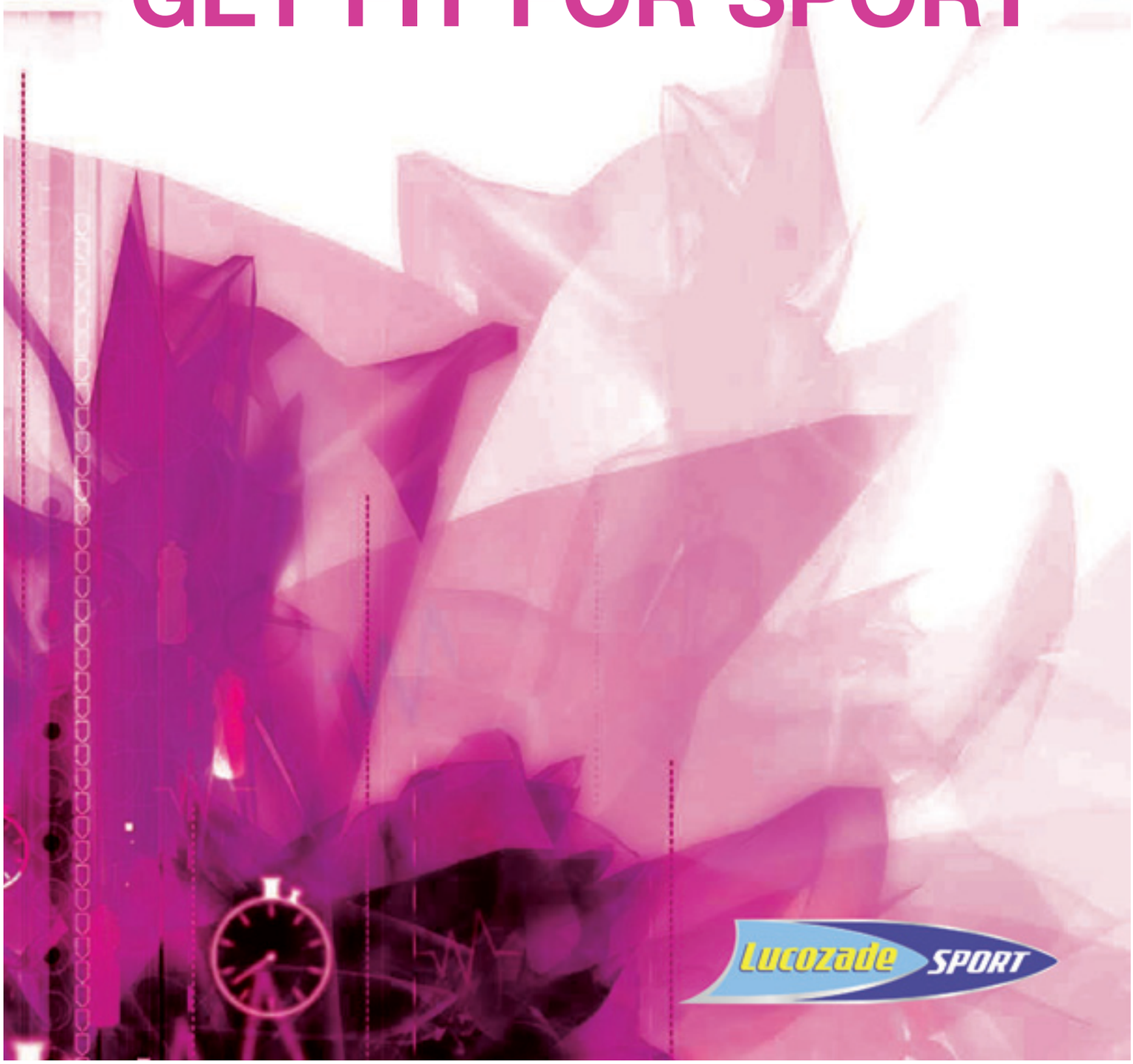
EMPOWERING IRISH SPORT

COACHING IRELAND
OILIÚINT ÉIREANN

GET FIT FOR SPORT



COACHING IRELAND THE LUCOZADE SPORT EDUCATION PROGRAMME

CONTENTS:

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GET FIT FOR SPORT:

INTRODUCTION

Many athletes have dreams and aspirations of competing in their sport at the very highest level. The dream may be to play in a National final, to represent Ireland at a World Championship, or even to win a medal at the Olympic Games. For others, participation in a local league or preparation for their first 10km race or marathon may be the focus. Whatever your sporting goals, an appreciation and understanding of the fitness demands, components of fitness and principles of training as they apply to your chosen sport is a must. A greater awareness and appreciation of how the body responds to training will help you to improve your fitness as well as enhance your preparation and sports performance. By implementing a structured training plan which caters for your specific needs, this will help you to avoid unnecessary fatigue and reduce the risk of injuries which could both hamper your training, and detract from the enjoyment and success you could achieve in your chosen sport.

