Image by master1305

Human Body

Junior Science

Is it Alive?

Revision

Biology is the study of living things.
A **living object** is an object that caries out life functions.
A **non-living object** is an object that has not been alive.
A **dead object** is an object that was once alive.

All living organisms are composed of cells. A cell is a small, membrane-bound compartment that contains all the chemicals and molecules that help support an organism's life.

Is it alive?

Revision

A twig once pulled off a tree is considered dead. A stick insect that looks a lot like a twig is alive, but how could you tell the difference?

If you observe the twigs carefully, you should see the stick insect, move, eat food, and get rid of waste.
The insect would be able to respond to the environment, for example it might move if something was brought up close to it, or a light was shone at the insect. If you waited long enough the insects in the tank might reproduce.
The stick on the other hand would do none of these things.

All living things share the characteristics described in MRS GREN

Life function	Gives us the ability to….
Movement	move through space
Respiration	obtain energy through biochemical reactions
Sensitivity	respond to the external environment
Cells	Smallest functional unit
Growth	increase in size
Reproduction	create more living things
Excretion	dispose of waste chemicals
Nutrition	extract useful chemicals from the environment

Revision

Systems in the Human Body

Life function	Human body system responsible
Movement	Muscular skeletal system
Respiration	Respiratory system
Sensitivity	Nervous system
Circulation	Circulatory system
Growth	Numerous systems
Reproduction	Reproductive system
Excretion	Excretory system
Nutrition	Digestive system (studied in year 9)

This year we cover the muscular-skeletal, respiratory and circulatory systems

The structure and functions of the human (as an animal) systems: skeletal, digestive, circulatory, respiratory.

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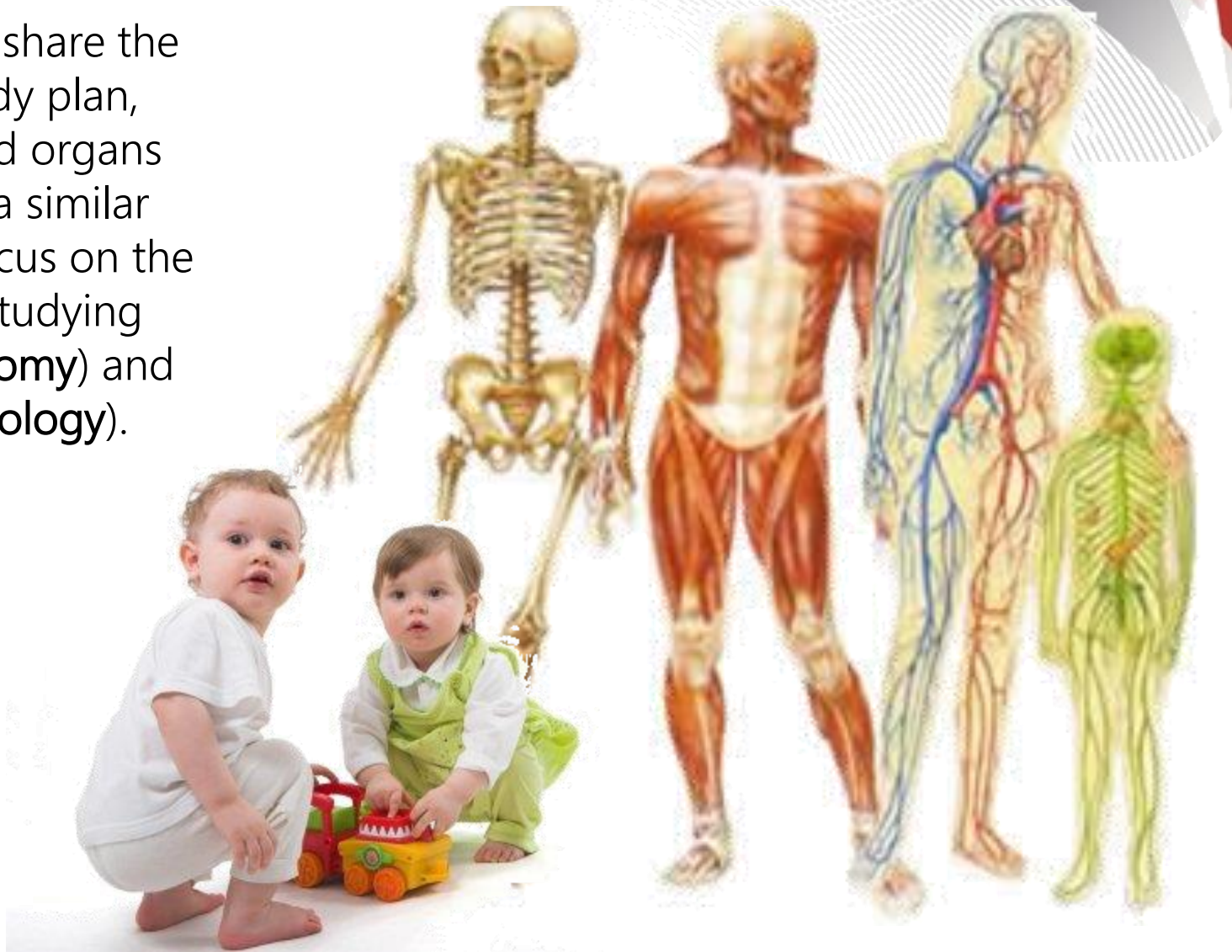
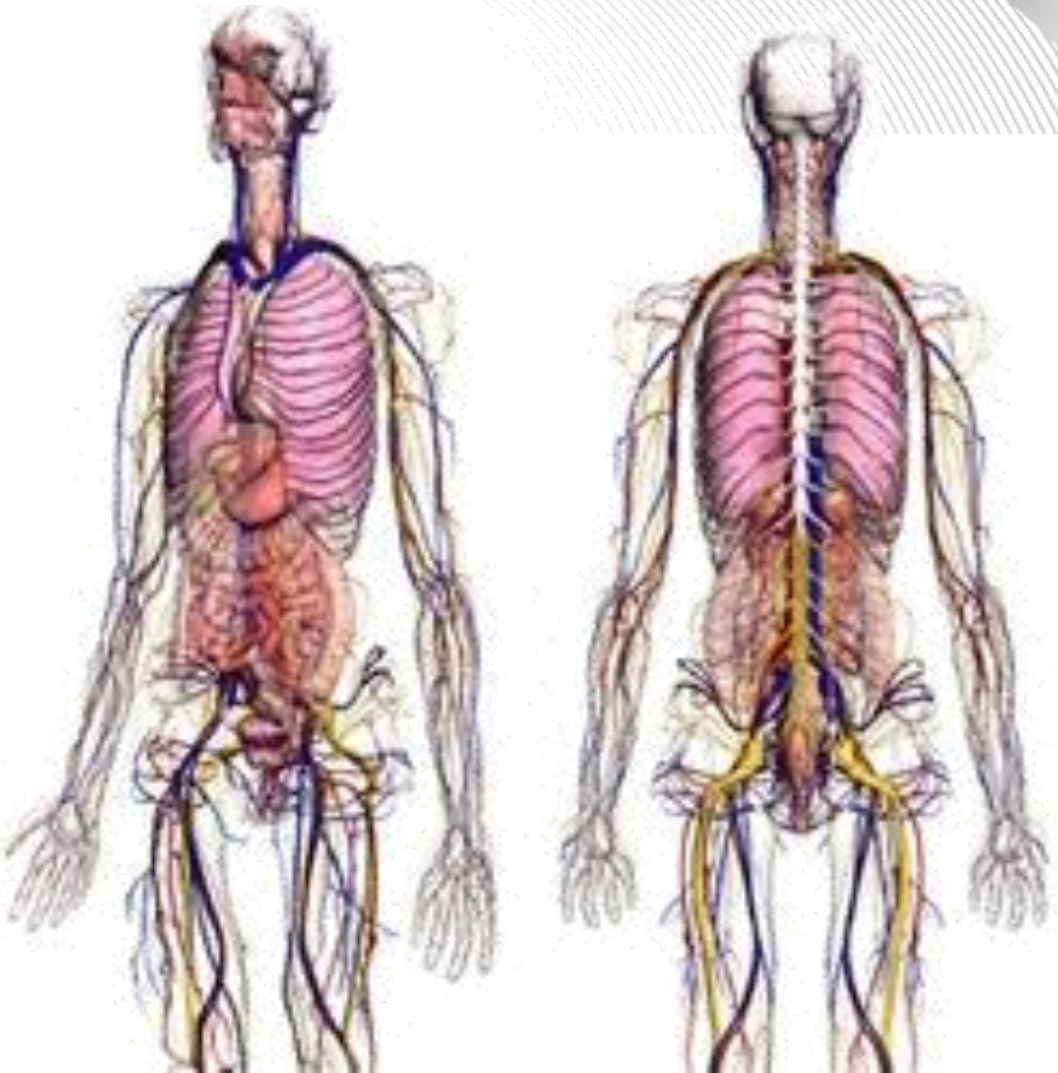
All vertebrates share the same basic body plan, with tissues and organs functioning in a similar manner. We focus on the human body, studying structure (**anatomy**) and function (**physiology**).



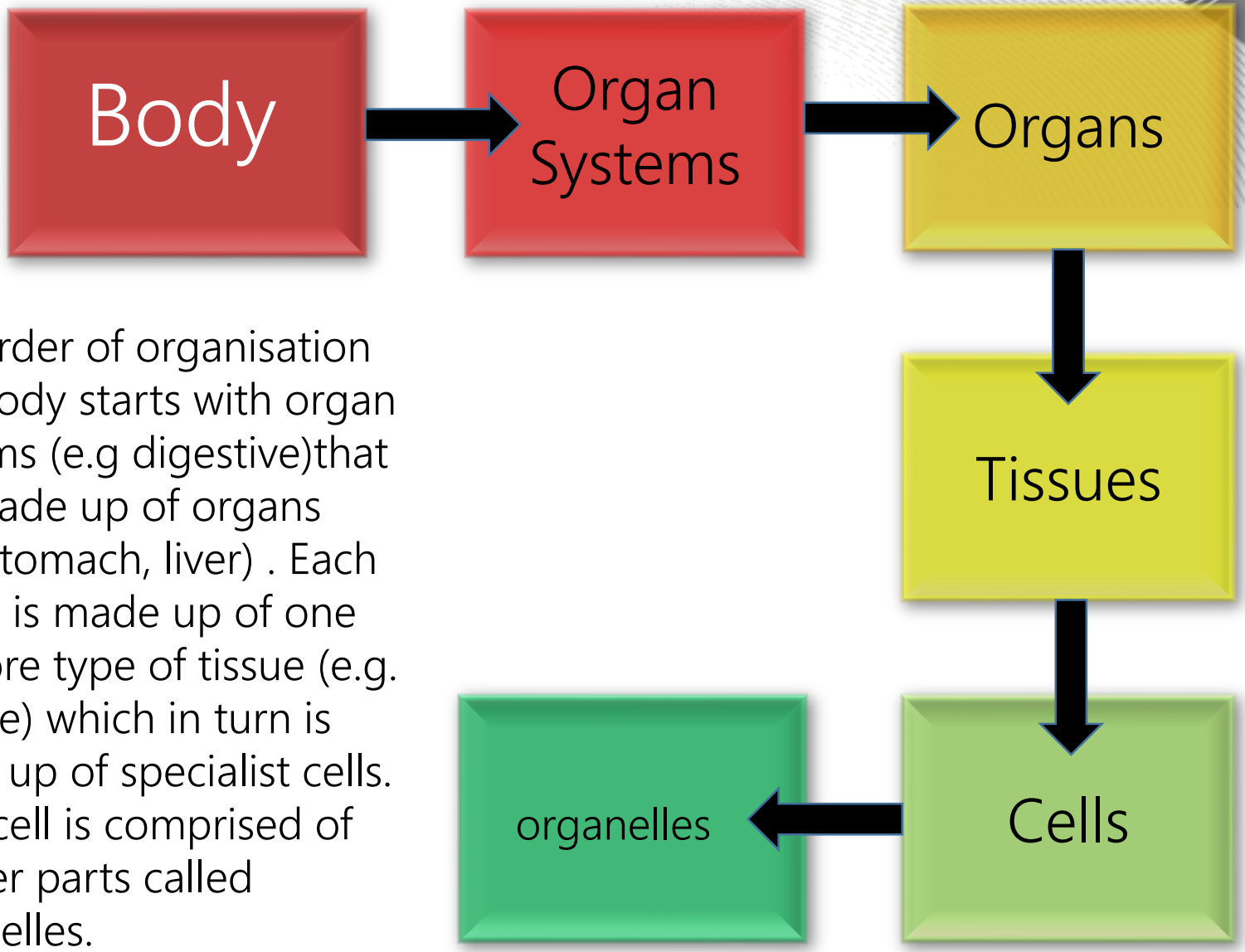
The body contains different organ systems

Different tissues functioning together for a common purpose are called **organs** (eg, stomach, kidney, lung, heart).

Organ systems are composed of individual organs working together to accomplish a coordinated activity. For example, the heart, veins and arteries all play a role in circulation.



Organisation in the human body



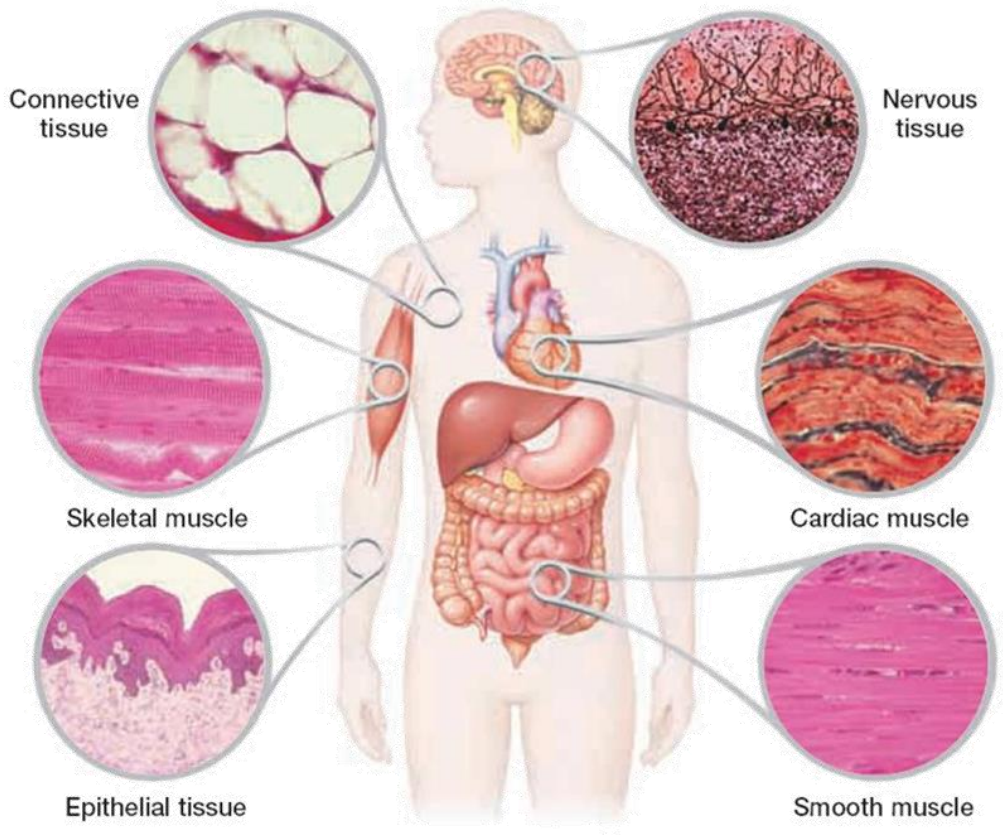
The order of organisation in a body starts with organ systems (e.g digestive)that are made up of organs (e.g. stomach, liver) . Each organ is made up of one or more type of tissue (e.g. muscle) which in turn is made up of specialist cells. Each cell is comprised of smaller parts called organelles.

