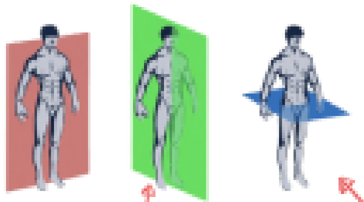
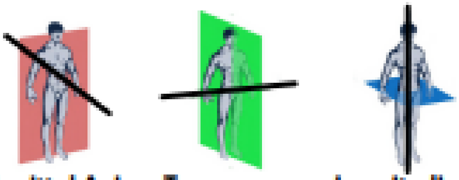
Applied Anatomy & Physiology - Skeletal System

Planes of Movement



Axes of Rotation



Hinge joints allow only backward and forward motion. There are 3 hinge joints

- Knee
- Elbow
- Ankle

Ball and socket joints are when a long bone fit into a cup shaped hole allowing circumduction.

This includes shoulder and hip joints

If its moving - it's a synovial joint

A synovial joint is a place where two or more bones meet.

Joint actions

- Rotation
- Flexion
- Plantarflexion
- Extension
- Dorsiflexion
- Adduction
- Abduction

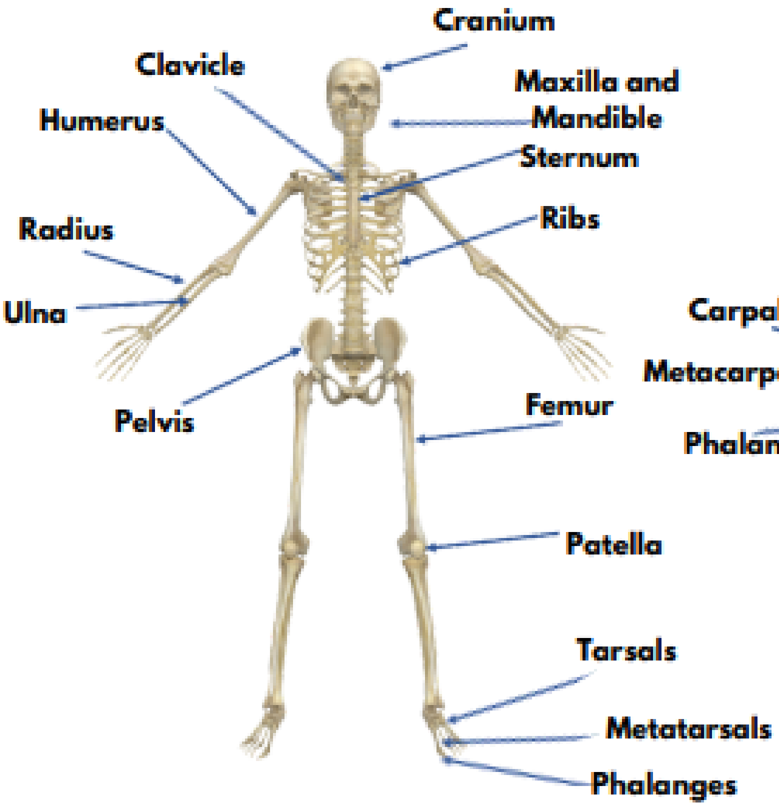
Condyloid joints allow circular motion but don't fully allow circumduction
The wrist is a condyloid joint

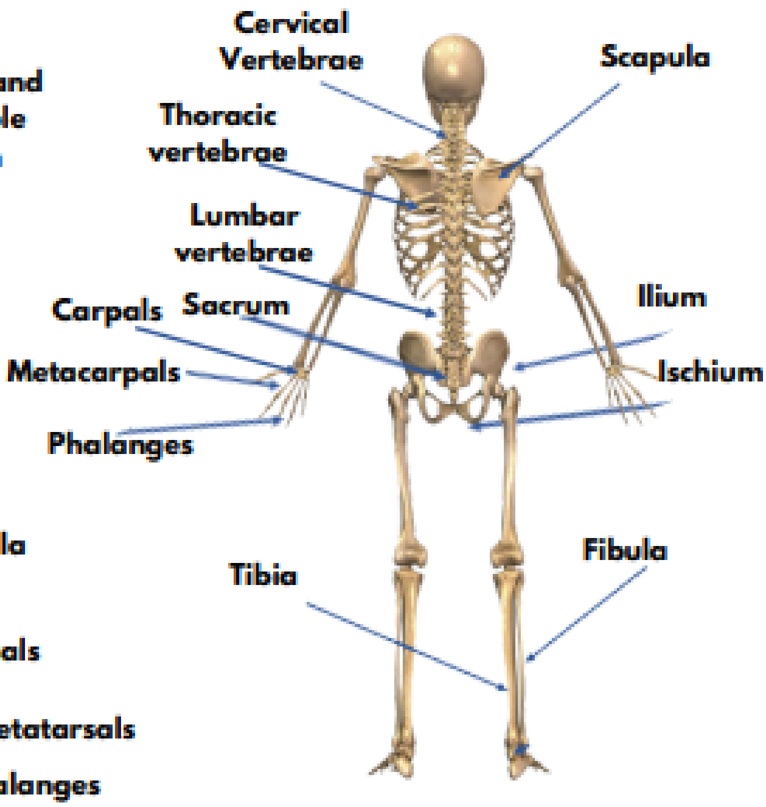
The vertebral column is the central axis of the skeleton.

