ICA

Physiology

The International Coaches Association

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Physiology

Introduction

For a soccer player to play to their maximum potential throughout a game, they need a constant supply of energy so they can follow team tactics and maintain optimum skills levels until the final whistle. To develop this energy, they can train in two ways: by blindly copying what athletes have done in the past; or by learning how research has shown that the body adapts to stress through training, and apply this knowledge to a training schedule tailored for their sport and own level of fitness.

The latter method could save hours of work and prove more beneficial than the former method. This section presents information for the latter method of training for soccer players.

The scope of this section is limited to the application of physiological concepts to soccer. While psychological aspects can, and do play a large part in preparing for maximum performance, they are a study unto themselves and not included here.No matter how many physiological principles are adhered to, if the athlete believes they are incorrect (or unlucky) it is unlikely they will get maximum benefit from using them. Ideally the athlete should be fully physiologically and psychologically prepared for competition.

By presenting the physiological basis for soccer preparation, athletes and coaches will develop a positive psychological approach to information, which has proven to be beneficial. hese seven sections are divided into subsections, each headed by a concept statement and followed by the physiological basis for that concept.

Energy and Movement - Throughout the 90 minutes of a soccer game, energy is supplied by both anaerobic and aerobic energy systems.

Each muscle must make its own energy before it can help in movement.

To make us move, our muscles have to shorten and pull the bones they attach to into different positions. Each muscle is made of thousands of long fibers or cells which shorten when they have enough energy for a contraction. If enough fibers shorten at the same time, the whole muscle will shorten and we will move.

Each muscle fiber has to make its own energy. The energy for a contraction is released for use by the fibers when a compound in the fibers called ATP (adenosine triphosphate) is broken down. Very little ATP is stored in muscle cells, in fact there is not even enough stored to provide all the energy of a two-second sprint. In this way little energy is wasted, but it means we have to produce energy quickly and constantly to allow play to continue beyond the kick-off and until the final whistle. Additional ATP is produced in any of three energy systems present in muscle cells. These three systems are the PC (phosphocreatine) system, anaerobic glycolysis, and the aerobic system.

It is necessary to understand each system and its limitations and uses to be able to adapt them for optimal energy production while training and competing.

Energy needs for Soccer

At different times of the game a soccer player will draw energy from the three different systems.

Throughout the 90 minutes of a soccer game, energy is supplied by both anaerobic and aerobic energy systems. The dominant system at any one time depends on the intensity of exercise.
At rest almost all energy is provided aerobically using fat as a fuel, but as intensity increases, so does the dependence on anaerobic energy. This is because the anaerobic system can provide energy quickly without needing oxygen.

Quick energy of a short sprint will be almost entirely from anaerobic sources, whereas the energy for continual running will be predominantly from aerobic metabolism. The energy to start any exercise will be from the PC system. During periods of relative inactivity in a game, sources will be almost entirely aerobic.

Throughout the game of soccer, field players' energy is supplied by all three systems with the amount of energy from each depending on the intensity of exercise at the time. The goalkeeper's energy will be mostly from anaerobic sources as his play is normally an intense spurt of energy followed by a period of relative inactivity -- unless he is on a team which is under continual pressure in defense -- in this case aerobic metabolism will play a more important role to keep him active for longer periods of time.

The energy systems can be improved with training so that more energy can be available at any point during a game. While a sprinter must condition his anaerobic energy systems and a marathoner his aerobic system, the soccer player must condition all systems to be able to sprint when necessary, and be able to play for the full game.

The PC (Phosphocreatine) System

The PC system is the fastest producer of ATP in the body.

The PC system is our most rapid source of ATP. It is used to supply energy each time our energy requirement increases from a steady state. When ATP is needed to replace resting stores or for a higher energy output, a series of reactions takes place (see Figure 1). In the muscle cell a compound of phosphate and creatine called PC (phosphocreatine) splits, releasing some energy. This energy is used to unite two other molecules (ADP and phosphate) to produce one ATP. The ATP can now be broken down to provide energy for muscular contraction.

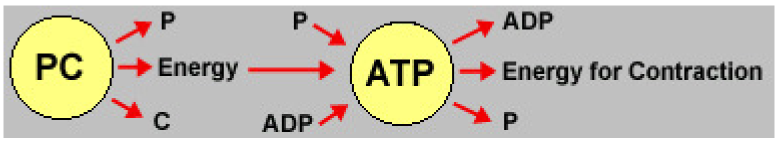


Figure 1. The PC System of Energy Production.
P = phosphate; C = creatine; ADP = adenosine diphosphate;
ATP = adenosine triphosphate.

The resting stores of PC can be replaced using some of the energy produced in one of the other two systems to reunite the phosphate and creatine. The restoration of PC stores is 70% complete after 30 seconds of rest, and 100% after three minutes.

Anaerobic Glycolyisis

Glucose, which comes from carbohydrates, is the fuel needed for intense exercise.

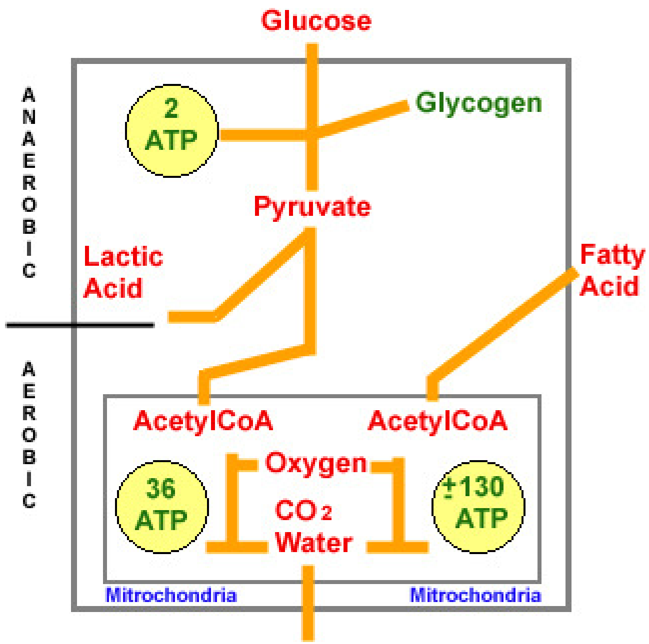
Anaerobic glycolysis and the aerobic system both produce ATP from the food we eat. The food is partially broken down in the stomach, then the food molecules are transported to the cells where they are further broken down to produce ATP. The primary food molecules used to produce muscular energy are glucose (from carbohydrates) and fatty acids (from fat).

Anaerobic glycolysis is a "high-octane" system of energy production, which supplies energy quickly, using glucose as a fuel. The glucose can come from a variety of sources. It can be absorbed from the blood passing the muscle fiber, it can be stored in the muscle fiber as glycogen, or it can be stored in the liver as liver glycogen. When glycogen is used as a fuel, it first has to be changed to glucose, and in the case of liver glycogen, it then has to be transported to the working muscle by the blood.

In anaerobic glycolysis, a glucose molecule is broken down to form pyruvate with the production of two ATP (see diagram). The pyruvate changes to lactic acid, which is a fatigue-related byproduct and possibly a cause of post-exercise stiffness.

While a person is resting, glycolysis provides only a small amount of the needed energy, but in an intense bout of work, like a 100-yard dash, glycolysis provides almost 100% of the total energy needed. When we exercise at maximum intensity using only glycolysis to supply our energy needs, we can only continue for a couple of minutes before the lactic acid builds up, energy production stops, and we fatigue.

Anaerobic glycolysis is vital whenever quick, or high-intensity energy is needed, but it is an expensive system to use because glucose and glycogen can only be stored in limited amounts and the lactic acid left in the cells leads to fatigue. The aerobic system does not leave lactic acid in the cell and can use fatty acids as a fuel.



The Aerobic System

During continuous exercise the muscle fibers must be supplied with oxygen so they can produce energy for a long period of time.

The aerobic system provides energy only when sufficient oxygen is present in the muscle fibers to help in the fuel breakdown. The PC system and anaerobic glycolysis are both called anaerobic energy systems as neither of them requires oxygen to produce ATP (anaerobic means without oxygen). If there is not enough oxygen in the cell, the aerobic system will not function and all the energy needed by the muscle fibers for contraction will come from anaerobic sources.