The body is made up of cells

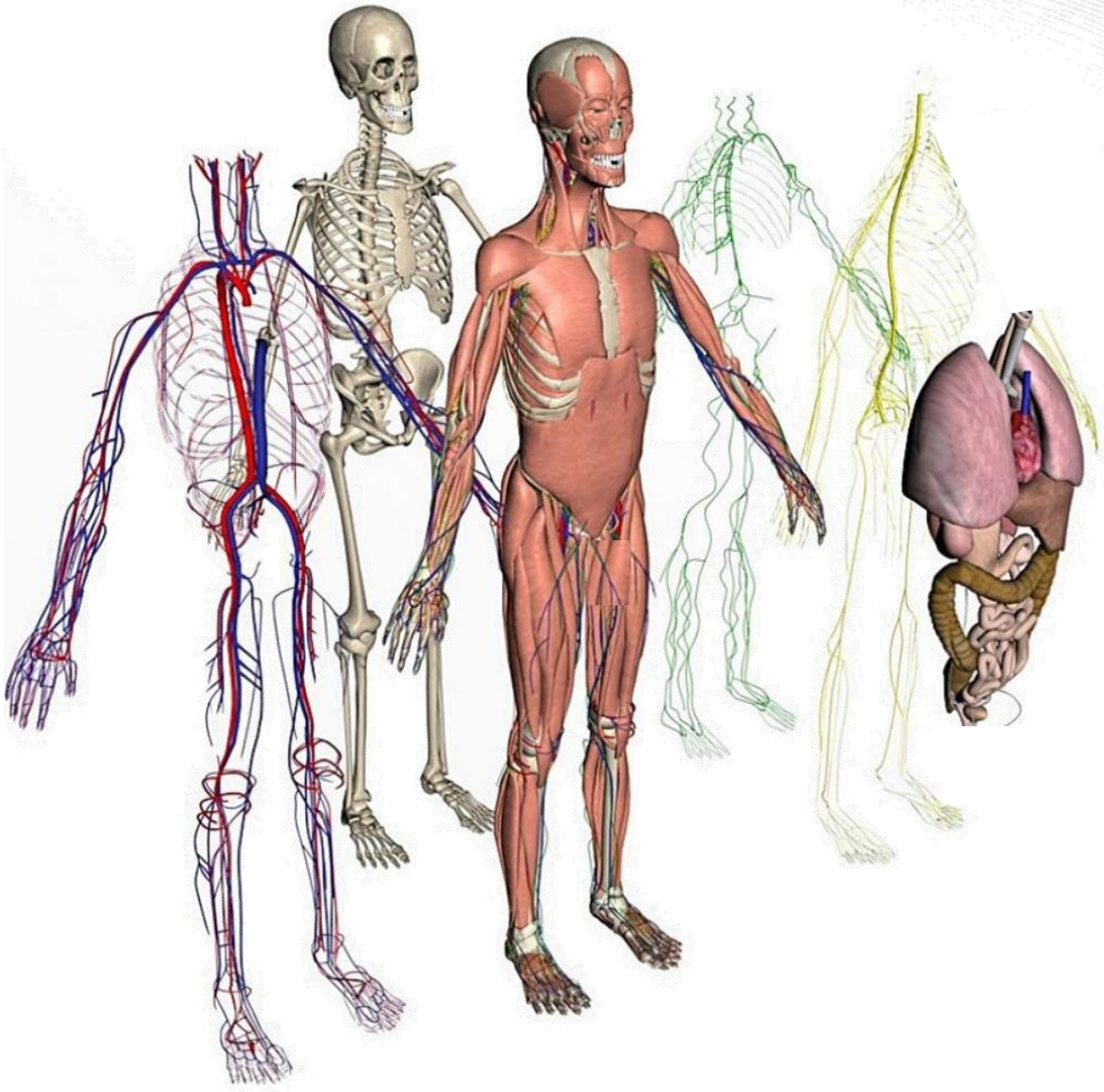
Extra for experts

Humans are made of complex **systems of cells**, which must be able to perform all of life's processes and work in a coordinated fashion to maintain **homeostasis** (a stable internal environment).

During a human's early development, groups of cells specialize into three fundamental embryonic layers. These embryonic layers **differentiate** into a number of specialised cells and tissues. Tissues are groups of cells similar in structure and function .

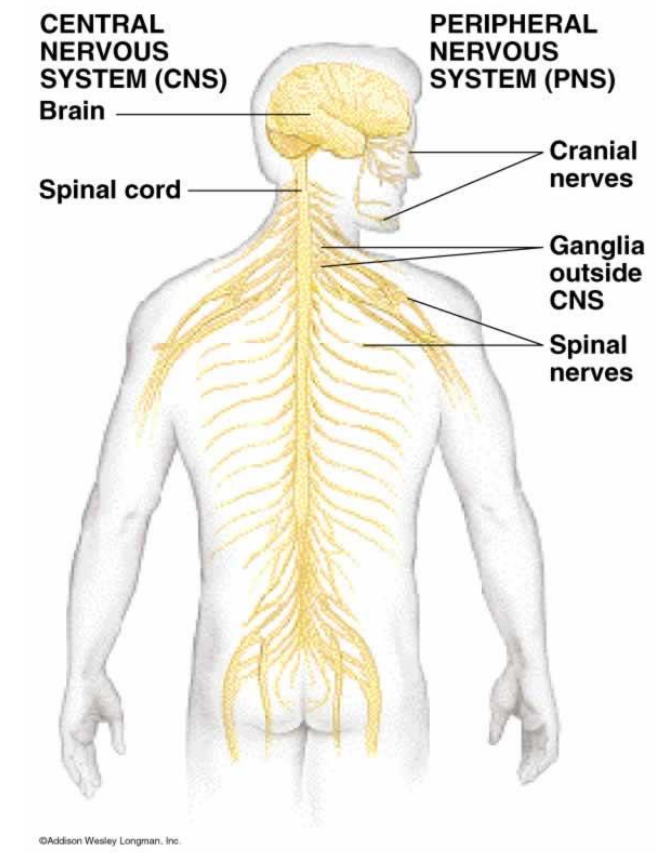


The Human Organ Systems



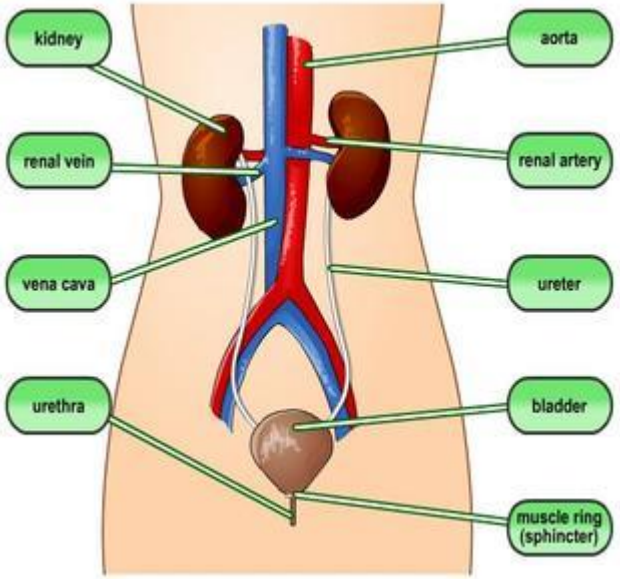
The Human Organ Systems that will be covered in detail in this unit include the **Cardiovascular** system: including the Heart and associated blood vessels, the **Muscular Skeletal** system: Including the skeleton, muscles of the arms and legs and supporting connective tissue, and the **Respiratory** system: including breathing, gas exchange and respiration.

Other Human Organ Systems

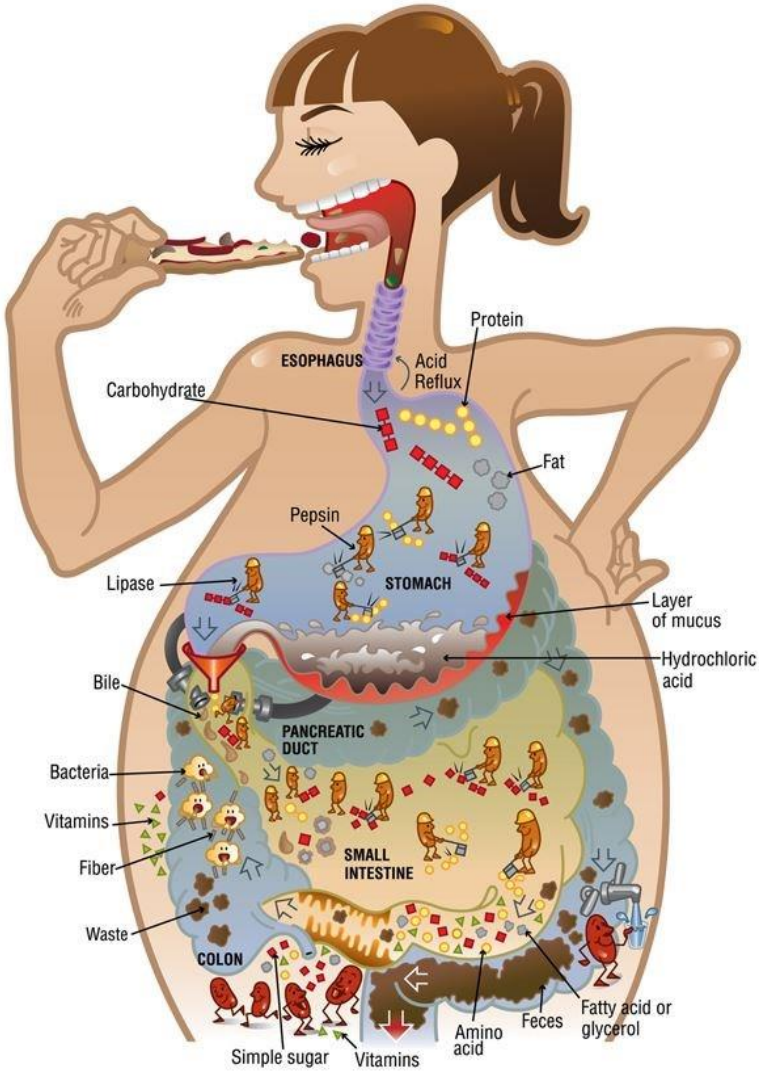


The **Nervous system** controls our body and sends messages from the brain to all parts of the body. It consists of the brain and connected nerves.

The **Excretory system** removes waste products from our bodies by filtering the blood through kidneys.



Other Human Organ Systems



The **digestive system** allows us to take in nutrients and water into the body to provide energy to our cells. Various parts of the food are digested (broken apart) and absorbed (taken into the blood) in different parts of the digestive system.

The body produces different enzymes and substances, such as acid, which break down all the components of the food.

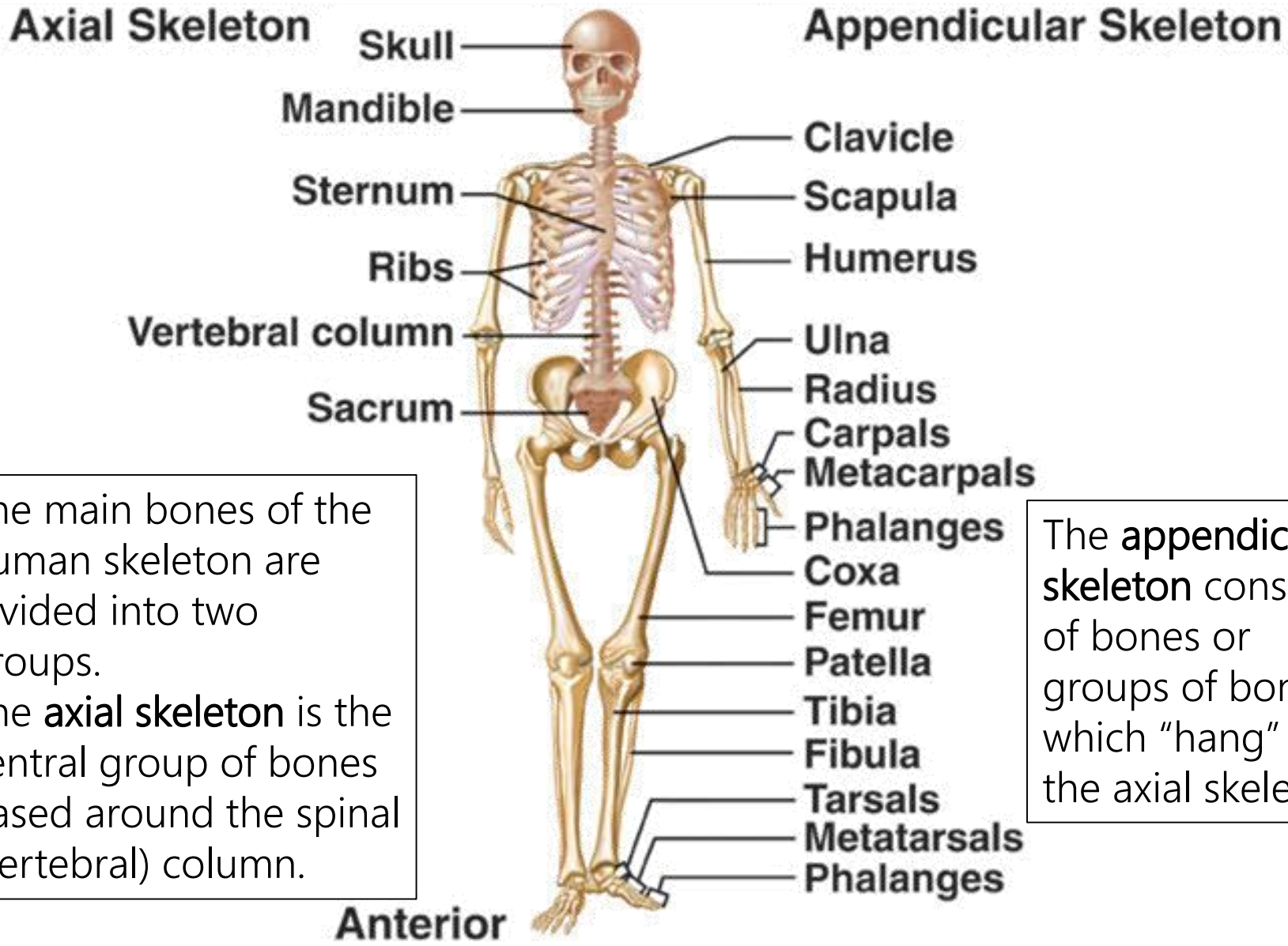
We also have numerous "helpful" bacteria which also help digest the food.

The Human skeletal system.

The human skeletal system is an **internal skeleton** that serves as a framework for the body. This framework consists of many individual **bones** and **cartilages**. This also includes **ligaments** and the **tendons** which hold bones to each other and to muscles that contract and cause the bones to move.
The adult human skeleton contains more than 200 bones.

The skeleton also provides **mechanical protection** for many of the body's internal organs, reducing risk of injury to them, **storage of minerals** and **production of blood cells**.

The main bones in the Human skeletal system.



The main bones of the human skeleton are divided into two groups.
The **axial skeleton** is the central group of bones based around the spinal (vertebral) column.

The **appendicular skeleton** consists of bones or groups of bones which "hang" off the axial skeleton.

The Human skeletal system.

