GCE PHYSICAL EDUCATION

PE2 UNIT GUIDE

Content Title: *The Long Term Effects of Exercise on the Body*

Key points

- Adaptations to the cardiovascular, respiratory and muscular systems.

Practical Application/Explanation

After we exercise over a period of time, adaptations take place within the body. The main adaptations take place in the:

- Heart
- Lungs
- Vascular System
- Blood
- Muscles

PHYSIOLOGICAL ADAPTATIONS FROM AEROBIC TRAINING

Adaptations to the Lungs

After training aerobically over a period of weeks, there will be changes in the lungs, which include:

- Improved efficiency/strength of the respiratory muscles (diaphragm and intercostals muscles).
- Increased proportion of ALVEOLI (air sacs which diffuse oxygen into the capillaries).
- Increased number of capillaries, which diffuse the oxygen from the alveoli into the blood.
- Increased tidal volume and vital capacity.

This means that more oxygen can be consumed and transported from the alveoli into the capillaries and into the red blood cells. The remaining systems then transport the oxygen to the working muscles and eventually back out as CO_2.

Adaptations in the Heart

The heart gets bigger and stronger (cardiac hypertrophy) with aerobic exercise.

This means that the heart can:

- hold more blood, increasing the stroke volume (the amount of blood pumped out of the heart per beat).
- beat with more force, which again will increase the stroke volume.

The result of this will be:

- a reduction in the resting heart rate (number of beats per minute).
- to increase the maximum cardiac output (the amount of blood pumped out of the heart in 1 minute).

Overall there will be more blood going to the working muscles, allowing the athlete to exercise for longer in the aerobic zone (taking longer to reach anaerobic threshold) as the exercise intensity increases.

Adaptations to the Vascular System

- Vasomotor control – The arteries will become more elastic, allowing them to vasodilate (become wider) and vasoconstrict (become narrower) more efficiently.

This improves the transportation of the blood to the working muscles. This is also a real health benefit by reducing the potential impact of hypertension (high blood pressure).

Changes in the Blood

- Increased number of red blood cells and therefore more haemoglobin.

This will mean that the blood will be able to carry more oxygen to the working muscles.

Adaptations in the Muscles

- Larger numbers of capillaries present to diffuse the oxygen into the muscles.
- Larger number of **mitochondria** (power plant of the cell which converts oxygen and food into energy).
- Increased amounts of myoglobin (concentrated form of haemoglobin that transports the oxygen into the mitochondria).

This will mean that greater amounts of oxygen can be carried into capillaries and then used for energy within the muscle (mitochondria).

Adaptations to the Bones and Joints

- Exercise stimulates deposition of calcium which makes the bones stronger.
- Tendons and ligaments increase in strength and flexibility.

Improvements to sporting performance

All of the above adaptations mean more oxygenated blood can be transported to the working muscles, allowing the performer to:

- Have a higher **VO_2 Max** (the unit of measurement of Aerobic fitness).
- Work aerobically for longer raising the **Anaerobic Threshold.**
- Increased oxygen uptake will mean recovery times after intense exercise will be shorter.
- Faster recovery means the body can replenish **CP stores** and **glycogen** at a faster rate.
- **Lactic acid** will be removed faster.
- **Myoglobin stores** will be re-saturated at a faster rate because of increased oxygen uptake.

Quick revision

After a period of prolonged aerobic training (up to 6 weeks), adaptations to the cardiovascular system are likely to occur, which include:

- **Cardiac hypertrophy** (resulting in increased stroke volume and max cardiac output).
- Increase in strength of the **diaphragm** and **intercostals** muscle (increasing the efficiency of the breathing mechanism).
- Increased density of **alveoli** and **capillaries** within the lungs (increase the rate of gaseous exchange).
- Increased number of **red blood cells** (increases the oxygen carrying capacity of the blood).
- Increased **elasticity (Vasomotor control) of arteries and arterioles** (allows greater volume of oxygenated blood to pass through the vessels).

- Increased **capillary density, mitochondrial density** and **myoglobin content** in the muscles (increased the amount of oxygen into the muscles converting it to energy).

