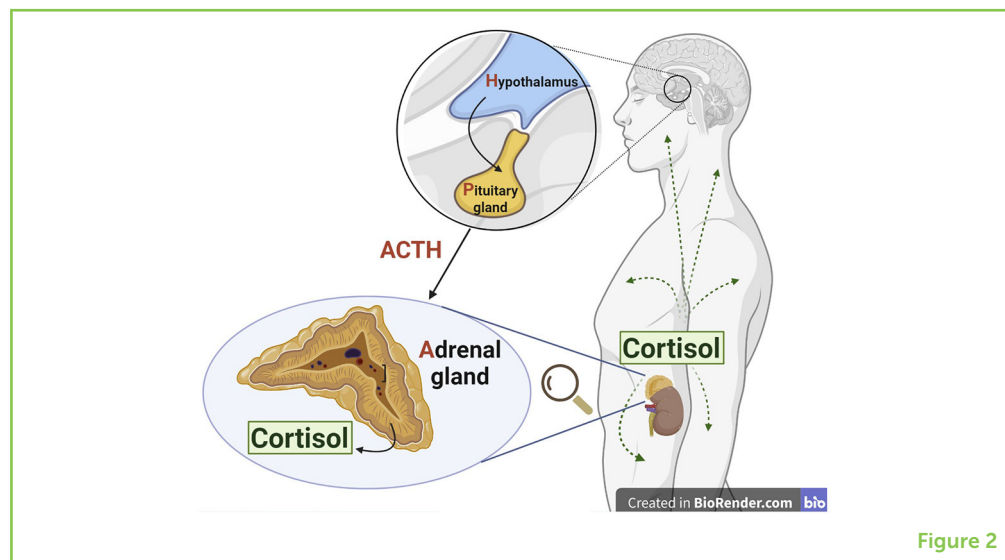
The hypothalamic-pituitary-adrenal (HPA) axis consists of a group of organs that control the release of cortisol into the blood. When the brain detects a need for cortisol, the hypothalamus sends a message to the pituitary gland. The pituitary gland then makes ACTH, which travels through the blood to the adrenal glands and tells them to release cortisol. The cortisol released by the adrenal glands travels throughout the body via the blood (created using BioRender.com).

HYPOTHALAMIC-PITUITARY-ADRENAL AXIS

Term used to describe the interaction of three organs in the body; the hypothalamus, the pituitary and the adrenal gland. It plays an important role in stress.

ADRENO-CORTICOTROPIC HORMONE (ACTH)

A hormone produced by the pituitary gland. Its main function is to send a message to the adrenal glands, telling them to produce cortisol.



as a team, creating what is called the **hypothalamic-pituitary-adrenal (HPA) axis** (Figure 2).

HOW DOES THE HPA AXIS WORK?

The HPA axis starts working when the body needs cortisol. When that happens, the front part of the brain communicates with another region of the brain, called the hypothalamus, which then sends yet another message to a tiny, pea-sized organ called the pituitary gland. The pituitary produces a hormone called **adrenocorticotrophic hormone (ACTH)**, which travels through the blood until it finds and binds to the adrenal glands. In response, the adrenal glands release cortisol into the blood. At this point, the body is ready to get to work (Figure 2)!

Here is an example to help you understand how the HPA axis works in a stressful situation. Imagine that your teacher has scheduled an important exam. As the time of the exam approaches, your hypothalamus starts working hard and, together with the pituitary gland, sends a message to the adrenal glands telling them to wake up and start producing cortisol. As cortisol travels through your blood vessels, it acts on the liver, muscles, and fat cells to give you extra energy to deal with your stressful exam. If you want to find out more about the HPA axis and how it works when you are in a stressful situation [3].

WHAT HAPPENS TO PEOPLE WITH ADDISON'S DISEASE?

Now you have learned how important cortisol is, but you might wonder whether all people produce the right amounts of cortisol. Unfortunately, they do not. Sometimes the adrenal glands produce

Figure 3

(A) Thomas Addison (1793–1860) was a British doctor who first described adrenal insufficiency, which was later named Addison's disease. (B) The adrenal glands of people with Addison's disease cannot produce cortisol. Note that the levels of cortisol (pink line) are not the same as in Figure 1. People with Addison's disease must be treated using hormone replacement therapy, to provide the hormones their adrenal glands are not producing (created using BioRender.com).

ADRENAL CRISIS

Life-threatening medical conditions requiring immediate treatment due to insufficient levels of certain hormones in the body.

HORMONE REPLACEMENT THERAPY

Medical therapy which consists on providing patients with certain missing hormones to restore normal hormone levels. This therapy is usually administered in tablets.