All sports require a certain specific level of fitness. This fact sheet looks at the various components of fitness and principles of training that may be required for your sport. A solid understanding of these areas will help you to effectively plan your training.

1. Genetics

2. Environment
   - Training:
     - Technical/Tactical/Physical/Mental
     - Lifestyle
     - Recovery/rest/sleep
     - Nutrition
     - Health
     - Recreation

Figure 1. Factors affecting Performance

Athletic performance is made up of a complex blend of a number of factors. An internationally renowned scientist famously once said “if you want to be an Olympic Champion, choose your parents carefully!” This implies that in order to get to the top of the medal podium you need to come from the right gene pool. This rather one-dimensional view point would suggest that top performers are born to succeed and not made, and that an athletes training environment only plays a nominal role in sporting success. Today it is generally accepted that success in any sporting endeavour is determined by a combination of factors including genetics, physical, mental, technical and tactical training and preparation as well as good lifestyle practices.

WHAT IS FITNESS?

The term “Fitness” relates to a general state of good health. More specifically in a sporting context it may be sub-divided into a number of areas:

- Physical fitness: This can be defined as the ability to perform everyday and sporting activities without undue fatigue. An individual’s level of physical conditioning is typically associated with their training status and other factors such as nutrition. The primary elements of physical fitness include:
  - Metabolic fitness: how well equipped is your body at creating and using the energy required for your sport.
  - Aerobic fitness: how well your heart, lungs and blood vessels are adapted to delivering oxygen to the working muscles during prolonged exercise. This is also referred to as cardiovascular fitness.
  - Anaerobic fitness: how well you are able to sustain single or repeated short bouts of high intensity exercise.
  - Musculo-skeletal fitness: how well your muscles and skeletal system are adapted to withstand the demands of training and competing.
- Mental fitness: how prepared your mind is for the psychological demands associated with training and competing.

Although other elements will be referred to, this fact sheet will predominantly focus on physical fitness

HOW FIT DO YOU NEED TO BE?

Most sports require an underlying base level of fitness. Achieving an appropriate level of fitness protects you from injury, and allows you to be reasonably competitive in your sport. It means that you are prepared (or “fit”) enough to

last a whole game, or make it to the finish line in your race. Participating in sports at a higher level requires you to be as fit as you possibly can. Unfortunately fitness is transient and specific, in other words you can't store up fitness to use at a later date, and being fit for one sport will not mean that will give you optimal fitness for another sport. For example, if you only do swimming training, you will be fit for swimming. Understanding the fitness demands of your sport and then determining your own strengths and weaknesses will help you to identify your fitness training needs. Watching, training with, and reading about how top athletes in your sport effectively prepare for competition will also give you some idea of what fitness demands are required for success.

YOUR BODY AND ITS RESPONSE TO EXERCISE AND TRAINING

A basic understanding of the components of fitness and body's responses and adaptations to training is a useful starting point when looking at how to get fit for sport.

