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Androgenic-Anabolic Alternatives

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ABSTRACT: Discusses the use of androgenic-anabolic steroids (AAS): how they work, what they do, who takes them, why people take them, their advantages, their disadvantages, and side effects. Documents a number of studies done with different AAS and varied conditions. Considers the medical applications of AAS. Gives a basic background of the muscle system; how energy is produced at the microscopic level and implemented all the way up to the macroscopic level. Discusses three alternatives that produce similar physiological effects including creatine, antioxidants, and protein supplementation.

The level of competition in sport is a constantly increasing struggle. The need and drive to win is a battle that many take on. For professional athletes, succeeding is what brings home the bread, whether it's scoring a touch down, blocking a shot, getting the highest, going the longest, or achieving the best time. For others who are trying to reach personal goals, the fight is just as potent. Losing weight, toning up, and building muscles are a few examples. People go to great lengths to achieve their physical goals in all walks of life. For some the desire to achieve their goals is so strong that they ignore other important areas in their lives; their families, their careers, and most basically their health. People subject themselves to unhealthy conditions to obtain faster, stronger, or more attractive bodies. One such condition is the use of steroids. Steroids have been proven to be beneficial for clinical usage. However, self-administration of steroids for other purposes can be harmful as well as deadly. Many studies have been done to test the positive as well as negative effects of steroids.

There are alternatives to using steroids. Many supplements sold on the market today are not only safer and less harmful but much less expensive, as well. Among these alternatives are creatine, whey protein powder, and vitamins (antioxidants.) Through proper usage of these and other similar products in conjunction with proper diet and exercise, many of the effects of steroids can be replicated without the harmful side effects. To gain a better understanding of how steroids work it is necessary to have at least a brief background of the environment that they operate in, namely the human body. Let's first look at the physiology of the muscle unit, and then go into detail on the mechanisms that allow steroids to be so powerful.

The main functions of skeletal muscle are support and movement. Without skeletal muscles the human body would be an immobile pile of skin and bones. Skeletal muscle maintains posture when the body is stationary. The main muscles that are responsible for this are found in the axial skeleton (the trunk of the body.) Muscles of the appendicular skeleton (appendages) are responsible for movement as well as many muscles of the axial skeleton. Lets look at the structure of a muscle by starting at the smallest functional unit of a muscle, the sarcomere.

A sarcomere is a section of a longer unit called a myofibril. Sarcomeres are connected end to end to make each myofibril. Inside a sarcomere are actin and myosin filaments. The actin filaments are composed of G actin molecules and proteins. The actin molecules are relatively thin compared to the myosin filaments and are more commonly referred to as thin filaments. Myosin filaments are composed mainly of myosin molecules. Myosin filaments are thicker in appearance compared to thin filaments and therefore are more commonly called thick filaments. The myosin molecules have enlarged heads at the end of them that act as hooks. The myosin heads are moveable and, when chemically stimulated, will hook into the receptor sites on actin molecules and pull the thin filaments toward the thick filaments. This movement causes shortening of the sarcomere. As was stated earlier, sarcomeres are connected end to end in great number to form myofibrils. As a sarcomere contracts (shortens) it causes the whole myofibril to shorten as well.

A muscle fiber is the next larger unit to be examined. Many myofibrils are arranged parallel to each other in the muscle fiber. Each myofibril runs almost the length of the muscle fiber. Spaced inside each muscle fiber between the myofibrils is thousands of mitochondrion, the energy powerhouses of the cell. ATP (adenosine triphosphate) is stored within the mitochondrion. ATP is what gives the muscle cells energy. When a muscle is stimulated, ATP is released out into the muscle. As the energy from ATP is given off, the ATP molecule looses a phosphate atom and it becomes ADP (adenosine diphosphate.)