When exercise intensity increases from a steady level the extra energy will initially come from anaerobic sources until enough oxygen can reach the working fibers for aerobic metabolism. When oxygen delivery reaches it s maximum, any additional energy will again come from anaerobic glycolysis. So whenever the muscle cell has sufficient oxygen, the predominant energy system will be the aerobic system, but any shortage of energy will be supplied by the anaerobic systems.

In the aerobic system, glucose is broken down to pyruvate releasing two ATP as in anaerobic glycolysis, but instead of changing to lactic acid, the pyruvate is changed to acetyl CoA and then further broken down using oxygen to produce carbon dioxide and water, and another 36 ATP. This gives a total of 38 ATP from one glucose molecule compared to the two ATP from anaerobic glycolysis, the end-products of carbon dioxide (CO-2) and water (H20) are released to the blood. See Figure 2 for a diagram of the aerobic system.

The aerobic system can also use fat as a fuel. The fat we eat has to first be broken down and stored before it can be used as a fuel for energy. Fat is a limitless source of energy for the body as even the leanest person has enough fat to provide energy for two consecutive marathons (26 miles each) if fat is the only fuel used. Fat is stored around the body in adipose tissue. It is released from these storage areas and transported by the blood, in the form of fatty acid, to the working muscle. When the fatty acid is delivered to the working fiber, it will be used as a fuel in place of other foodstuffs if there is enough oxygen to break it down.

The fatty acid enters the cell and is changed to acetyl CoA which follows the same pathway as the acetyl CoA produced in the aerobic breakdown of glucose, resulting in ATP, Cox, and H20). Where one glucose molecule can aerobically produce 36 ATP, a fat molecule which has many potential Acetyl CoA molecules can produce 100 to 200 ATP! The numbers vary in fat breakdown as there are different types and sizes of fat molecules which produce varying amounts of ATP.

Table 1 shows a comparison of ATP produced in aerobic and anaerobic metabolism.

TABLE 1.
A comparison of ATP produced in Anaerobic and Aerobic Metabolism.

Energy System	**Glucose to Lactic Acid**	**Glucose to 20 & CO2**	**Fatty Acids to H20 & CO2**
Anaerobic	2	2	0
Aerobic	0	36	100 - 200
Total ATP Produced	2	38	100 - 20

Key Words

ACETYL COA - compound in the aerobic breakdown of fatty acids and glucose
ADIPOSE TISSUE - storage tissue for fat
ADP (adenosine diphosphate) - an end-product when energy is released for movement
AEROBIC ENERGY - energy produced using oxygen
ANAEROBIC ENERGY - energy produced without using oxygen
ATP (adenosine triphosphate) - compound in the muscles which is the source of energy for movement
CO2 (carbon dioxide) - gas end-product of aerobic metabolism
FATTY ACIDS - form in which fat is transported
GLYCOGEN - storage form of glucose, found mostly in muscles and the liver
GLYCOLYSIS - the breakdown of glucose or glycogen to pyruvate
GLUCOSE - sugar, a primary source of energy
H2O (water) - an end-product of aerobic metabolism
LACTIC ACID - end-product of anaerobic glycolysis which can cause stiffness and fatigue
METABOLISM - chemical changes constantly occurring in the body
MITOCHONDRIA - structure in the cell where energy producing reactions using oxygen take place
MUSCLE FIBER - contracting portion of a muscle cell
PC (phosphocreatine) - a compound used to make ATP

Advantages of a Trained Player -

While a well-trained soccer player can concentrate on the game, an unfit player will be counting the seconds to the final whistle.

A trained soccer player can work harder and longer than an untrained player.

The trained player has numerous physiological advantages over his out-of shape counterpart. The changes that take place in the body during training allow the player to play at a higher intensity throughout a game than before training. Some anaerobic adaptations occur with quick, burst-type training, while the aerobic adaptations are related specifically to endurance training.

Anaerobic Adaptations

Training improves the PC system and anaerobic glycolysis so more energy is available for short bursts of work and high-intensity work.

The overall capacity of the PC system is improved with training. This seems to be due to increasing amounts of ATP and PC stored in the body, and the production of more enzymes which help the chemical changes take place. So with training, more energy can be supplied quicker and more often through the PC system.

Anaerobic glycolysis is improved in three ways with training. After training each muscle cell stores more glycogen to be used as fuel, the enzymes which change glucose to pyruvate may increase so speeding up and increasing the quantity of glucose breakdown, and the cell can tolerate more lactic acid before it fatigues.

For the above adaptations to take place, both systems must be stressed in training. This is best done by using fast, burst-type activity and maximum intensity sprints.

Aerobic Adaptations

The endurance-trained soccer player can run farther and recover quicker than an untrained player. The aerobic system shows greater adaptation to training than the anaerobic systems. Adaptation takes place in each trained muscle cell, in the oxygen delivery system, and in the amount of fuel available.

The muscle cell adapts to training by increasing its resting stores of oxygen, increasing the number and size of its mitochondria which are the structures in the cell where the oxygen can be used to make energy from glucose or fat, increasing the energy-releasing enzymes, and by making optimum use of the oxygen which is supplied. These adaptations allow the muscle fibers to produce ATP quicker and more efficiently than before training.

The oxygen delivery system has many adaptations, which help more oxygen to reach the cells of trained athletes. The delivery of oxygen to working cells is the primary limitation to aerobic metabolism. Without sufficient oxygen, the cells have to rely on anaerobic metabolism to produce energy.

More oxygen gets into the system because the blood supply to the lungs, maximum breathing frequency, and blood volume increase. Also, more red blood cells are produced which contain more hemoglobin, the carrier substance for oxygen. These adaptations allow more oxygen to be carried in the blood.

The delivery of the 'super-charged' blood improves because the heart, which is the muscle which pumps the blood around the body, adapts by increasing in strength so it can pump more blood more forcefully through the system after training. Even at rest more blood is pumped with each beat of a trained heart -- this causes a lower resting heart rate in aerobically trained people because the same volume of blood can be pumped with fewer beats. The heart muscle itself shows training adaptations so it can pump more efficiently after training. At the cell level the number of blood vessels increases around the trained cells so it becomes easier for them to extract more of the oxygen which is in the blood.

After training, more fuel is made available for aerobic metabolism than before. Training increases the enzymes needed to produce glycogen in muscle cells. In this way the trained cells can store more than double the amount of glycogen, which is one of the primary limitations to prolonged work. The muscle cells adapt to use more fat as a fuel because training improves the fat release from the adipose tissue areas so more fat can be transported to the working muscle cells for energy production. At the cell level, more fat can be used as a fuel because training increases the enzymes, which help fat release and fat breakdown. These adaptations allow some glycogen to be saved for later in the activity.

General Adaptations

While a well-trained soccer player can concentrate on the game, an unfit player will be counting the seconds to the final whistle. he fit player's body shows adaptations in various ways other than those given above. After training, the body's cooling system works more efficiently, so exercise can be tolerated for a longer period of time in hot weather. The time to clear lactic acid from the muscle fiber and blood is substantially decreased after training so the fit athlete can recover quicker after intense bouts of exercise. While the athlete's weight may stay the same during the training period, the trained athlete will have a lower ratio of fat to muscle so he will have more muscle to carry less fat making work at any intensity easier.

Putting it all together, we find that if a trained and an untrained soccer player compete against each other, the trained one will be able to do very much more running, will maintain her maximum speed for longer, and will recover quicker than the untrained one. The trained one will be running more efficiently, that is making best possible use of his energy sources.

The differences in the players will be more pronounced as the game progresses. The unfit player slows as the game continues, finds it harder to keep pace, and will ache for the final whistle while his fit opponent can concentrate on team tactics and be as effective at the end of a game as at the outset.

Key Words

AEROBIC - with the use of oxygen.
ANAEROBIC - without the use of oxygen.
ENZYMES - protein compounds that speed up chemical reactions.
GLYCOGEN - storage form of glucose.
HEMOGLOBIN - compound in the red blood cells which carries oxygen.
MITOCHONDRIA - structure in the cell where reactions using oxygen for energy production take place.

Oxygen as a Limit to Energy Production - To produce energy for soccer we need a continual fuel supply.

