

PE2 REVISION GUIDE

Content Title: Recovery after exercise

Key points

- Alactic and lactacid oxygen debt
- Methods to speed up recovery process

Practical Application/Explanation

- When we exercise and work **anaerobically** we have to re-pay all the energy/ATP that we have used and remove the lactic acid from our blood.
- After high intensity anaerobic exercise we are still breathing very fast and our Heart Rate is also very high. This is known as **OXYGEN DEBT**.
- **Alactic** and **Lactacid** Oxygen Debt.
- Methods to speed up the recovery processes e.g. cool down.

ALACTIC AND LACTACID OXYGEN DEBT

Oxygen Debt - because we have 2 anaerobic energy systems, there are two ways in which oxygen debt is repaid:

A - Alactic component

- This system repays the CREATINE PHOSPHATE.
- It takes approximately 30 seconds to repay 50% of your CP stores with 98% getting repaid after 3 mins. This information is vital to a coach or athlete when looking at recovery times for power events and exercises.

Approximate Creatine Phosphate Recovery Times (these will vary depending on the fitness level of the individual).

Recovery Time (seconds)	CP recovery (%)
15	60
30	70
45	80
1 min	85
2 min	90
4 min	97

B – Lactacid component

- The lactacid component restores the MUSCLE GLYCOGEN in the anaerobic glycolysis energy system.
- Oxygen also removes the LACTIC ACID.
- There are four possible fates Lactic acid when broken down by oxygen:
 - Excretion in urine and sweat
 - Conversion back to glucose and glycogen (this is why a cool down is so important)
 - Conversion to protein
 - Conversion to carbon dioxide and water.
- The oxygen also re-saturates the myoglobin stores. Myoglobin is related to haemoglobin but has a greater affinity for oxygen, which in turn means it can carry greater amounts of oxygen into the working muscles.
- **OXYGEN DEFICIT** also has to be re-paid, oxygen deficit occurs as we begin to exercise. The aerobic system does not work quickly enough to supply energy at the start of physical activity (it's like an engine starting slowly and beginning to warm up), hence the body gets its energy anaerobically, which has to be re-paid.

Methods to Speed up Recovery Process

a. Cool down

By cooling down and exercising at a low intensity (jogging etc.) then greater amounts of oxygen are consumed. This means creatine phosphate stores will replenish at a faster rate. The more oxygen that is present then the quicker the body can remove lactic acid and turn it back into energy and re-saturate the myoglobin stores.

b. Eating a high carbohydrate and protein meal within 30 minutes post exercise

The optimum time for the uptake of carbohydrate and protein is within 30 minutes of finishing exercise. By eating High Glycaemic Index carbohydrate (carbohydrate that release energy quickly e.g. sugary foods) and Low Glycaemic Index (carbohydrate that release energy at a slower rate e.g. fruit, wholemeal bread, wholemeal pasta and rice), then the body is able to begin restoring the glycogen used over exercise period (see nutrition). Also proteins help the muscles to grow and repair.

c. Recovery supplements

The use of recovery supplements is widely used in sport for recovery purposes. They often contain a mix of **carbohydrate** (to re-supply the glycogen stores), **protein and amino acids** (for growth and repair of the muscle) and **creatine** (helps restore CP stores).

d. Ice baths

The theory behind ice baths is that when we exercise at a high intensity, small micro-tears occur in the muscles. Some research believes that it is these micro-tears that cause **Delayed Onset of Muscle Soreness (DOMS)** or at least the swelling that takes place around the micro-tears. It is believed that Ice Baths reduce the swelling around the muscle micro-tears and reduce the pain that they cause, this means that the performer is able to train at a higher intensity the next day. It must be noted that research on this is not conclusive.

e. Massage

Massage can serve two purposes; the first is psychological benefits e.g. the relaxing feeling of the massage and the fact that it can be invigorating (providing it is not a deep muscle massage).

Secondly, it can help physically by returning de-oxygenated blood from the muscle tissue to the heart to be re-oxygenated.

f. Compression Clothing

Recent studies have concluded that compression clothing can help recovery by maximising the pumping action of the muscles in returning blood to the heart and help with subsequent removal of lactic acid and blood lactate.

FATIGUE

Fatigue is inevitably linked to the energy systems and the by-products of producing energy. Here are the main reasons why fatigue occurs if exercise intensity and duration are significant enough:

- a. Lack of energy i.e. insufficient CP and glycogen stores.
- b. Effect of lactic acid inhibiting the enzymes that are needed in the production of energy e.g. lactic acid preventing the enzyme ATPase from effectively breaking down ATP to release energy.
- c. Dehydration and the reduction of plasma volume in the blood that will slow the delivery of blood and therefore oxygen to the muscles. Because of the reduced blood flow to the muscles, the heart has to work harder and increase Cardiac Output (amount of blood pumped out of the heart per minute). The heart does this by increasing Stroke Volume (amount of blood pumped per beat) and Heart Rate (number of beats per minute) to meet the demands of the body.
- d. When we sweat we also lose electrolytes such as potassium and sodium (which are used to move glucose in and out of the cell). This can obviously be a problem in energy supply.

Top Tips:

You must understand the difference between the alactic and lactacid oxygen debt and specifically what each system repays/removes. The candidate must also be able to provide specific examples of how the methods to speed up recovery and why each are used.

Example 1: Cool down keeps oxygen levels elevated and therefore this means that more lactic acid can be removed (speeds up lactacid recovery) and then converted back into glucose/glycogen. Also the cool down can speed up the re-saturation of myoglobin.

Example 2: A high carbohydrate meal including protein can help restore muscle glycogen and blood glucose levels. The optimum time for uptake of carbohydrate into muscles is within 30 minutes of stopping exercise. Protein can help repair damaged muscle tissue and help re-growth (see nutrition/hydration section for more details of optimising recovery).



Exam Style Questions

1. Levels of sporting performance decrease with the onset of fatigue.
 - (a) Describe the physiological factors that cause fatigue in sporting activity. [4]
 - (b) Explain the terms alactic and lactacid oxygen debt and describe the strategies you have used to speed up these recovery processes. [6]

Answers