Like all energy, ATP is neither created nor destroyed, just converted from one form to another. ADP is not disposed of but recycled back to ATP. This is done through the use of two components: phosphocreatine and creatine phosphokinase. Phosphocreatine donates a phosphate atom to the ADP molecule to convert it back to ATP. The phosphocreatine molecule then becomes creatine after it looses its phosphate atom. Creatine phosphokinase is a catalyst that speeds up the reaction and is not altered or converted to another type of molecule. The only role of creatine phosphokinase is to speed along the reaction. Another component of energy production is glycogen. Glycogen is dispersed throughout the muscle just as the mitochondrion. Glycogen is metabolized (broken down or used up) in the mitochondria to quickly replenish ATP stores when a skeletal muscle contracts. More glycogen in the muscles equals more energy is available more quickly. The average amount of glycogen stores falls

somewhere between 10-25 milligrams per gram of muscle depending on diet conditions (Bove 11.)

Also surrounding all of the myofibrils are transverse tubules, tubes that aid in neuromuscular communication. A sheath called an endomysium surrounds each muscle fiber. Many muscle fibers run parallel to each other, much in the same way that the myofibrils were organized, to make up a larger unit called a muscle fascicle. The group of muscle fibers in the muscle fascicle is bound together by another sheath called the perimysium. Muscle fascicles are large units that are visible to the unaided eye. Many muscle fascicles are combined together to form an even larger unit, the muscle. The muscle fascicles are bound together by a sheath called the epimysium. As a muscle discontinues or ends, the sheaths that surrounded all of the units of muscle continue on to attach to bone. These sheaths: the epimysium, perimysium, and endomysium continue on to form tendons. Tendons are connective tissues that connect the muscles to bone and other muscles.

The myosin heads on the thick filaments flex when the activation sites on the thin filaments are exposed. This movement is started when a motor neuron is electrically stimulated and acetylcholine is released into the neuromuscular junction (synaptic cleft.) The neuromuscular junction is the point at which a neuron meets a muscle fiber. Neurons are the communicating branches of the body. They send messages from the brain to the muscles. Acetylcholine is a chemical inside the neuron that is released when the neuron is electrically excited. After being released acetylcholine diffuses across the synaptic

cleft to receptor sites on the sarcolemma of the muscle (sarcolemma is the cell membrane of a muscle fiber.) The sarcolemma receives the acetylcholine molecule at its receptor sites and releases an action potential throughout the muscle by means of the transverse tubules (mentioned earlier.)

An action potential is an electrical impulse that is transmitted very quickly. The target of the action potential is the sarcoplasmic reticulum, which is spread throughout the muscle fiber in between the myofibrils. The sarcoplasmic reticulum houses a surplus of calcium ions (Ca 2+.) Once the action potential reaches the sarcoplasmic reticulum these calcium ions are released into the muscle fiber in great numbers. The calcium ions find their way to the sarcomeres where they bind to troponin. Troponin is one of the proteins on the thin filaments that were mentioned previously. Once calcium ions bind to troponin the thin filaments change shape and expose the activation site. As soon as the activation site is exposed, the head of a myosin molecule hooks onto it and flexes. The activation sites remain exposed and the heads on the myosin molecules remain flexed until the action potentials stop. A chemical called acetylcholinesterase causes the action potential to cease by breaking down the acetylcholine. Once the acetylcholine is gone, the action potentials stop and the sarcoplasmic reticulum re-uptake calcium ions. This in turn causes the myosin heads to release and cause the activation sites to become available. This process relaxes the muscle.

Each motor neuron controls a number of muscle fibers. The neuron and fibers it controls is referred to as a motor unit. The number of fibers involved varies. Exercise causes the

muscle fiber to develop a larger number of mitochondria, higher concentration of glycolytic enzyme, larger glycogen reserves, and more myofibrils and thick and thin filaments.

