Anabolic Steroids: Cheating Through Chemistry

At first, it was hailed as one of the great moments in sports history. On September 29, 1988, at the Summer Olympics in Seoul, Korea, Canadian sprinter Ben Johnson won the 100-meter final with a world record-shattering time of 9.79 seconds - a time that has never been approached since. Three days later, though, what had been one of sports' greatest moments suddenly became one of its most infamous. The International Olympic Committee announced that Johnson had tested positive for the banned drug stanozolol, an anabolic steroid commonly used by athletes to build muscle and increase strength. Johnson was stripped of his medal and banned from the Olympic Village, and his world record was nullified. (1)

Although Johnson was not the first athlete to be caught using anabolic steroids, the controversy surrounding his case sparked greater worldwide awareness of the widespread use of anabolic steroids and the dangers surrounding them. As the years passed and more and more cases like Johnson's surfaced, athletes, coaches, and spectators were forced to realize that Johnson's case was not isolated. Today, anabolic steroid use has reached epidemic proportions at all levels of athletic competition, and it has become evident that the drugs can have debilitating and even deadly side effects.

What are anabolic steroids?

All anabolic steroids are synthetic compounds whose molecular structure is similar to that of the natural male sex hormone testosterone. Testosterone affects development of the male body in two important ways: it has an anabolic effect - increased growth, especially of muscular and skeletal tissue - and an androgenic effect - increased development of male sexual characteristics. Anabolic steroids are constructed synthetically in such a way that they maximize the anabolic effect of testosterone while minimizing the androgenic effect. (2)

Once taken into the bloodstream, anabolic steroids bind to hormone receptors on skeletal muscle and other cells and stimulate the synthesis of certain specific enzymes. (1) These enzymes, such as RNA polymerase, promote two important biochemical reactions: creatine phosphate synthesis and protein...
synthesis. Creatine phosphate is a molecule that can be metabolized in the absence of sufficient oxygen as a short-term source of energy. Increased creatine phosphate synthesis thus allows athletes to train harder and for longer periods of time, and therefore build more muscle. Protein synthesis is essential for the long-term development of increased muscle mass or "bulk". Stimulation of creatine phosphate synthesis and protein synthesis occur in various ratios, depending on the specific anabolic steroid used. (2)

In addition, anabolic steroids promote nitrogen retention by the body. By allowing for better utilization of the nitrogen in ingested protein, anabolic steroids help athletes to build body mass. However, this effect is offset by the body's homeostatic mechanisms, which are designed to maintain a stable environment; therefore, in order to increase body mass by using anabolic steroids, athletes must also adhere to a diet with sufficient protein and calories - up to 10,000 calories daily. (1)

Hundreds of different steroids have been synthesized, with varying levels of anabolic and androgenic effects. It is important to note that not all steroids are synthesized for abuse by athletes. Many steroids are used to treat illness and injury; for example, corticosteroids such as cortisone have been used to treat a wide variety of medical problems. (2) However, it has been the family of anabolic steroids which are synthesized for their capacity to increase strength and promote muscular development that have stirred such controversy in the area of athletics.

How anabolic steroids are used

The two most common methods for delivery of anabolic steroids are oral ingestion and intramuscular injection (3). Oral anabolic steroids are usually distributed in the form of tablets or capsules which are swallowed; such steroids are effective for only a short period of time before they are broken down. As a result, oral steroids must be taken in relatively large doses of up to 200 mg per day. (2) Both stanozolol, the steroid used by Ben Johnson, and dianabol, one of the most popular and potent steroids used today, are taken orally (2).

Injectable steroids are not as easy to categorize, but can be divided into two general categories, known as "oils" and "waters" (3). "Oils" are longer-lasting anabolic steroids; they are injected directly into a muscle, usually the buttocks, and are released slowly over time. Such steroids do not have to be taken as often as oral steroids; for example, 200 mg of nandrolone, a potent and widely used injectable steroid, is designed to last for 17 days (2). "Waters" are short-acting injectable steroids; they are taken in the same
manner as "oils", but their effect does not last nearly as long (3).