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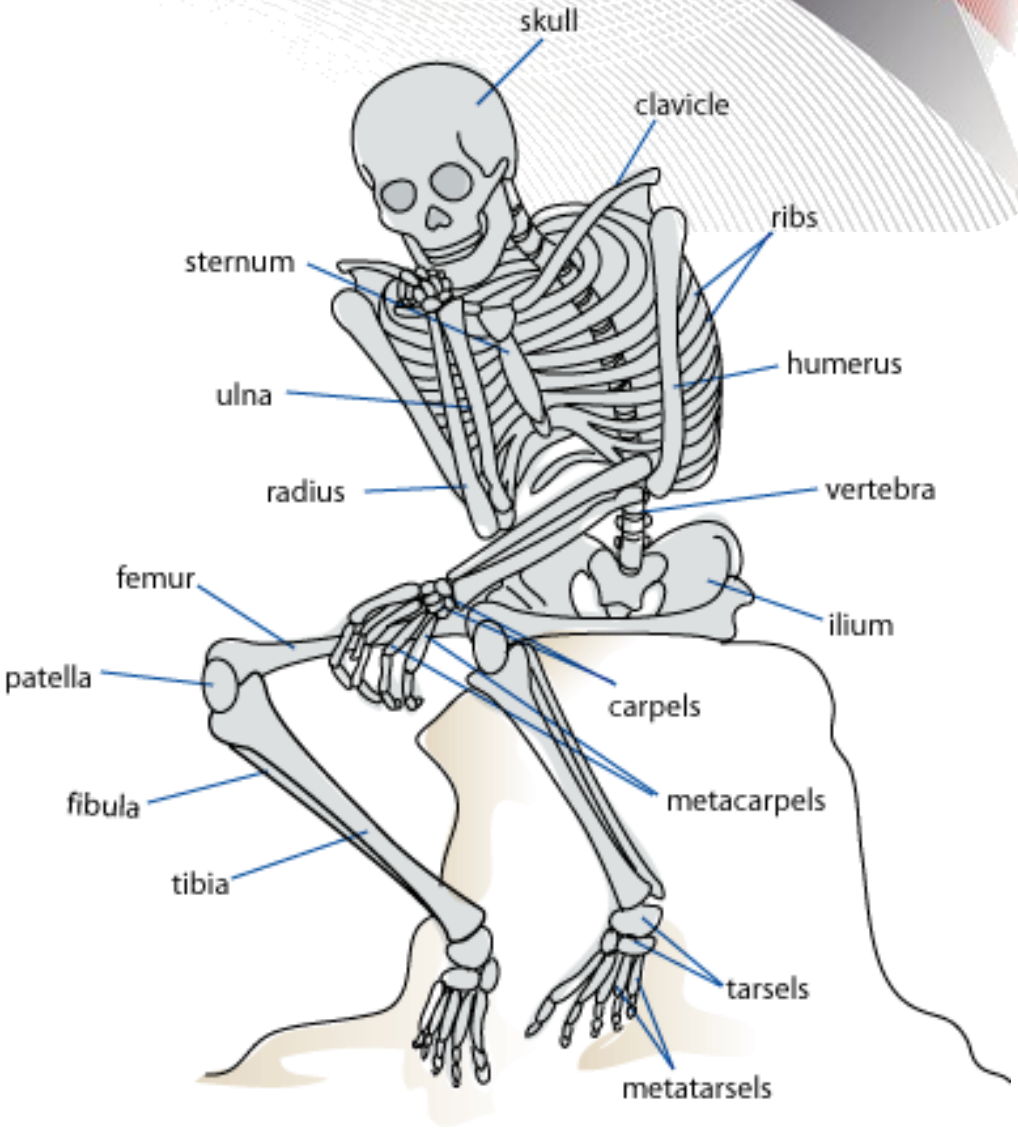
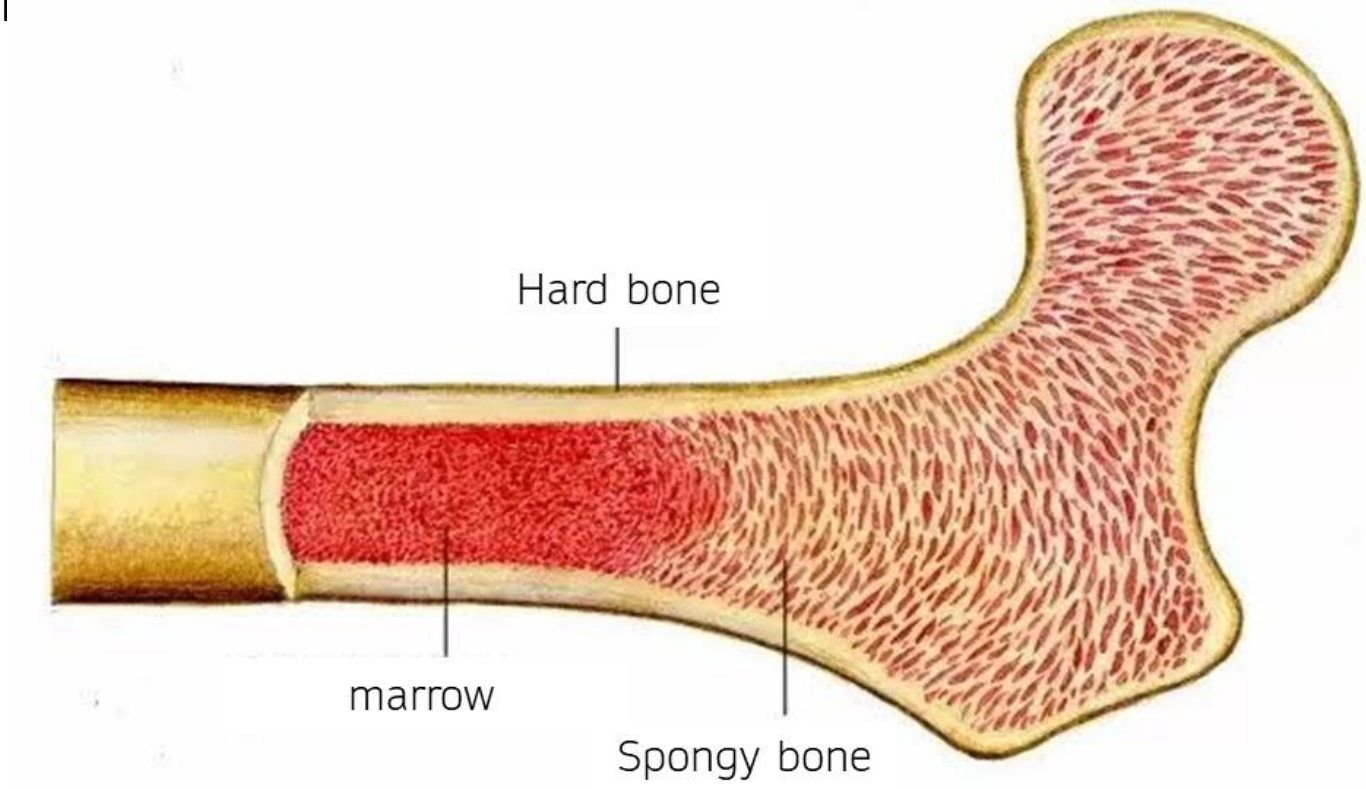
The main bones of the human skeleton are:
The **Skull**
Shoulder girdle - clavicle and scapula
Arm - humerus, radius and ulna
Hand - Carpals, Metacarpals and Phalanges
Chest - Sternum and Ribs
Spine - vertebrae, Sacrum (5 fused or stuck together bones) and Coccyx (the tiny bit at the bottom of the spine).
Pelvic girdle - Ilium, Pubis and Ischium.
Leg - Femur, Tibia and Fibula
Ankle - Talus and calcaneus
Foot - Tarsals, Metatarsals and Phalanges

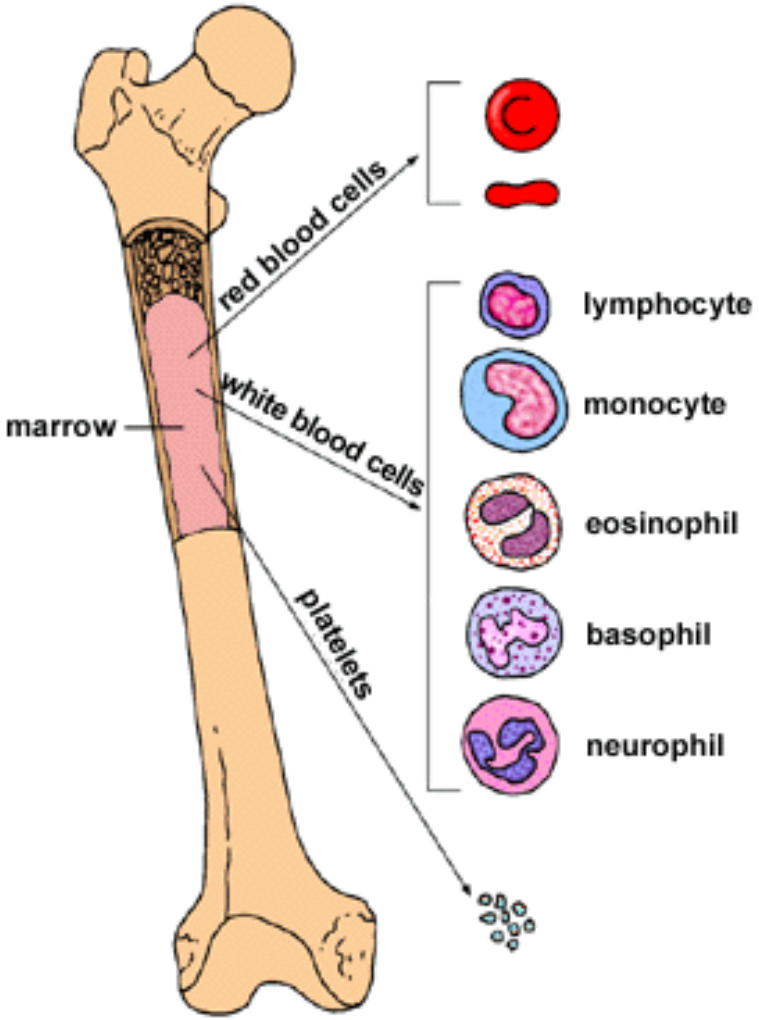


The structure and functions of Hard and Spongy Bone

The four main functions of bones are to - protect organs, store minerals Calcium and PO_4, produce blood, provide support and allow movement.
Hard (cortical) bone - on the end and sides aid strength, keeps the weight of bone to a minimum
Spongy bone – is a mesh of bone filaments, provided more internal strength



The structure and functions of Marrow



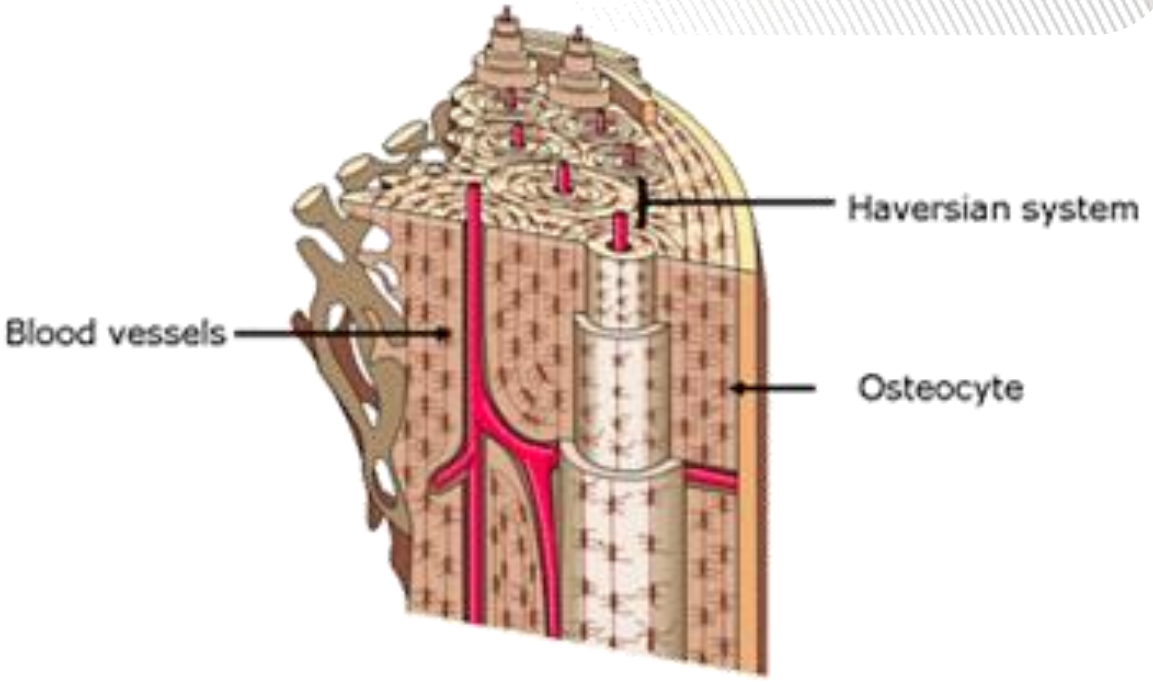
Marrow – in the middle of long bones produces red blood cells, white blood cells and platelets.
There are two types of bone marrow:
red marrow that is responsible for producing red blood cells, white blood cells and platelets
yellow marrow consisting mainly of fat cells
There are many blood vessels and capillaries woven through the marrow making it very vascular.
At birth and in early childhood most of the marrow is red. More and more of it is converted to the yellow type as a person ages. About half of adult bone marrow is red.

The structure and functions of Haversian canals

Extra for experts

GZ Science Resources

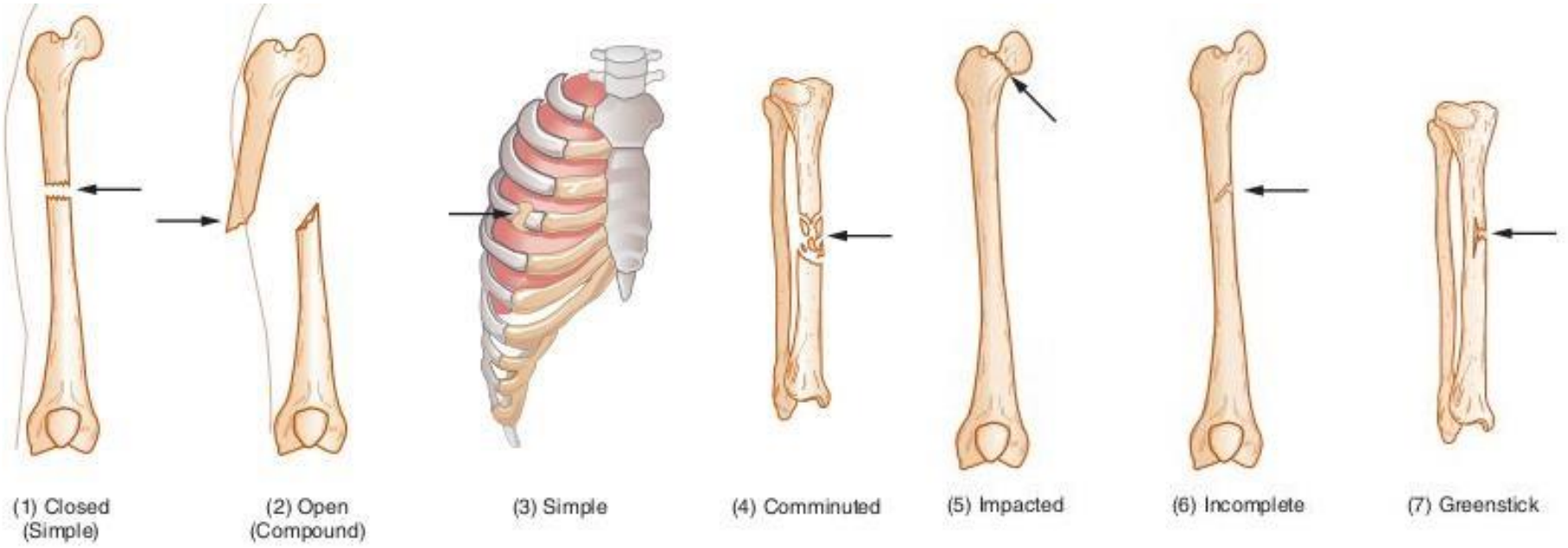
Haversian canals contain nerves/blood to provide nutrients to the cells. A haversian canal is a central canal within the haversian system— a network of canals inside compact bone. Haversian canals occur in the center of compact bone and contain blood vessels, connective tissues, nerve fibers and lymphatic vessels. Compact bone, surround these canals. Haversian systems run parallel to the long axis of bones. Each cylindrical unit within compact bone is an entire haversian system.



Fractured Bones

Extra for experts

Bones are very strong and designed to handle a fair amount of impact and weight. Occasionally when the force is sudden and strong such as in a car accident or falling the bones will fracture.
The type of fracture depends on how much damage is done, whether there is a crack (greenstick) or the bone is broken all the way through, as well as if it remains inside the body (closed)or breaks through the skin (open)



Ouch! How the body repairs Fractured Bones

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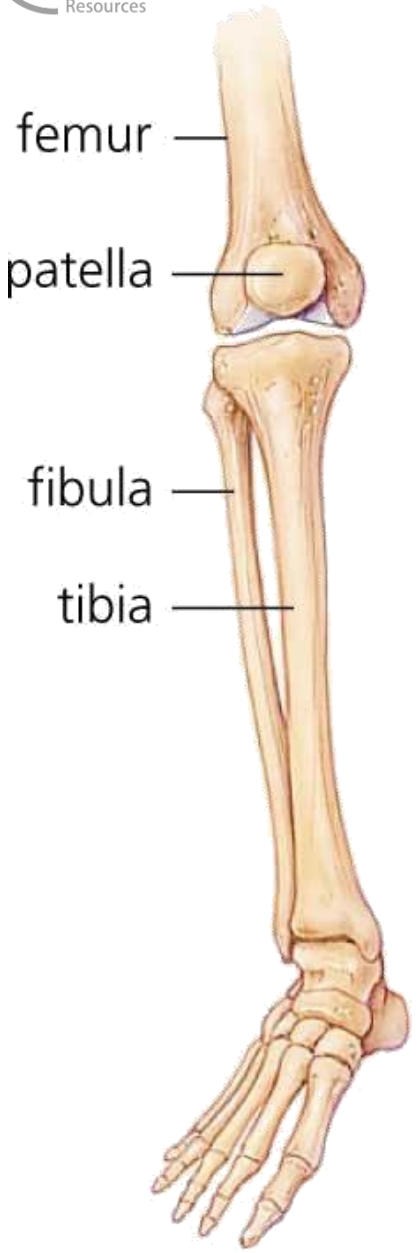
Extra for experts

Most of the time the part of the body surrounding a broken bone is put into a cast to keep it still and allow the body to heal and repair the bone. So how does the body do this?