A fit and healthy body is not only attractive by the standards of today's society but it leads to an all around better life. Exercising, eating properly, and recovery are the three main ingredients to maintain a healthy body. Assuming that a healthy diet and rest are observed, let us discuss exercise. There are two components of exercise recommended for a person to stay in shape, cardiovascular exercise and strength training. Cardiovascular exercise increases the capabilities of the heart and lungs by repeatedly exposing the body to an anaerobic environment at various levels. Through repeated exposure to this type of environment, the efficiency of the heart to pump blood, and of the lungs to obtain oxygen, increases. This is valuable to an athlete who needs endurance to succeed in his or her sport. Cardiovascular exercise is also important for the average person as well. It has been shown to prevent heart disease, decrease obesity, and slow the effects of aging.

Strength training is also important for athletes and weekend warriors. The most direct method for increasing strength is weight lifting. Not only does weight lifting increase muscle size and tone but it also increases bone density and can delay the onset of osteoporosis. Weight lifting causes an increase in lean muscle mass by making microscopic tears in the muscle fibers. The increase in muscle size occurs when the

muscle repairs itself, when the repair occurs the muscle over compensates so that the fiber is less likely to tare again, by enlarging the muscle fiber.

There are genetic limitations placed on each individual. One such limitation is directly related to the composition of the muscle as far as muscle fiber type (fast, intermediate, and slow.) Other limitations include bone size, and number of muscle fibers. Previous studies have shown that muscle fibers in cats and in rats have divided in response to heavy weight resistance (Gonyea 426-431 and Ho 433-440) (Fox 153) but no studies in humans have suggested this phenomenon. This may be due the lack of human studies. Textbooks state, however, that the amount of muscle fibers a person has is genetically determined and not subject to change.

It is human nature to want to exceed one's own limitations. People always have and always will strive for more. There are numerous ways that a person can change their body. One such method is through the use of steroids. Many athletes turn to steroids to give them a competitive edge. Weight lifters and body builders are the most common abusers of steroids because their reason for competing is strength, muscle size, and muscle definition. Androgenic-anabolic steroids are thought to allow the muscle fiber to increase in size beyond its genetic determination.

There are approximately thirty different classified types of AAS. There is no steroid that has been isolated that produces only anabolic effects. The androgenic effects are seen as an unwanted side effect in many cases. Androgenic-anabolic steroids are commonly

referred to as anabolic steroids. This term is improperly used because there is no steroid that has anabolic but not androgenic effects. The proper name for steroids is androgenic-anabolic steroids or AAS. Anabolic means to build up and androgenic means to masculinize.

Many studies have been done in hopes of discovering the true effects of AAS. Some early studies pointed to the conclusion that steroids have little to no effect on strength and gain in lean muscle mass. "Only slight or insignificant effects should be expected from even large doses of steroids in normal sexually mature animals." (Williams 176) Many of these earlier studies could be proven to be inaccurate. Many of them were done on only animals (Williams 165). It is questionable whether the substances administered to the animals would have the same effects on humans. Human studies were eventually performed as time passed; but early findings could not prove AAS had any type of effect. There are numerous reasons why these earlier studies could not substantiate the effects of steroids. "It is difficult to compare many of the published studies as different AAS drugs, different dosages, different training regimen, different levels of experience of athletes, different diets, and different study periods have been used." (Reilly 137)

Another factor to consider is that many of the subjects that were administered a steroid lost body fat but gained weight. However, only the difference between the starting body weight and final body weight were taken into consideration when summaries of the experiments were reported. This would mask the effects of the steroid administered. One finding in these earlier studies that did pave the way for future studies was that if any

increase in body weight or strength did occur it was more often that not in the subjects that were in training.

The first published study on humans performed in 1942 by Samuels, Henschel, and Keys showed no change in grip strength of 4 medical students (Morgan 380). The study was done over a period of 3 weeks with 50 mg/day of methyl testosterone. A possible reason for the lack of change could be attributed to the fact that the medical students underwent no training before or during the experiment. However, many studies after this were performed with methyl testosterone and no great change in strength or weight was recorded either. Methyl testosterone may have no effect on humans and therefore produce no results.