In order to achieve maximum muscle buildup, an athlete will usually take an anabolic steroid for 6 to 12 weeks and then stop for an equal period of time; this process is called "cycling" (1,4). However, athletes attempting to "bulk up" quickly often are tempted to resort to even riskier practices. One such practice, called "stacking", involves taking more than one steroid at a time to avoid response "plateaus" which develop from taking a single steroid for an extended length of time. Many "stackers" take both oral and injectable anabolic steroids at the same time. (1,4) Another risky but common practice is "pyramiding", which involves starting with a low dose of anabolic steroid, gradually increasing the dose, and then tapering off at the end of the cycle (1).

Athletes who use these methods often see rapid and remarkable results, including increased strength, greater stamina, and rapid buildup of muscle mass. Unfortunately, it has become increasingly clear in recent years that these results carry with them several side effects, which can be debilitating and even fatal.

**Side effects of anabolic steroids**

From the mid-1970s through the mid-1980s, Lyle Alzado was one of the star players in the National Football League. His massive, muscular, 300-pound physique struck fear into the heart of every opposing player, and upon his retirement from the league in 1986 he was hailed as one of the best ever at his position. His story seemed to be a rarity in the sports world - one of pure, unblemished success.

However, when Alzado reappeared in the public spotlight in 1991, the situation was completely different. He admitted to anabolic steroid use throughout his football career. He had ignored his doctor's warning in 1982 (5) and continued to use steroids even after his NFL retirement. Alzado revealed that he had beaten his wife out of steroid-induced rage, and described how his lifelong steroid abuse had brought on fatal brain cancer (6). After devoting the final months of his life to speaking out about the dangers of anabolic steroids, Alzado died on May 14, 1992, at age 43 (1).

Just as the case of Ben Johnson brought anabolic steroids to the attention of the public, the tragic death of Lyle Alzado showed the public just how deadly anabolic steroids can be. Although Alzado is the only high-profile professional athlete to die as a direct result of anabolic steroid abuse, many other athletes at
the high school and college levels have died or have developed serious health problems as a result of anabolic steroids.

One of the deadliest side effects of anabolic steroids is liver toxicity. Specifically, steroids taken orally are extremely toxic to the liver, since they are broken down all at once (2). Prolonged use of oral steroids, therefore, can lead to jaundice, hepatic cholestasis, liver tumors, or fatal liver failure (1). Injectable steroids, since they bypass the liver and enter the bloodstream directly, are not as hepatotoxic (2). Prolonged steroid use can also lead to changes in the mechanism of blood clotting, glucose metabolism, and the ratio of "good" (HDL) to "bad" (LDL) cholesterol (1,2).

Steroids also cause severe adverse effects in the brain. By dramatically increasing the level of cortisol, the body's primary stress hormone, anabolic steroids can cause high blood pressure, stress, and more serious neurological problems (2). Many longtime steroid users, including Alzado, describe how anabolic steroids make them more aggressive and periodically cause them to fly into uncontrollable "roid rages". Steroid users also may develop psychological problems such as delusions and paranoia, referred to as "bodybuilder's psychosis." (2) As in Alzado's case, the cumulative effect of steroids on the brain can lead to brain cancer.

Anabolic steroids also affect the reproductive and endocrine systems. When a user takes large amounts of an anabolic steroid, the body responds through a homeostatic mechanism by decreasing testosterone production, which can alter libido and sex drive (2). In addition, although steroids are designed to minimize androgenic effect, androgenic side effects often develop when steroids are used over a long period of time. Such side effects, common to both sexes, may include acne, increased facial and body hair, and impotence. (7) In addition, men may experience priapism (persistent and painful erection) or prostate enlargement, and since another homeostatic response to steroid use is to convert testosterone to the female hormone estrogen, gynecomastia (development of breastlike tissue) may occur in males.

