Edexcel (A) Biology A-level

Topic 7: Run For Your Life

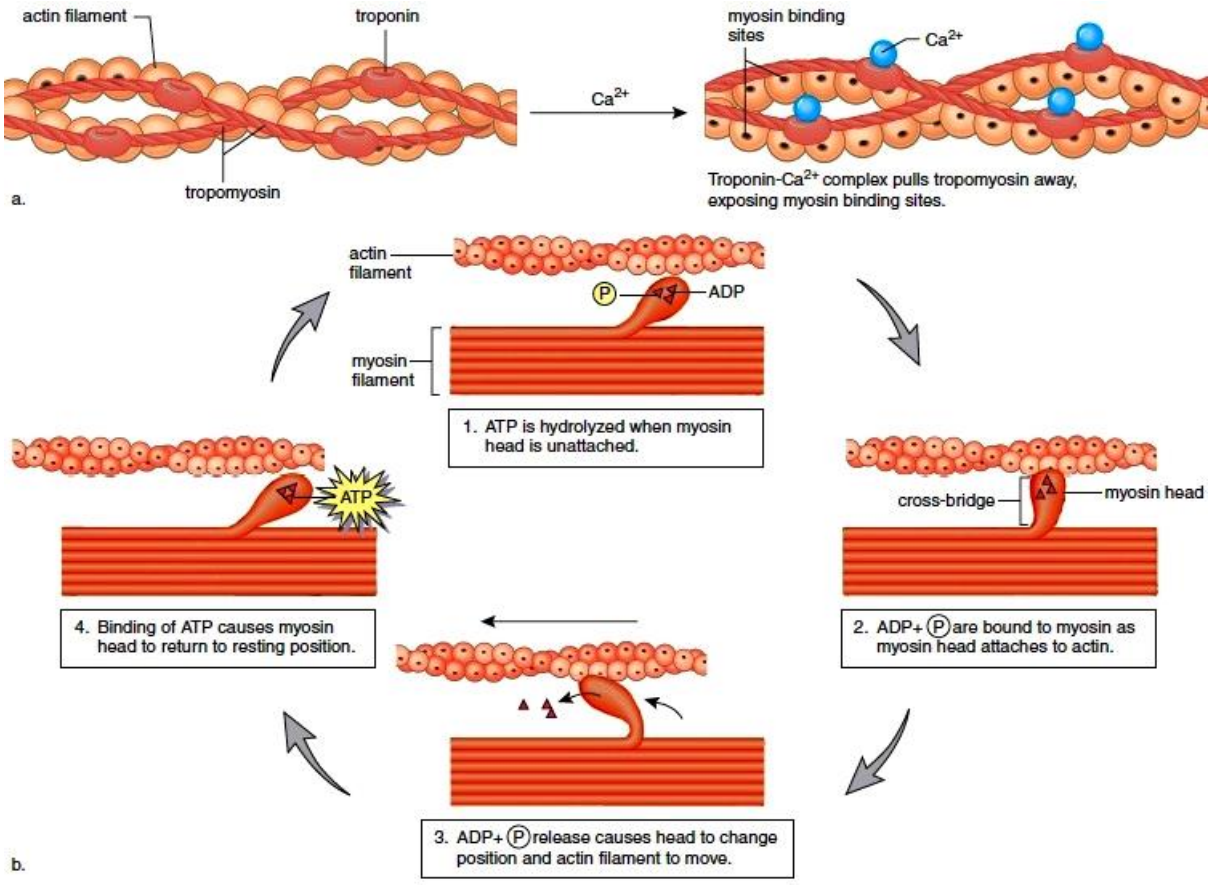
Notes

Movement

Key words:

