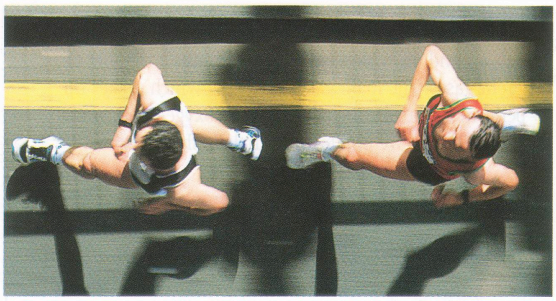
ENERGY SYSTEMS



Energy for Exercise

Food is the source of energy for the human body and it also provides nutrients for growth and repair. When food is eaten, this is what happens…

- The food is broken down into **soluble** chemicals (e.g. **glucose**) by **digestion** in the **gut**.
- The soluble chemicals pass through the gut wall into the **blood**.
- The blood carries the soluble food chemicals to all of the body's **cells**, where they will be used for:

Energy

Repair

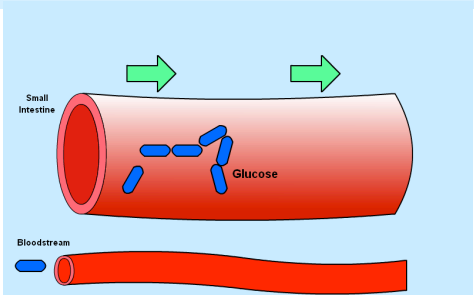
Growth

Making Energy Available to the Cells of the Body

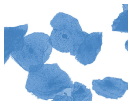
The muscles of the body use both **carbohydrates** and **fats** to produce energy. The following diagram shows how carbohydrates are used.

Making Energy Available to the Cells of the Body

- The glucose enters the **small intestine** where it passes into the **blood**.

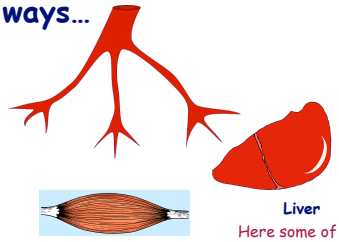


The glucose is then used in 3 different ways…



Body Cells

Glucose diffuses easily into the cells and is used to meet their energy demands.



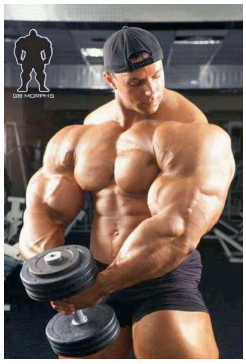
Skeletal Muscle

Glucose is stored here as **glycogen** and is used when the body is working harder.

Liver

Here some of the glucose is stored as **glycogen** and used to maintain blood sugar levels.

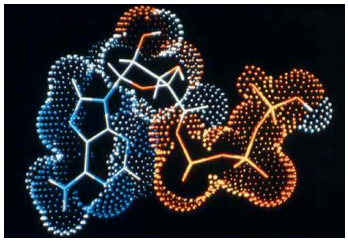
HOW DO MUSCLES WORK



- Anything you do needs energy.
- When muscles work they have to lengthen and shorten.
- For this to work your muscles need energy

Adenosine Tri-Phosphate (ATP)

- This is a chemical which is vital for muscle contraction.
- Without ATP muscle contraction cannot go on.



Adenosine Tri-Phosphate (ATP)

However

The body only has enough ATP for 1 explosive act

After this there is no ATP left

Muscle Contraction cannot take place

Therefore

Physical activity can no longer continue

So

Energy has to be created by other means

THE CREATINE PHOSPHATE SYSTEM

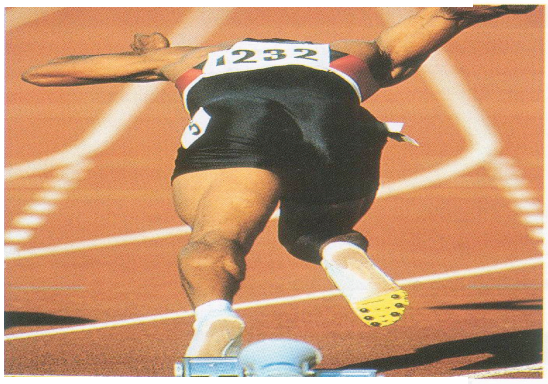
ATP (Energy)

Adenosine Phosphate (ADP) + Creatine Phosphate

This system is extremely efficient
It does NOT need oxygen
It leaves no waste product

However

We are only able to use this for about 10-15 seconds before this system runs out.