Finally, steroids have been shown to be quite addictive. Surveys taken in 1992 showed that up to half of anabolic steroid users eventually experience dependency symptoms (1). Lyle Alzado's addiction to steroids has previously been mentioned. In addition, Ben Johnson, after his disgrace in 1988, attempted to stop using steroids and make a comeback; however, his "clean" times were considerably slower than those he recorded while he was using steroids, and although he qualified for the 1992 Summer Olympics, he finished last in his qualifying heat. Shortly afterward, in 1993, he tested positive for anabolic steroids again, and this time was banned from competition for life. (1)

The History of Anabolic Steroids: Development of the "Silent Epidemic"

The muscle-building properties of testosterone have been known for over 100 years (1). By 1935, testosterone derivatives had been synthesized in the laboratory, and they were allegedly given by Adolf Hitler to the German army in World War II to increase the aggressiveness of his troops (1,2). By the
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1950s, weight lifters were using testosterone derivatives to increase their size and strength, and in the late 1950s, dianabol, the first widely available anabolic steroid and still one of the most potent, was introduced. In response to the growing use and dangerous side effects of anabolic steroids, the International Olympic Committee banned them in the late 1960s (1). When this failed to deter athletes from using steroids, the IOC instituted testing for anabolic steroids at the 1976 Summer Olympics in Montreal. Even before the scandal surrounding Ben Johnson erupted in 1988, stories of athletes getting caught using anabolic steroids had already reached the public; for example, in 1987, 21 college football players were suspended from bowl games after testing positive for anabolic steroids (1).

A new and disturbing trend which has been revealed within the last few years is the systematic use of anabolic steroids by the sports programs of entire nations, particularly in Eastern Europe. For example, the national sports program of East Germany, prior to the collapse of communism there in 1989, would routinely distribute anabolic steroids to its athletes before competitions, including requiring female athletes to take large amounts of testosterone (8). Most recently, similar allegations have been made with regard to Chinese female athletes. After dominating the swimming competition at the 1992 Summer Olympics, ten members of the Chinese women's swim team tested positive for anabolic steroids in 1994 and 1995, prompting speculation about systematic steroid use by the national sports program. The lackluster performance by the Chinese women's swim team at the 1996 Summer Olympics seems to confirm this speculation.

Despite the tragic stories of people like Lyle Alzado and Steve Courson, a football player who developed near-fatal cardiomyopathy as a result of chronic steroid abuse (1), anabolic steroid use has continued to grow. A 1993 survey by the American Medical Association revealed that more than one million people use or have used anabolic steroids (9). From isolated cases of steroid use in the 1950s, the abuse and adverse effects of anabolic steroids have become more and more widespread and significant. Today, anabolic steroid use truly is, as an ABC News documentary in 1992 called it, a "silent epidemic". (1)

Conclusion: Prospects for the Future

Despite ongoing efforts to educate athletes about the dangers of anabolic steroids, the "silent epidemic" is becoming more and more widespread. Steroid use is growing fastest among 12 to 17-year-olds; the
average age at which children start using anabolic steroids is now 15 (9). Such statistics indicate that it is unlikely that the use of anabolic steroids will be curtailed easily.

In addition, newer and more powerful anabolic steroids are constantly being developed. The most popular new steroid is human growth hormone (HGH), a synthetic form of the hormone secreted by the pituitary gland to promote muscular and skeletal growth (2). Like many other steroids, it is produced by bacteria with recombinant, or genetically altered, DNA. Although it remains expensive (it costs up to $5000 per cycle), it is difficult to detect by conventional drug-testing methods and is rapidly becoming the drug of choice among young athletes with the means to afford it.

The unfortunate conclusion, then, is that anabolic steroids will remain a part of the sports landscape for some time to come. With this in mind, the sports community must take action: to educate athletes about the dangers of anabolic steroid use, develop treatments for their side effects, and improve methods of steroid detection. These steps might help to reduce the incidence of chemical cheating in sports.

-- Scott Lovitch