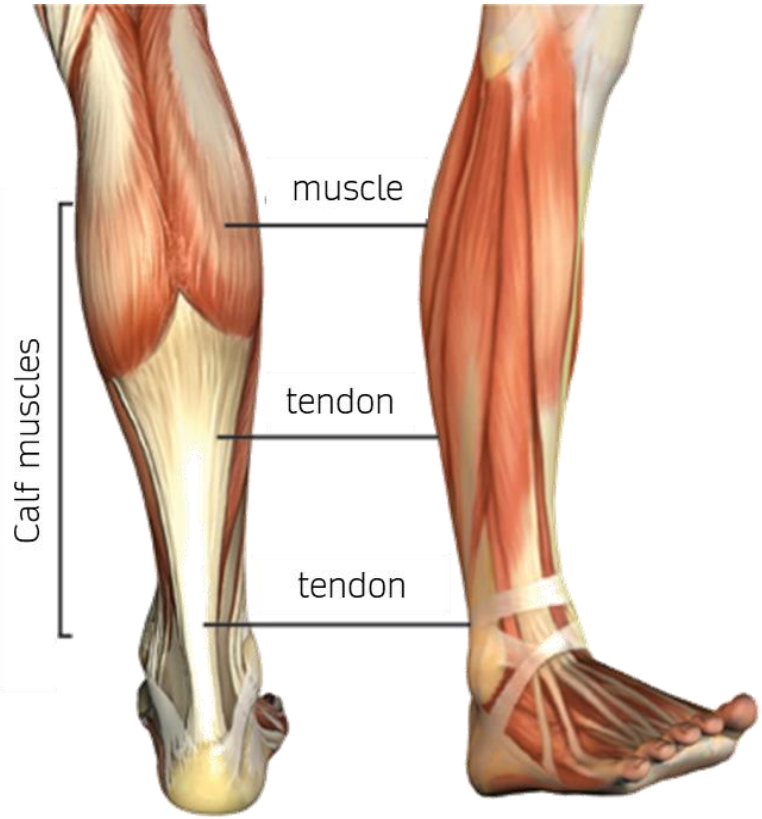
>Immediately after the injury is flooded with natural painkillers called endorphins, which temporarily block out pain.
>An injury then starts to swell because the body is sending extra oxygen and nutrients to the injury to begin the healing process.
>A large hematoma, which is a collection of blood, surrounds the break in the bone.
>Stem cells , which are responsible for making new cells, usually divide every one to two days. Now that there is an injury, they will divide every three minutes.
>Within four weeks the hematoma will harden around the break, making the injured area extra strong.
>Over the next several months, osteoclasts (bone cells) will "eat away" the hardened hematoma and the injury will be repaired.
>Within a year of the injury, the bone will be almost as strong as it was before the break

How muscles help our bones move

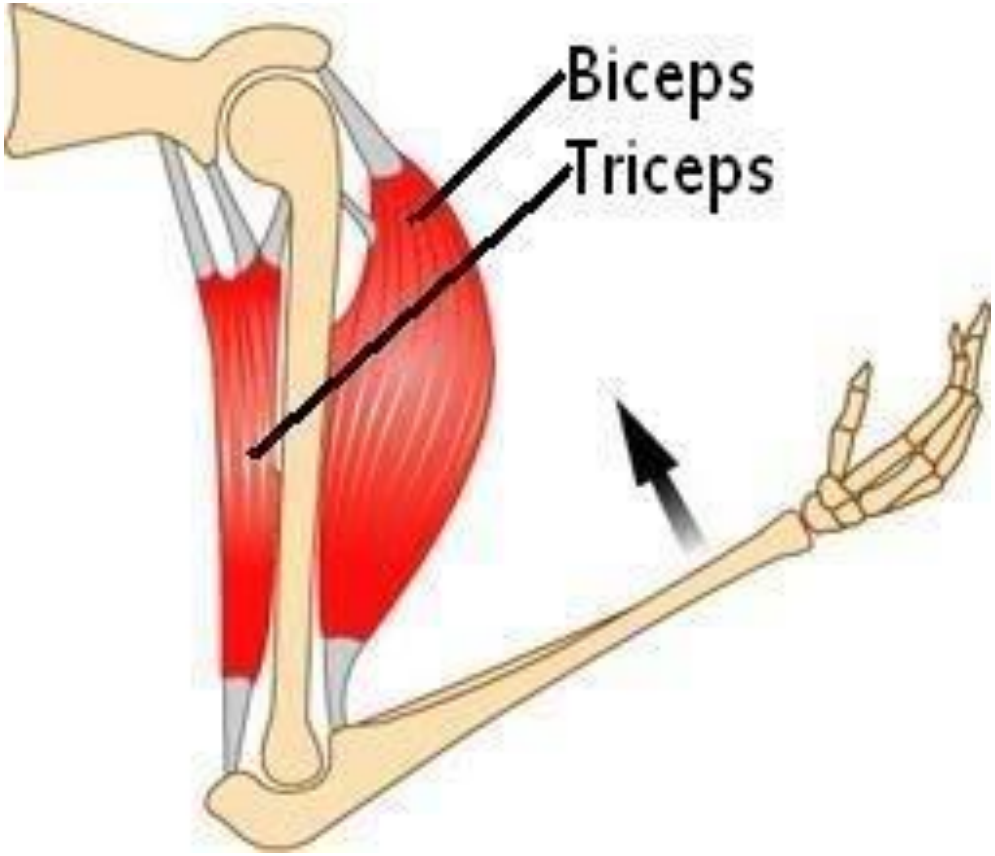


Bones in the body create a rigid frame that the muscles can pull against to provide movement. The thigh muscles attach across the knee joint etc.

The muscles are attached to the bones by **tendons**. Bones are held together with **ligaments**. When the muscles contract they shorten and move the bones at the **joints**. All of the bones in the skeleton require muscles in order to move them. The muscles are attached by the nervous system to the brain which controls their movement – either voluntary or automatically when required

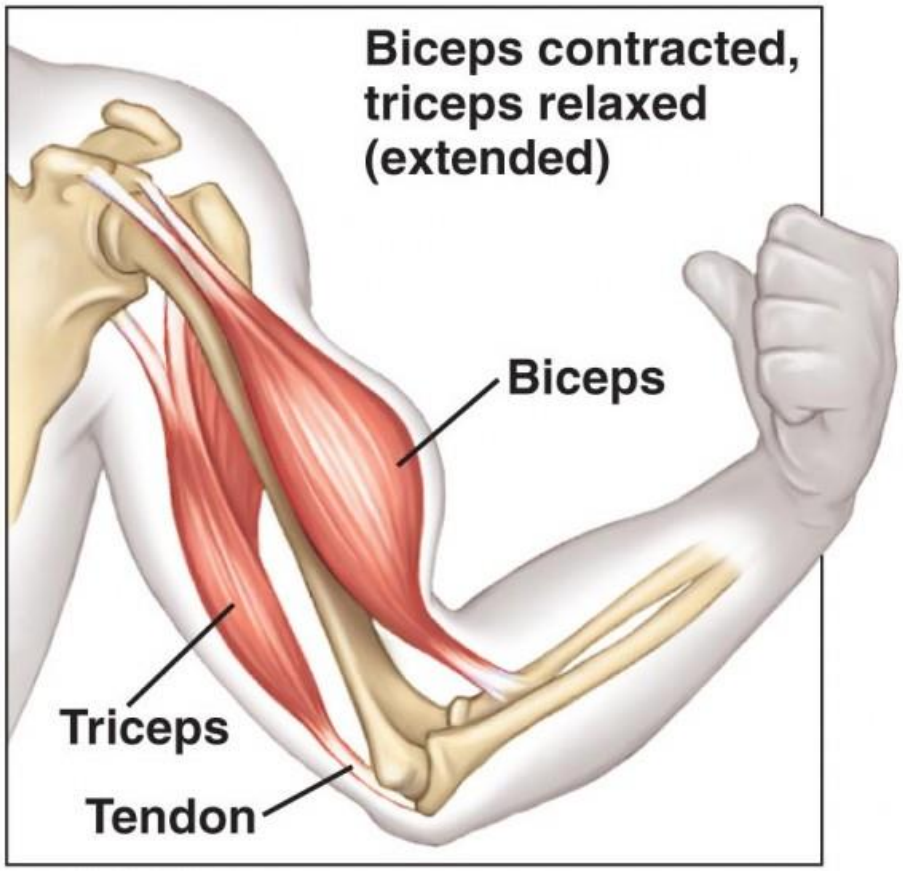


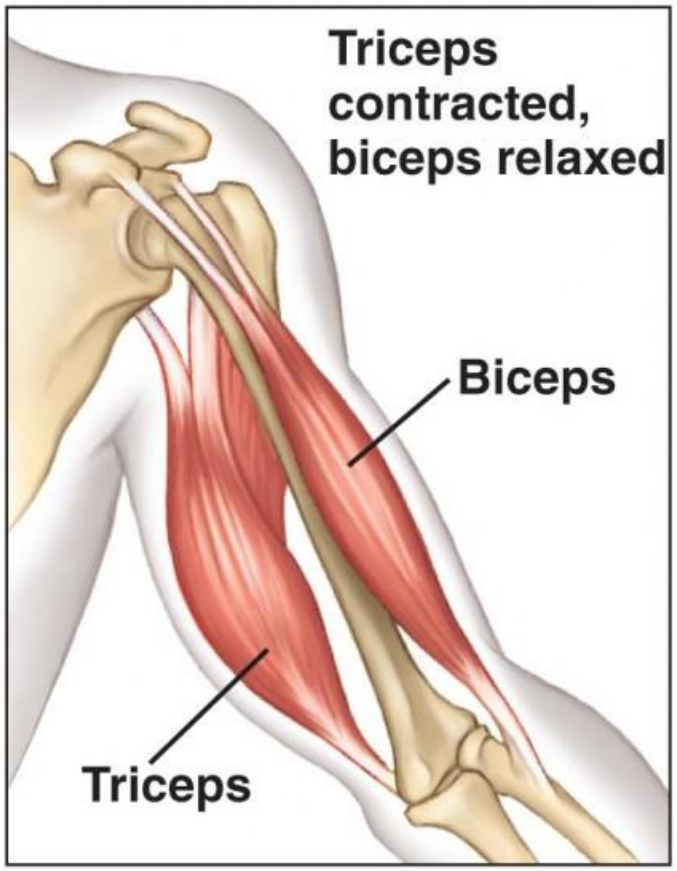
The structure of the skeleton and muscles of the human arm



Whenever a set of bones needs to move in both directions then a pair of muscles are required.
In the arm the pair of muscles are the **biceps muscle** and the **triceps muscle.**

The antagonistic muscles and bones act together to flex or extend the arm





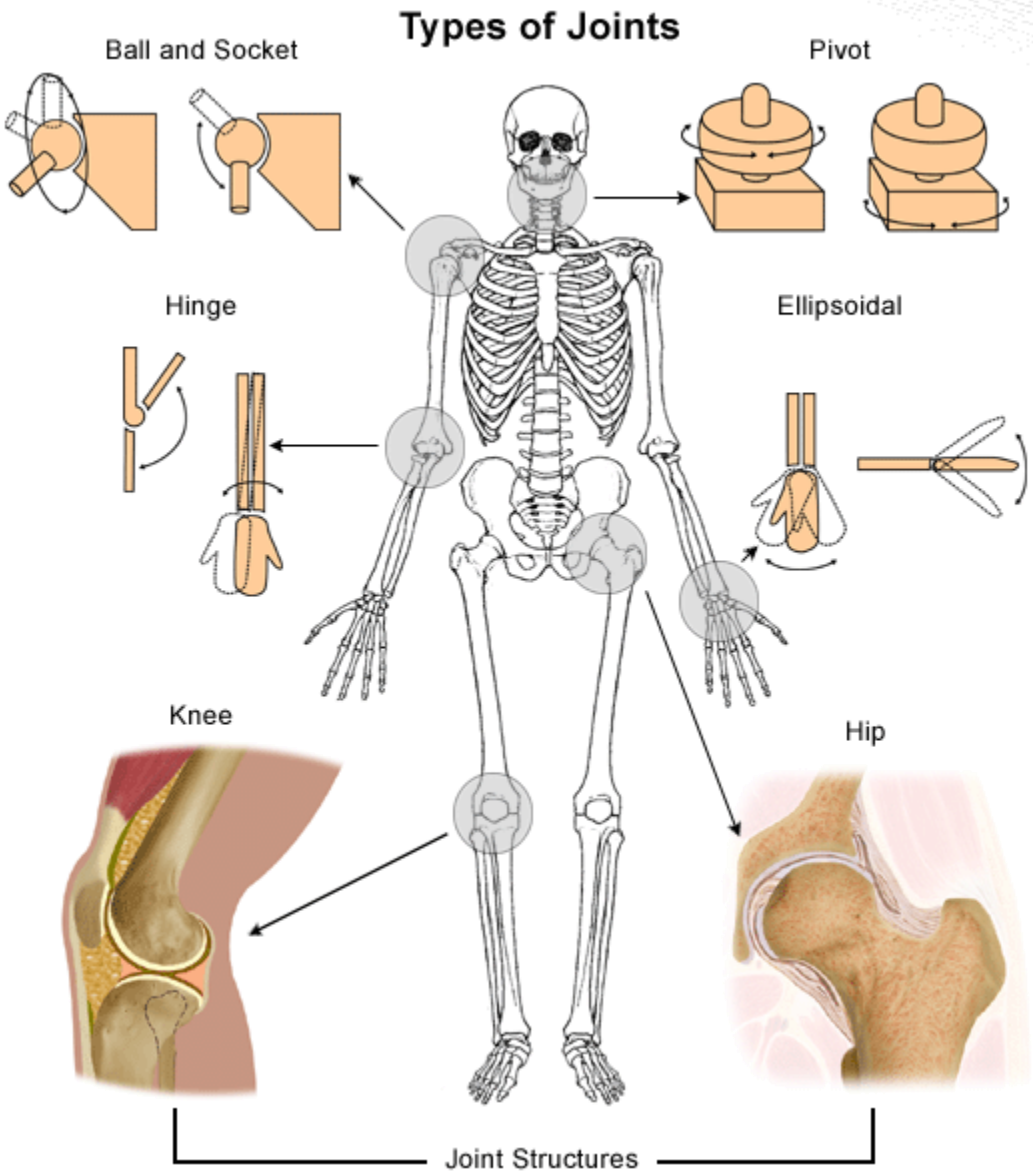
Muscles can contract, but are not designed to actively lengthen, so they are arranged as opposing **antagonistic pairs**. As one muscle shortens, another is stretched and vice versa. The contacting muscles move the bones they are attached to.

The antagonistic muscles and bones act together to flex or extend the legs

The main muscle group that lifts the legs to walk and run are known as the **quadriceps**. As they contract the leg is lifted up.

The **hamstring muscles** at the back of the leg form part of the antagonistic pair with the quads. When they contract the leg moves backwards completing the walking motion.

A joint occurs where two bones meet .



Movement of the skeleton occurs at the joints where two or more bones meet. There are different categories of joints. Freely movable, or synovial, joints allow a range of movement determined by the structure of the joint. Examples of movable joints are the **ball and socket** (shoulder), **hinge** (elbow), **pivot** (between the skull and neck) and **ellipsoidal** joint (hand and arm). **Ligaments** are inelastic connective tissues which hold bones together in a joint.

Other types of joint

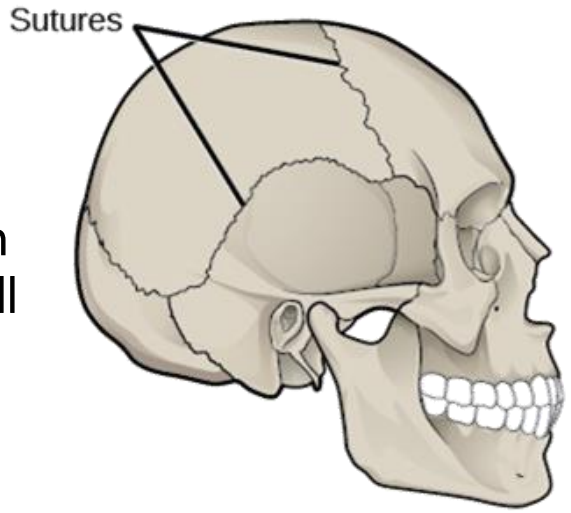
Extra for experts

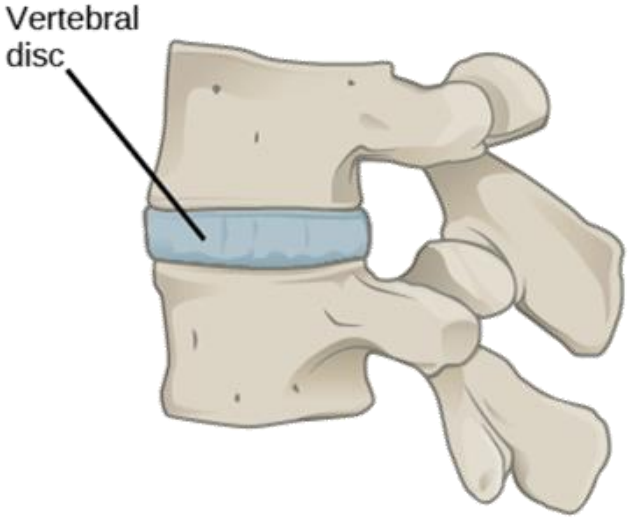
The two other groups of joints include the non-movable **Fibrous joints** and the moveable **Cartilaginous joints**.