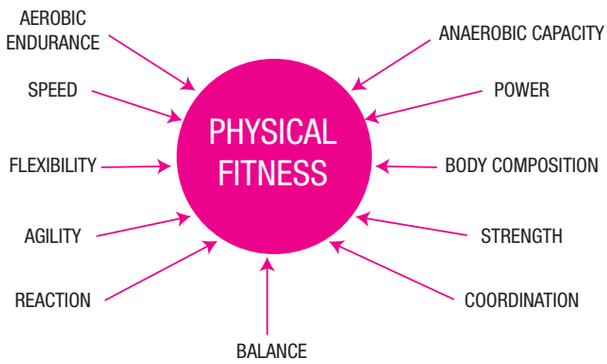

Figure 2. Components of Fitness

Aerobic Fitness

The cardiovascular system consists of the heart, the lungs, and the blood vessels (arteries, veins and capillaries). The working muscles require a steady supply of oxygen (O_2) in order to produce energy aerobically. As this process occurs, carbon dioxide (CO_2) is also produced, and the body must remove this. When you start exercising, the rate and depth of your breathing increases bringing more oxygen into your lungs. The oxygen is carried by the blood to the heart and then pumped through the arteries to your muscles. The oxygen then leaves the blood, enters the muscles and is used to release energy from the carbohydrates fats and proteins. The carbon dioxide produced is removed from the muscle into the blood and is then carried back to the heart through the veins. The heart then pumps this blood to the lungs where the carbon dioxide is exhaled. More oxygen is absorbed by the blood and the cycle continues. Cardiovascular fitness is simply how good your heart lungs and blood vessels are at supplying oxygen to the working muscles and how good the muscles are at using this oxygen. The fitter you are the more you can meet the energy demands of exercise with the aerobic system.

Training has a number of positive effects on the cardiovascular system, including:

- An increase in the heart's size allowing it to pump more blood with every beat.
- An increase in the number of small blood vessels or capillaries in the muscles to allow more oxygen to be delivered and more carbon dioxide to be taken away.
- An increase in enzymes or chemicals which allow the muscle to make energy aerobically.

Musculo-Skeletal Fitness

The musculoskeletal system consists of all the muscles, bones, tendons (which attach the muscles to the bones) and the ligaments (which attach the bones to each other). Together these structures allow our body to create the movements required for sport.
Musculoskeletal fitness is concerned with strength, power, endurance and flexibility.

Bone, tendon and ligament strength can be affected by a number of factors. Including age, genetics and nutritional factors. Weight bearing exercise has been shown to improve strength of bones tendons and ligaments and a lack of exercise, over a prolonged period of time will weaken these structures.

Unlike bone, muscle will adapt to training relatively quickly; growing larger or changing their characteristics so that they can exert more force or continue contracting for longer. The amount and type of adaptation will depend on several factors including the type of training undertaken, whether you are male or female, your age and genetic factors (inherited from your parents). There are two main fibre types in every muscle slow twitch and fast twitch. The percentage fibre type determines, to some extent, whether you are more likely to be a speed-type athlete (predominance of fast twitch fibres) or a more endurance-type athlete (greater slow twitch fibres).
There is a long continuum between fast and slow twitch fibres, and most people fall somewhere in the middle. It is possible that training can have some role in altering the relative proportions of these fibre types. In elite athletes, marathon runners have a much higher proportion of slow

twitch fibres to the general population. Similarly a weightlifter will have a higher proportion of fast twitch fibres.

Specific training can affect the strength, power, or endurance of muscles:

i. Muscle strength is the amount of force a muscle can produce. Strength can be improved in two ways. Firstly you can train a muscle to exert more force (or lift a heavier weight) by practicing the movement (or lift) so that the brain learns the appropriate sequence electrical signals to control the muscle contractions. The second way to increase strength is by increasing the size of a muscle by increasing the diameter of the muscle fibres - this is called hypertrophy. By making the muscle exert large forces (or lift heavy weights) you can cause microscopic damage in the muscle fibre and provide a stimulus for the muscle to repair. During this repair process the muscle fibre overcompensates and gradually the muscle fibre increases in size and strength. In reality both of these mechanisms come into effect when an individual undertakes a resistance training programme. A typical maximal strength training programme would typically consist of 4 to 5 sets of 1-3 repetitions of a resistance exercise (or lift) using a weight which is about 90% of your maximum (1RM = one rep max i.e. the greatest amount of weight an athlete can lift for one repetition only). A novice may get significant strength gains using 8-12 reps at 60-70% of 1RM. When weight training it is essential to maintain good weight lifting technique at all times.

ii. Muscle power is the rate at which you develop force and is important in many sports. A weightlifter, for example, must be able to lift a heavy weight quickly. Similarly, a soccer player needs a significant amount of power when striking a ball or accelerating off the mark. Both athletes need to develop more powerful muscles. Power is developed through lifting submaximal weights whilst focusing in the speed of movement. A typical power training session may consist of performing 3-6 repetitions of an exercise using a resistance (or lifting a weight) anywhere between 30-85% of a maximum and repeating this 3-6 times (sets) (ACSM, 2002), with an emphasis on explosiveness and good lifting technique. Another excellent power training method is plyometrics which involves bounding type of activities, however it is important to have a good strength base before incorporating these types of advanced training methods into any programme.

