The effects of exercise and sports performance on the energy systems.

Introduction.

- All movement requires energy.
- The method by which our body generates energy is determined by the intensity and duration of the activity undertaken.
- Activities that require short bursts of effort (sprinting or jumping) require the body to produce large amounts of energy over a short period of time.
- A marathon runner would require energy production over a longer period and at a slower rate.

Introduction.

- The body's energy systems facilitate the process of making energy.
- The energy systems of the body can work aerobically or anaerobically.
- All energy systems work together but the type of activity and its intensity will determine which system is predominant.

The role of ATP in exercise.

- Energy makes our muscle fibre contract.

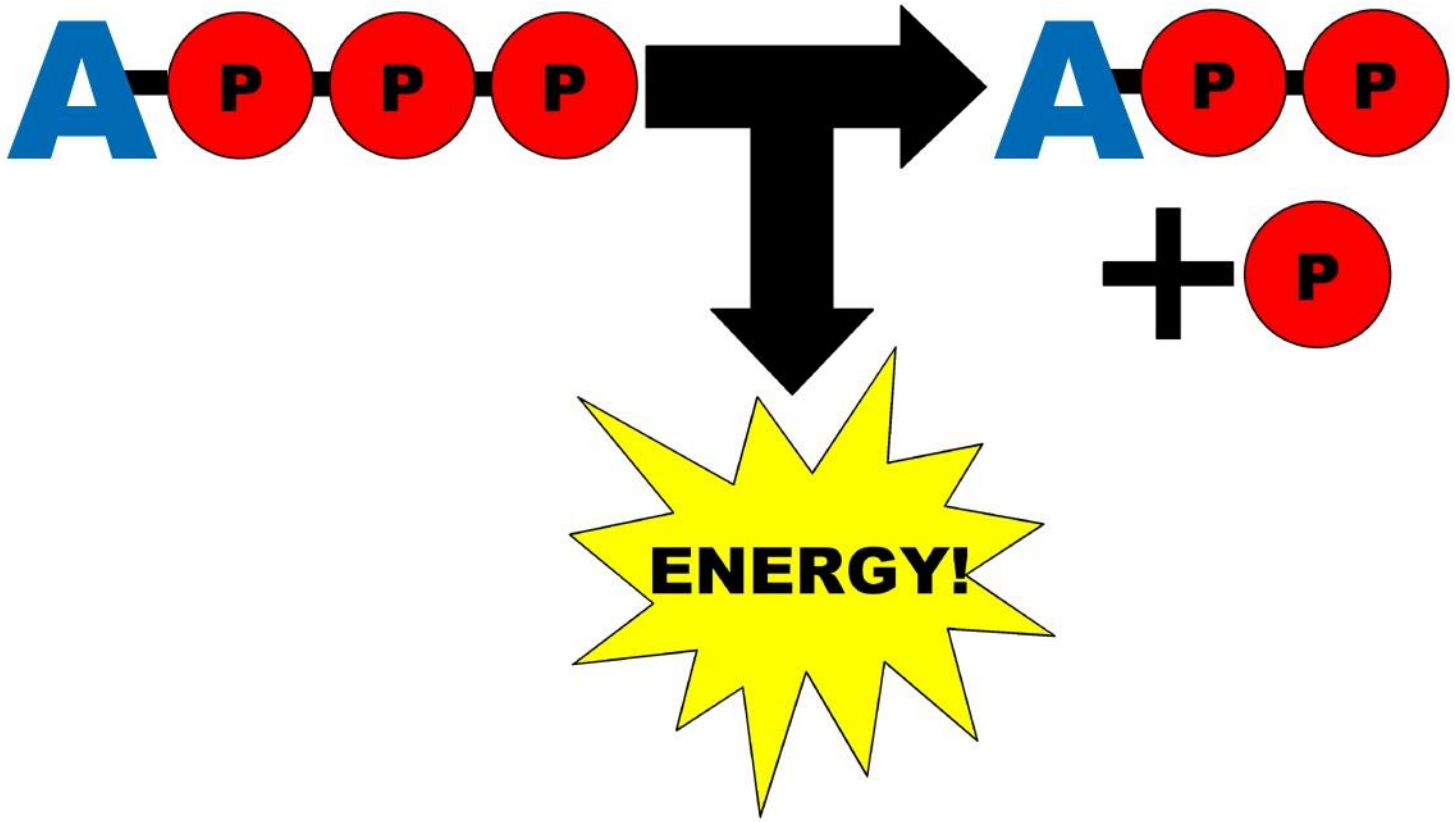
- We get energy from the following fuels-
- Phosphocreatine
- Carbohydrates/ glycogen
- Fats