Fibrous joints are fixed in which no movement between the bones is possible. These joints do not allow movement because the bones are held firmly together by bundles of strong collagen fibres. Fibrous joints include the sutures of the skull bones and the peg and socket joints of the teeth in the jaw bone.

Cartilaginous joints allow only slight movement. Often a pad of cartilage unites the two bones. An example of this is the joints between vertebral bones in the spine with cartilage discs between.

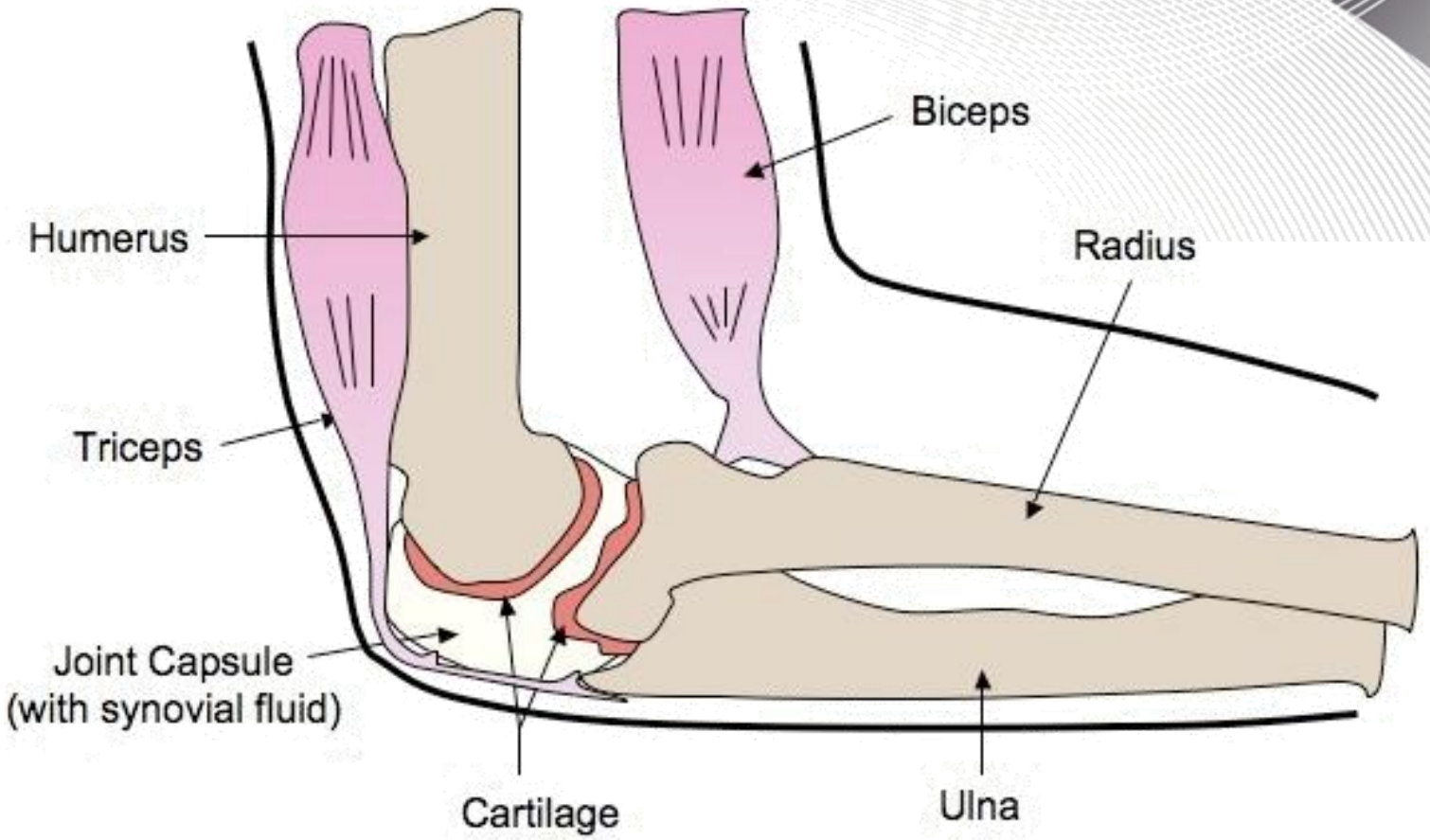
Fibrous joints in the skull





Cartilaginous joints in the vertebra

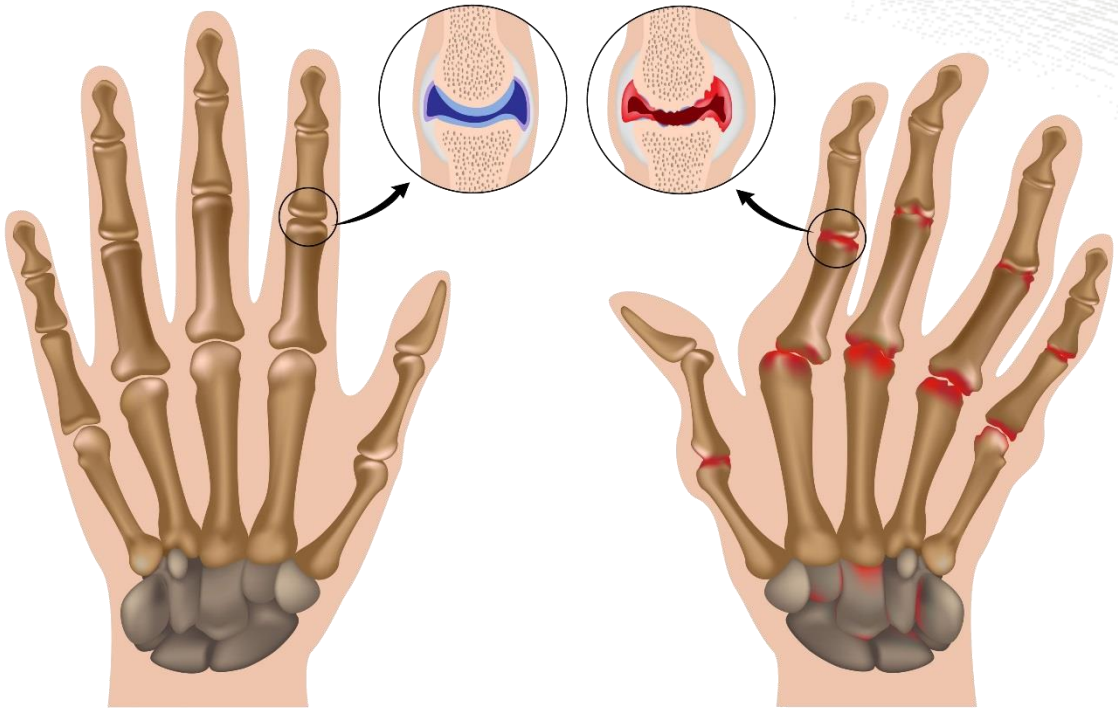
The synovial joint



Cartilage is a tough, rubbery surface that allows movement between bones, replaced by wear, it lubricates the joint under pressure. The joint capsule is filled with a fluid to assist free movement of the joint. Ligaments hold the bones together and tendons hold the muscles to the bone.

Rheumatoid Arthritis – A case study

Extra for experts



Normal

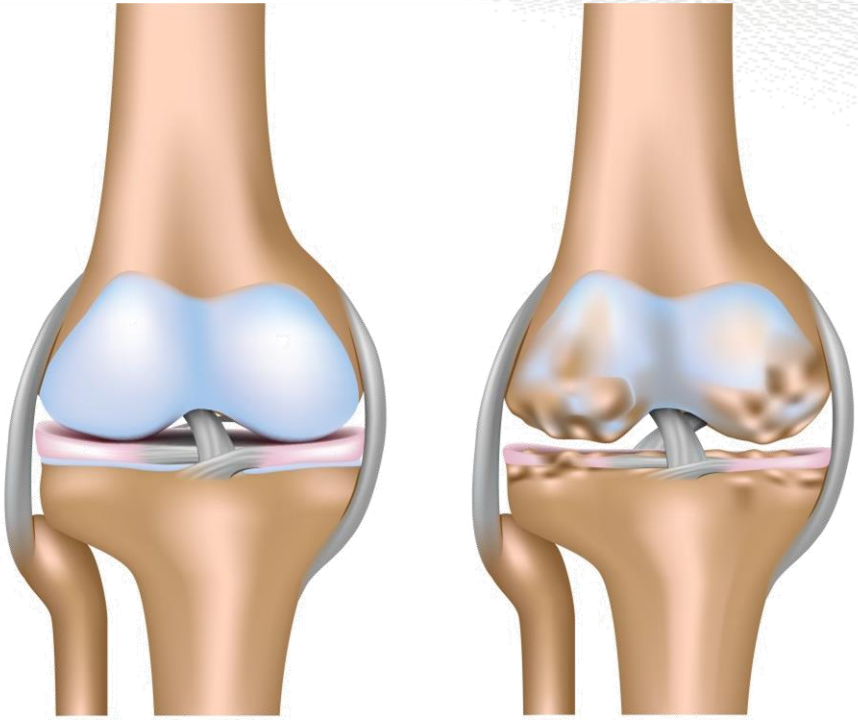
Rheumatoid Arthritis

Arthritis is inflammation of the joints (the points where bones meet) in one or more areas of the body.
There are many different types of arthritis including Rheumatoid arthritis.

Rheumatoid arthritis is a disease of the immune system, which normally protects us from infection by attacking viruses and bacteria. RA causes the immune system to mistakenly attack healthy cells such as the thin membrane that lines the joints. This causes fluid to build up in the joints, causing pain and inflammation. Over time this can wear away the cartilage and erode bone, causing a lack of function and mobility

Osteoarthritis – A case study

Extra for experts



Healthy knee joint

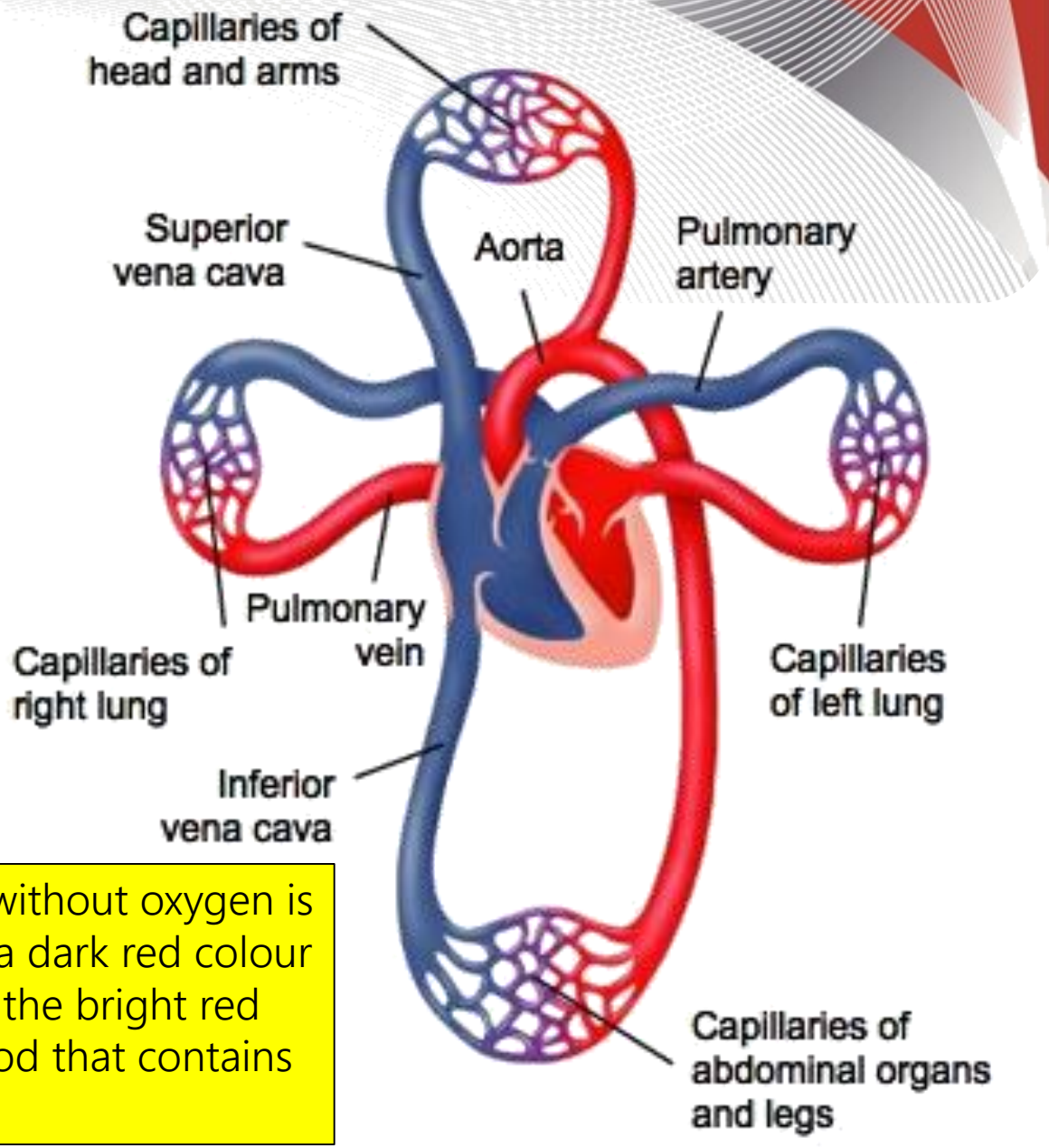
Osteoarthritis

Osteoarthritis is the most common form of arthritis and is most common in people over the age of 65.

Osteoarthritis is a disease where there is a breakdown in the cartilage covering the ends of bones where they meet to form a joint and allow movement. As the cartilage wears away, the bones become exposed and rub against each other. The break down of cartilage also affects the shape and makeup of the joint so that it no longer functions smoothly.