iii. Muscle endurance is the ability of muscle to continue to contract producing the required force, repeatedly. Circuit training using the athlete's own body as the resistance or with light weights is a good way to develop muscle endurance. Repeating an exercise (e.g. press-ups) until the muscles are fatiguing and then taking a rest and repeating the exercise provides the stimulus for the muscle to increase in the number of capillaries, and improve its capacity to create energy anaerobically and removal waste products such as lactic acid. For more information on circuit training see the circuit training fact sheet.

iv. Flexibility is the range of motion around a joint or series of joints. Flexibility is specific to a joint and different sports require different degrees of flexibility. Flexibility is best improved by regular stretching, either at the end of a session or as a separate training session (perhaps in the evening 3-4 hours after the main training session).

v. Coordination is the ability to integrate sensory system, nervous system and musculo-skeletal system in order to control the independent body parts involved in complex movement patterns. Coordination is particularly important in high skilled activities requiring intricate movement patterns such as gymnastics or slalom canoeing.

vi. Balance is the ability to maintain a stable and specific orientation in relation to the immediate environment. Balance is closely related to other components of fitness such as flexibility, strength and coordination.

vii. Agility is the ability to perform intricate sports specific skills at speed. Agility type movements are generally multi-directional and unplanned by nature. Most field sports such as rugby soccer and GAA would involve a high level of agility where deceleration speed is as important as acceleration speed.

viii. Body Composition plays an important role in almost every sport. Body weight is predominantly divided into muscle, fat and bone. Generally sports participants should strive to have a relatively low fat content and a high muscle content. It is important to remember that some fat is essential for normal bodily function. In contrast excess fat can impair performance.

Mental Fitness refers to the readiness of the athlete to cope with the psychological pressure of training and competing, as well as coping with the effect his or her exercise regime has on their normal life outside of their

sport. For further information on mental fitness you should consult an accredited sports psychologist in the Service Directory available from the Irish Institute of Sport, or read the Coaching Ireland publication Success from Within (Hackett, 1998). Sports Psychology services are available free of charge to Carded athletes.

B. Exercise and The Energy systems

There are three major ways that your body can meet the energy requirements in sport. The body uses all these systems but the predominant source of energy depends on the intensity, duration and type of exercise that you are doing. (See Fig 3)

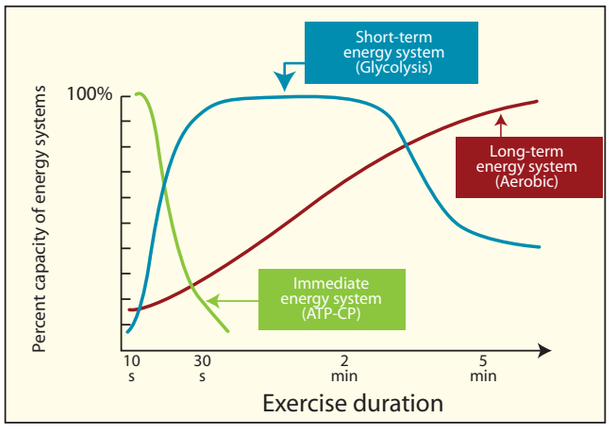

Figure 3. Time course of energy production

1. Immediate Energy (Creatine Phosphate system (ATP-CP))

The ATP-PC system produces energy very rapidly. It uses two fuels Adenonsine triphosphate (ATP) and creatine phosphate (CP), which are stored in your muscles. High levels of power can be generated using this energy source. It is used at the beginning of exercise, or for short high intensity bursts of exercise (e.g. lifting a weight, throwing a shot put, or during a short sprint). Initially the small stores of ATP are used to provide energy for muscle contraction. These are supplemented by the small, but renewable fuel CP, which is stored in the muscles. During maximal exercise, together these two energy stores ATP and CPlast approximately up to 8 seconds only. Renewing this source is done rapidly and automatically by the body immediately after you stop exercising or reduce the intensity of exercise.