The strongest evidence for benefits from an AAS have come from methandienone or more commonly known as Dianabol. "Dianabol was the most potent anabolic steroid tested and doses of 1.25 mg/day had an appreciable effect." (Morgan 381). "The best evidence for strength benefits from anabolic steroids comes from studies with methandienone (Dianabol)" (Yesalis 144). "The frequently cited review by Haupt and Rovere (1984) sorted two dozen studies into those that reported strength and body weight gains and those where there was no effect; nearly all of the studies in the group where strength gains were noted employed methandienone" (Yesalis 144). Based on the many recent studies that have been done on methandienone, it can be concluded that this substance will produce a weight gain and improvement in strength. With the mixed

findings it can be said that different AAS have different effects. The AAS that shows the highest rate of effectiveness has been methandienone.

Now that it has been established what the effects of a few different AAS are, let us look at what happens at the muscular level. What is known about what happens when steroids are administered is that protein synthesis in the muscle increases. Specifically, proteins that are produced promote anabolism in the muscle. Androgenic-anabolic steroids also promote a positive nitrogen balance in the body, which helps prevent the catabolic effects of cortisol.

Cortisol is a hormone released from the adrenal glands in response to various stressors (emotional, physiological, and environmental). A specific example of cortisol release is during exercise. Cortisol stimulates the flight or fight mechanism in the body to recruit energy to prepare the body. It breaks down proteins in the muscles to get this energy and if cortisol levels are too high, often the muscle will not grow. Among some of the other benefits of AAS are increased aggressiveness while competing and an increase in motivation. (Reilly 138)

Steroids have for some time had a place in clinical medicine. Doctors commonly prescribe AAS because of their ability to grow new tissues. Many times steroids are given to HIV and AIDS patients because of the amount of tissue loss they incur. "Case reports of HIV/AIDS patients treated with a variety of oral and injected anabolic steroids indicate increases in appetite, strength, lean body mass, libido, and an improved sense of

well being in patients" (Yesalis 39.) Steroids are also used to treat hypogonadism, delayed puberty, impotence, male climacteric symptoms, heredity angioedema, metastatic breast cancer, postpartum breast pain and engorgement, endometriosis, as a contraceptive, to slow the aging process in males, and to treat muscular dystrophy. "There are many documented side effects of AAS that include reproductive changes, virilisation, feminization, liver alterations, metabolic disorders, musculoskeletal injuries psychiatric complications, and cardiovascular effects." (Reilly 139) Long-term use of steroids can be very dangerous. Extended use of steroids has been linked to liver diseases, including liver cancer (Williams 175.)

On top of the health hazards, AAS cause abnormal bodily changes as well. As was stated earlier, androgenic means to masculinize. In men, androgenic-anabolic steroids leads to baldness, acne, and excess body hair. Steroids are also masculinizing in women and the effects are even more pronounced. On top of the acne, baldness, and excess body hair is growth of facial hair, deepening of the voice, complications with menstruation and clitoral enlargement (Williams 176). The clitoris is a homologous structure to the penis. The androgenic effect on the clitoris causes it to become more like the homologous male member. Deeper voices and facial hair are also predominantly male characteristics.

There are limitations when using AAS to enhance athletic performance. Once the muscle becomes bigger and stronger there is more of a chance that injury could occur. After the initial effects of AAS take place the bones and ligaments that are used in conjunction with the muscle are at higher risk of being damaged. Speaking hypothetically, a bone

and a muscle system capable of moving 300 pounds of weight is altered using AAS. The muscle grows but the bone does not. The muscle is now capable of moving 350 pounds of weight yet the bone is still only capable of moving the original 300 pounds of weight. This means that a football player can hit harder but can be injured more easily. Endurance athletes observe few if any benefits from the use of steroids. A down side for endurance athletes using AAS is increased body weight. A study done by Johnson and O'Shea showed little effect of methandienone on running or swimming performance in three separate instances (Yesalis 163).