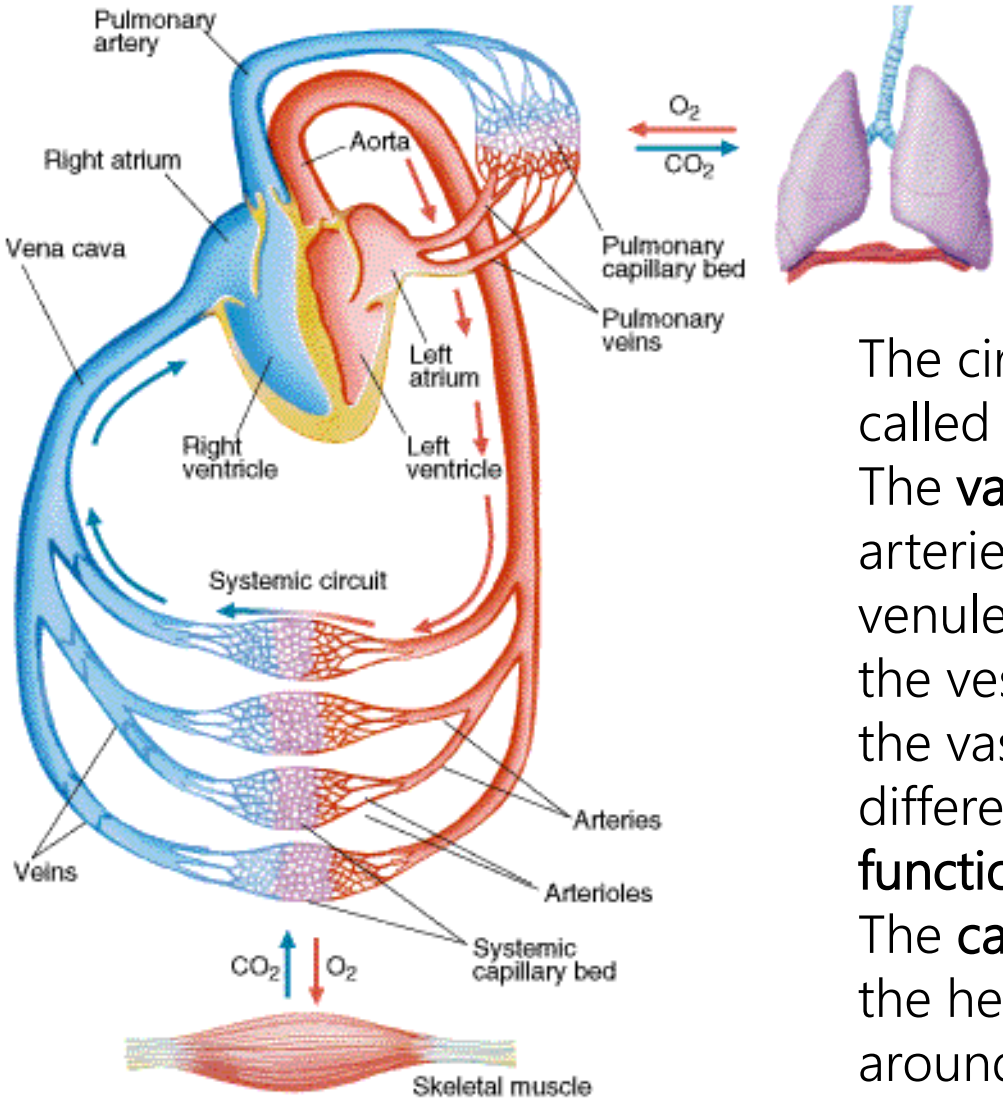
The circulatory system

The **structure** of the circulatory system consists of blood, blood vessels and the heart. The **function** of the circulatory system is to be the body's transportation system, moving oxygen, carbon dioxide, nutrients, wastes, hormones, vitamins, minerals and water throughout the body. It also aids in regulation of temperature.



Note: blood without oxygen is not blue but a dark red colour compared to the bright red colour of blood that contains oxygen

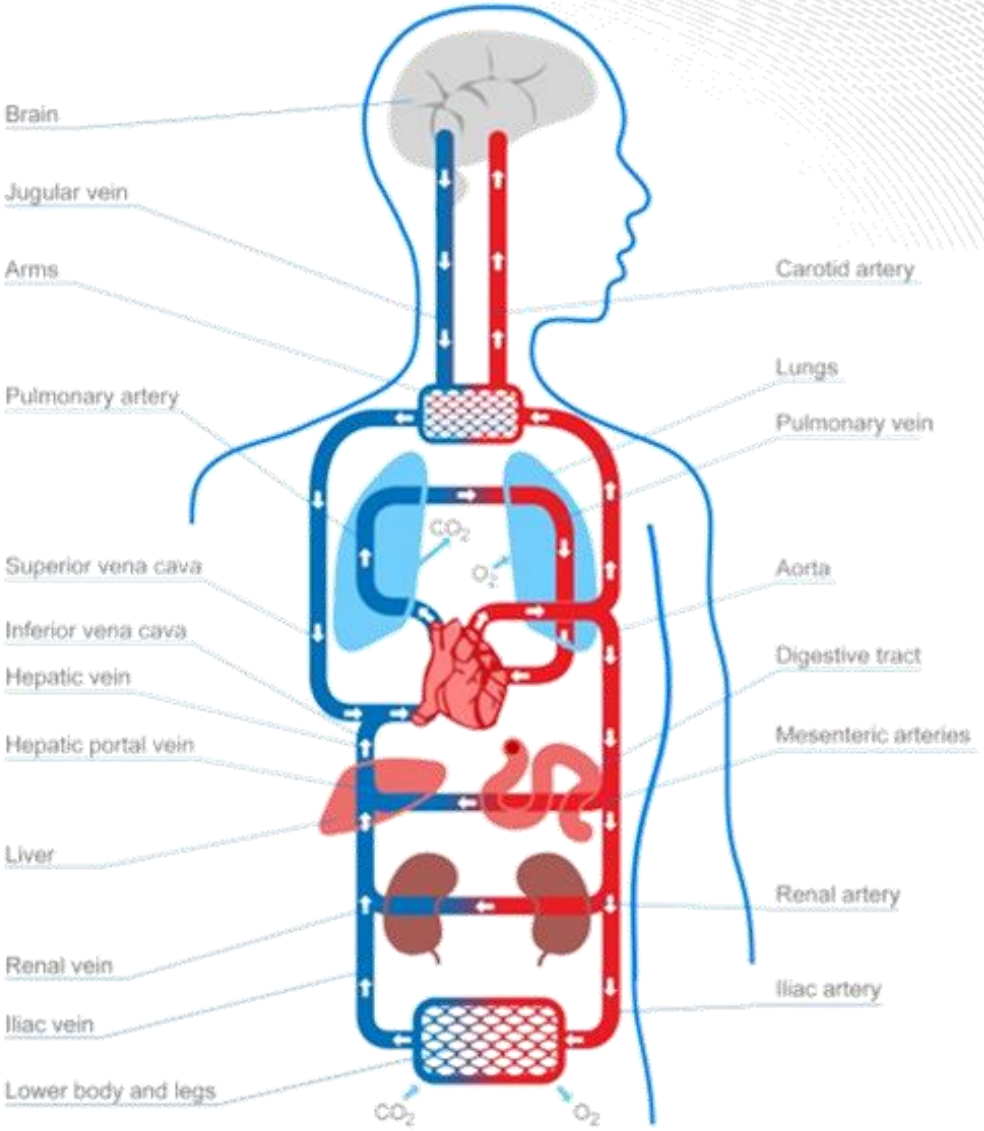
The cardio vascular structures



The circulatory system is sometimes called the cardio vascular system. The **vascular** system is composed of arteries, arterioles, capillaries, venules and veins. The **structure** of the vessels in the different parts of the vascular system varies and the differences relate directly to the **function** of each type of vessel. The **cardio** system is composed of the heart that pumps the blood around the body.

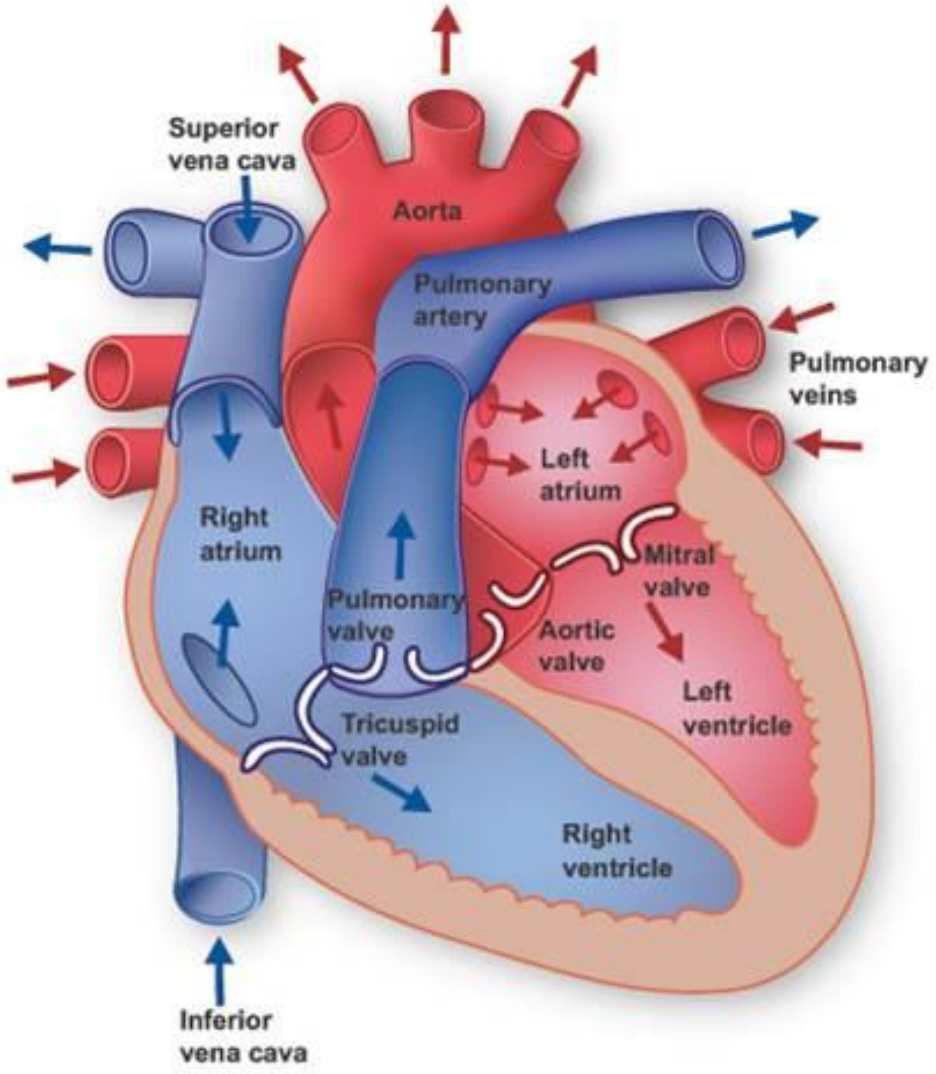
Components of the circulatory system

The circulatory system connects to many other systems and transports vital chemicals around the body required for life.
The respiratory system provides oxygen to the blood to move around the body and removes carbon dioxide.
The blood filters through the excretory system to remove waste products from the body.



The digestive system provides a way for energy from food to be supplied to every cell via the circulatory system.
The heart in the circulatory system is a muscular pump to keep everything moving around a circulatory system.

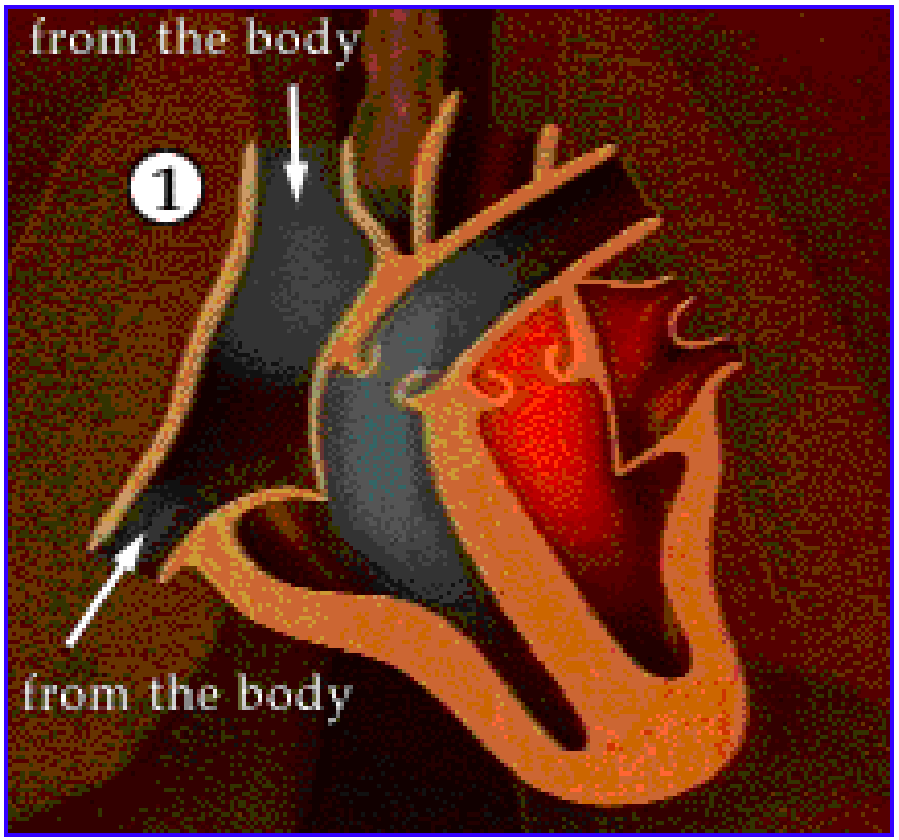
The external and internal structure of the mammalian heart and its function.



The Human has a four chambered heart with full division between the ventricles. This means there is no mixing of the oxygenated and deoxygenated blood. It contains valves, and heart beat is controlled by the nervous system pacemaker.

Note: blood without oxygen is not blue but a dark red colour compared to the bright red colour of blood that contains oxygen

The external and internal structure of the mammalian heart and its function.



The function of the Circulatory system must:

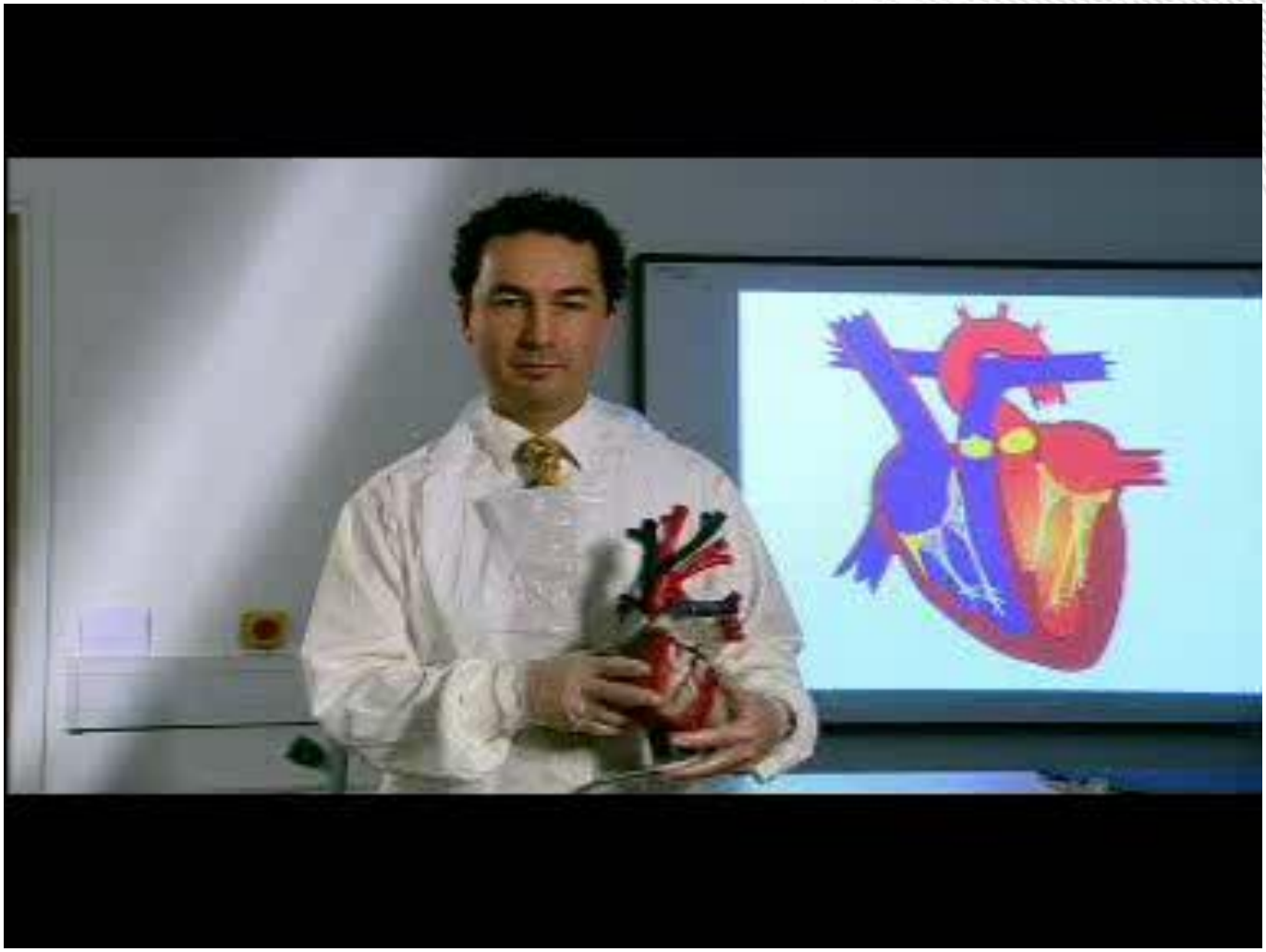
>ensure delivery of blood to all tissues

>adapt so that blood flow can be controlled and changed to individual tissues or the body as a whole

>convert a pulsating blood flow in the arteries into a steady flow in the capillaries to allow optimum **diffusion** to and from the cells