- **Tendons** – non-elastic tissue which connects muscles to bones
- **Ligaments** – elastic tissue that joins bones together and determines the amount of movement possible at a joint
- **Joints** – the area where two bones are attached for the purpose of permitting body parts to move, they're made of fibrous connective tissue and cartilage
- **Skeletal muscles-** muscles attached to bones, they are arranged in antagonistic pairs
- **Antagonistic muscle pairs-** pairs of muscles which pull in opposite directions – as one muscle contracts, the other relaxes**. Flexors and extensors** are an antagonistic muscle pair such as triceps and biceps. When the triceps relaxes, the biceps contracts to lift the arm

Muscle contraction occurs as following:



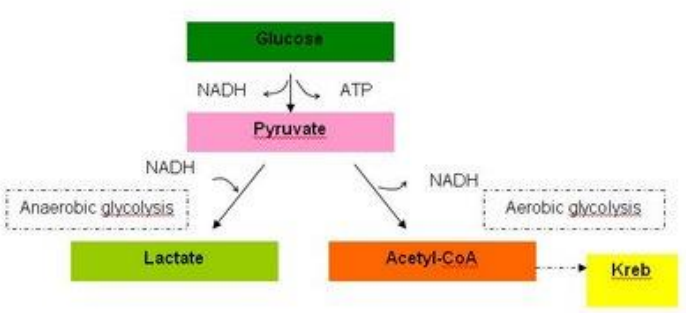
Aerobic Respiration

Aerobic respiration as splitting of the **respiratory substrate**, to release carbon dioxide as a waste product and reuniting of hydrogen with atmospheric oxygen with the release of a large amount of energy whereas **anaerobic respiration** occurs in the absence of air. Respiration is a multi-step process with each step controlled and catalysed by a specific intracellular enzyme. It yields ATP, which used as a source of energy for metabolic reactions, and generates heat.

It has four stages:
- Glycolysis
- Link Reaction
- Kreb's Cycle
- Oxidative Phosphorylation

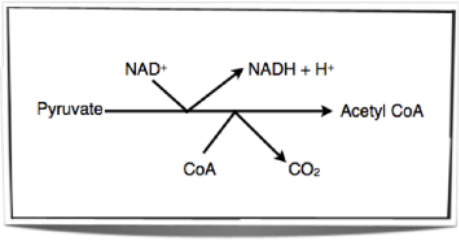
Glycolysis

Glycolysis is the first process of both aerobic and anaerobic respiration. It occurs in the cytoplasm.
In this process glucose is **phosphorylated** to produce 2 molecules of **pyruvate**, 2 molecules of ATP and 2 molecules of NADH. In anaerobic respiration the pyruvate is further converted into lactate with the help of NADH. **Lactate** is then converted back to pyruvate in the liver. Lactate **decreases blood pH** which affects the Central Nervous System. Reduced stimulation from the CNS affects muscle contraction.



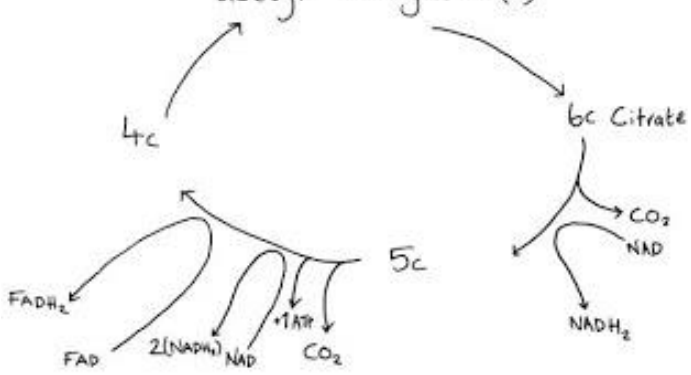
Link Reaction and Kreb's Cycle

The next step of aerobic reaction is **the link reaction**, where pyruvate is converted to **acetyl coenzyme A** with the help of **NADH.**