The muscle cells can only use the aerobic system to produce energy if they have an adequate supply of oxygen.

To produce energy for soccer we need a continual fuel supply to the working tissue, a supply of oxygen to be able to use glucose and fat as a fuel, and we need enzymes to help this breakdown take place. For soccer, the most critical of these factors to understand is the supply of oxygen.

When oxygen supply to the cells is low, or insufficient, any energy those cells need for contraction will have to be produced through the anaerobic energy systems which use only glycogen and glucose and cannot supply energy for a long period without causing fatigue.

The oxygen we need in the cells comes from the air we breathe. In the lungs, the oxygen passes to the blood where some of it dissolves in the blood fluid, but the majority of it is picked up and carried on hemoglobin in the red blood cells. Under normal conditions not all the oxygen from the air can be taken into the blood so there is still some in the air we breathe out.

The oxygenated blood leaves the lungs, goes to the heart and is pumped throughout the body. The blood flows to where it is most needed at any one time: during exercise, more blood goes to the working muscles than at rest; in the heat, more goes to the skin to help cool the body; and after eating, more blood goes to the gut to help digestion. At the working cell, oxygen leaves the blood, enters the cell and is used in the breakdown of fat and pyruvate to supply ATP for energy.

Carbon dioxide is an end-product of the aerobic system and must be removed. It passes from the cell to the blood, is picked up by the hemoglobin and transported to the lungs and exhaled. Water, the other end-product, is used in the body, excreted, or sweated out.

As energy requirement of exercise increases, so does the need for oxygen, so we breathe deeper and more often to get more oxygen into the blood, the heart pumps quicker and more forcefully so more blood is pushed through the vessels, the vessels open wider in the working tissue admitting more blood to deliver its oxygen supply, and more blood returns to the lungs laden with carbon dioxide. This system determines the ultimate limit to energy production.

If the oxygen supply is limited for any reason, less energy will be produced through the aerobic system and a greater dependence will be placed on anaerobic metabolism to make up the difference in energy supply for any given level of activity. When more use is made of anaerobic energy exhaustion will occur sooner than had aerobic energy been used. This is because of the lactic acid, which builds up during anaerobic glycolysis, and a possible glycogen shortage.

Some factors which can limit the oxygen supply in the conditioned athlete are: altitude, smog, smoking, digestion, and excess heat.

Competing at Altitude

Endurance performance will be better at sea level than at high altitude.

At any altitude over 5,000 feet above sea level, aerobic energy output will be limited because the oxygen supply to working tissues will be lower. Up to 5,000 feet the blood can still reach saturation with oxygen, but after that, as altitude increases, less oxygen can be breathed with every breath because air at a high altitude is under a lower pressure than at sea level.
This reduces the amount of oxygen, which can be picked up by the hemoglobin and carried to working muscle cells.

The body tries to compensate for its lack of oxygen by breathing quicker, but this in turn can cause temporary problems in some, although not all, athletes. As the breathing frequency increases to take in more oxygen, more carbon dioxide gets washed out of the body and the balance of oxygen to carbon dioxide gets upset. This imbalance causes a temporary sickness called mountain sickness.

Those affected may feel light-headed, nauseous, lose their appetite, lose sleep at night and frequently have headaches. These are obviously not ideal conditions to be under while trying to compete. Some people are unaffected by mountain sickness, while in others its effects can be felt for two to seven days. Vulnerability is increased by cold weather, colds, or sustained exercise.

The body does show some effective adaptation to altitude. During the first two to six weeks at altitude, more hemoglobin is developed in the blood so the oxygen that is available can be picked up easier and carried to the working muscles. Residents at altitude have some other adaptations which improve their aerobic capacity by making the best possible use of the oxygen that does get to the muscle tissue. These adaptations only last for two to four weeks after moving back to sea level and take months to develop.

If a match has to be played at an altitude of over 5,000 feet by non-altitude residents, the best physiological time to compete would be on the first day at altitude before the effects of mountain sickness are felt. The worst time would be from two to seven days after arriving at the high altitude. After that, the players would start to benefit from the body's adaptations and the effects of mountain sickness would have subsided.

Altitude residents as well as visitors to altitude have a lower aerobic capacity at altitude than at sea level so exercise must be reduced while at a high altitude. While allowing adaptation to take place in the days prior to competition exercise intensity and volume must be lowered. This could be a disadvantage of training at altitude as it may not allow sufficient time for adequate match preparation.

Allowing complete adaptation as seen in altitude dwellers is probably not applicable to soccer training unless an important match or tournament is to take place at a high altitude and warrants the time (nearly a year) of relocating the players. However, by understanding the limitations that high altitude places on the body, athletes and coaches will be better prepared for the stress caused by the altitude and exercise.

Smog and Exercise

Smoggy conditions are not only detrimental to performance; they may be dangerous to an athlete's health.

Practice and matches should be avoided when smog levels are judged to be detrimental to health, as in the case of issued smog alert. Carbon monoxide (CO) and ozone (O_3), are two types of smog which cause different problems at different times of the day and year, but both limit the oxygen supply to the working muscle tissue and thus lower aerobic performance.

High carbon monoxide levels in the air, caused mainly by engine and automobile exhaust, result in a lowered amount of oxygen available to the tissues similar to that at altitude. Here there is sufficient oxygen in the air, but the CO competes with the oxygen for space on the hemoglobin, and wins, so less oxygen can reach the cells, which lowers the aerobic contribution to total energy production placing more dependence on anaerobic energy.

Fortunately high CO levels are isolated in their occurrence, present mostly in metropolitan areas, in cold weather, and at commute time, so avoidance of competition at high CO smog levels is a relatively simple matter.

A more dangerous problem occurs with ozone smog. Ozone is the yellowish haze caused by trapped polluted air, which has been exposed to sunlight. Ozone smog is most intense in hot weather in the middle of the day, in areas with little moving air commonly called smog bowls.

Ozone is a lung irritant. The body tries to protect itself from the ozone by constricting the airways in the lungs. This allows less air to enter the lung with each breath. To compensate for the lower volume of air in each breath, breathing frequency increases. While the increased breathing frequency will keep the total volume of air about the same, not as much oxygen will be able to reach the blood in the lower, or deeper parts of the lungs and in turn less oxygen will be able to reach the muscles, and again, more dependence will be placed on anaerobic metabolism.

No acclimatization to ozone smog has been reported and with high ozone exposure permanent lung damage has been observed in laboratory animals. This plus the extra stress which is placed on the body as it tries to compensate for the low oxygen availability are good reasons to avoid practice and competition in ozone smog.

The ozone smog problem seems to be harder to avoid than high CO levels and is more dangerous, but if competition must take place in a smoggy area, a site with as low ozone levels as possible should be sought, and competition should be restricted to early morning and evening matches when the ozone levels are lowest.

Air quality control centers provide maps, which show smog levels throughout the year in smoggy areas. If you live in a polluted area it will be worth your while to contact a center and find a low-smog area for your practice and matches.

Smoking

Smoking severely limits aerobic energy production, but its effects are reversible and most ex-smokers can reach the same energy output as non-smokers given enough time to adapt.

As with ozone exposure, cigarette smoking causes a constriction of the air passages in the lungs. With as few as 10 inhalations, the air flowing into the lungs may drop by as much as 50%, thus limiting the area over which blood can pass to pick up its oxygen. The blood that does reach the air will also have a lower capacity to carry oxygen in a smoker, similar to the athlete in CO smog condition. The CO from the cigarette competes with the oxygen for place on the hemoglobin, thus limiting the amount of oxygen that can be taken up. Marijuana smoking has the same short-term effect on oxygen uptake as cigarette smoking.

The lungs of smokers are not as elastic as those of non-smokers, so in order for the smoker to inhale, he will have to use more energy than a non-smoker, which will further limit his aerobic energy supply. Total abstinence from smoking for 24 hours does decrease this extra cost of breathing, but does not reduce it to a non-smoker's level. The longer the time of abstinence, the better the oxygen supply becomes until after a few months, ex-smokers are no longer limited and compete with non-smokers, provided they did not incur any permanent disease or damage while smoking.