The usage of steroids is a highly debated subject. Many types of steroids are illegal to use in the United States. Recently Mark McGwire, a baseball player in the major league, has been criticized for using a legal over the counter supplement called Androstenedione. Androstenedione is not a synthetically created supplement. Androstenedione is produced naturally in the body in small quantities (Schrof 3.) This technicality is what allows Androstenedione to be sold in stores. Due to its effects on the human body, Androstenedione can be classified as an androgenic-anabolic steroid. Androstenedione has the same side effects as other AAS as well, including hair loss and breast development in men.

Aside from all the bad publicity that steroids receive, they are unarguably strong healing agents. The medical applications for steroids are numerous. The search for a perfect steroid, or one very close to it (one with out harmful side effects), is not a waste of time. It could be argued that if a steroid was made that produced no side effects it would be a

positive contribution to society. If by taking a steroid, a person could achieve an attractive looking, stronger body with increased energy and no side effects, it would be a good thing. If diseased muscles could be healed through steroid treatment it would be a good thing. If damaged or injured muscles could be healed faster and made stronger through prescribed steroids, it would be a good thing. However, until we find a perfect steroid, a person taking legal or illegal forms of AAS should understand the risks that are associated with taking them. That person should weigh the importance of their goals to the importance of living a long and healthy life.

Is the use of AAS completely unsafe? When a steroid is administered for healing purposes in a clinical setting the amount used is very miniscule compared to the amounts athletes commonly use. To achieve quick results athletes often use steroids in near toxic dosages. This behavior is obviously unsafe due to the fact that prolonged use of the steroid at such high doses *will* become harmful and toxic. In the book *Anabolic Steroids in Sport and Exercise* Charles E. Yesalis points out "The use of anabolic steroids in clinical trials to evaluate their effect as a contraceptive, as a hormone replacement in aging males, and in studies to assess their impact on strength and muscle mass, supports the argument that some anabolic steroids can be used safely at moderate to supraphysiological doses, at least in the short term" (Yesalis 7). How many athletes know how much is enough for themselves?

There are many moral and ethical concerns raised behind the use of AAS. Does the use of AAS equate to cheating? An athlete who chooses to accept the risks associated with

taking large amounts of AAS achieves an unfair advantage over his or her competitors. Sports are about maximizing the potential of the human body and the camaraderie and competition associated with that. An athlete should not be forced to use AAS just to be able to compete with competitors who are using AAS. In *Anabolic Steroids in Sport and Exercise*, Yesalis quotes a German physician, Dr. Willner, "At competitions we want to measure physical performances, not test the effects of drugs... In my view, there is nothing more reprehensible than using pharmacological substances in an attempt to improve one's performances in competition with others who bring to the sporting encounter only that fitness that they have achieved through training" (Yesalis 5). Willner brings up a good point, there are athletes that train in the purest of sense and work very hard to achieve their goals; if these athletes are loosing to those that don't have to train as hard because they are using illegal substances, then we are doing an injustice to those that worked so hard.

There are alternatives to using steroids that can produce similar effects when combined with a training regime. Creatine is one of these alternatives. The human body naturally produces creatine. "Creatine uses phosphate from creatine phosphate to quickly replenish ATP from ADP" (Burke 145.) ATP (adenosine tri-phosphate) is where energy is obtained. Upon conversion of ATP to ADP (adenosine di-phosphate) a phosphate atom is removed and energy is given off when this bond is broken. The more ATP that is recycled (converted back to ATP from ADP) the more energy that can be produced by the muscle. Creatine helps in sports where explosive power is needed, sports that require quick movements for short periods of time. Creatine also shows signs that it can increase

lactate threshold. This allows an endurance athlete to have a higher tolerance to the pain involved with lactic acid build up in the muscles. The down side for athletes that rely on endurance to win is that creatine causes fluid retention and therefore weight gain. If a distance runner is carrying extra weight, it will most likely slow him or her down.