Sprinting 100m uses our creatine phosphate system

THE GLUCOSE/LACTIC ACID SYSTEM or anaerobic glycolysis

ATP (Energy)

Adenosine Di-Phosphate + Glucose

When Creatine Phosphate runs out, the muscles call upon the stores of GLUCOSE (Glycogen).

However

There is a side effect with this type of energy system.

A waste product call PYRUVIC ACID is produced.

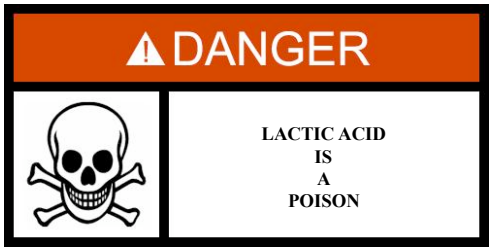
THE GLUCOSE/LACTIC ACID SYSTEM or anaerobic glycolysis

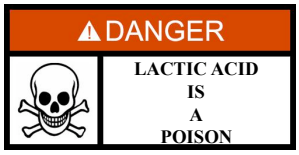
ATP (Energy)

Adenosine Di-Phosphate + Glucose

This in itself is OK if levels of activity are reduced to enable this Pyruvic Acid to be broken down by OXYGEN into CARBON DIOXIDE and WATER.

However, if levels of activity are not reduced and not enough oxygen is being breathed in, then this Pyruvic Acid is not broken down and converts into LACTIC ACID.

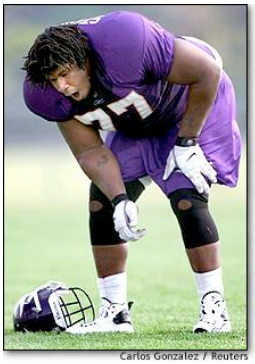




After a while Lactic Acid will make the muscles ache and eventually it will cause cramps and the muscles will stop working.

The athlete has to rest while blood brings fresh supplies of oxygen to the muscles.

He/She is repaying back the **OXYGEN DEBT**



Gasping for air after a hard game

to

Repay the oxygen debt

Running the 400m uses our lactic acid system

THE AEROBIC SYSTEM

(glucose, fats, oxygen)

This system is used during lower levels of activity when there is enough energy being delivered to the working muscles to clear away ALL the Pyruvic Acid.

At lower levels of activity FATS can be used as a muscle fuel.

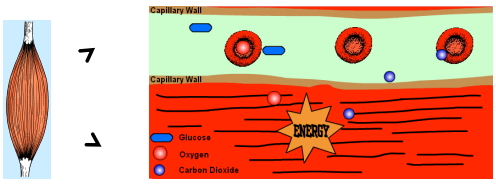
This preserves its stores of GLUCOSE for as long as possible.

As a general rule, the more intense the activity, the more GLUCOSE is used instead of FAT.

Running the Marathon uses our aerobic system

A slow steady supply of energy is needed throughout the Marathon

Aerobic Respiration – With Oxygen



The Process of Aerobic Respiration

Glucose

Oxygen

Energy for Muscles to contract and create Movement

Water

Carbon Dioxide

Aerobic Respiration – With Oxygen

Aerobic respiration involves the release of energy from the **slow** breakdown of glucose using **oxygen**, inside the cells.

1. **Glucose** and **oxygen** are transported to the working muscles by the blood.
2. Glucose and oxygen are then used by the muscles of the body to produce energy.
3. This process creates **carbon dioxide** and **water**.
4. The carbon dioxide passes back into the blood for removal.

How Aerobic Respiration Happens…

1. **Glucose** and **oxygen** are carried by the **haemoglobin** in the red blood cells.
2. Glucose and oxygen pass into all the muscle cells of the body and is used to help produce energy for **muscular contractions**.
3. **Aerobic respiration** produces carbon dioxide & water as waste products.