In short, smoking severely affects aerobic energy output. If you are a smoker and fit, imagine how much better you could be if you could work at your full capacity. For better performance, kick the habit, or if you cannot (or will not) abstain on the days of competition so the smoking will have the least possible effect on your performance.

Digestion and the Pre-game Meal

A pre-game meal should be well-planned and finished at least two and half hours before starting to exercise.

Blood is directed around the body by reflexes, which constrict or relax the blood vessels to control the amount of blood which goes to each area of the body. At rest, about 15% of the total blood flow goes to the muscles, the remainder goes to the other organs. During maximum exercise, about 90% of the blood flow goes to the working muscles and skin, and only 10% to the other organs.

When we eat, blood is sent to the digestive organs to pick up and transport the nutrients around the body. After a late or heavy pre-game meal, energy supply may be limited by the amount of blood available to transport oxygen to working tissues for energy production.

Two problems can arise: either the blood supply will continue its digestive duties and limit the supply to the muscles; or it will supply blood to the muscles, neglecting its digestive duties and leave undigested food in the stomach which can cause heartburn, indigestion, and the feeling of food rattling in the stomach. Either way, optimum performance will be limited.

The pre-game meal should consist of plenty of fluids, and food that is easily digestible by the athlete, does not cause gas, and satisfies his hunger. Fats and proteins take a long time to digest so should be avoided, whereas carbohydrates can be fully digested in under three hours and can possibly be used as fuel in the ensuing match. The traditional high-protein steak pre-game meal was based on the false presumption that the muscle consumed itself as fuel during exercise. Protein is not an important fuel for energy production and the breakdown of protein can facilitate dehydration during exercise because the by-products of protein breakdown need large amounts of water for excretion in the urine.

The pre-game meal should be finished at least two and a half hours before the start of warm-up. Nervousness slows the digestion rate so nervous athletes should allow even more time between the pre-game meal and warm-up. Several commercially prepared liquid meals are on the market. The meals specifically designed as pre-game meals (not those for muscle bulk development) are well balanced in nutritive value, they contribute to the fluid needs of athletes, and are rapidly absorbed. They are highly recommended as pre-game meal substitutes or for use during tournament or camp play when there is often insufficient time to digest a normal meal.

Some Suggested Pre-game Foods, and Foods to be Avoided.

Foods to Eat	
Breakfast	Lowfat yogurt, fruit (canned, fresh and/or juice, hot or cold cereal, french toast, hotcakes, muffins, coffee, tea, low fat milk
Lunch	Fresh or canned fruit, crackers, cookies, bread, pudding,granola bars, water, fruit juices, soda, lowfat milk
Foods to Avoid	Eggs, butter, anything fried, cheese, whole milk, meat,poultry, avocado

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As a post-game meal, the athlete should eat a well-balanced meal which satisfies his hunger but does not cause discomfort because of over filling. If he is competing the next day, the athlete must be sure to take in extra carbohydrates, avoid fatty foods, bulky foods, and foods which cause gastric disturbances, and be sure to take in plenty of fluids.

If he is competing later the same day, he should eat a light, nutritious meal which is easily digestible. It should contain plenty of fluids and be taken as soon as possible to allow sufficient time for digestion. Here a liquid meal, or a pre-game liquid meal substitute is recommended.

Exercise in the Heat

Exercise in the heat can severely limit energy production and can be dangerous to the unacclimatized athlete. Heat is produced by working cells while they generate energy. As the muscle temperature rises, the rate of metabolism increases to a point. After that point the excessive heat slows the action of the cell's enzymes and limits energy production. To avoid this overheating, the body tries to rid itself of any excess heat by transporting it via the blood to the skin or by radiation. More heat can be lost in dry weather than humid weather since evaporation is quicker in a drier environment.

Heat can easily be lost in cold weather because the blood cools when it reaches the colder skin, but in hot weather, heat is not lost through radiation and all the cooling must be done through the evaporation of sweat, some of which is taken from the blood fluid (or plasma).

As exercise continues in the heat, more fluid is lost from the blood and the total blood volume drops. As body temperature continues to increase, more blood is sent from the muscles to the skin for cooling. These two changes reduce the amount of blood available for the transport of oxygen to the working tissues and cause a limit to aerobic energy production, more dependence on anaerobic energy and exhaustion will then occur sooner in the heat. Excessive strain is also placed on the circulatory system as it tries to adjust to the lower blood volume and increasing internal temperature.

If exercise continues in the heat and the body can no longer control its temperature, it can suffer from heat injury. Symptoms of heat injury are shown below. Heat cramps can lead to heat exhaustion which in turn can lead to heat stroke which can cause permanent damage to the nervous system which controls the body's temperature regulation. Without proper care heat stroke can lead to death. The athletes who are most susceptible to heat injury are those who are unaccustomed to working in the heat, overweight, ill, and the highly competitive athlete who will over-extend himself.

Heat injury can be avoided by drinking plenty of fluids, acclimatizing to heat, wearing clothing which allows sweat to evaporate, and being aware of the limitations to exercise in the heat.

The most serious consequences of profuse sweating is the loss of body fluids. Fluids should be replaced as they are lost. In hot weather athletes should drink 8-10 ounces of fluid 10 to 15 minutes before activity, take extra water breaks during activity and at half time during matches take in extra water. The body can absorb a maximum of one cup of water every 15 minutes, but this amount can be reduced if either salt or glucose is added to the water (a 10% glucose solution decreases the volume leaving the stomach by 50%).

On hot days when heavy work is done, like at the summer soccer camps in hot areas, the athletes should weigh themselves before the next practice. The athlete will of course be thirsty after work in the heat, but thirst is a poor indication of body fluid needs. Thirst is satisfied before the body has had enough replacement fluids, especially if the fluid taken is ice cold. So, on hot days, drink your fill, and then have some more.

There are several thirst quenchers on the market designed especially to act as replacement fluids during exercise. These drinks have been developed so as to be quickly absorbed but unless they are properly diluted, with at least the suggested amount of water, they will remain in the stomach. Drink plain water, you can't go wrong.

Clothing for work in a hot environment must allow easy evaporation of sweat. Only sweat which evaporates possesses "cooling power"; when sweat rolls off the body or is trapped in clothing it contributes nothing to heat loss. Ideal clothing should be loose-fitting and made of lightweight cotton, not synthetic materials.

Symptoms, Causes, and Treatment of Heat Injury.

Heat Cramps

Symptoms:
muscle pain and spasm.

Causes:
excessive salts lost from the body.

Treatment:
stretch sore muscles, rest and drink plenty of fluids; to avoid heat cramps take in plenty of fluids and increase salt intake prior to the period of heat stress.

Heat Exhaustion

Symptoms:
profuse sweating, weak but rapid pulse, dizziness, general weakness, goose bumps.

Causes:
ineffective circulatory adjustments, excessive sweating.

Treatment:
stop exercising, drink lots of fluid, move to a cooler area.

Heat Stroke - MEDICAL EMERGENCY

Symptoms:
sweating ceases, skin is dry and hot, bright red face, temperature dangerously high (above 105 d - death ensues soon after 108 d), may or may not be conscious.

Causes:
failure of temperature regulating mechanism in the brain.

Treatment:
while waiting for medical aid cool the body by immersing in cold water and apply ice packs.

As you sweat, some salt leaves the body with the fluid from the blood. This salt can be adequately replaced by putting extra salt on your food during meals. Salt tablets are unnecessary unless more than 6 pounds of weight is lost due to sweating. If this is the case, see an athletic trainer or someone trained in athletic nutrition for guidance in taking salt tablets. Salt tablets can cause a further loss of body fluid unless they are taken with sufficient water and should be avoided except in the rare case where very high sweat loss occurs.

The body acclimatizes to work in the heat by improving circulation and sweating responses. To acclimatize, exercise in the heat for progressively longer time spans for 5 - 8 days before competing in the heat, and always take sufficient fluids during the acclimatization period. Withholding fluids simply slows the acclimatization process.