The most common method for taking creatine is to go through a loading phase and then a maintenance phase. The loading phase is a process where 20 grams of creatine is taken in 5-gram doses every day for 5 days. This is followed by the maintenance phase, which is commonly 5 grams a day for a period of time. The effects of creatine and its safe usage are somewhat controversial. One study done on 14 swimmers suggested that creatine lowered 50 yard sprint times (Peyrebrune et al., 1997). Studies have shown that creatine is indeed absorbed by the body when orally ingested. Creatine uptake is measured in humans by monitoring how much is taken orally and how much is excreted in the urine. "A recent study has shown that oral creatine supplementation can increase the amount of creatine and phosphocreatine in the skeletal muscle and the rate of phosphocreatine resynthesis (Harris et al. 1992; Greenhaff et al., 1993a, 1994a,b)" (Peyrebrune 271). "Other studies have shown that creatine can increase muscle peak and mean power output during cycling (Birch et al., 1994); increase total work and reduce fatigue during repeated maximal exercise (Balsom et al., 1993; Greenhaff et al., 1993b, 1994a; Bogdanis et al., 1996); improve running performance times (Harris et al., 1993); and improve recovery in repeated bouts of high intensity exercise (Balsom et al., 1993; Greenhaff et al., 1993a,b, 1994a; Bogdanis et al., 1996)" (Peyrebrune 271).

As was discussed earlier, exercise causes the release of cortisol. It also causes free radicals to form. Free radicals work much to the same extent that cortisol does, having a negative effect of muscle development. AAS reportedly counter the effects of cortisol and by the same means have a reaction that opposes the effects of free radicals. What are free radicals? Free radicals are atoms or molecules that have lost an unpaired electron. It is an electrons nature to want to pair up with another. Free radicals float around the body, after intensive bouts of exercise, and will look for available electrons to pair up with. Free radicals damage tissues by taking their electrons. Another reason for the formation of free radicals is that when the body fights off infections it kills the invading pathogen. Upon destruction of the pathogen by white blood cells many smaller fragments result. The bonds that held the pathogen together are broken, when bonds are broken, energy is released. Some of the energy that is released when the bonds of the pathogen are broken is released in the form of free radicals.

Recently there has been great concern over reducing free radicals in hopes of slowing the aging process. Supplementing a normal diet with antioxidants slows the aging process. "With increasing experimental, clinical, and epidemiological evidence which shows the involvement of free radicals and active oxygen species in a variety of diseases, cancer, and aging, the role of antioxidants has received increasing attention" (Papas 14). There are many types of antioxidants and they are taken to react with the free radicals to prevent them from breaking down body tissues.

One such type of antioxidant is very common; vitamin C, also known as ascorbic acid. "Ascorbic acid is an outstanding antioxidant and reducing agent" (Papas 161). The word reducing agent is defined as ascorbic acid giving up an electron to another atom or molecule. When ascorbic acid losses its electron it becomes semidehydroascorbic acid. What makes ascorbic acid such a good antioxidant is that is can donate a second electron and become dehydroascorbic acid. This is beneficial because now more than one free radical can be converted to a less harmful substance by a single ascorbic acid molecule. Why isn't semidehydroascorbic acid or dehydroascorbic acid just as harmful as any of the free radicals that they help oxidize? Free radicals are generally unstable. This means that they seek out electrons very actively and desperately try to steal them from other molecules. Semidehydroascorbic acid is a very stable molecule and doesn't have a strong attraction to the first electron it looses, so is does not desperately seek out other available electrons. Dehydroascorbic acid does however, seek its lost electrons and is more unstable; but it is quickly converted to a more stable molecule by breaking apart its ring structure to form diketogluconic acid. There are other antioxidants that work much to the same extent that ascorbic acid does, these include vitamin A and vitamin E.

Antioxidants can be obtained from eating many types of fruits and vegetables. They can also be obtained by supplementing ones' diet with multivitamins. The recommended dosage for ascorbic acid is 60 mg per day to prevent symptoms of deficiency. 200 mg per day is considered the optimal dosage and 1000 mg per day is the maximum recommended amount (Papas 180). The recommended amount for vitamin A also known as beta-carotene is 5-7 mg per day. The minimal needed intake is around 3 mg per day.

