OVERVIEW

The game of tennis places unique physical demands on its players. In return, players develop a unique set of physical qualities and capacities for accomplished and successful performance.

The complexity of designing and then implementing a conditioning programme suitable for the demands of the game can be appreciated by considering that the single rally is often over quicker than a 100 metre sprint, yet matches can sometimes take longer than a marathon to complete!

Throughout, players are required to run, start, stop, twist, turn, jump, slide, recover and hit in different directions and planes of movement. When one takes into account that both court surface and game style of the player also impact upon the physical nature of tennis play, the physical demands put on players becomes clear for all to see.

Over the past quarter of a century, players have become bigger, faster and stronger and the way the game is played has changed accordingly. Specialised physical training that is well-planned and implemented according to sound principles has become a key factor in success on the court.

It is important for trainers, coaches and athletes to be able to first assess fitness and recognise specific weaknesses, then to design an appropriate training programme to improve fitness, and finally to know how to implement the programme to optimise fitness gains.

As part of this, it is important to understand the biomechanical, biochemical and physiological demands that the sport of tennis places upon the body.

Many of the physiological processes related to play involve converting stored chemical energy to mechanical energy in order to run, hit the ball, and recover. In addition, after each rally, the chemical energy in the muscles must be rapidly restored.

These processes occur continuously throughout a match and a player's ability to continue playing relies heavily on one's ability to efficiently and rapidly convert, utilise, and replenish energy, as it is required.

MEETING THE ENERGY DEMAND

First, it is important to understand that there are three energy-generating pathways – one aerobic (dependent on oxygen) and two anaerobic (not dependent on oxygen) pathways. All of these pathways are important for the sport of tennis given that the sport relies heavily on anaerobic metabolism for serving, sprinting, jumping, and hitting, while also requiring adequate aerobic capacity in order to sustain match play for up to 5 hours.

The immediate source of energy for all muscle contractions is a chemical called adenosine triphosphate (ATP) which occurs naturally in the body.

The energy needed for muscle contraction is produced when an ATP molecule is broken down into adenosine diphosphate (ADP) and phosphate. The three energy systems described below all function to replenish the ATP stores in a muscle.

1. **ATP-PCr System (anaerobic)**
   At the beginning of maximal exercise your oxygen supply cannot meet your energy demands, and therefore work is anaerobic. During this period you are using your phosphocreatine (PCr) stores to supply immediate energy using the ATP-PCr system (also called the immediate, or phosphagen, energy system).

   A muscle cell has a small amount of ATP floating around that it can use immediately, but only enough to last for about three seconds. However, ATP can be resynthesized from a compound called creatine phosphate until these stores are depleted.

The PCr system can supply the energy needs of working muscles at a high rate for only 8-10 seconds. In tennis, the ball is in play for about 10-30% of the time and out of play for about 70-90% of the time (i.e. 3-8 seconds of work with 15-25 seconds of rest per point). These data suggest that the ATP-PCr system is mainly used during tennis, with restoration of the PCr in the recovery periods between points and games.

2. **Anaerobic Glycolysis (anaerobic)**

As the limited PCr stores dwindles, another anaerobic system known as the glycolytic or the short-term energy system takes over. Carbohydrate, in the form of glucose or glycogen can be broken down to a molecule called pyruvate and provide energy in the form of ATP via the "fast glycolytic" pathway.

The pyruvate is converted to lactic acid and then to lactate. Lactic acid inhibits the very process that created it. Lactic acid in the muscle interferes with and diminishes the energy output of the glycolytic energy system.

This system provides most of the energy for moderate to high intensity exercise lasting up to 2 minutes. The glycolytic pathway comes into play during intense rallies that last longer than 10 to 15 seconds, or when recovery periods during practice or play are kept very short.

3. **Oxidative Metabolism (aerobic)**

The oxidative metabolism system, also known as the long-term energy system, can produce 12-13 times more ATP molecules than fast glycolysis, but it takes longer. If the exercise intensity is submaximal and there is plenty of oxygen present, then the aerobic system will be utilised.

Carbohydrate, fat and protein can all be used as fuel sources for aerobic metabolism. The first step is "slow glycolysis", which follows exactly the same series of reactions as fast glycolysis, but pyruvate is sent to the mitochondria in the cells to be converted to acetyl CoA rather than lactic acid. Following glycolysis, further ATP can be produced through the Krebs cycle, electron transport chain and beta oxidation.

This energy system comes into play during any exercise lasting longer than one minute, and as duration of exercise goes beyond several minutes, aerobic energy production becomes increasingly more important.

Even when the intensity of play is high and the anaerobic systems are utilised, oxidative metabolism continues at the same time. When the exercise intensity falls, i.e., between points, aerobic metabolism is already working to rapidly help the muscle cells to recover.

WHAT IS FITNESS?

Physical Fitness, according to the American College of Sports Medicine (ACSM), can be defined as "a state characterised by a) an ability to perform daily activities with vigour and b) a demonstration of traits and capacities that are associated with low risk of premature development of the hypokinetic disorders (i.e. those associated with physical inactivity".

The most frequently cited components of physical fitness fall into two groups, one related to health and the other related to athletic skills.

Health Related Fitness typically includes cardio-respiratory endurance, body composition, muscular strength and endurance, and flexibility.
The concept that underlies health-related fitness is that better status in each of the constituent components is associated with lower risk for development of disease and/or functional disability.

- Cardiorespiratory Endurance - the ability to deliver oxygen and nutrients to tissues, and to remove wastes, over sustained periods of time.
- Muscular Strength - the ability of a muscle to exert force for a brief period of time.
- Muscular Endurance - the ability of a muscle, or a group of muscles, to sustain repeated contractions or to continue applying force against a fixed object.

- Flexibility - the ability to move joints and use muscles through their full range of motion.
- Body Composition - refers to the makeup of the body in terms of lean mass (muscle, bone, vital tissue and organs) and fat mass.

Skill Related Fitness consists of those components of physical fitness that have a relationship with enhanced performance in sports and motor skills. The components are commonly defined as agility, balance, coordination, power, speed and reaction time.

- Agility - the ability to rapidly change the position of the entire body in space with speed and accuracy.
- Balance - the ability to control the body's position, either stationary or while moving.
- Co-ordination - the ability to use the senses, such as sight and hearing, together with body parts in performing motor tasks smoothly and accurately.
- Power - the rate at which one can perform work.
- Speed – the ability to perform a movement within a short period of time.
- Reaction Time – relates to the time elapsed between stimulation and the beginning of reaction to it.