Key Words

ACCLIMATIZATION - process of adjusting to a new environment (e.g., altitude).
CO (carbon monoxide) - an air pollutant and cause of smog.
DEHYDRATION - state of being without sufficient fluids.
HEARTBURN - pain in the chest after eating.
HEAT CRAMPS - sudden contraction of a muscle due to fluid imbalance after exercise in the heat.
HEAT EXHAUSTION - discomfort due to ineffective cooling of the body during exercise in the heat.
HEAT STROKE - failure of the brain to control body temperature and a medical emergency.
MOUNTAIN SICKNESS - high altitude sickness which affects some people when they first arrive at altitude.
NUTRIENTS - nourishing ingredient or substance.
O_3 (ozone) - an air pollutant and cause of smog.
POST-GAME MEAL - the meal immediately following a game used to replace energy stores.
PRE-GAME MEAL - meal which should be easily digestible that precedes a game or practice.
RADIATION - transfer of heat through airwaves.

Fuel as a Limit to Energy Supply - There is no instant, quick energy available that will replace the need for adequate training, proper diet and match preparation.

Working muscle fibers need a constant supply of suitable fuel to supply energy for exercise.

For the best possible performance during a soccer game, we need to have abundant fuel available for the body to breakdown and release energy. Ideally, the aerobic breakdown of glucose and glycogen is the most efficient energy source, but unfortunately the body cannot store enough of either to last a field player through an entire game. We need another fuel to augment energy supply. This fuel is fat, a virtually limitless source of energy when you realize that it takes less than one pound of fat to supply the entire energy needs of running a marathon (26.2 miles).

For maximum energy supply throughout the game, we should store as much glucose (as glycogen) as possible and save it only for intense workouts by using fat as an alternate fuel source for lower intensity work. This will allow the athlete to play at a higher intensity throughout the game without feeling the effects of fatigue.

The problem with using glucose as an aerobic energy source is its limited storage quantity, whereas a limit to using fat, is its release from the adipose tissue storage areas and delivery to the working tissue. Proper training can increase glycogen storage and enhance fat release, delivery and breakdown. Both of these limits can be helped even further by understanding how these fuels are limited and how to use them to the best advantage.

Increasing Available Glycogen

By manipulating the diet in the days before competition, more glycogen can be stored in the body for use during the competition.

The muscle and liver cells store glucose as glycogen for use when needed for energy.
By manipulating the diet, the athlete can trick his body into storing even more glycogen than normal. The manipulation called carbohydrate loading or glycogen super compensation can be useful to trained soccer players.

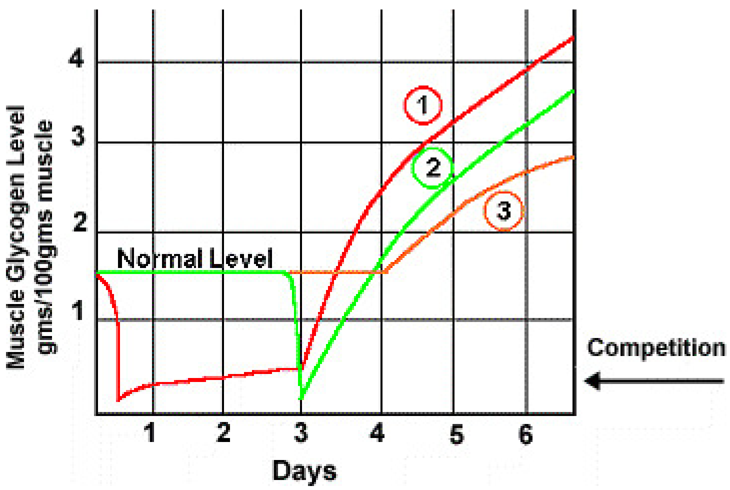
Loading can allow them to work at a high intensity for a longer period of time than without loading, or work for the same period (like a game of 90 minutes) but at a higher intensity.

Loading does effect individuals differently, so should be tested to see its effects prior to using it before an important game. Some people take longer to load while others find the benefits of loading are outweighed by feelings of stiff, heavy muscles. If used regularly, the dietary manipulation could be detrimental to the athlete's health so it should only be practiced for very important matches, trials, or tournaments.

To carbohydrate load the athlete must lower his glycogen stores by a prolonged bout of exercise (like an hour of intense continuous play). He then keeps his glycogen levels low by eating mainly protein and fat for the next 2 days, then he switches to eating mainly carbohydrates for the 2 to 3 days before the competition.

The body will store extra glycogen in preparation for another famine. Heavy practice must be curtailed during the loading routine and only light exercise and ball work should be done to allow for maximum loading. The curtailed exercise before a match can be a negative effect of carbohydrate loading if match preparation is affected. Other negative effects of loading can be the increase in body weight due to the extra glycogen and water stored, and possible dietary deficiencies. Abnormal heart responses (ECG abnormalities) have also been observed in people after carbohydrate loading.

Smaller increases in glycogen stores can be induced by less drastic dietary manipulations. These regimes are probably more suitable to the soccer player. Increases in glycogen stores can be induced by depleting stores as in the previous regime, and then immediately changing to a high carbohydrate diet. A third pattern follows normal activity patterns but stresses eating a carbohydrate rich diet for the two or three days before competition. While the increased glycogen storage is not as much as under the more drastic manipulation the increases are significant and should aid performance.



Carbohydrate Loading Patterns
1. Deplete glycogen stores, follow a fat and protein diet, then a high carbohydrate diet.
2. Deplete glycogen stores, follow a high carbohydrate diet.
3. Follow a high carbohydrate diet with no other manipulation.

Glucose or Sugar as an Energy Booster

Eating glucose within an hour of game time can actually reduce the amount of energy available during the game.

When you chomp on a candy bar or slurp down a sweetened drink, the glucose levels in the blood soon rise. In response, insulin, a hormone from the pancreas, is secreted and causes glucose to be stored in the cells. Generally the pancreas over-reacts to high sugar levels, secretes extra insulin, and more glucose is stored in the cells than was just taken in, leaving the glucose levels in the blood lower than before the extra glucose was consumed (from the candy bar or drink). Lower blood-glucose levels mean that less blood glucose is available to the working cells. Normally this is no problem, but if the levels are lower at the start of exercise, energy supply will be limited and the "sugar-high" athlete will fatigue quicker than had he avoided the sweet treat. These reactions are detrimental to performance if the glucose intake occurs about 30 to 45 minutes prior to exercise.

There is no instant, quick energy available that will replace the need for adequate training, proper diet and match preparation.

Increasing Fat Availability

A couple of cups of coffee taken before a soccer game may increase the amount of energy the soccer player derives from fat during the game.

At any intensity of exercise an endurance-trained soccer player will use more fat than an untrained player to provide energy for movement, thus sparing his glycogen stores.
Training increases the enzymes that help breakdown and release fat from adipose tissue storage sites. The main limit to fat usage even in the trained athlete is still its release from the storage areas and delivery to working tissue.

While fat release does increase with training, extra fat may be released and used for energy production if the athlete drinks tea, coffee, cola, or a caffeine containing drink at least one hour before exercise. A number of studies have shown that fat levels in the blood rise significantly about an hour after ingesting caffeine. Athletes have been able to work for longer at a set intensity, or get more work done in a set amount of time after having about two cups of coffee (5 mg caffeine per kg body weight) an hour before exercise. This increase in work potential can help soccer players play at a high intensity for a longer time during the game.

When the athlete takes caffeine prior to a game, the feeling of fatigue will be delayed during the game because fat will play a greater role in energy production throughout exercise and the muscle cells can then save more glycogen for use later when fatigue normally would have set in.

While the use of caffeine prior to exercise may help supply more energy, some people suffer from its well-known effects on the nervous system and find that becoming excessively keyed up or nervous is detrimental to their play. Also, caffeine is a diuretic and may cause dehydration unless the athlete drinks extra fluid to replace the caffeine-caused fluid loss.

When side-effects outweigh the benefits, caffeine should be avoided. Individuals react differently -- some may benefit from the stimulation caffeine causes -- so its effectiveness should be tested before taking it prior to an all-important match, and each player must decide whether caffeine will benefit his performance or not.

Alcohol

Alcohol does not belong on the training table of the serious athlete.

While alcohol contains many calories, it should not be used to boost the athlete's caloric intake. Alcohol has a very low nutritional value, so rather than taking in the "empty" calories from alcohol, the athlete should eat or drink something that will provide the body with calories plus other nutrients.