- The body maintains a continuous supply of energy through the use of adenosine triphosphate (ATP).

How is ATP broken down for muscular contraction and then resynethsised?

- The process is supported by an enzyme ATPase which breaks off the final phosphate and releases energy.

- ATP can then be resynthesised by adding a Phosphate back on (ADP+ P = ATP.



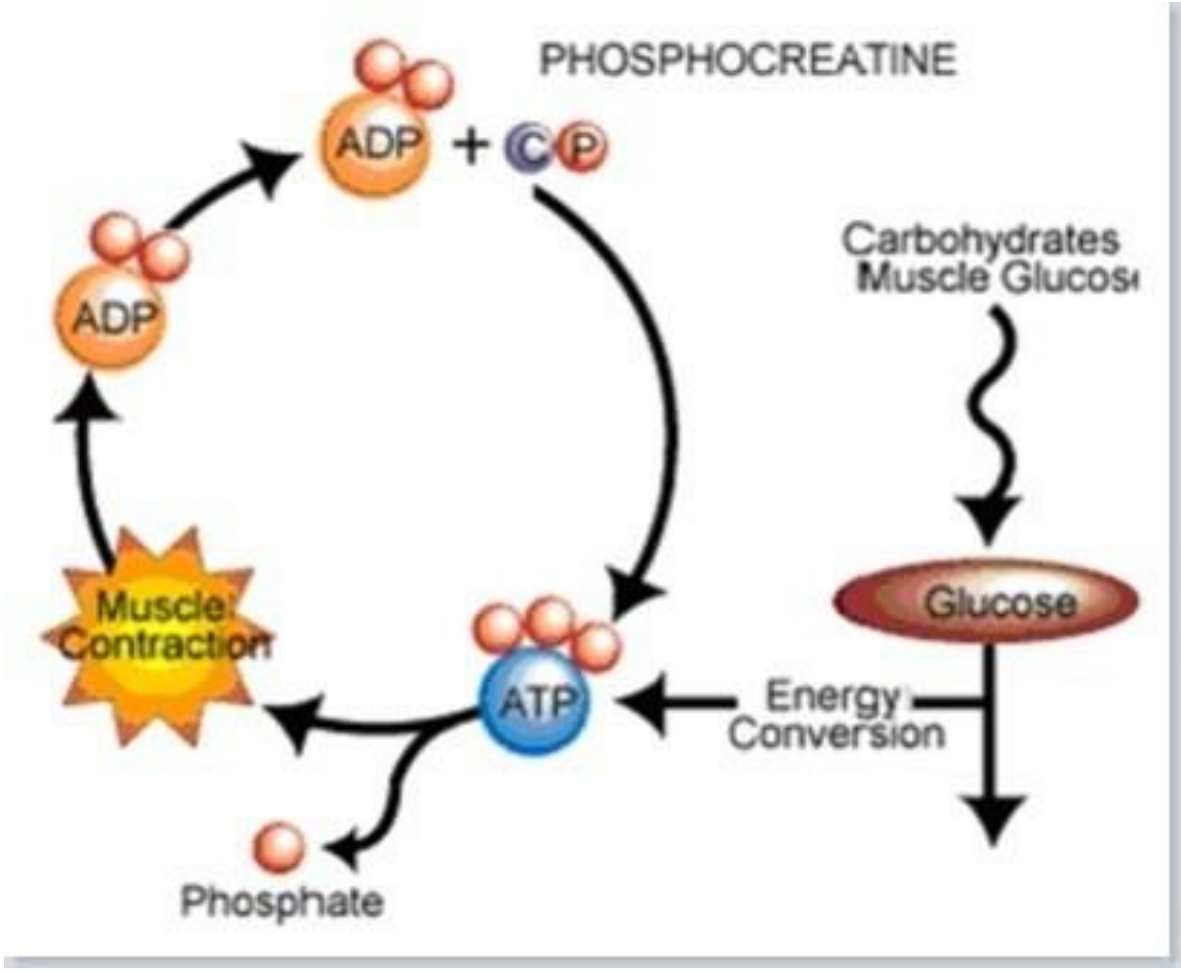
How does ATP work?