Studies have shown no advantages to taking beta-carotene in amounts of more than 20-30 mg per day (Papas 151). The recommended amount of vitamin E to be taken each day is controversial. There is some question as to high dosages being toxic but little evidence to prove it. "The most common supplemental doses are 100, 200, 400, and 800 IU" (Papas 205). The minimum amount of vitamin E recommended each day by the USDA RDA is 30 IU.

Protein supplementation is another way that the effects of steroids can be replicated. Whey protein is one of the most commonly purchased sports enhancement products sold today. Whey is a byproduct that comes from manufacture of cheeses and caseins. Whey was originally thought of as a waste product and undesirable. This waste product was soon recognized to be a valuable source of nutrients, especially protein (Damodaran 77).

As a person exercises he/she changes the amount of protein that is metabolized during the workload. There are marked increases in the amount of amino acids that are oxidized during exercise. "Of these amino acids, the oxidation of the branched chained amino acids (BCAA) leucine, valine, and isoleucine appears to be increased during catabolic states" (Tarnopolsky 157). A catabolic state is when larger molecules or macromolecules are broken down to obtain energy for an expenditure such as exercising. Through the consumption of large amounts of protein in a persons diet, the amount of catabolism that takes place in the muscle is reduced. The breakdown that does occur in the muscle is then quickly repaired by the available amino acids. It is possible to monitor the changes in muscle protein using the mixed-muscle fractional breakdown rate (FBR) and mixed-

muscle fractional protein synthetic rate (FSR). This is done by measuring the content of various amino acids in the blood at different times following exercise. As was stated earlier AAS promote protein synthesis in the muscles and a positive nitrogen balance. Consumption of protein, in time monitored and measured quantities, can have a very similar effect.

"Testosterone concentration in blood plasma increases acutely following resistance exercise. Therefore, the post-exercise period may be and ideal time for the ingestion of amino acids to promote protein synthesis" (Lamb 139.) Post work out ingestion of protein is almost a necessity. Non-sedentary people have higher requirements for protein to replace what is being used daily. Along with fat and carbohydrates the body also depends on protein for energy. "On average male and female endurance athletes obtain about 14% of their dietary energy from protein. This is about 1.8g and 1.2g protein per kg of body weight per day. Males who participate in resistance exercise consume more protein (2.0g per kg of body weight per day) which represents a larger proportion of daily energy intake (18%)" (Lamb 140-141.) The amount of protein recommended by the Food and Drug Administration is not enough for an active individual. If a person is attempting to obtain larger and stronger muscles and does not want to go the route using AAS, they should definitely consider the advantages of excess protein supplementation. In a sedentary individual, excess protein supplementation has no known advantages and in fact will be converted to excess body fat if it is not used as energy.

The best source of energy and the most easily obtained energy comes from complex and simple carbohydrates. Both of these components are necessary to get the most of out of a work out. After strenuous exercise it is best to restore what your body has lost with simple carbohydrates. Consuming enough carbohydrates is important to maintain and increase glycogen levels in the muscles. A carbohydrate drink following exercise is also helpful in facilitating the transport and absorption of protein in the body.

In retrospect there are a number of alternatives to using AAS. When making the choice whether or not to use AAS, one should consider both the advantages and disadvantages. While AAS cause an increase in testosterone very quickly, they do more harm than good to the body in the long run. To gain muscle mass it is necessary to increase the amount of testosterone and growth hormone in the body. This can also be done through the use of safer alternatives such as creatine, antioxidants, protein supplementation, and carbohydrate supplementation. If a person wants immediate results for purposes of becoming more competitive and has no moral dilemma using steroids and is not concerned with the side effects, then there are no arguments why they should not use steroids. If a person is willing to put in hard work and effort to obtain their goals then they should go the route of the AAS alternatives. No long term conclusive studies have been done that demonstrate the effects of the alternatives with a rigorous training program. However, the short-term effects of these supplements have proven them to be very strong competitors of AAS.

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