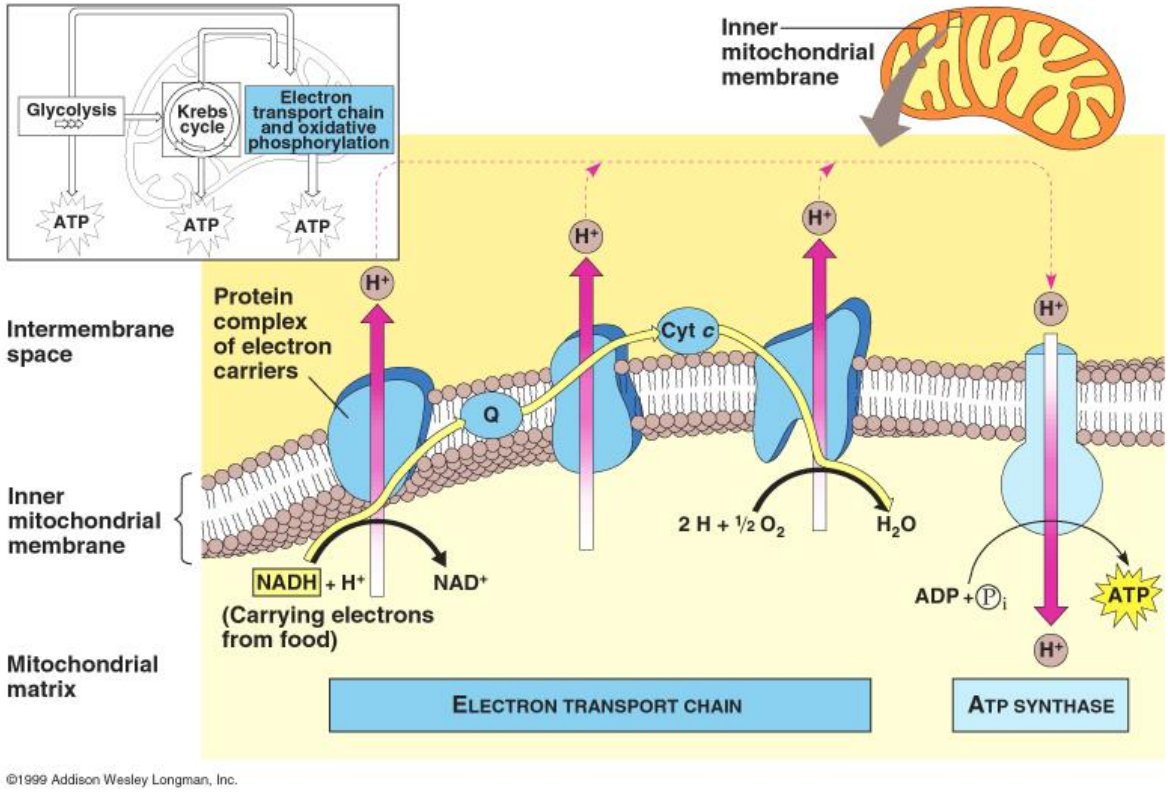


Acetyl-CoA then enters the **Krebs cycle**, where glucose is oxidised and carbon dioxide, ATP, **reduced NAD and reduced FAD** are produced.

Both the Link reaction and Kreb's cycle occur in the **mitochondrial matrix**.



Oxidative Phosphorylation



Oxidative phosphorylation is the process in which ATP is synthesised via **chemiosmosis** in the **electron transport chain** in mitochondria. This process generates the majority of ATP in aerobic respiration and it occurs as following:

- Reduced coenzymes carry **hydrogen ions** and electrons to the electron transport chain, which occurs on the **inner mitochondrial membrane.**
- Electrons are carried from one electron carrier to another in a series of **redox reactions**: **the electron carrier** which passes the electron on is oxidised, whereas the electron carrier which receives it is reduced.