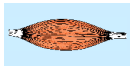
Facts about Aerobic Respiration

- During aerobic respiration, the **heart** and **lungs** supply the muscles with plenty of **oxygen**.
- The **carbon dioxide** is breathed out via the lungs, while the water is lost as sweat, urine or in the air we breathe out as water vapour.
- As long as the muscles are supplied with enough **oxygen**, exercising aerobically can be carried out for a long period of time.

Aerobic respiration is how **marathon** runners produce the **energy** that is used in long periods of less intensive effort.

Glucose and **oxygen** produce…

Some is used for muscle contractions, creating movement.



The rest is converted into heat to warm the body.

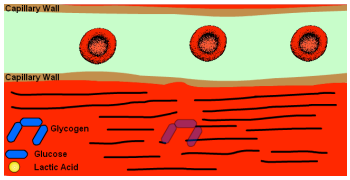
Aerobic respiration is how **marathon** runners produce the **energy** that is used in long periods of less intensive effort.

Glucose and **oxygen** produce…

Carbon dioxide, which is carried away by the blood & excreted through the lungs.

Water, which is carried away by the blood and excreted through the lungs, sweat and urine.

Anaerobic Respiration – Without Oxygen



The Process of Anaerobic Respiration

Glucose

Energy for muscles to contract and create movement

Lactic Acid

Anaerobic Respiration – Without Oxygen

Anaerobic respiration involves the release of a little energy, very quickly from the incomplete breakdown of glucose without using **oxygen**, inside the cells.

1. Glucose is made available by the breakdown of glycogen stored in the working muscles.
2. The glucose is used by the muscles of the body to produce energy, without the use of oxygen.
3. This process creates lactic acid, which passes back into the blood for removal.

How Anaerobic Respiration Happens…

1. Glucose is transported to the muscles of the body via the blood.
2. Glucose passes into the muscles cells and is used to produce energy for muscular contractions.
3. Anaerobic respiration produces lactic acid as a waste product.

Facts about Anaerobic Respiration

- During **anaerobic** respiration, your muscles are not supplied with enough oxygen.
- The **lactic acid** builds up due to the shortage of oxygen. This is known as an **oxygen debt**, which needs to be paid back once exercising has finished.
- The lactic acid build-up will soon make your muscles feel tired and painful, so exercising anaerobically can only be carried out for **short periods** of time.

Oxygen Debt

Question: How do sprinters pay back their oxygen debt at the end of a race?

Oxygen Debt

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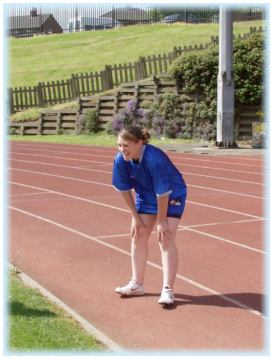


Oxygen Debt

Answer: Sprinters will continue to breathe more deeply and rapidly for a number of minutes at the end of their race. This will enable them to pay back the oxygen debt, and allow lactic acid levels to fall.

Anaerobic Respiration is how **sprinters** produce the **energy** that is used in short periods of **'all out effort'** - high intensity. Oxygen cannot reach the muscles fast enough, so anaerobic respiration is used.

Glucose Produces…

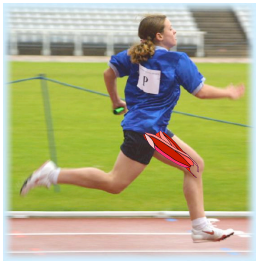
ENERGY

The rest is converted into heat to warm the body.

Some is used for muscle contractions, creating movement.

Anaerobic Respiration is how **sprinters** produce the **energy** that is used in short periods of **'all out effort'** - high intensity. Oxygen cannot reach the muscles fast enough, so anaerobic respiration is used.

Glucose Produces…



Lactic acid quickly builds up & makes the muscles feel tired & painful. 'All out effort' cannot last for very long!

Energy and Types of Physical Activities

Each physical activity or sport you undertake requires a different energy system…

- Some use mainly **aerobic** respiration.
- Others use mainly **anaerobic** respiration.
- Most use a combination of the two.

Energy and Types of Physical Activities

Track Events and their use of Aerobic Respiration

Event	Percentage of Aerobic Respiration
Marathon	100%
10,000 m	95%
5,000 m	83%
1,500 m	60%
800 m	50%
400 m	20%
200 m	10%
100 m	Less than 1%

Energy and Types of Physical Activities

Basketball players use both systems