Remember that alcohol is a depressant, not a stimulant, and while you get a temporary feeling of well-being after drinking alcohol, after a time the alcohol acts as a mind and body depressant. Alcohol taken before a game can slow both mental and physical reaction time -- obviously not conducive to skillful soccer. Alcohol also slows the removal of lactic acid from the cells so the athlete with alcohol in his system has a slower recovery time from intense bouts of exercise and will fatigue quicker.

Alcohol consumption can cause dehydration where there is less fluid available for the body's normal functions. This can lead to heat injury.

For the serious athlete, alcohol has no place on the training table when preparing for competition.

Protein and Vitamin Supplementation

A balanced diet will supply the soccer player with sufficient protein, minerals, and vitamins for the most strenuous work.

If a balanced diet is followed no supplementation of either vitamins, minerals, or proteins is necessary to aid energy supply or general health.

Increased physical activity does not greatly affect to the protein requirement as protein is not an important source of fuel under normal circumstances. Even during periods of heavy training the amount of protein which the athlete takes in to form a balanced diet should be adequate. The recommended amount of protein is 1 gram per kilogram of body weight a day (60 gms/kg/day).

The belief that if small quantities of vitamins and minerals are good for performance then large doses will produce champions is not supported by research findings or the majority of professional nutritionists. Some vitamins taken in excess, especially the fat soluble ones (A, D, E, & K) can be toxic and harmful. The water soluble vitamins (B & C) are simply excreted making expensive urine if taken in excess.

The B group of vitamins (thiamin, riboflavin, and niacin) is closely involved in energy production, so a shortage of these will severely hamper energy supply. However, if the player follows a balanced diet, these vitamins will be provided without using supplements. Megadoses of any vitamins should only be taken under the recommendation of doctor; nutritionists feel that no harm can be done by taking a multivitamin daily as long as it does not exceed the recommended daily allowances of any single vitamin.

Key Words

ADIPOSE TISSUE - storage site for fat.
BALANCED DIET - diet which includes a correct ratio of fat, protein, and carbohydrate.
CALORIE - unit of work or energy.
CARBOHYDRATE - basic foodstuff including sugars, starches, and cellulose.
CARBOHYDRATE LOADING - method of increasing the normal body stores of glycogen in preparation for competition.
DIURETIC - substance which tends to increase the discharge of urine.

EKG (electrocardiogram) - instrument used to record the function of the heart.
EMPTY CALORIE - calorie with no nutritional value.
FAT - basic foodstuff containing glycerol and fatty acids.
GLYCOGEN SUPER-COMPENSATION - see carbohydrate loading.
HYPOGLYCEMIC - state of having low blood sugar levels.
INSULIN - hormone which controls glucose levels in the blood.
PROTEIN - basic foodstuff containing amino acid.

Other Limiting Factors - To perform well in cold conditions the player must be aware of the problems cold can cause.

The soccer player's performance may be limited by any number of physiological factors.

While a shortage of either oxygen or fuel can limit the player's performance, they are not the sole factors, which can limit optimal performance in the endurance athlete. Some other possible physiological limits are cold, obesity, dieting, and menstruation.

Exercise in the Cold

To perform well in cold conditions the player must be aware of the problems cold can cause.

In the cold, the player may fail to warm-up sufficiently or become chilled during times of relative low intensity in a game. Either of these conditions can cause a cooling of the muscles and could make the player more prone to injury, as cold muscles are less resilient or elastic than warm ones.

A small drop in body temperature induces shivering which is the body's way of producing extra heat to warm itself. Glycogen is the chief fuel source for shivering so even if you are not exercising, the precious glycogen stores are being tapped. Shivering can also interfere with coordination and enzyme reactions are slowed in the cold, making less energy available for movement.

To avoid these and other problems in the cold, stay warm before a match, stretch and warm up indoors as much as possible, and stay warm and keep moving throughout the game.

Clothing choice is important for a cold weather game. It should be chosen to help maintain an optimum body temperature throughout the game. It must keep the player warm during warm-up and must not hamper the body's cooling mechanism during the game when excess heat may be produced by exercising and must be eliminated. Damp clothing restricts evaporation and the body cannot lose its excess heat.

After exercise, the damp, cold clothing will conduct heat away from the body, which can cause chilling. The player who sweats a lot should wear loose clothing, which allows heat and moisture to escape, but he must stay warm before exercise and wrap up afterwards.

In the cold, the blood supply to the hands, feet, and skin is reduced to help keep the central part of the body warm by decreasing heat radiation. At the onset of exercise, even less blood reaches the hands and feet due to further constriction of the blood vessels. This is part of the redistribution of blood to working muscles in the legs. When the body warms up, the blood supply will return to the hands, but the fingers take a long time to regain their sensitivity.

One way to avoid having insensitive, numb hands at the outset of a game in the cold is to make sure the hands are kept warm, especially during the beginning of exercise by wearing gloves. This may make it necessary to leave all ball work practices to the end of the warm-up period when the redistribution has taken place.

Breathing cold air is not harmful to the lung tissue, but inadequate clothing, improper warm-up, high winds and a cold wind-chill factor all add up to possible musculoskeletal or joint injuries, discomfort, and chilling, if precautions are not observed on cold days.

Obesity

It is difficult for an obese person to function efficiently, let alone compete with his ideal-weight counterpart.

Every pound of fat you carry is deadweight -- it slows you down and only a minimum is necessary to contribute to energy production.

There are various methods to determine an ideal weight for each individual. Height and weight charts do not adequately adjust for different body types and amount of muscular development. The preferred method of finding an ideal weight is to calculate the percent of body fat and compare it to the ideal level of fat for the person's age, sex, and activity level. Between 10 and 16 percent body fat is ideal for a highly competitive female soccer player, and between 4 and 10 percent for men.

A good way for the over fat person to appreciate the extra workload he is placing on his body by carrying excess fat, is to calculate his excess weight and let him run a few laps carrying something of equal weight. He will soon realize the effect of his extra weight and may be inspired to lose it conscientiously.

Dieting

A dieting soccer player may not be able to perform to his maximum ability.

Volumes have been written about losing weight. Two basic rules of weight loss are: expend more energy than you take in, and lose weight gradually.

If weight is lost quickly, much of the loss is due to water loss and part of it is due to protein lost from the muscles and other tissue. While the athlete should always eat a well-balanced diet, to lose weight he should eat smaller portions and avoid desserts and between-meal snacking making sure water and calorie intake are sufficient.

It can be dangerous to go on a crash or fad diet especially during training. The body may become over-stressed due to insufficient fuel for energy needs and the athlete may be slow and tired at practice, feel faint or sick during activity, and generally his performance will be poor; in other words, he will be unable to achieve his optimal performance. A slow, controlled weight loss, accomplished by modifying his eating habits with the help of a nutritionist or trainer, where necessary, is better for the over fat person. Changing eating habits helps weight loss and keeps weight off.

Following the competitive season an athlete often puts on extra weight. This is due to his lower energy output when practices and games are over, yet no corresponding drop in caloric intake. The extra calories he takes in, whether they are from fat, carbohydrate, or protein will all be converted to fat. At the end of the season a conscious effort must be made by each player to either maintain his body weight by maintaining his energy output or by modifying his diet.

Menstruation

The psychological factors of menstruation may play a larger part in the limiting of optimal performance than the physiological factors.

Tradition has regarded the female menstrual period as a disability, best treated by inactivity in the early phases of flow. However, research suggests that the effect of the menstrual cycle on performance is remarkably small. It seems that variation in performance may be induced by psychological factors that accompany menstruation, like depression, fatigue, and nervousness. If the physical discomfort of dysmenorrhea (painful periods) can be controlled there should be no limit in performance due to menstruation.

Irregular menstrual cycles have been reported in some athletes. One study of distance runners showed an absence of menstruation (amenorrhea) in many women who run from 70 - 100 miles a week. In another study 20 women trained (running) for 16 months and did not show any interruption in menstrual regularity. The disruption of the cycle could be related to stress, but this has not been confirmed. It also seems that if the athlete's psychological pressures are reduced, any irregularity possibly caused by them, may disappear. Menstrual irregularity related to exercise is currently under extensive investigation. Present knowledge suggests that if the regularity of an athlete's menstrual flow changes or ceases she should see a gynecologist or other doctor.