- **Hydrogen ions** move across the membrane into the **intermembrane space** – as a result of that the concentration of the hydrogen ions in the intermembrane space is high
- Hydrogen ions diffuse back into the **mitochondrial matrix,** down the **electrochemical gradient.**
- ATP is produced on **stalked particles** using ATP synthase.
- Hydrogen atoms are produced from hydrogen ions and electrons. The **hydrogen atoms are then combined with oxygen to produce water.**

Cardiac Cycle

Due to the heart's ability to initiate its own contraction, it is referred to as **myogenic:**

1. Depolarisation originates in the **Sinoatrial Node**.
2. Depolarisation spreads through the atria - causes atrial systole. Cannot spread directly to the ventricles due to the region of nonconductive tissue - annulus fibrosus.
3. Stimulates another region of conducting tissue - **Atrioventricular Node**.
4. Slight delay for atrial diastole. AVN passes depolarisation into the conducting fibres - **Bundle of His**.
5. Bundle of His splits into two branches - **Purkyne Fibres**. Causes ventricle systole.

There are 3 stages of the cardiac cycle:

1) **Atrial systole** – during atrial systole the **atria contract. T**his forces the atrioventricular **valves open** and blood flows into the ventricles.

2) **Ventricular systole – contraction of the ventricles** causes the **atrioventricular valves** to **close** and **semilunar valves to open,** thus allowing **blood to leave the left** ventricle through the **aorta** and right ventricle through the **pulmonary artery**.

3) **Cardiac diastole –** atria and ventricles relax **and pressure inside the heart chambers decreases.** The causing **semilunar valves** in the aorta and pulmonary arteries close, preventing backflow of blood.

Electrical changes in the heart are caused by the spread of **wave of depolarisation** which can be measured and detected with an **electrocardiogram (ECG**). Some diseases affect the wave of depolarisation within the heart thus affecting the **ECG pattern** therefore ECG can be used in the diagnosis of various heart diseases including cardiovascular heart diseases.

Cardiac output = stroke volume x heart rate

Cardiac output can be regulated by controlling the heart rate. **Factors which increase the**

heart rate include:

- **Low pH** caused by high carbon dioxide concentration, detected by chemoreceptors located in carotid arteries, aorta and the brain. The receptors send impulses to the medulla oblongata where the cardiovascular centre is located
- **Stretch receptors** respond to muscle movement, for instance during exercise
- **Decrease** in blood pressure, monitored by baroreceptors in the sinus
- **Adrenaline** is a hormone released to stimulate the fight or flight response

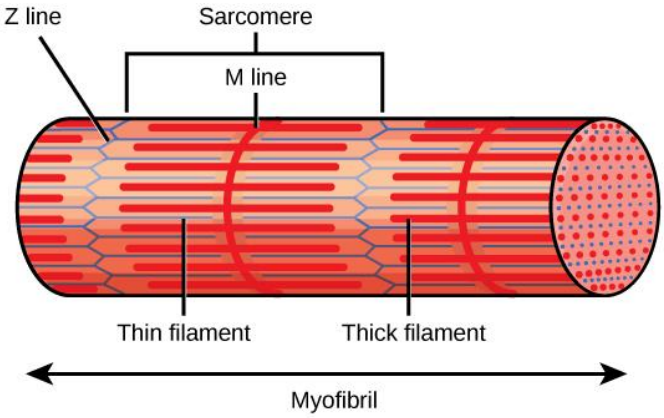
The relevant receptor sends an impulse to the **Cardiac Control Centre in the medulla oblongata**. An impulse is then sent to the **Sinoatrial Node** along a **sympathetic neurone**, depolarisation occurs and **noradrenaline is released** at the SAN. This results in increased heart rate.

Ventilation rate = tidal volume x number of breaths per minute

Ventilation rate is controlled via the same mechanism in response to the following changes to conditions:

- **Increase in carbon dioxide concentration** in blood which causes pH to drop
- **Impulses from stretch receptors** in muscles and tendons caused by exercise
- Voluntary control

Muscles



- **Slow twitch fibres** are specialised for **slow contractions** and are adapted to **long periods of exercise,** such as marathon running and therefore **do not fatigue quickly. Fast twitch fibres** are adapted for **rapid release of energy** during intense exercise such as sprinting – **the contractions are intense and in short bursts.**

- Slow twitch fibres contain many **mitochondria** and a lot of **myoglobin** which results in slow twitch fibres being dark in colour. Fast twitch fibres have very few mitochondria and thus they are lighter in colour.