There are 5 groups of the vertebral column -
Cervical curve
Thoracic curve
Lumbar curve
Sacral curve
Coccyx (tailbone)

Joints have articulating bones which connect joints to the skeletal system.

They can move within the joint, making them flexible





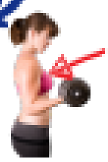
Applied Anatomy & Physiology - Muscular System

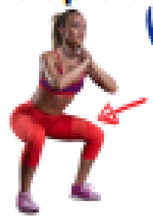
Muscles CANNOT push - so they work in antagonistic pairs.

Whilst one muscle pulls (the agonist). Its pair muscle will relax (the antagonist).

Isotonic muscle contraction - a muscle contracts and movement is present

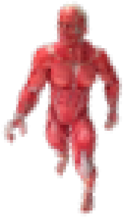
Concentric contraction - muscle shortens therefore generating force





Eccentric contraction - muscle lengthens due to a greater opposing force

Isometric muscle contraction - when a muscle contracts but its length does not change.



All muscles are made up of individual fibres. Muscle fibres can either be -
Slow oxidative (type I - slow twitch)
Fast oxidative glycolytic (type IIa - fast twitch)
Fast glycolytic (type IIX - fast twitch)

Fixator Muscles - a muscle that stabilises one part of the body while another part moves.

Slow Oxidative (type I)	Fast Oxidative Glycolytic (type IIa)	Fast Glycolytic (Type IIX)
Slow Twitch	Fast Twitch	Fast Twitch
Slow Contrations	Fast Contractions	Very Fast Contractions
Aerobic Activity	Fatigue relatively quickly	Fatigue very quickly
e.g. Marathon	e.g. 800m	e.g. 100m

Skeletal muscles only contract when stimulated by electrical impulses from the central nervous system (CNS)

↓

A nerve impulse is initiated in the motor neurone

↓

The impulse is conducted down the axon of the motor neuron by a nerve action potential

↓

A neurotransmitter (acetylcholine) is secreted into the synaptic cleft to conduct the impulse across the gap

