



Energy Systems and Growth

Understanding Energy Systems and Growth

Understanding how your body produces energy is vital to understanding why you train in certain ways to enhance your energy systems and how they are directly linked to growth and development.

Energy Systems

System 1 – ATP –PC (Anaerobic – without Oxygen)

System 2 – Lactic Acid (Anaerobic – without Oxygen)

System 3 – Anaerobic (with oxygen)

Our Primary Energy System is the **ATP** System which provides immediate energy at all time. There are three Secondary Energy Systems: Phosphocreatine System (**PC**), **Lactic Acid** System and **Aerobic** System. They are used by our body to replenish the ATPs broken down for energy when you perform. At any given time, all three Secondary Energy Systems are employed. The proportion in which each system is used depends on the energy requirements and the intensity of the exercise.

ATP System (Anaerobic)

For immediate energy, our body just grabs the ATPs (Adenosine Triphosphate, ie the energy currency used by humans) floating around in our body. Unfortunately, humans only store a limited quantity of ATPs so this system is primarily used for short explosive movements such as a push off on a turn.

Phosphocreatine System – (ATP-PC) (Anaerobic)

Phosphocreatine (PC) System is the fastest system to generate ATPs. It doesn't require oxygen. When our body senses that we are beginning to exert maximal effort, it breaks down PC for energy to replace ATPs that are used up. PC System can only provide energy for 5-8 seconds of maximal effort. Beyond that, other fuel source must be used.

Lactic Acid System (Anaerobic)

Lactic Acid System is the second fastest. It also doesn't require oxygen. It releases the glucose in muscle glycogen. Then glucose is broken down into lactic acid to release ATPs. The lactic acid generated can be transported to cells to be oxidated for energy or it can be transported to the liver to re-generate glucose when we have energy from other sources. Similar to the PC System, the Lactic Acid System can only last about 60 to 180 seconds of all-out effort. It is the primary fuel source for short distance swims like 100m and 200m events.

Aerobic System

This system produces energy by the complete breakdown of glucose. The chemical reaction requires oxygen to be present. The chemical reaction is the most complex of all the energy systems therefore it is a much slower process but has no upper limits providing an ample supply of oxygen to reach the muscles in order to produce energy at the required rate. Basically, any exercise that lasts more than a couple minutes uses this as the primary fuel source.

Growth

Everybody has a chronological age which represents your age in calendar years. This doesn't represent your rate of physical development, as everyone grows and develops differently.

Swimming is a late specification sport in terms of growth and development so your true potential will not be realised until you have fully matured. For girls full maturity typically occurs between 13-19 years and for boys 15-21 years. There were two 15 year old girls who were Olympic Champions in 2012 yet the youngest male Champion was in their 20s.

Your development needs to be considered in several ways;

- 1- Physical – Growth and development of muscles, bones and energy systems.

Before adolescence (puberty) swimmers have very limited anaerobic capacity (energy system 1 and 2) so the majority of training is focused on aerobic work outs. Growth spurts are common and can happen rapidly but physiological developments are much slower. For example the bones in a swimmers legs may increase in length but it will take time for the muscles to develop the strength to use the limbs effectively.

- 2- Skill Development – Skill / co-ordination / balance – the development of complex movements which continues till maturity.

The development of skill and the correct technique is very important so swimmers can perform as efficiently as possible. Technique and stroke work continue through a swimmers career to ensure that the strokes are performed correctly and the movements are strengthened. During childhood and

adolescence it's vital to always perform actions correctly and slow down if required to do so. Growth can have a dramatic effect on the body's movements / skill as rapid growth will change the body for a period of time so swimmers will need to adjust and be adaptable.

- 3- Psychological – Growth and development of the mind, concentration, social skills, emotional skills and educational knowledge.

This can be a complicated area influenced by a lot of factors. Maturity or lack of maturity is a widely used term to describe a child's behaviour / attitude but this is also linked to their ability to train and perform. The swimmers who have the best concentration and focus have the best technical ability in general as they are able to perform the correct technique for longer.