- Moreover, slow twitch fibres have low levels of **creatine phosphate** and **glycogen,** whereas fast twitch fibres have high levels of both creatine phosphate and glycogen.

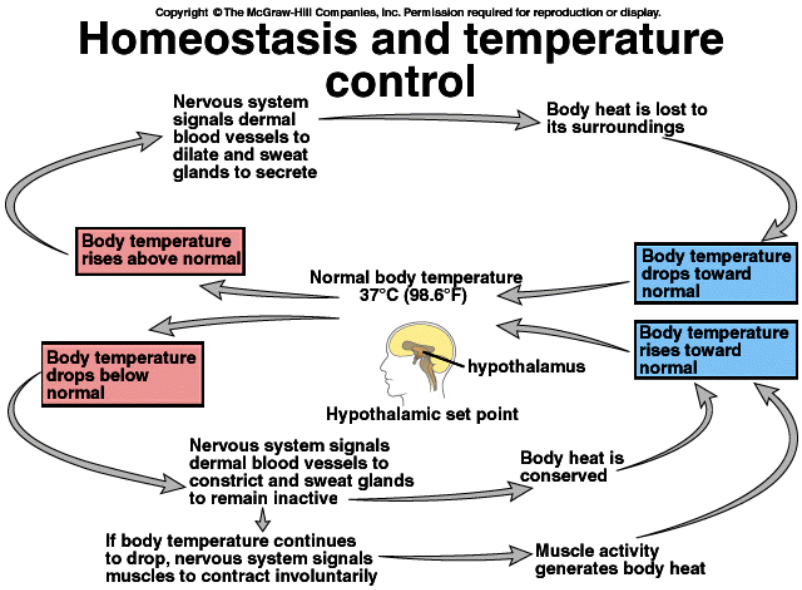
Negative and Positive Feedback

Negative feedback which counteracts any change in internal conditions. This means that all changes are **reversed to restore the optimum conditions**. Another example of a control pathway is **positive feedback,** which doesn't occur as often as negative, and has an opposing effect and increases the original change in the conditions. An example of positive feedback is **dilation of the cervix during childbirth**.

Homeostasis and Exercise

Homeostasis is the control of internal conditions such as temperature. A homeostatic system consists of **receptors, a control mechanism and effectors** which interact together. Homeostasis maintains the body in a state of dynamic equilibrium during exercise, the process occurs as following:

- Firstly the changes in temperature are detected by **thermoreceptors** in the skin, or thermoreceptors in the **hypothalamus,** which detect changes in blood temperature.
- Hypothalamus **stimulates** effectors to either decrease or increase the body temperature.



Disadvantages of exercising too much include:

- **Wear and tear** on joints

- Suppression of the **immune system**

Disadvantages of exercising too little:

- Increased risk of **obesity**
- Increased risk of **CVD**
- Increased risk of **diabetes**
- Suppression of the **immune system**
- Increased levels of **LDLs**

Medical Technology

Keyhole surgery is a non-invasive method which uses **fibre optics** to repair damaged joints quickly. It is also much cheaper than conventional methods as it doesn't require as many members of stuff and the recovery time is shorter.

A **prosthesis** is an artificial body part which enables those with injuries and disabilities to regain appearance or function of a particular body part as well as participate in sports.

Transcription Factors

Transcription factors are proteins that bind to DNA.

Transcription factors bind to specific base sequences:

- **Promoter** Sequences
  - Found upstream of the gene they act on - enable the binding of RNA polymerase and therefore promote transcription.
- **Enhancer** Sequences
  - Regulate DNA activity by changing chromatin structure - making it more or less open to RNA polymerase. Open = active gene expression, closed = gene inactivity - transcription factors either stimulate or prevent transcription of the gene.