- Energy is made by converting ATP into ADP.
- By binding a phosphate back with the ADP, ATP is resynthesised.
- Our muscles have very small amounts of ATP stored in them, so to replenish ATP quickly, the body uses a number of systems.
- A muscle cell has enough ATP to last 3 seconds.

- https://www.youtube.com/watch?v=r9SFsWbMO0w

The ATP- PC (alactic system).

- Anaerobic.
- Important in sports such as sprinting, shot put.
- High intensity, short duration exercise (10 seconds).



How does the ATP-PC system replenish ATP?

- It takes place in the sarcoplasm.
- The fuel used is phosphocreatine (PC).
- PC breaks down into creatine and phosphate with energy using the enzyme creatine kinase.
- 1 ATP is resynthesized per 1 molecule of PC.
- ADP+PC= 1ATP

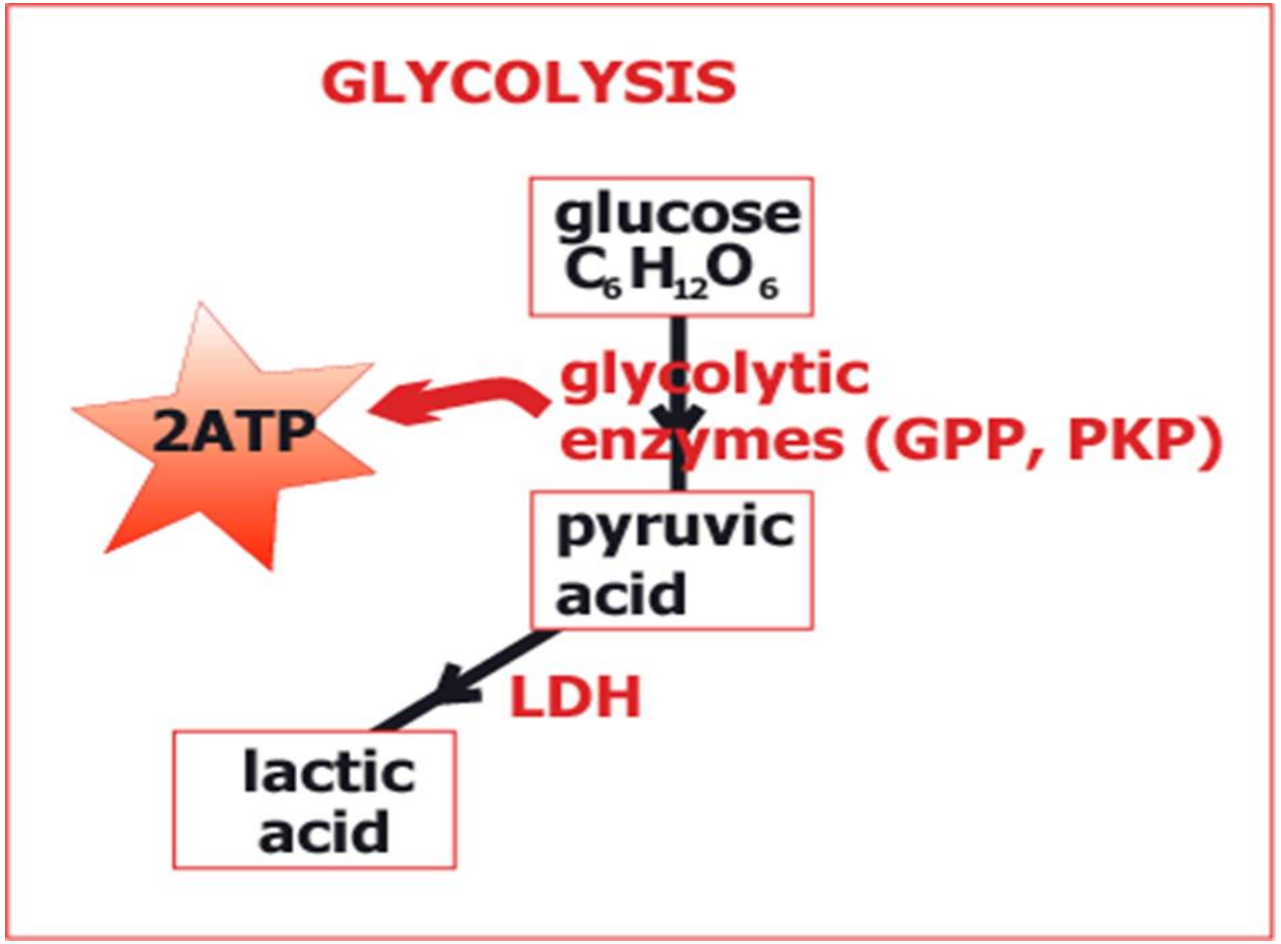
Remember-

- The body breaks down carbohydrates from the foods we eat and converts them into glucose.

- When the body does not need to use the glucose for energy, it stores some of it in the liver and muscles. This is then used for energy production and is known as glycogen.

The Lactate System/ Anaerobic glycolysis.

- Higher intensity over a longer period eg. 400m.
- Anaerobic.
- 60-90 seconds maximal work uses this system.



Describe the process of Anaerobic Glycolysis.

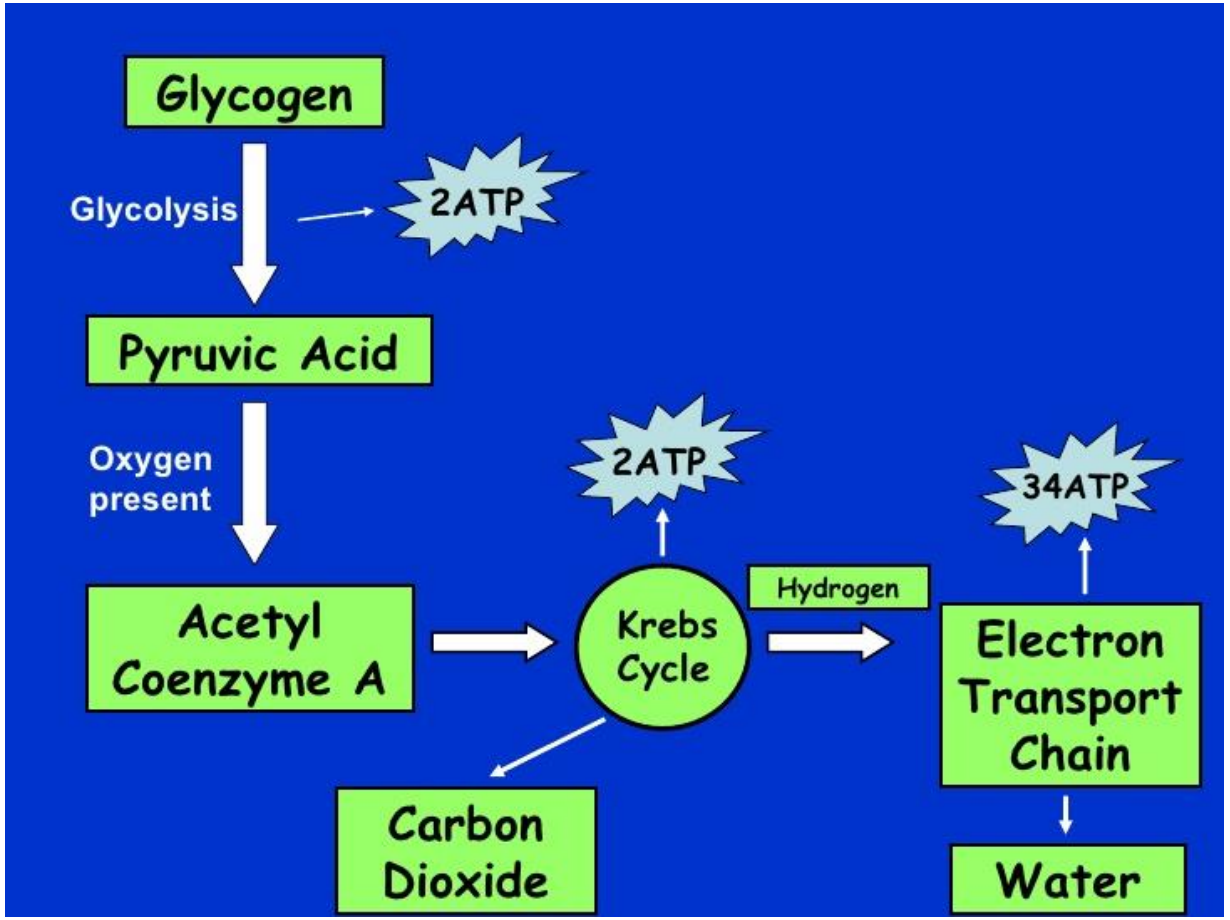
- Glycogen is converted into glucose.
- Glucose is broken down into pyruvic acid using glycolytic enzymes.
- Pyruvate is then converted into lactic acid.
- This breakdown resynthesizes 2 ATP.