Training Zones and Heart Rate

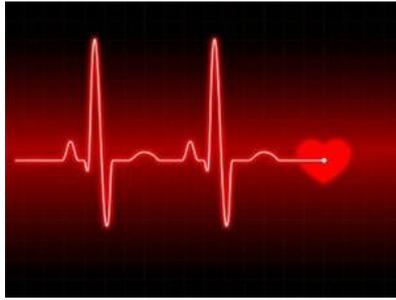
We have had a look at energy systems and now understand the basic principles of how our bodies produce energy. Training your body to enhance each energy systems capacity and efficiency is vital to performing well in competition.

You can only increase your capacities whilst you grow hence the importance of volume of training during age group and youth swimming. When growth slows and a swimmer nears maturity the training focus changes to maximising a swimmer's given capacity.

The types of training that you undertake to achieve this can be categorised into 5 training zones.

Heart rate is a very good tool for gauging which training zone you are working in. Heart rate can be measured with a heart rate monitor or alternatively you count the number of beats in 10 seconds using the pace clock and multiply by 6. The best way to do this is through the carotid artery in the neck once you have finished a swim. Heart rate monitors offer a more accurate and constant monitoring of heart rate which can be viewed whilst you are swimming via a watch on your hand. You'll need to work out your maximum heart rate before you can work out your required heart rate for each training zone. Training zones are calculated by using BBM (beats below maximum). For example a swimmer has a maximum heart rate of 220 beats per minute so if working in the A1 (70 below maximum) training zone a swimmer's heart rate would need to be at 150 beats per minute.

Using swimmer rest times or personal best times + 5s or 10s are other ways to work out which zone you are training in. This relies more on the coach's knowledge of the swimmer to set the correct times and for swimmer to put in the desired effort. Heart rate monitors are recommended to give an accurate heart rate and a better understanding of the training zone you are trying to work in for a specific set.



Training Zones

Zone 1 Aerobic – 30-70 beats below maximum

There are three types of aerobic training:

A1 – Aerobic Recovery – heart rate 70 beats below maximum – Swimmers use this type of training for recovery swims during training sets and cool down at the end of a session.

A2 – Aerobic Maintenance - heart rate 40-50 beats below maximum – Swimmers use this type of training for swims usually between 200-1500m, technical sets and drill sets.

A3 – Aerobic Development – heart rate 30-40 beats below maximum – Swimmers use this type of training for swims of 50-400m and is used for enhancing aerobic capacity.

Zone 2 Anaerobic Threshold – 20-30 beats below maximum

This is the point at which lactate accumulation begins to rise sharply and is termed threshold, the point before the anaerobic system is used. Swimmers use this type of training for swims between 50-400m, short repeat distances and short rest periods trying to maintain an even pace during swims.

Zone 3 High Performance Endurance – 10-20 beats below maximum

This type of training is intense but not at maximum. Swimmers who reach their maximum heart rate too early in a set may not be able to sustain their effort throughout the total distance to be swum. Swimmers use this type of training for swims between 50-200m repeat sets with swimmers aiming to hold the intensity of each repeat set through the duration.

There are three types of training in this zone; Critical Speed (CS), Lactate removal and MV02.

Zone 4 Anaerobic – 10 beats below maximum

This training zone is commonly known as lactate training. There are two types of anaerobic training; Lactate Tolerance and Lactate Production/Peak Lactate. Swimmers use this type of training for short swims of 25-100m and sometimes split 200m swims. Short swims at near maximum effort with lengthened rest periods.

Lactate Tolerance sets last for approx 300-1000m helping swimmers build up resistance to lactic acid to enhance performance in competition. Recovery swims are important in-between and after these sets.

Zone 5 Sprint Sets – maximum heart rate

This training zone is used for short maximum speed sets swum over 10-25m with sufficient rest to perform at maximum. Starts, turns and 25m sprint sets are typical examples of sprint training.

Once you have calculated your maximum heart rate, fill in the sheet on the next PDF to give you an accurate heart rate guide for each training zone and pass on a copy to your coach.

Recommended

Polar FT4 heart rate monitor, this is a fairly basic model but provides all the information swimmers need. The FT4 consists of a strap with monitor which goes around the body with the monitor in-line with the heart. The readouts are displayed on a watch which swimmers wear and gives constant heart rate throughout training as well as maximum heart rate, calories burnt etc. The monitor comes with a standard strap it's likely swimmers would need to order an extra small strap with the monitor. The monitors can be used in the water and at land training.