Key Words

CALORIE - unit of work or energy.
CRASH DIET - sudden change of eating habits to cause a quick weight loss.
DYSMENORRHEA - pain which accompanies menstrual periods.
FAD DIET - restricts certain foods to encourage quick weight loss.
HYPOTHERMIA - state of having a low body temperature.
IDEAL WEIGHT - having the correct ratio of fat to body weight.
OBESE - having excess fat.
OVER FAT - having excess fat.

Training Principles - Performance will improve to the greatest extent when the training program simulates the movement patterns and speed of play used in the game.

Following the basic training principles can save time and energy when they are applied to practice sessions.

There are several training principles, which apply to all methods of conditioning. Application of these principles when designing and using conditioning programs will allow the player and coach to get optimum results out of the time and effort they put into training for soccer.
By understanding and following these principles the soccer player and coach can tailor a program to meet their own needs and be confidant that they are correctly preparing for competition.

The principles that will be discussed in this section are: overload, specificity, intensity of practice, excess physical stress, and staleness.

Overload

The overload principle states that strength, endurance, and cardio respiratory fitness improve only when stress (exercise) is applied at levels that are above those normally encountered. When we place extra stress on our body it tries to adapt to the new workload. The amount of stress needed for maximum playing ability in soccer should be applied gradually so the body has time to adapt to the new work expected of it. The routine of adding more stress or a heavier workload as the body adapts to the previous one, is called progressive resistance overloading. Overload that stresses the body too much or too quickly can result in physical breakdown or injury.

Stress in soccer takes the form of drills, small games, conditioning sequences, or any activity which serves to extend the players' current level of conditioning. Overload can be achieved by increasing the intensity of exercise, extending exercise time while maintaining the intensity, shortening rest intervals, or combining any of these methods.

Each individual must work at above his own level to obtain maximum improvement.
In this way the already fit player can improve his fitness level, while the less fit one can progress at a suitable rate without inviting strains or other injuries. This aspect is particularly important at

the beginning of the season where some players have trained conscientiously, some have gone to summer camps, and others have done little preparation. Practice must be designed to place an optimum amount of stress on each player to maintain fitness in some while building it in others. Ideally, players should all follow off-season training schedules so they are in good condition at the beginning of the season and the coach can plan a practice suitable for the whole group.

The overload principle should be applied to all methods of training. It can be used for aerobic and anaerobic conditioning, as well as strength, flexibility, and skill development. In all instances the athlete should work slightly beyond his current level of achievement so the body can adapt to the new level. For example, in skill development, if a player on a squad continually practices drills at slightly above his confidence level -- just out of control -- he will increase his skill level continuously as his body tries to adapt to be able to handle the higher level work. If each player understands the adaptations which occur with overload training and is willing to push himself, the skill level will improve in both the weaker and the stronger players.

Remember, overload is a principle which must be applied individually so each player can be stressed relative to his current conditioning and ability.

Unfortunately overload works in reverse as well. If the stress to the body is reduced, the body adapts to the lower stress and strength and conditioning can be lost. This is obvious in the case of injury or a break in training where conditioning, strength, and skill levels deteriorate, but coaches and players must appreciate similar effects when a player changes position, say from a midfielder to a sweeper, or has limited playing time as in the case of a substitute. In case their roles revert to the more stressed ones, these players must do some extra work to maintain their higher level of fitness.

Specificity of Training

Performance will improve to the greatest extent when the training program simulates the movement patterns and speed of play used in the game.

Specificity of training means that adaptations to training occur only in the areas that are stressed during training. Only the muscles and the energy systems which are used will adapt to training. Slow endurance running will improve only the aerobic system in the muscles used for slow running, and short sprint work will only improve the anaerobic energy sources in the sprinting muscles. A soccer player who conditions only through slow distance work will not be prepared physically to sprint during a game.

This principle of specificity should lead serious soccer players to select off-season sports which are compatible with some aspects of soccer (such as lacrosse or field hockey which have energy expenditure patterns similar to soccer).

To apply the principles of specificity, the athlete or coach must concentrate his training on the specific areas which need improvement. He must identify the energy systems and muscle groups used in soccer that need improvement and make sure that some work during practice directly stresses those areas. To get quicker off the mark, some training time must be devoted to that aspect of soccer; the striker must practice turning with the ball as he does in a game; the left outside midfielder cross lots of balls while under pressure; the goalkeeper must practice clearances and saves using all angles; and another example would be defenders practicing one on one defending.

Intensity of Practice

If the player practices at below match intensity, some muscle fibers which will be needed during a match will not be trained.

Practice helps to coordinate the nerve signals to each muscle fiber. Good coordination means the fibers contract efficiently, only the necessary fibers contract, and the contraction takes place at the right time to create efficient motion (without wasted energy).

For varying movement intensities, different nerves and fibers are used. All the fibers used in a mild action (e.g., jogging), will be used in a similar, but faster or more powerful action (e.g., sprinting), but here they will be helped by additional fibers which are activated only when needed. If the player practices at a low-intensity, he will be training only the low-threshold fibers. The others which are only activated at higher intensities will not be used and will not show any training adaptations. It is imperative to practice at match-intensity so that all the fibers which will be used in competition will be trained.

Some examples of skills which need game-intensity practice are: ball control skills, running with the ball, a quick backswing and drive or kick, and a goalkeeper's dive to prevent a shot. In any one-on-one drill the better player will not improve his skill if he relaxes against a weaker opponent by as much as possible, the practice will be worthwhile for him, and the weaker player will get a sense of accomplishment when he eventually does win the ball.

Some injuries can be prevented by progressively working up to match intensity. Muscles adapt to the stress placed on them, so the intensity of practice sessions should be increased from the beginning of the preseason and reach match intensity by the first game. The muscles will then be ready to control the body in all-out competition. The muscles can gradually adapt to the stress placed on them and muscle and joint injuries can be averted.

Some coaches have been afraid to work their athletes too hard in case of inducing staleness, however, better results are obtained with a high-intensity, short practice than a low-intensity, drawn-out practice while doing the same amount of work. An intense 60 minute practice is better than a low-key two-hour practice that can induce boredom which has been identified as a factor in staleness.

Excess Physical Stress

Excess stress is harmful to the athlete and may delay their season preparation.

While stress is needed during any conditioning program to cause the energy systems and muscles to adapt to a higher workload, players and coaches must guard against applying excessive stress in training. If an player works to exhaustion, it may be several days before he is capable of another good workout. While some soreness and fatigue are normal, especially in the early stages of training, delayed muscle soreness must be guarded against as it is a signal of excess stress especially in the hip, thigh, and front leg (shin) areas. Some muscle soreness and injury can be avoided by adequate warm-up and cool down and by increasing exercise intensity gradually whenever a program is started or changes. A player with chronic soreness should not continue in a conditioning program if he feels any muscular pain during exercise after a warm-up.

Staleness

Physiological and psychological factors can cause staleness in soccer players.
Staleness implies a general fatigue as a result of overtraining or sustained emotional stress. Staleness can be caused by physical or emotional reasons such as: inadequate rest after hard work, boredom from too much routine, worry, a poor diet, and frequent and excessive emotional tension. Symptoms include a drop in performance, chronic fatigue, apathy, lack of enthusiasm for activity, gradual weight loss, tiredness, and irritability.

The best cure for staleness is rest, diversion, and a minimum of practice. The stale player must be freed from any sport-related worries -- he needs renewed motivation to play once he has rested.

Key Words

DETRAINING - loss of condition due to lower stress**.**
LACTIC ACID CLEARANCE - removal of lactic acid from the muscle fibers.
LOW-THRESHOLD FIBER - muscle fiber which is used in low intensity work as well as in high intensity work.
MUSCLE GROUP - the muscles which work together to effect a motion.
OVERLOAD - adding more resistance to work than can easily be handled.
PROGRESSIVE RESISTANCE OVERLOAD - training method where more resistance is added to work each time the body has adapted to the previous workload.
RANGE OF MOTION - number of degrees a joint will allow the body parts to move through.
SPECIFICITY - principle where adaptation takes place only in body parts which are stressed.
STALENESS - physical apathy caused by boredom or excessive work.
STATIC STRETCHING - method of stretching where the muscle is held in a stretched position for a length of time.