Lactic Acid Production.

- Lactic acid is a by product of anaerobic glycolysis.
- Lactic acid accumulates and diffuses into tissue fluid and blood.
- If it is not removed quickly it builds up to impede muscle contraction and causes fatigue. It also cause pain and the performer may have to stop.
- A performer would need 8 minutes of recovery time and the removal of lactic acid.

Aerobic System.

- Long term energy system.
- If plenty of oxygen is available, glycogen and fatty acids break down to yield large amounts of ATP (38 in total).
- Carbon dioxide and water are waste products.



The Krebs Cycle

- The process of the krebs cycle occurs in the mitochondria.
- Pyruvate combines with CoA to create Acetyl CoA.
- Acetyl CoA combines with oxaloacetic acid to make citric acid.
- The by product is carbon dioxide.
- The H+ ions are transported to the electron transport chain.
- 2 ATP are made.

Describe the process of ATP production from carbohydrates through the aerobic energy system.

- Carbohydrates are broken down into glucose.
- Glucose is broken down into glycogen.
- This then goes into the krebs cycle and enters the electron transport chain.

Jasmine is a county rugby player and she trains regularly to improve her performance.
Evaluate the importance of the aerobic system for Jasmine's rugby performance.

UNSTUCK-

- What type of exercise intensity will this system be suited to?
- When during the rugby game will this system be used?
- What stores are replenished during recovery?
- Identify what is removed during recovery.
- How much ATP is made using this system?
- When would this system NOT be useful?

Jasmine is a county rugby player and she trains regularly to improve her performance.

Evaluate the importance of the aerobic system for Jasmine's rugby performance.

- The aerobic system is used in low intensity exercise.
- It is the main source of energy when jogging, resting during her games.
- When recovering, phosphocreatine stores will be replenished and lactic acid will be removed.
- High number of ATP are made.
- Aerobic system is not useful when sprinting down the wing. The ATP-PC system would be better suited to this.

Evaluate the importance of the aerobic energy system for elite 100m sprinters in competition and training.

- Consider why is might be useful for the 100m sprinter.

- Consider why is might not be useful for the 100m sprinter.

