

# Muscleman: A Surprising Case of Shrinkage

by

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Frank was an all-around athlete in high school. He played football in the fall, wrestled during the winter, and was a sprinter on the track team during the spring. After graduation, Frank attended State University to study American history. In order to focus on his studies, he decided not to participate in team sports. However, he worked out at the gym almost every day and became interested in bodybuilding. Although Frank had a muscular body and was very strong, his muscles weren't as large as most body builders who were of similar height.

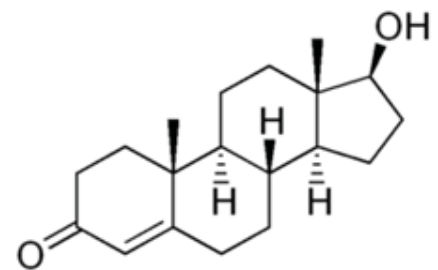
Frank became friends with several students who had experience competing in body-building events. He asked them for some training advice and all of them agreed that anabolic steroids were the only way Frank could build the muscle mass required for competition. One of his friends offered to get the steroids and show him how to use them. Frank agreed and began administering himself injections of trenbolone acetate. Although he was convinced that the drug would help him build muscle mass, he was unaware of the fact that trenbolone is a synthetic steroid that is used in animal agriculture to increase muscle growth in livestock. It is typically administered as an ester derivative (e.g., trenbolone acetate).

The chemical structure of trenbolone is similar to that of testosterone, the naturally occurring hormone that is produced by the testicles. Trenbolone acts in the same way that testosterone acts, but the esterified form of the hormone is approximately three times more potent than the naturally occurring hormone; that is, three times more testosterone is required to produce the same effects as a particular amount of trenbolone acetate.

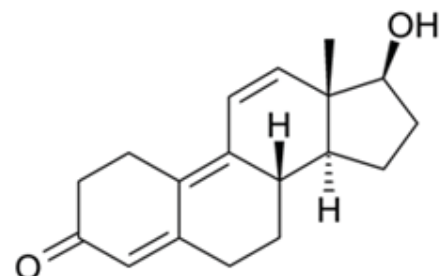
Because Frank was an avid weight lifter and worked out for at least 60 minutes each day, he experienced an increase in strength and larger muscles within two months. Although he was very pleased with the development of his physique, he became quite alarmed about one side effect of the anabolic steroid; that is, his testicles had shrunk to about 25% of their original size.

At the time Frank became interested in body building he was taking a course in human anatomy and physiology. He first noticed his testicular atrophy when the class began studying the reproductive system. Frank soon learned that testosterone is necessary for the testicles to produce sperm, the male gametes. It is also responsible for maintaining masculine patterns of body hair and muscle and fat distribution. His textbook provided useful information about regulation of the testicles.

The regulation of testosterone production and release from the testicles involves a part of the brain known as the hypothalamus as well as the anterior pituitary gland. The hypothalamus produces gonadotropin-releasing hormone (GnRH), a hormone that acts on the anterior pituitary gland to stimulate release of luteinizing



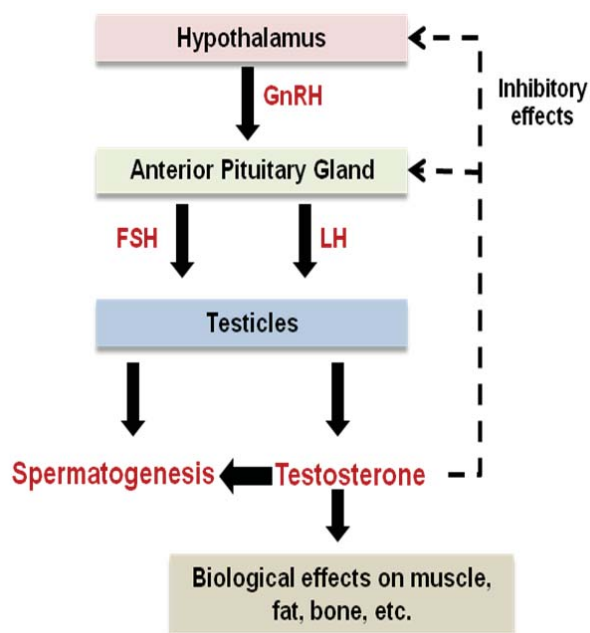
Testosterone



Trenbolone

hormone (LH) and follicle stimulating hormone (FSH). These two pituitary hormones then act on two types of testicular cells to stimulate synthesis and secretion of testosterone. LH affects the testicles in two ways. First, it is required to maintain both the number and size of Leydig cells, testicular cells that produce testosterone. Second, it stimulates the biosynthetic pathways responsible for testosterone synthesis. FSH acts primarily on the Sertoli cells, nurse cells that provide support for spermatogenesis (the production of sperm). Overproduction of testosterone is prevented by a negative feedback loop whereby testosterone acts on the hypothalamus and pituitary gland to suppress release of GnRH as well as LH and FSH, respectively.

The more Frank learned about the male reproductive system, the more motivated he was to research the use and side effects of anabolic steroids. He soon began to understand the biological mechanism responsible for his condition. In addition, he learned about other side effects associated with the use of this type of drug.



### Questions

1. Based on the information provided about the regulation of testosterone secretion, propose a testable hypothesis to explain how trenbolone acetate caused Frank's testicles to shrink.
2. Propose an experiment to test your hypothesis.
3. Some advocates of anabolic steroid use report that the testicular atrophy associated with the use of trenbolone acetate can be alleviated if users also inject themselves with human chorionic gonadotropin, a hormone similar in structure to LH and FSH and producing the same biological effects as these two hormones. Explain how this treatment might work.
4. Men who develop testicular cancer usually have the affected testicle surgically removed. Obviously the removal of one testicle reduces blood levels of testosterone. However, over the course of several months, levels of testosterone return to normal. In addition, the size of the remaining testicle typically increases to almost twice its original size. Explain these results in terms of the mechanisms regulating testosterone secretion by the testicles.
5. Take some time to do research on the use and abuse of anabolic steroids and compile a list of the major side effects in men and woman. Based on this research, address each of the following questions:
  - a. Some anabolic steroids mimic the effects of testosterone (i.e., androgenic) whereas others act as estrogens (i.e., estrogenic). What are the major differences in side effects between these two classes of drugs?
  - b. Explain the physiological basis for the difference in side effects between estrogenic and androgenic steroids.
  - c. Based on your research, assess the risks and benefits of anabolic steroid use as a means to build muscle. Based on this assessment, indicate whether or not you would recommend the use of these drugs to a friend who was interested in building muscle mass.



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