Year Round Schedule - The off-season is a time for the soccer player to recover from the previous season while maintaining their aerobic fitness.

A soccer player will benefit from a year-round training schedule built around the competitive season.

The competitive soccer season in the United States runs from early September to late November -- a total of less than three months which is a limited time in which to significantly improve physical or skill ability.

With the large number of players competing in the summer selection and developmental camps, it seems the season for these people has now been extended to start in July, making it almost five months long, and longer for those selected for the national squad. For optimal playing ability and skill development the serious soccer player should follow a year-round training schedule.

Off-Season

The off-season is a time for the soccer player to recover from the previous season while maintaining their aerobic fitness.

The off-season is a period of "active rest" where the athlete can divorce himself from playing, especially if the pre-season and season were very intense. During this period, however, the soccer player should maintain his aerobic conditioning and after feeling fully recovered from the previous season, he should start work at increasing his strength for the next season.

The strength training program should be designed to strengthen the athlete's whole body as mentioned in the section on strength training. Strength workouts should be undertaken three times a week with at least one day between workouts.

To maintain his aerobic fitness, the player can take part in other aerobic running sports like cross-country running or skiing, field hockey, lacrosse, or basketball from 3 to 5 times a week. If he does not play an aerobic sport his workouts of at least 20 minutes each can consist of endurance-type interval training, circuit training, continuous running, or any other training method which will maintain aerobic adaptations. The athlete should try to arrange his schedule so that his strength workouts fall on different days from his running workouts.

Pre-Season

The pre-season for soccer should prepare the player for intense competition.

The pre-season training period of about three months is devoted to improving anaerobic and aerobic fitness, and the skill components of soccer. Pre-season preparation should include a continuation of a strength program, a lot of technique practice, and anaerobic and aerobic running training.

The off-season strength program must be adjusted for pre-season training by including a higher number of repetitions (10 to 12) per set using a lower resistance. Two intense workouts a week will maintain the strength levels developed during the off-season.

The running program during pre-season should include speed and endurance interval training and small game play. Running workouts, preferably not on the same days as strength workouts, should be followed from 3 to 5 days a week. The intensity and amount of work done must increase gradually using the entire three-month period to reach match intensity.

By the end of the pre-season period, the player should be at an aerobic and anaerobic fitness level where he can play a game of soccer without fading. His agility and technical skills should be back to where they were (or better than) at the end of the previous season.

If players report for the season out-of-shape, they may be more susceptible to injury because if they play, they will be competing without allowing time for their bodies to properly adapt to the stresses of competition. They are more likely to fatigue during practices and early-season games, which could further predispose them to injury. To prevent these chances of injury, each player must take the responsibility on himself to arrive in good condition at the beginning of the season.

The Season

Season practice should be devoted to team concepts and match strategy.

The season workouts concentrate on preparing for matches by developing better skills, working on strategy, and maintaining fitness.

To assess the fitness level of incoming players, an easy field test to use is the 12 minute Cooper Test where the athletes see how far they can run in 12 minutes. Those running furthest will be the more aerobically fit, while those covering the least distance will be the athletes who may not be in competitive condition.

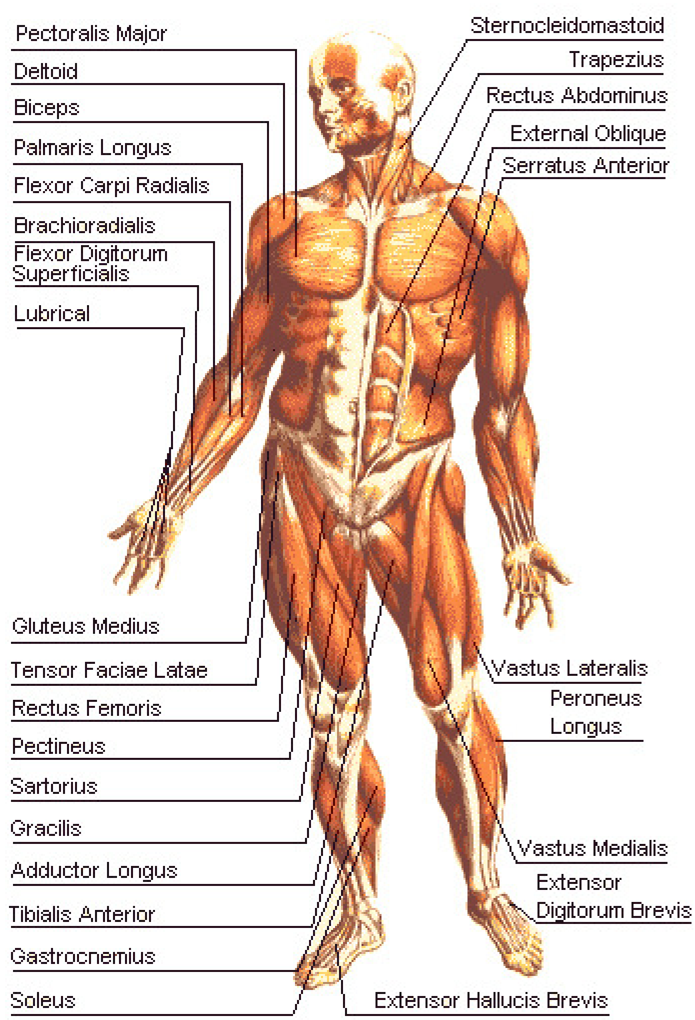
The workouts during the season must be planned around the match schedule. The day before a game, practice should be restricted to a thorough warm-up, technique work and strategy practice, and a cool-down. On these days lots of running and drawn-out drills should be avoided.

A total of 4 to 6 intense workouts a week should be ideal for optimal training and improvement. The day of lowered intensity practice before a game should not be counted as one of these workouts, but the game should be counted for the players who participate.

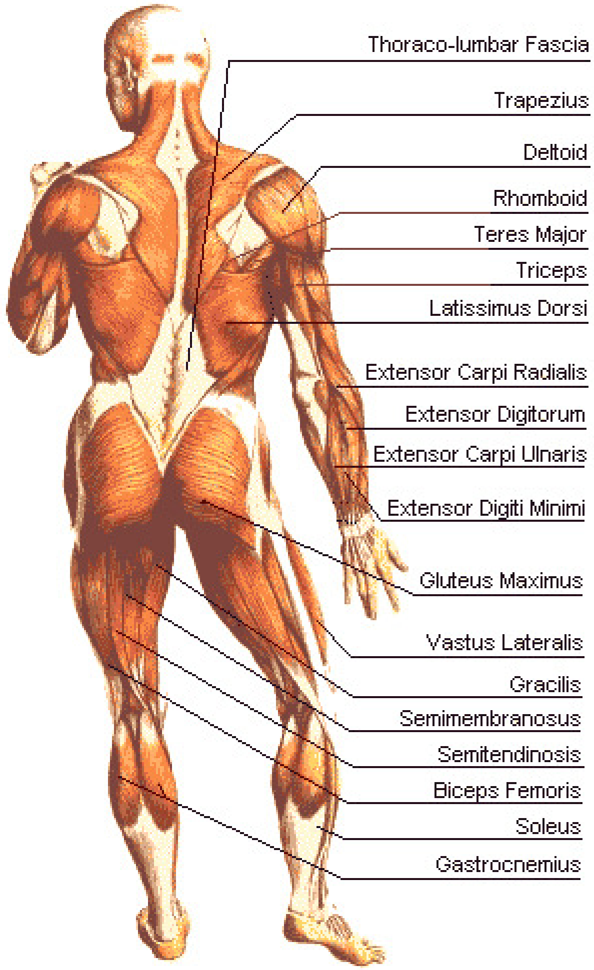
Substitutes who do not get sufficient playing time or players who see limited action need to maintain their conditioning by completing an extra workout.

Courtesy Dr. Pommy Mcfarlane

Muscular System Model



Anterior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Trapezius
Deltoid
Rhomboid
Teres Major
Triceps
Latissimus Dorsi
Extensor Carpi Radialis
Extensor Digitorum
Extensor Carpi Ulnaris
Extensor Digiti Minimi
Gluteus Maximus
Vastus Lateralis
Gracilis
Semimembranosus
Semitendinosis
Biceps Femoris
Soleus
Gastrocnemius

Posterior