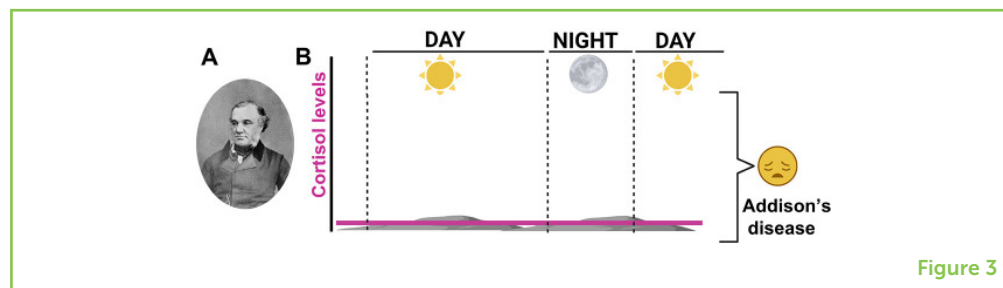


Figure 3

too much or too little cortisol. Those people whose adrenal glands produce little or no cortisol suffer from the medical condition Dr. Addison described. Addison's disease is also called adrenal insufficiency because the adrenal glands produce insufficient amounts of hormones (Figure 3). Adrenal insufficiency is not very common, but it can be a life-threatening condition. As observed by Dr. Addison, patients with adrenal insufficiency suffer from chronic fatigue, muscle weakness, dizziness, loss of appetite, and weight loss. In its severe form, when the cortisol levels are very low, the body cannot perform its normal functions. In that case, adrenal insufficiency patients can suffer what it is called **adrenal crisis**, which can be deadly if it is not treated.

Fortunately, adrenal crises do not happen very often, but patients with Addison's disease must be carefully monitored and treated for throughout their lifetimes, to avoid it.

TREATING ADDISON'S DISEASE: NOW AND IN THE FUTURE

How do doctors care for patients with adrenal insufficiency? Doctors use a treatment called **hormone replacement therapy**. With this therapy, patients take two or three pills a day to replace the missing cortisol. These pills allow patients to feel stronger and healthier. Unfortunately, hormone replacement therapy does not help all patients to feel better. It can be difficult to achieve the proper amount of hormones needed by the body, and some patients suffer unpleasant side effects, such as low energy. Also, when these patients face a stressful situation, they need to take extra cortisol, since their adrenal glands cannot produce the amount they need to fight that stress.

To sum up, the adrenal glands are important organs that produce hormones, such as cortisol. Cortisol controls many bodily functions, helping us deal with stress and keeping us healthy and strong. People suffering from adrenal insufficiency, also called Addison's disease, do not produce enough adrenal hormones. They are often treated using hormone replacement therapy, which has several drawbacks. Scientists are looking for new ways to help

people with adrenal insufficiency, since hormone replacement therapy is not always ideal. As we explained, in patients with adrenal insufficiency, cortisol-producing cells are missing or do not function properly. In the laboratory, scientists are trying to generate cortisol-producing cells that resemble healthy adrenal cells [4]. In the future, these cells could be used to replace the faulty cells in patients with adrenal insufficiency, helping them to live healthier, happier lives [5].

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YOUNG REVIEWERS



CHI LOK, AGE: 11

My name is Chi Lok, and I am eleven. I have an interest in cybersecurity and coding, and like to spend my free time reading.



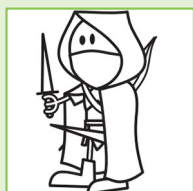
FURQAN, AGE: 10

My name is Furqan and I am right now in 3rd standard. I enjoy outdoor activities and doing crazy things. I always find pleasure hearing, learning and exploring about science because it is my interest. Eating has become my new hobby and I enjoy having it with my siblings.



JASPER, AGE: 11

Jasper is 11 years old. He is a member of Mensa and his favorite subjects are math and science. He has read every single book of Rick Reardon, twice, and this has piqued his interest in Greek Mythology. He has represented his school nationally in skiing and in his spare time he does rock climbing.



LIAM, AGE: 12

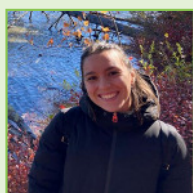
Liam is a student who really loves his school. So far, maths is his favorite subject. At home when he is not doing homework, he obsesses over the stockmarket and enjoys playing violin and piano; giving his parents free concerts. As a little child, he was obsessed with puzzles, jokes and TV theme songs. Not much has changed. He cannot imagine life without maths, music and pancakes.

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