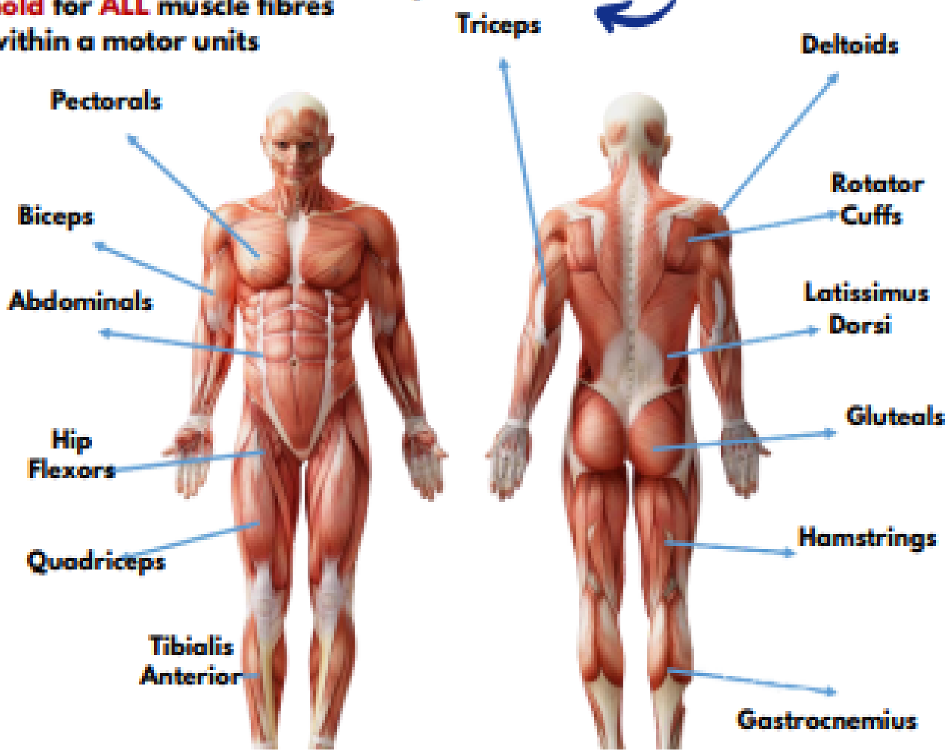
THE ALL OR NONE LAW

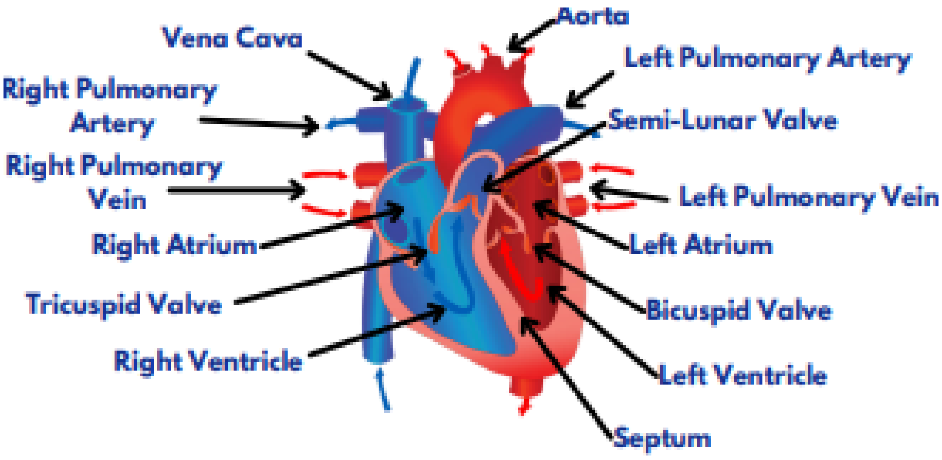
For a stimulus to result in a muscle contraction, the stimulus strength must be high enough to reach the threshold for ALL muscle fibres within a motor units

Most muscles contain both slow and fast twitch muscle fibres.

The proportion of muscle fibre types in each muscle is largely genetic.

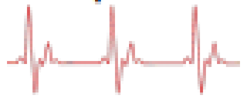
However, training can affect the composition of your muscles





The **cardiac conduction system** is a group of cells found in the wall of the heart.

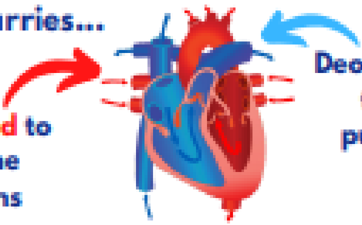
The heart is **myogenic**, meaning it is capable of generating its own electrical impulses



Cardiac Conduction System

Sinoatrial Node (SAN)
↓
Atrial Contraction
↓
Atrioventricular Node (AVN)
↓
Bundle of His
↓
Purkinje Fibres
↓
Ventricular Contraction

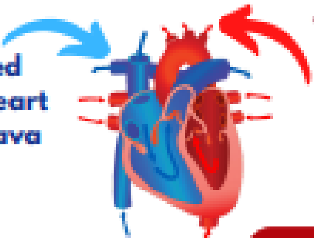
he Pulmonary Circuit carries...



Oxygenated blood to the heart via the pulmonary veins

Deoxygenated blood to the lungs via the pulmonary arteries

The Systemic Circuit carries...



Deoxygenated blood to the heart via the vena cava

Oxygenated blood to the body via aorta.

Applied Anatomy & Physiology - Cardiovascular System

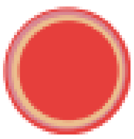
Stroke Volume - The volume of blood pumped out by the heart ventricles in each contraction

Cardiac Output - The volume of blood pumped out by the heart ventricles per minute = HR x SV

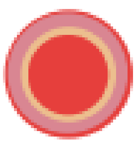
During exercise, blood must be distributed to the areas of the body that require increased oxygen supplies.
In order to do this, blood flow is redistributed through a mechanism called **vascular shunting.**

Chemoreceptors detect a change in blood acidity/CO2 levels - they are located in the wall of arteries.