>return blood to the heart

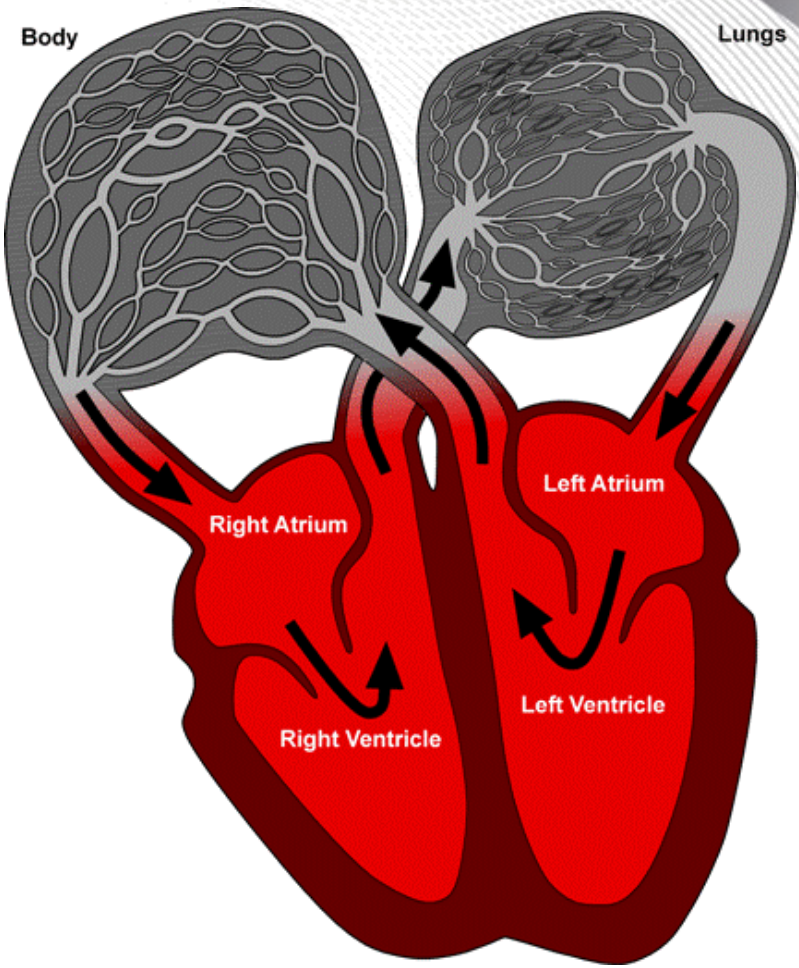
The external and internal structure of the mammalian heart and its function.



Flow of blood through the heart

Blood enters the heart into the atrium and then is pumped into the ventricle and out of the heart. The valves between atrium and ventricle prevent the blood from flowing backwards. The left side of the heart is more muscular than the right hand side as it needs to pump oxygenated (rich with oxygen) blood to the entire body.

The de-oxygenated (with most of the oxygen used by the body) blood returns to the right hand side through the atrium and ventricle, then out to the lungs to have the carbon dioxide removed and more oxygen added back to the blood.



Arteries carry blood away from the heart, veins carry blood towards the heart.

Circulatory system

A **Deoxygenated blood** enters the right atrium of the heart via the vena cava.

B **Deoxygenated blood** is pumped from the right ventricle, via the pulmonary artery, to the lungs.

C In the **lungs**, blood picks up oxygen and gets rid of carbon dioxide.

D **Oxygenated blood** travels back to the heart in the pulmonary vein.

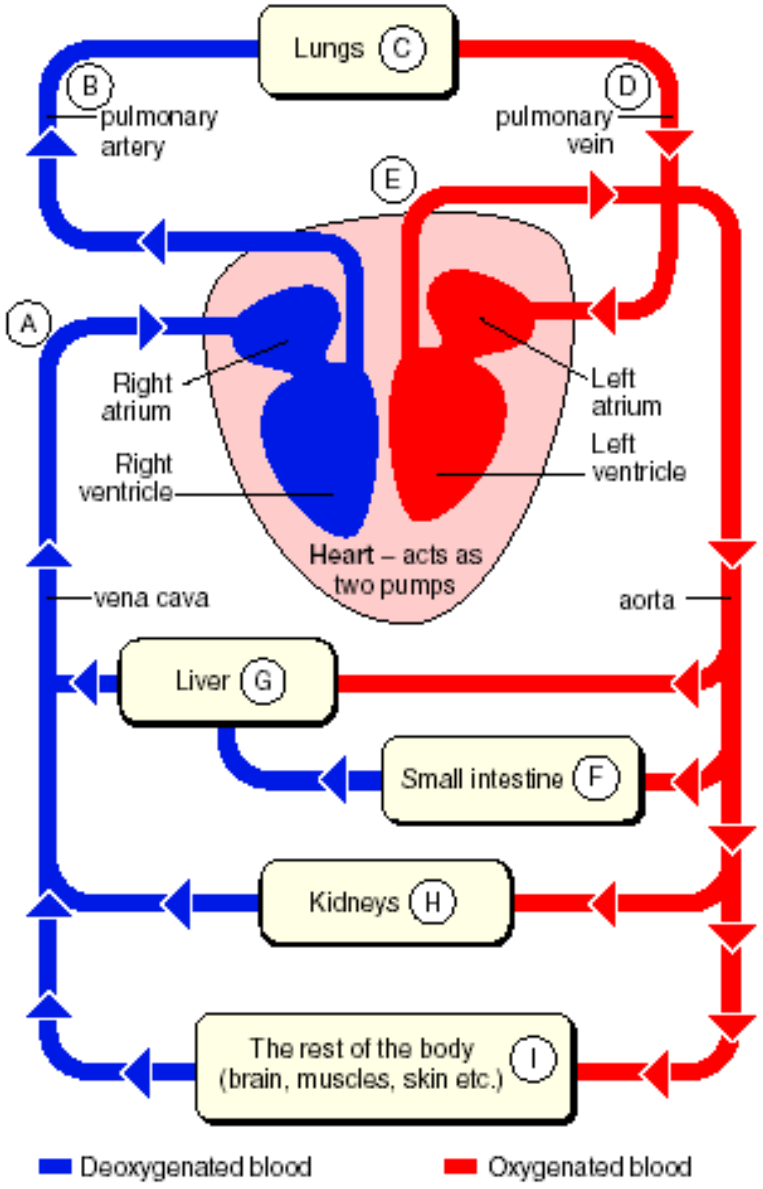
E **Oxygenated blood** is pumped to vital organs and the whole body from the left ventricle, via the aorta.

F Digested food is absorbed by blood through the walls of the **small intestine**.

G Digested food is processed and stored in the **liver**.

H Waste products (urea, water, salts etc.) are removed from the blood in the **kidneys**.

I Blood supplies the **rest of the body** with food and oxygen. It carries away waste products.



The heart is a pump with two circuits

Arteries carry blood away from the heart, veins carry blood towards the heart.

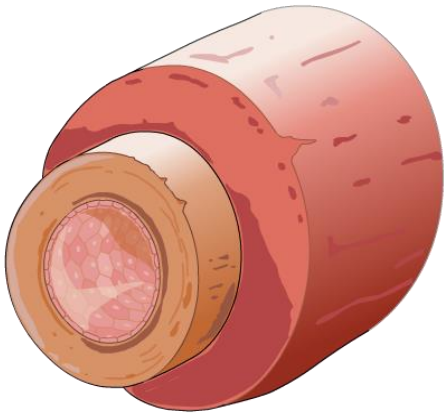
There are three main types of blood vessels:

>arteries, which carry blood away from the heart at relatively high pressure.

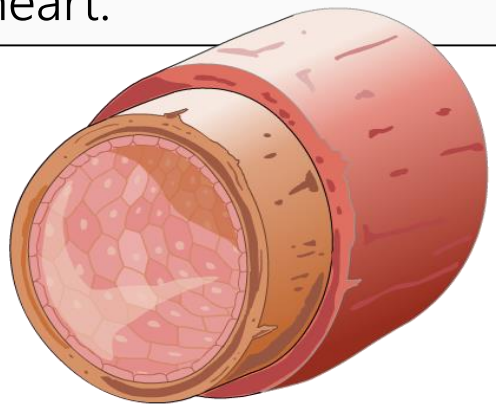
>veins, which carry blood back to the heart at relatively low pressure.

>capillaries which provide the link between the arterial and venous blood vessels

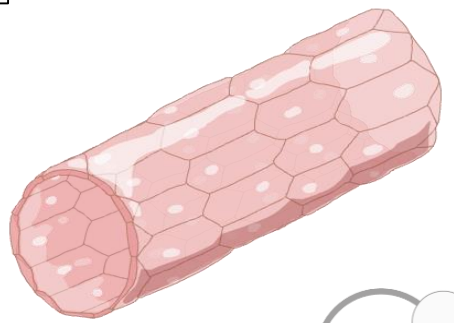
Arteries have thick muscular and elastic walls to accommodate the high blood pressure of the blood leaving the heart.



Veins have thinner, non-muscular walls to accommodate the lower blood pressure of the blood returning to the heart.

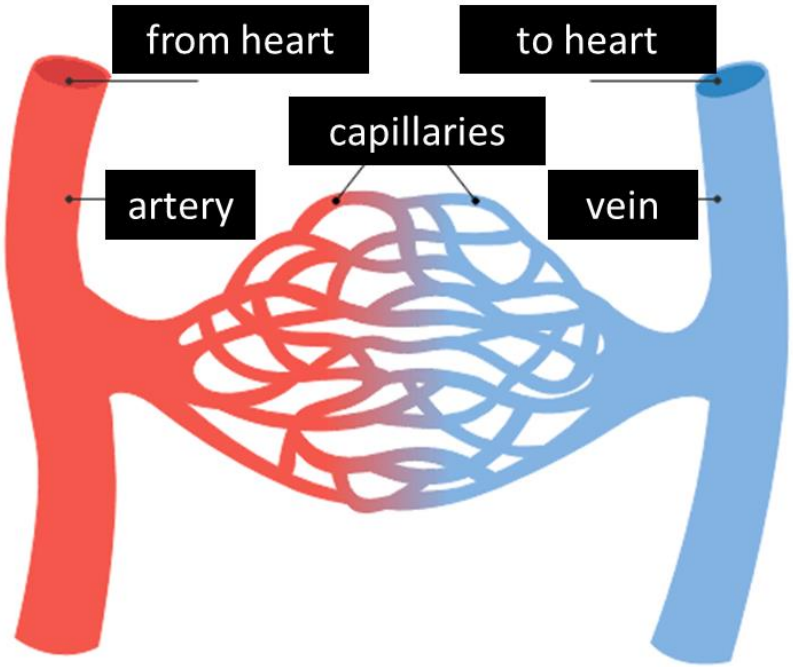


Capillaries are only one cell thick.



Capillaries link arteries with veins and are the sites of exchange with the tissues.

Arteries divide into smaller arterioles around targeted tissues. The arterioles divide once more into smaller capillaries which are only one cell thick. Nutrients and O_2 diffuse across the membranes of the capillaries from the blood to the cell supplied – from high to low concentration. Waste products, such as CO_2, will diffuse from the cell into the capillary near the venule end. The venules re-join into veins and waste product contained within the blood will be pumped back to the heart.



Arteries carry blood away from the heart, veins carry blood towards the heart.

The Arteries and veins have different structures because they have different functions

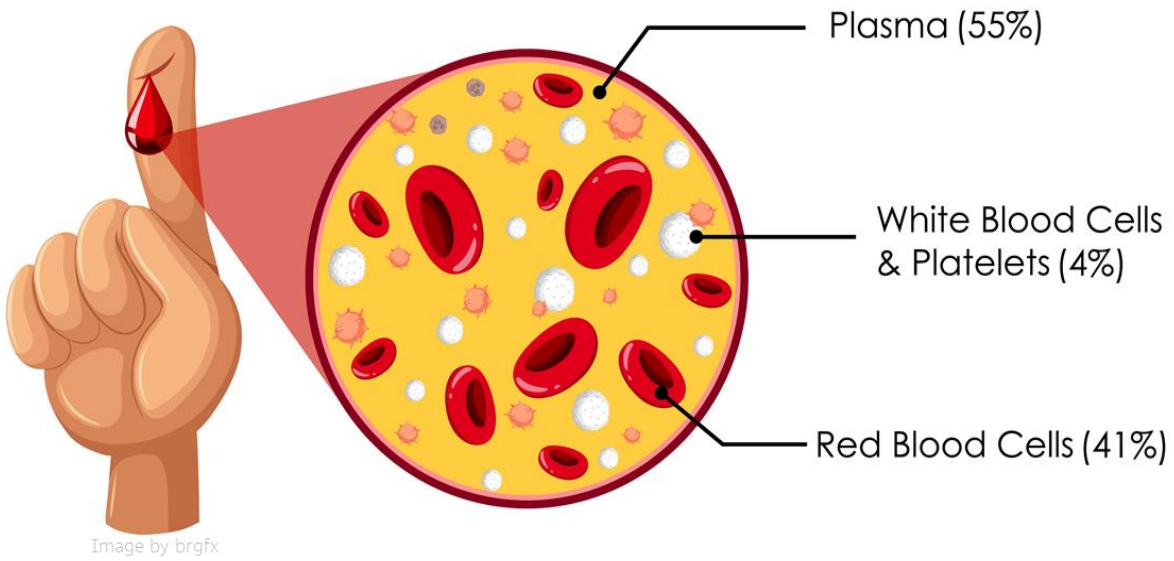
	Artery	Vein
Direction of flow in relation to heart	Blood Flows from the heart	Blood flows into the heart
Pressure in the vessels	High pressure	Low pressure
Structure of walls	Thick and muscular to handle the high blood pressure.	Thin and can stretch with changing volumes of blood
Other structures		Contains valves to prevent back flow of blood

Blood consists of fluid (serum) containing cells: white blood cells, red blood cells and platelets.

White blood cells (leucocytes) – some produce antibodies to tag foreign and harmful objects, others surround and eat tagged objects. White blood cells prevent infection becoming established. Make up the immunity system. Cells contain nucleus.

Red Blood cells (erythrocytes) – contain haemoglobin, a pigment which binds to oxygen molecules and carries it through the circulatory system. They contain no nucleus.

Platelets – they collect where there is a hole in the blood vessels and stop the unwanted flow of blood by clotting.



Red blood cells carry oxygen, attached to haemoglobin, around the body of a mammal.

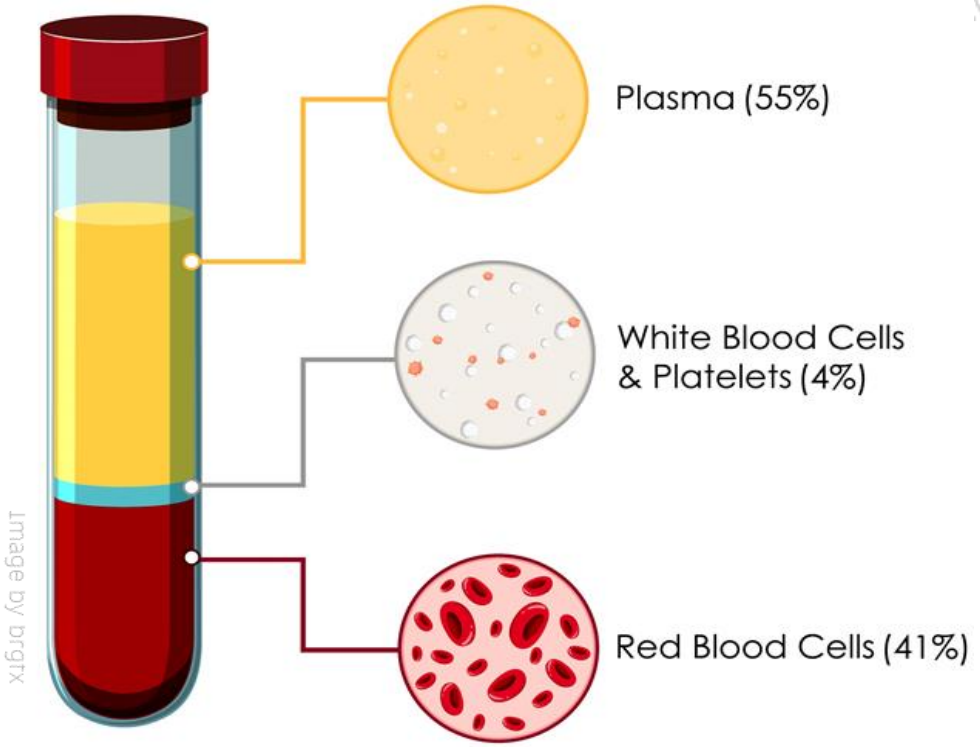
Mammalian red blood cells (**erythrocytes**) lose their nuclei and cell organelles when they are mature in order to provide more space for **haemoglobin** (oxygen carrying pigment).