Evaluate the importance of the aerobic energy system for elite 100m sprinters in competition and training.

Aerobic Glycolysis.

- https://www.youtube.com/watch?v=PQMsJSme780

Krebs Cycle

- https://www.youtube.com/watch?v=uF9XYgLDlFI

Electron Transport Chain.

- https://www.youtube.com/watch?v=C8VHyezOJD4

https://www.youtube.com/watch?v=dWe8vtztW-4

ATP Generated in ETC.

- 38 molecules of ATP are generated in the ETC.

- Depending on the intensity and duration of the exercise and your level of fitness, recovery from this energy system can range fron a few hours to 2-3 days.

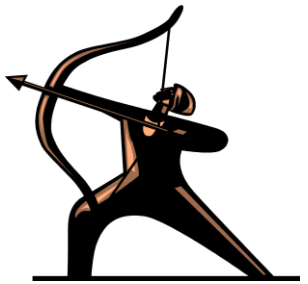
Let’s Remember.

1. Identify what ATP stands for?
2. How long does the ATP store last for?
3. Draw out how ATP is made.
4. Identify the system a 100m sprinter would use to generate ATP?
5. Explain how the ATP- PC system generates ATP.
6. Explain how lactic acid is made and the effects it has on the body.
7. Where does the aerobic energy production occur?

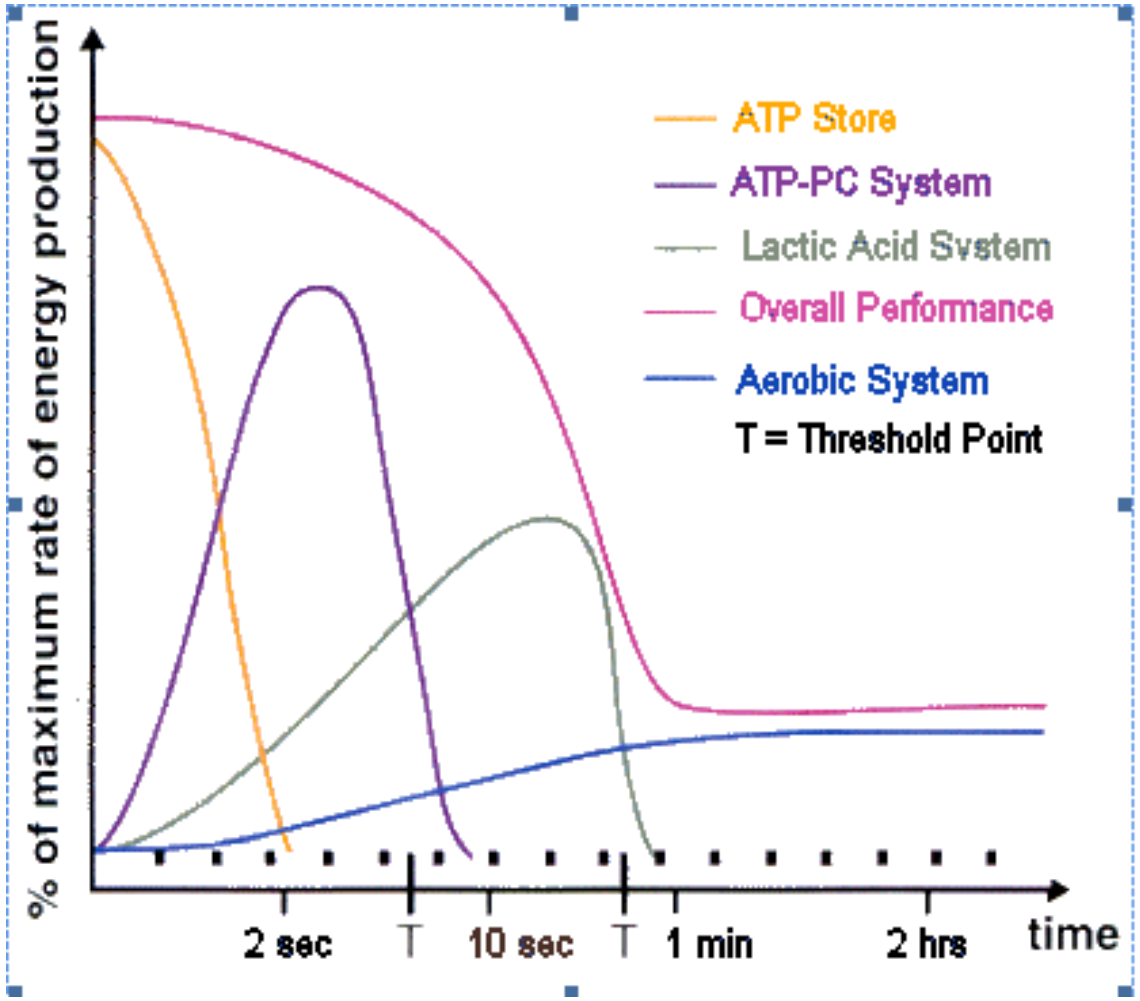
Apply our knowledge.