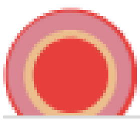
The **vasomotor** is located in the **Medulla Oblongata** in the brain and is responsible for the regulation of heart rate, blood pressure and the redistribution of blood flow.



Vasodilated artery



Normal artery



Vasoconstricted artery

Heart rate can be regulated by -

1. Neural controls
2. Intrinsic controls
3. Hormonal controls

Sympathetic system increases the number of cardiac impulses, increasing heart rate (e.g. during exercise).

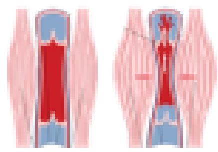
Parasympathetic system decreases the number of cardiac impulses, decreasing heart rate (e.g. at rest).

Starling's Law - Stroke volume increases in response to an increase in venous return.

Venous Return -
The flow of blood back to the heart,via the veins and specifically the vena cava

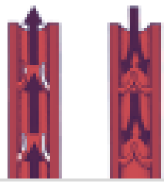
Venous return mechanisms -

1. The Skeletal Muscle Pump



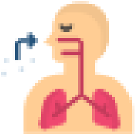
2. The Respiratory Pump

3. Pocket Valves



The Respiratory system has two functions:

1. Pulmonary ventilation:
- Inspiration and expiration of air



2. Gaseous exchange
- External respiration - movement of oxygen into the blood and carbon dioxide into the lungs
- Internal respiration - release of oxygen into respiring cells and waste into blood.

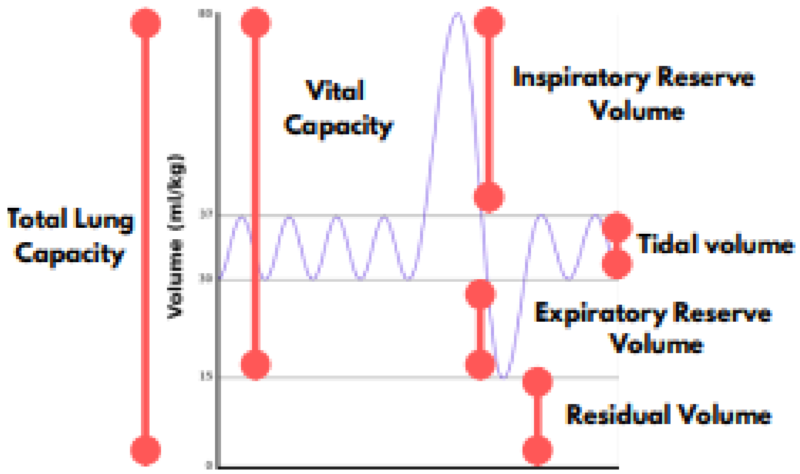
The diaphragm changes shape during ventilation -

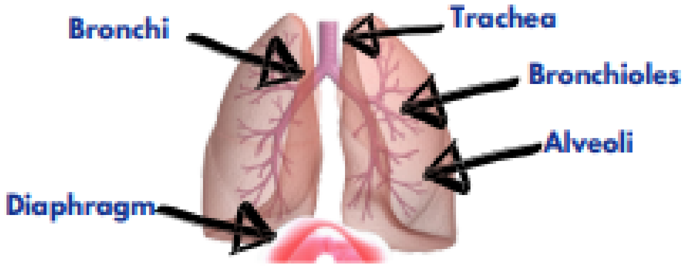
Inhalation - Contracts and flattens

Exhalation - Relaxes and becomes dome shaped

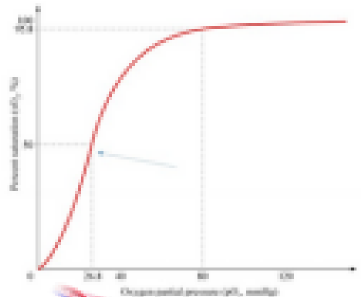
Lungs are the main organ involved in respiration.

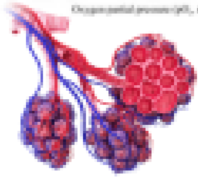
Spirometer Trace -





Oxyhaemoglobin Dissociation Curve





MECHANICS OF BREATHING DURING EXERCISE

Applied Anatomy & Physiology - Respiratory System

Inspiration

Sternocleidomastoid and Pectoralis Minor cause a greater expansion of the rib cage and sternum.