2. Short-Term Energy (Anaerobic or Lactic Acid system)

The anaerobic system (meaning “without oxygen”) is also very good at supplying energy quickly and is useful for high intensity exercise. This system uses carbohydrates (stored in the body as glycogen), from the food you eat, which is broken down to release energy. The length of time you can exercise using primarily this energy source, depends on

- The intensity of the exercise (the higher the intensity, the less time it is available)
- The fuel you have available to burn
- How well trained you are in utilising this energy and in removing its by-products.

Unfortunately anaerobic production of energy creates a by-product called lactic acid. Lactic acid [HLa] is composed of two substances, a hydrogen ion [H+] and a lactate ion [La-]. Accumulation of the [H+] leads to the following;

- Pain and a burning sensation in the exercising muscles,
- An increase in the rate of breathing, and ultimately,
- An inability to continue exercising at such a high intensity due to impaired muscle contraction and function.

If you were only using anaerobic energy production, you would only be able to continue exercising at very high intensities (e.g. sprinting) for 15-30 seconds (see Table 1). The anaerobic energy system will, however, still be the predominant energy source during high intensity exercise lasting up to about 2 minutes. Training the anaerobic system usually involves interval training, where the intensity of intervals and the work:rest ratio can be varied to achieve different results.

3. Longer-Term energy (Aerobic system)

The aerobic system (meaning “with oxygen”) is the most energy efficient, i.e. it produces the most amount of energy per gram of fuel. This system utilises all three macronutrients (fats, carbohydrates and proteins) as energy sources, in the presence of oxygen to release energy. The major disadvantage of the aerobic system is that it supplies energy relatively slowly, and hence the intensity of the exercise you would be capable of maintaining is relatively low. It is the primary source of energy for prolonged endurance activity.

Summary of Energy Production

Energy Production method	Fuel	Energy liberated (ATP produces a unit of energy)	Time available*	By products
Phosphocreatine (ATP-PC)	Creatine Phosphate	1 ATP	Up to 8secs	Nil
Anaerobic	Glycogen	3 ATP	15-30secs	Lactic Acid
Aerobic	Glycogen Fats	39 ATP 129 ATP	Almost unlimited	Carbon dioxide & water

Table 1.Summary of Energy Production

General Health Benefits

Current recommendations suggest that in order to maintain and promote good health, adults aged between 18-65 years of age should engage in 'moderate' aerobic (endurance) activity for a minimum of 30 minutes for 5 days weekly. Alternatively, you can participate in 'vigorous' intensity activity for a minimum of 20 minutes on 3 days each week. The exercise can be done in bouts of no less than 10 minutes at a time, over the course of the day (ACSM and AHA 2007).

In addition to aerobic activity, you will benefit from performing activities designed to maintain and improve muscular strength and endurance on a minimum of two days per week. Such activities would include exercises using your own body resistance, weight training, weight bearing activity and stair climbing. It should also be remembered that individuals participating in aerobic and strength activities above the minimum recommended levels outlined provides for additional health benefits as well as enhanced physical fitness. Put simply, the more exercise you do the greater the health benefits and the lower the risk. Furthermore, physical activity of longer duration or higher intensity has been associated with further risk reduction. Nevertheless for those starting off you should aim for the lower end of this target and gradually increase your physical activity levels as you establish a training routine and become fitter. Aspiring athletes will of course need to increase the level and specificity of training to maximise sports potential.

HOW DO YOU IMPROVE YOUR FITNESS?

When it comes to designing training programmes there is no blueprint for success. The human body is a complex biological system which responds and adapts to the stimulus of exercise in different ways. It is therefore important to take into account individual needs, personal circumstances and training goals. Whether you are a serious athlete or somebody trying to improve your general health and fitness, there are some fundamental training principles you should adhere to. These principles provide a framework on which to systematically develop training programmes and apply to all levels of the sporting spectrum. These principles of training neatly spell the word 'SPORT'.

Principles of Training:

Specificity

The effects of training are specific to the type of activity undertaken. Adaptations reflect the demands placed on the body. For example, endurance training will predominately affect endurance capabilities such as cardiovascular (heart and lung) fitness where as resistance training will mainly improve muscular strength. More specifically performing arm curls with heavy weights (90% 1RM) will increase the strength of the biceps but will have little if any effect on other muscles, cardiovascular fitness or even muscle endurance. The implication of this principle is that those involved in training programme design such as a coach, trainer or the athlete themselves should therefore have a good understanding of critical factors such as the physical demands of the sport, and the specific needs of each individual. Such needs analysis serves as a starting point for designing effective fitness and exercise training programmes.