All these adaptations improve sporting performance by:

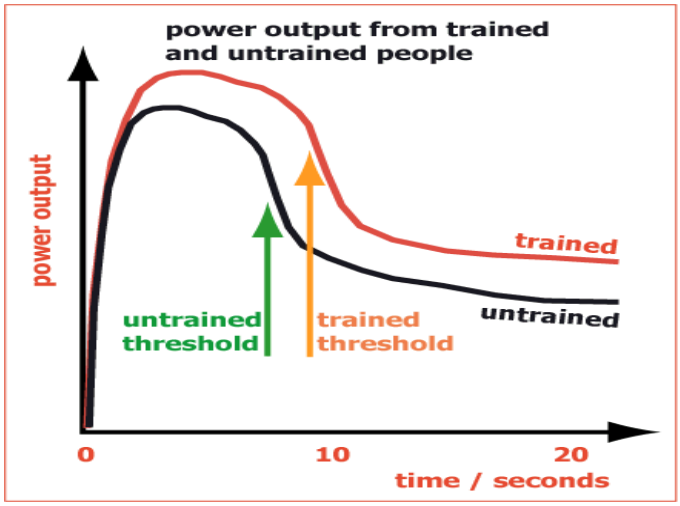
- Increasing the individuals VO_2 max, meaning it will take longer to reach anaerobic threshold.
- Glycogen and CP stores will be conserved.
- Onset of blood lactate (OBLA) will be delayed.
- Individual will recover quicker after intense exercise by restoring CP and glycogen store at a faster rate.
- Removing lactic acid and re-converting it to energy at a faster rate.

Adaptations to the Body after Anaerobic Exercise

Anaerobic exercise includes such activities as sprinting, weight training and anything where a sportsperson is working close to their maximum. Anaerobic adaptations are fewer than aerobic but are no less important.

These adaptations include changes mainly in the muscles, they are:

- Muscle hypertrophy (increase in size of the muscles).
- Increased anaerobic energy stores (more Creatine Phosphate and Muscle Glycogen present).
- Greater tolerance to **lactic acid** (also known as **buffering** capacity of the muscles) allowing exercise to go on for longer.
- Co-ordination of the neural system improves i.e. the firing patterns of the neural impulses are more co-ordinated to the sporting movement being carried out.



Improvements to sporting performance

Anaerobic adaptations will mean:

- Because of increased muscular hypertrophy, the performer will be able to increase the amount of force, power output, speed and strength to a given sporting situation.
- The performer will also be able to remain in the anaerobic zone for longer due to the increased energy stores (CP and glycogen) and increased tolerance to lactic acid.

Quick revision

High intensity exercise results in the following adaptations:

- **Muscular hypertrophy**, increased **CP** and **glycogen** stores and increased **tolerance to lactic acid.**

This will help sporting performance by:

- Being able to work in the **anaerobic zone** for a longer period of time.
- The muscles being able to **exert greater force** thus increasing speed, strength and power of the performer.

Top Tips:

As well as having knowledge and understanding of the actual physiological adaptations, it is of equal importance to understand the actual effects of the adaptation and the potential positive effects on sporting performance e.g. cardiac hypertrophy can help increase stroke volume and maximal cardiac output. This increase in oxygen reaching the muscle will increase the VO_2 max of an individual which will increase the anaerobic threshold allowing the athlete to work in the aerobic zone for longer. A high VO_2 doesn't necessarily mean a high level of sporting performance, it is more important that an athlete is able to sustain exercise around their anaerobic threshold for prolonged periods e.g. an elite marathon runner. An anaerobic example is muscular hypertrophy, which can increase the force exerted by a muscle, thus allowing faster contractions allowing greater sprint speed or increasing leg power when jumping.

Exam Style Questions

1. Identify two physiological adaptations that could occur as a result of your training and explain how these adaptations could affect your sporting performance.

[4]

Physiological Adaptation	Effects on Sporting Performance
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.....	.....

2. Explain how long-term physiological adaptations of power training could help develop sporting performance. Use specific examples. [4]

Answers