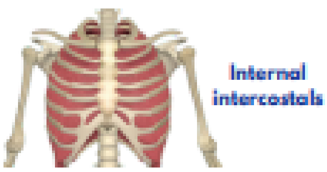
They result in the increase of lung volume, making a larger pressure gradient than at rest, increasing the depth of breath.

Gas Exchange - Where the waste product carbon dioxide diffuses out of the blood and oxygen diffuses into the blood.
This takes place in the alveoli.

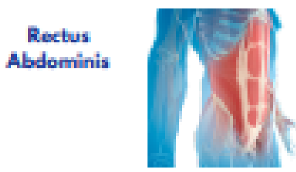
This is possible vecause of the conceps of diffusion, partial pressure and concentration gradients

Each gas will diffuse down their own concentration gradient

Expiration



Internal intercostals and rectus abdominis create a greater down and inward movement of the rib cage and sternum.



The volume in the lung is decreased, meaning the pressure in the thoracic cavity increases, forcing more air out than at rest.

The Respiratory Control Centre (RCC) is located in the medulla oblongata.
It receives information from sensory nerves and sends signals to motor nerves to change rate of respiratory muscle contraction.

Regulation of Breathing

1. Chemical control - chemoreceptors.
2. Neural control - thermoreceptors, baroreceptors and proprioceptors.

Applied Anatomy & Physiology - Energy Systems

Aerobic Respiration

The usual process for releasing energy for your muscles - occurs **WITH** oxygen.

The equation for aerobic respiration -

Glucose + Oxygen
=
Energy + CO_2 +Water

Anaerobic Respiration

This is when your muscles have to work at a very intense level - occurs **WITHOUT** oxygen.

The equation for anaerobic respiration -

Glucose = Energy + Lactic acid

Exothermic reaction - gives off heat/energy.
Endothermic reaction - requires heat/energy

The **ATP** molecule is how your energy is stored and used in the body.
Up to **38 ATP** are produced across the 3 stages.

The continual breakdown and resynthesis of **ATP** is known as a **coupled reaction.**

There are two anaerobic energy systems -

1. ATP-PC System
2. Anaerobic Glycolytic System (Lactic Acid System)

Aerobic energy systems involved **three** stages -

1. Glycolysis
2. The Krebs Cycle
3. The Electron Transport Chain

AT ANY ONE TIME **ALL** ENERGY SYSTEMS WILL BE IN USE BUT **ONE** WILL BE PREDOMINANT

Lactate Accumulation - the increase of lactate as a result of anaerobic activity.

Lactate threshold - the point during exercise at which lactic acid quickly accumulates in the blood.

OBLA (onset of blood lactate accumulation) - the point at which blood lactate levels go above 4 millimoles per litre.

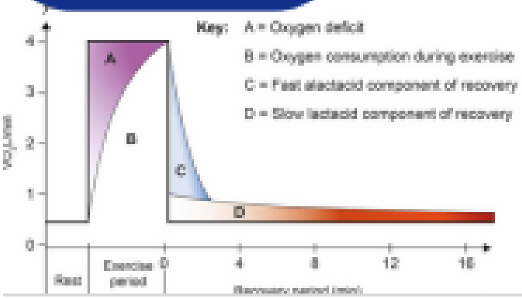
Buffering Capacity - the ability of hydrogen carbonate ions to neutralise these effects of lactic acid.

VO2 max is the maximum volume of oxygen that can be consumed by the working muscles per minute.

After exercise, **post exercise oxygen consumption (EPOC)** will take place - it is the volume of oxygen consumed in recovery ABOVE the resting rate.

- Repays the oxygen debt and begins to break down lactic acid
- To resaturate myoglobin with oxygen
- Resynthesis ATP levels

The intensity of training requires different **work-rest ratios** to insure the training targets the correct energy system.



Altitude's effect on body systems

At higher altitudes, **barometric pressure decreases**, so there is less oxygen in the air.
Therefore partial pressure of oxygen is less than at sea level, meaning that oxygen delivery is slower as the **diffusion rate decreases.**

Benefits of altitude training -

1. Low oxygen increases erythropoietin production
2. This increases red blood cell production.
3. Oxygen extraction becomes more efficient.

Thermoregulation

Muscular contractions and chemical reactions produce **metabolic heat**, which may not be removed from the body quickly enough, causing further body temperature rises.

This can cause **cardiovascular drift** - an upward drift in heart rate.