Progression

As a result of regular training (overload), physiological changes (adaptations) take place. Once this adaptive phase has occurred, if the training load is not progressively increased, no further improvement in fitness will result. In order to optimise the training stimulus to further enhance the fitness gains, the 'FITT' principles can be manipulated and varied as appropriate to the needs of the individual and phase of training. These are:

F – Frequency – How often?
I – Intensity – How hard?
T – Time – How long?
T – Type – the type of training (e.g. endurance, strength etc)

Seyle 's General Adaptation Syndrome (GAS)

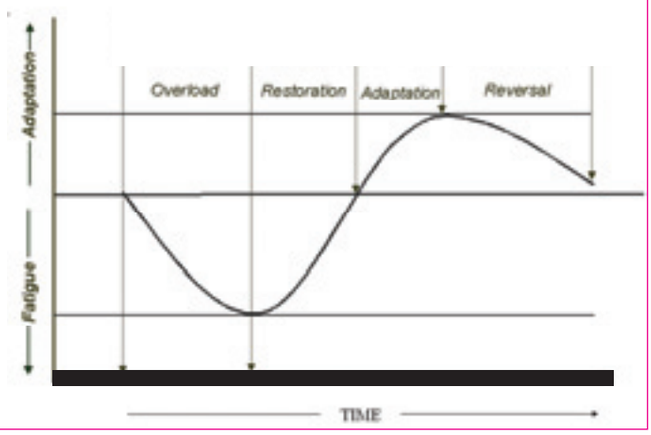

Figure 5.

Overload

Physiological adaptations resulting from training are dependent on the appropriate training stress or load. In order to bring about physiological changes which result in improved physical fitness, training must push the body beyond the level it is used to. This training 'overload' provides the stimulus for the body to adapt and become fitter, stronger and more resistant to fatigue.

Reversibility

The adaptations to training are reversible. If training ceases, is infrequent or not sufficiently intensive the effects will diminish and over time training benefits will be reversed leading to de-training. It's very much a case of 'use it or loose it! For well-trained athletes however, any competitive edge lost by a week's injury or bed-rest illness will usually be recovered in 2 or 3 weeks.

Tedium

Insanity is "doing the same thing over and over again and expecting a different outcome!" Therefore in order to elicit a continuous improvement in the responses and adaptations to training, the exercise stimulus in terms of training type needs to be constantly varied. This also minimises the risk of boredom and staleness.

Balancing Training and Recovery

Training can produce microscopic muscle damage, fatigue and imbalance in the body. It is during the recovery period, between sessions that the training adaptations occur leading to improve fitness levels. Many athletes incorrectly assume that since training improves fitness, more training will make you even better. Often "more is less and less is more!" Recovery is an often overlooked part of the training programme. Failure to allow adequate recovery is one of the factors that can lead to injury, overtraining and burnout. Careful planning, for example doing muscle fitness sessions on alternate days with cardiovascular fitness on the other days or by alternating heavy and light sessions, as well as incorporating recovery and rest days, will allow the athlete to optimise the benefits their training whilst ensuring sufficient recovery.

The physiological adaptations that result from training usually occur in a predictable and uniform manner when conditioning programs adhere to these 5 principles. This concept is related to Selye's (1956) General Adaptation Syndrome (GAS) model which refers to the manner in which humans react to stress. An adaptation of the GAS model specific to physical training is outlined in Figure 5. Following a single bout of training there is a phase of acute fatigue and reduced performance. With an appropriate period of recovery this acute fatigue is followed by a phase of restoration and adaptation. Once this period of super compensation occurs unless further training stress (overload) is imposed a reversal (de-training) in training adaptation will occur.

CONCLUSION

Effective fitness training programmes require careful planning and attention to the components of fitness and principles of training, taking into account the specific demands of the sport and the needs of the individual. No matter what your motivation for engaging in sport, by incorporating these fundamental principles into the design of any training programme will ensure a balanced approach which seeks to enhance the overall training benefits.

FURTHER READING

Look up the Coaching Ireland website for more details on Getting Fit for Sport. http://www.coachingireland.com

Lucozade Sport Sports Science and Nutrition Centre
http://www.lucozadesport.com/lucozade/wwwroot/index.html

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