Case Teaching Notes

for

“Muscleman: A Surprising Case of Shrinkage”

by

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Introduction / Background

This case is designed to help students develop a deep understanding of negative feedback control systems. The purpose is to examine the defining features of a negative feedback system, not to explore the details of the hormonal regulation of male reproduction. It is suitable for any physiology course including: Introduction to Human Anatomy & Physiology; Human Anatomy & Physiology; Human Physiology; and Animal Physiology. It might also be useful for a core course in General Biology. The case can be introduced during an introductory discussion of homeostasis or the initial portion of a section on basic endocrinology.

The concept of negative feedback is typically introduced by showing a flow chart depicting how some physiologic variable (e.g., body temperature) is maintained and comparing this to how room temperature is maintained by a home heating system. Although these diagrams are effective in illustrating the main components of and flow of information within negative feedback systems, they fail to illustrate how these systems change or compensate in response to various stimuli. This case provides an opportunity for students to analyze negative feedback systems and apply the concept to solve what might appear to be a shocking side effect of anabolic steroid use.

The case involves the hormonal control of testicular function. Specifically it explores how the testicles respond to changes in concentrations of LH and FSH, pituitary hormones that control testicular activity and are regulated by the negative feedback actions of testicular hormones such as testosterone. The fact that this case involves a timely and controversial issue (i.e., use of anabolic steroids in athletics) and that the biological effects of testosterone are visible and dramatic make the case interesting to students. Because the goal is to explore the concept of negative feedback regulation and not to provide instruction on the male reproductive system, it is necessary to provide background information concerning the biological effects of testosterone as well as the regulation of testosterone production. If this case is used in the context of studying the endocrine system, then it becomes useful in illustrating the general features of hypothalamic-pituitary-endocrine organ systems. The basic flow of information in this system is similar to those regulating activity of the ovaries, adrenal cortex, and thyroid gland.

The questions in the case are designed to promote scientific reasoning; that is, hypothesis development, hypothesis testing, and application of general concepts to solve problems.

Objectives

- Recognize a negative feedback system.
- Identify major components of a negative feedback system.
- Explain the negative feedback regulation of LH and FSH release.
- Apply the concept of negative feedback to analyze and explain a major side effect of anabolic steroid use.

Classroom Management

I designed this case for use in the second half of my two-semester course sequence in Human Anatomy & Physiology. I also use the case in my Animal Physiology course as well as in my Introduction to Human Anatomy & Physiology course. It works best when used with small groups consisting of between 20 and 24 students. However, I have used it in larger classes consisting of more than 50 students.

One of the questions requires students to perform research. This could be assigned as homework or could be done during class time if students have access to computers.

It has been my experience that students have no trouble memorizing diagrams that depict simple negative feedback systems. Unfortunately, students...
The most obvious concept to explore is the role of testosterone as a negative feedback signal controlling release of LH and FSH, pituitary hormones that regulate testicular function. If students understand the diagram depicting the negative feedback loop controlling testosterone secretion, they should understand that Frank’s testicles shrank because the trenbolone acetate increased the negative feedback signal that regulates LH and FSH secretion. The reduced levels of these hormones resulted in less stimulation of testicular size and activity. It is important to link this effect with the concept of homeostasis. One might ask what is the variable being regulated in this case? In this case secretion of LH and FSH is regulated by the combined actions of endogenous testosterone and trenbolone acetate.

A second block of analysis involves hypothesis testing. Students may accurately diagnose the cause of Frank’s shrinking testicles, but have difficulty developing a way to verify their hypothesis. Keep in mind, the issue isn’t whether or not the trenbolone acetate caused Frank’s testicles to shrink. Rather, the question is how can we prove that the anabolic steroid produced this effect by exerting negative feedback action on LH and FSH release.

A third block of analysis deals with further manipulation of the feedback loop to counter the effects of trenbolone acetate. If the students fully understand this system, they will realize that giving injections of a hormone that has both LH and FSH activity will stimulate testicular growth by compensating for the low LH and FSH levels resulting from trenbolone acetate. It is interesting to consider what effects injections of human chorionic gonadotropin will have on testicular production of testosterone.

A fourth block of analysis is not directly related to the case, but allows students to more thoroughly explore the feedback system. The case deals strictly with the effects of increasing the negative feedback signal. However, a thorough understanding of this system also requires an appreciation for the effects of a reduced negative feedback signal. Specifically, students are asked to explain how removal of one testicle can cause the remaining testicle to almost double in size. This illustrates the concept of compensatory hypertrophy.

The final block of analysis deals with the use of scientific information to make informed judgments. It would be misleading if students came away from the exercise thinking that shrunken testicles were the only side effect of anabolic steroid use. Although students might be aware that the use of anabolic steroids is controversial, they are likely unaware of the many side effects of these drugs. This block of analysis allows students to make risk-benefits analysis and develop their own opinions regarding the use of these drugs. One of the issues that will arise from this discussion is whether or not these drugs are “safe.” A discussion of safety is likely to raise ideas such as dose-response and LD 50.
A separate issue is whether or not it is fair to use these drugs. Since Frank is interested in competitive body building, it might be instructive for students to explore the issue of fairness in competitive sports.

**Answer Key**

Answers to the questions posed in the case study are provided in a password-protected answer key. To access those answers, go to the key. You will be prompted for a username and password. If you have not yet registered with us, you can see whether you are eligible for an account by reviewing our password policy and then apply online or write to answerkey@sciencecases.org.

**References**


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