- Describe the process of ATP production from carbohydrates through the aerobic energy system. (5 marks)

- Evaluate the importance of the aerobic energy system for elite 100m sprinters in competition and training. (6 marks)



The Energy Systems in combination



Draw out and complete the table (pg 5).

Duration	Classification	Energy supplied by	Sport example
1-3 seconds	Anaerobic	ATP (in the muscles)	A punch in boxing
3-10 seconds			
10-45 seconds			
45 seconds- 2 minutes			
2 minutes- 4 minutes			
Over 4 minutes			

Exam Preparation.

- **Revision session:**
- Split the learners into small groups and give each group a different specification topic.
- Ask each group to design revision question cards for their topic.
- On completion, photocopy each set of resources and give to the other groups as revision material.

Adaptations of the energy systems to exercise.

- Increased Creatine Stores-

Short duration, interval training using high intensity exercise improves your ability to produce anaerobic work.

Body adapts by storing more creatine in the muscles which will improve the ATP- PC system.

You can then exercise for longer anaerobically using fast and powerful movements.

Increased tolerance to lactic acid-

Anaerobic training will stimulate the muscles to be better at tolerating lactic acid and clearing it.

With endurance training, the capillary network extends allowing greater volumes of blood to supply the muscles with oxygen and nutrients. Muscles will use fat as a fuel source more efficiently and can work harder for longer without fatiguing.

The body’s maximal oxygen consumption increases.

Aerobic Energy System.

- Aerobic system can produce more energy
- As the cardiovascular system improves, more oxygen can be delivered which is needed to produce ATP.
- Lactic can be oxidised and removed.

Increased use of fats as an energy source.

- Fat is the primary energy source during low intensity exercise.
- Fat combustion powers almost all exercise at approx. 25% of **aerobic capacity.**
- Fat oxidation increases as exercise continues for a long time and glycogen depletes.
- A trained athlete has a greater opportunity to burn fat than a non trained athlete as they are more efficient at delivering oxygen to the working muscles as well as a greater number of mitochondria.

Aerobic Capacity

- The maximum amount of oxygen that can be consumed during maximal exercise.

Increased storage of glycogen and increased numbers of mitochondria.

- Muscles increase their oxidative capacity with regular training. This is because-

- Long term exercise increases the number of mitochondria in the muscle cells.
- Increase supply of ATP
- Increase in the number of enzymes involved in respiration.
- The muscles can store more glycogen meaning that anaerobic glycolysis can continue for longer.

Exam Questions.

- Explain why it is an advantage for long distance runners to have high numbers of mitochondria. (2 marks)

Additional Factors affecting the energy systems.

- Diabetes and hypoglycaemic attack-

This is where the glucose in your blood is too high.

It prevents glucose being used as a fuel for energy.

Hypoglycaemia is low glucose levels in your blood.

If you have low levels then you will not have the energy to carry on with activities.

- Children's lack of lactate system-

Lactate system is not fully developed in children. Therefore during high intensity exercise lactic acid builds up.