Because the cells have no nucleus or organelles, they cannot produce any protein, and therefore they cannot divide or repair themselves. They are constantly replaced by new red blood cells.

Red blood cells are **biconcave disks** and this shape optimises the cell for the exchange of oxygen in the lungs. The red blood cells are flexible so they can fit through tiny capillaries, where they release their oxygen to cells.

Plasma transports glucose, carbon dioxide, urea and hormones.

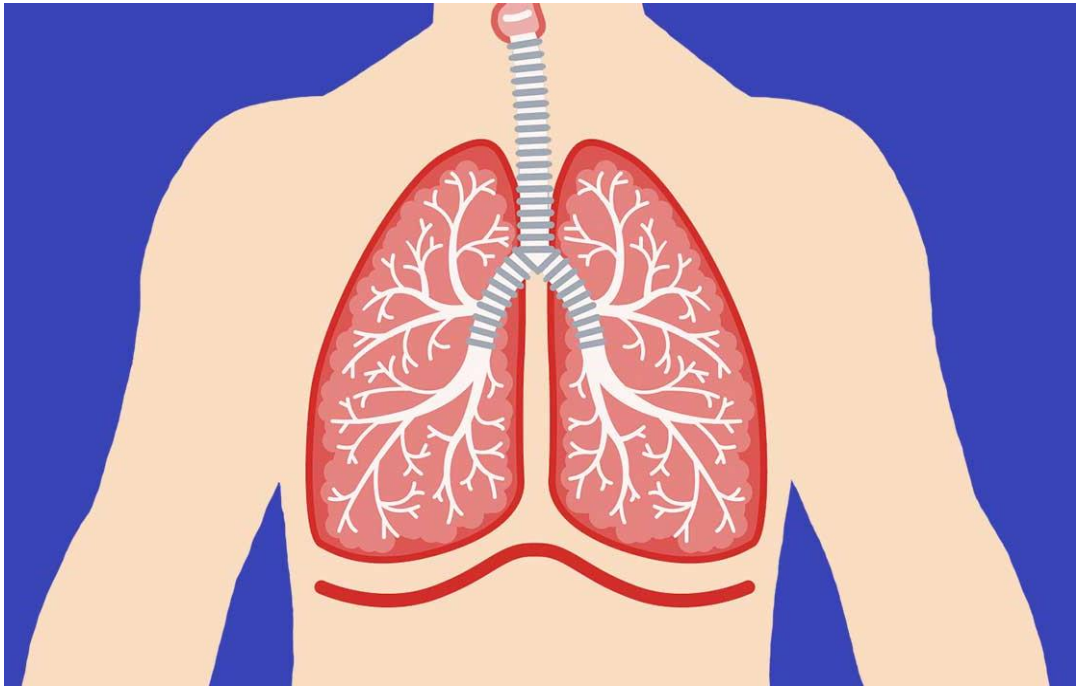
Plasma carries **dissolved** molecules required by the body to each cell and waste products like **carbon dioxide** and **urea** out of the body. Plasma also carries a large number of important proteins. Albumin, the main protein in blood, helps control the water content of tissues and blood.
Plasma is usually yellow in colour due but can become milky when it transports fat absorbed from the intestines to other organs of the body.



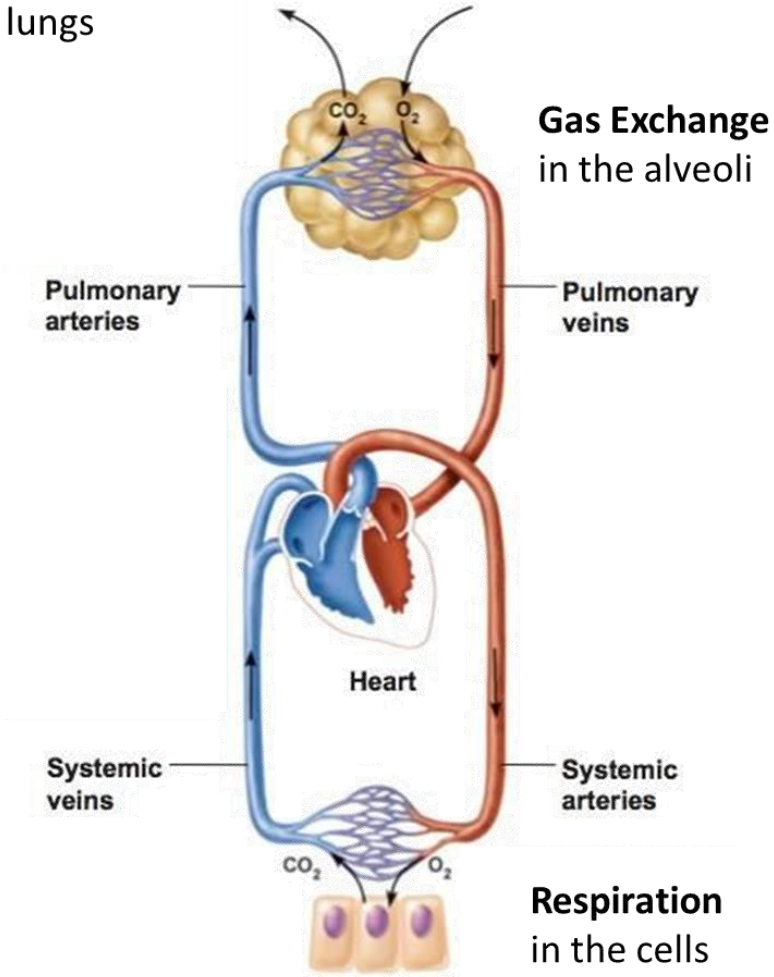
The respiratory system

The **respiratory system** consists of organs that deliver oxygen to the **circulatory system** for transport to all body cells. The respiratory system also assists in removing the waste product of carbon dioxide from the body.

Oxygen is a vital element for metabolism (cell reactions). The breaking apart of glucose (sugar) by oxygen in each cell to release energy is called **respiration**.



Breathing, Gas Exchange and Respiration… What's the difference?



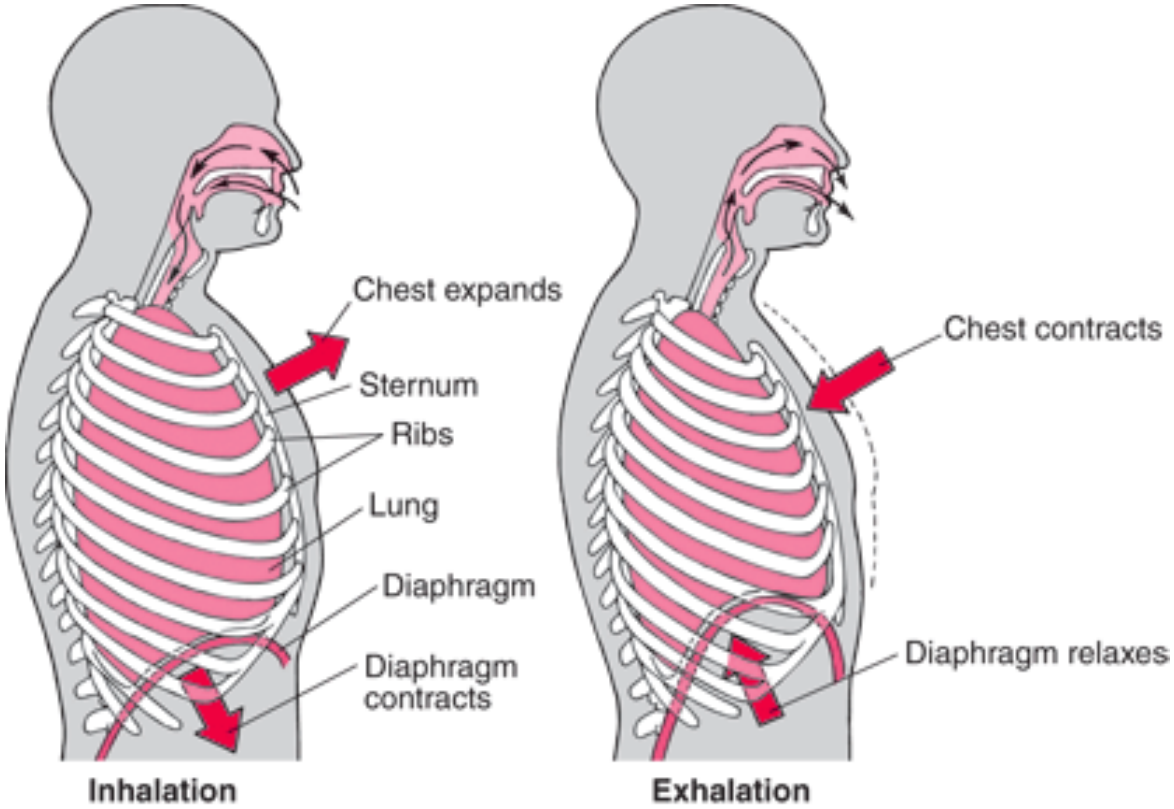
Breathing is the **physical process** by which air (containing oxygen) is forced into the lungs due to the ribcage and their associated muscles pulling the diaphragm downwards. The air (containing high amounts of carbon dioxide) is then forced out of the lungs by the same process that moves the diaphragm up. It involves Inhalation and Exhalation.

Gas exchange is the process where **gasses diffuse** across a gaseous exchange surface. In humans, oxygen diffuses from the inhaled air into the blood and carbon dioxide diffuses from the blood into the exhaled air. The gaseous exchange surface in Humans is the Alveoli.

Respiration is the metabolic process that **occurs in the cell** where organic molecules are broken down to release energy. In humans, this process takes place inside the mitochondria of cells. Aerobic respiration requires oxygen whereas anaerobic respiration takes place in absence of oxygen.

Breathing mechanism.

Breathing (the movement of air in and out of the lungs) is produced by pressure differences created by changing the size of the pleural cavity. The **diaphragm** contracts and the rib cage is raised. The volume of the pleural cavity is increased, creating a partial vacuum between the lung cavity and the atmosphere, and air enters the lung. Air breathed out contains more carbon dioxide and less oxygen than air breathed in.



Aerobic respiration involves transferring energy from glucose to a cell; oxygen is needed and carbon dioxide is produced.

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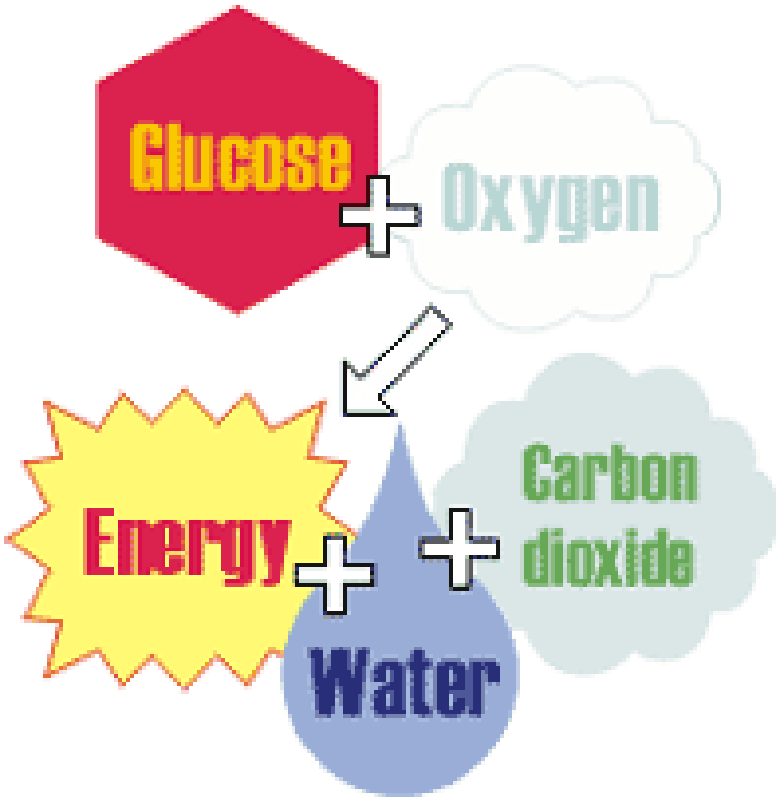
Cellular respiration is a process whereby energy is released from the breakdown of molecules in food at the cellular level.



Glucose enters the cell and **oxygen** diffuses in – which has previously entered the body via the respiratory system and transported to each cell through the circulatory system.
Glucose is broken apart in a series of steps to release **energy** required for the body. Each reaction is assisted by enzymes.
The products of these reactions are **water** and **carbon dioxide** – which diffuses back out of the cell and eventually out of the body via the circulation and respiratory systems.

Anaerobic respiration can occur in human muscles and that lactic acid is produced.

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Extra for experts

Sometimes our muscles require more oxygen than we can supply by normal breathing. Without oxygen present, **anaerobic** respiration takes place. The glucose is broken down and releases some energy. Carbon dioxide is produced along with lactic acid. The **lactic acid** is a waste product and must be removed from the body.

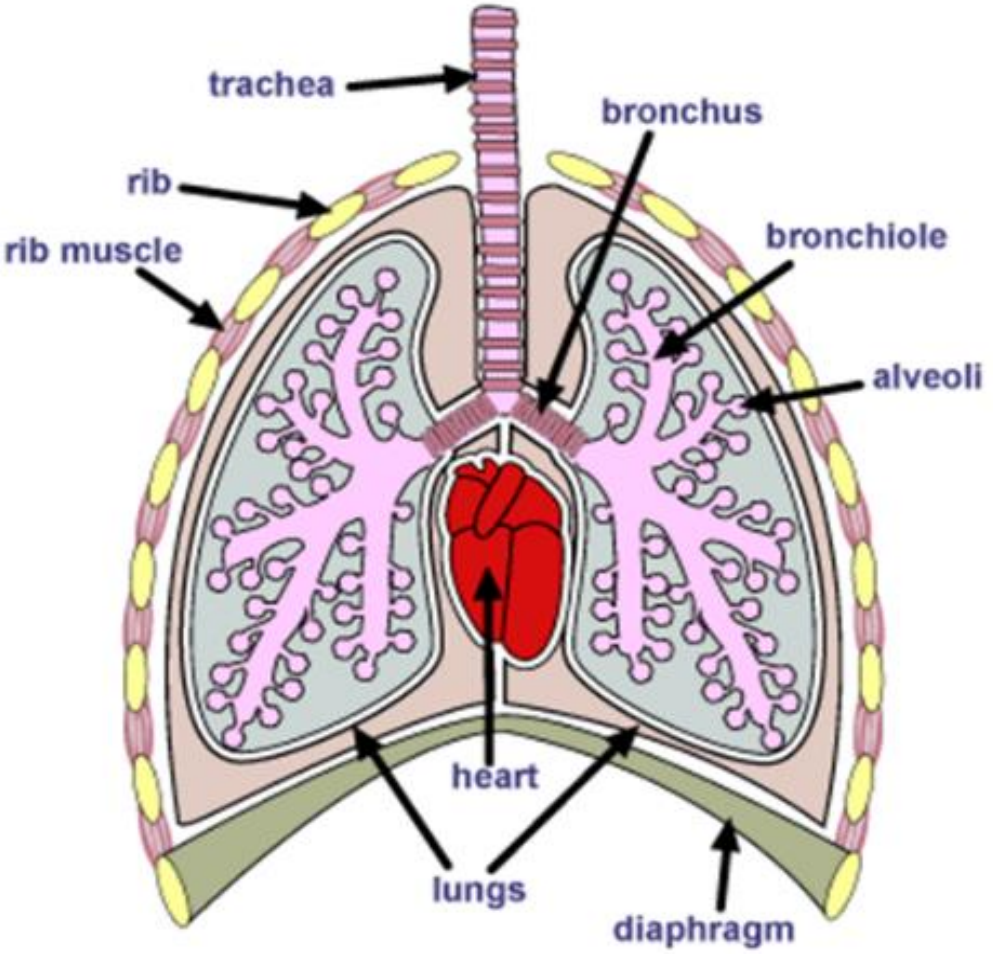
Comparing aerobic and anaerobic respiration

Extra for experts

Feature	Aerobic respiration	Anaerobic respiration
Oxygen requirement	Yes always	none
Waste products	Carbon dioxide and water	Carbon dioxide and lactic acid
Efficiency in releasing energy from glucose	Very efficient (most of glucose's energy is released)	Less efficient (some energy locked in lactic acid is not released)
Some energy is released as heat	yes	Yes, but less than for aerobic respiration

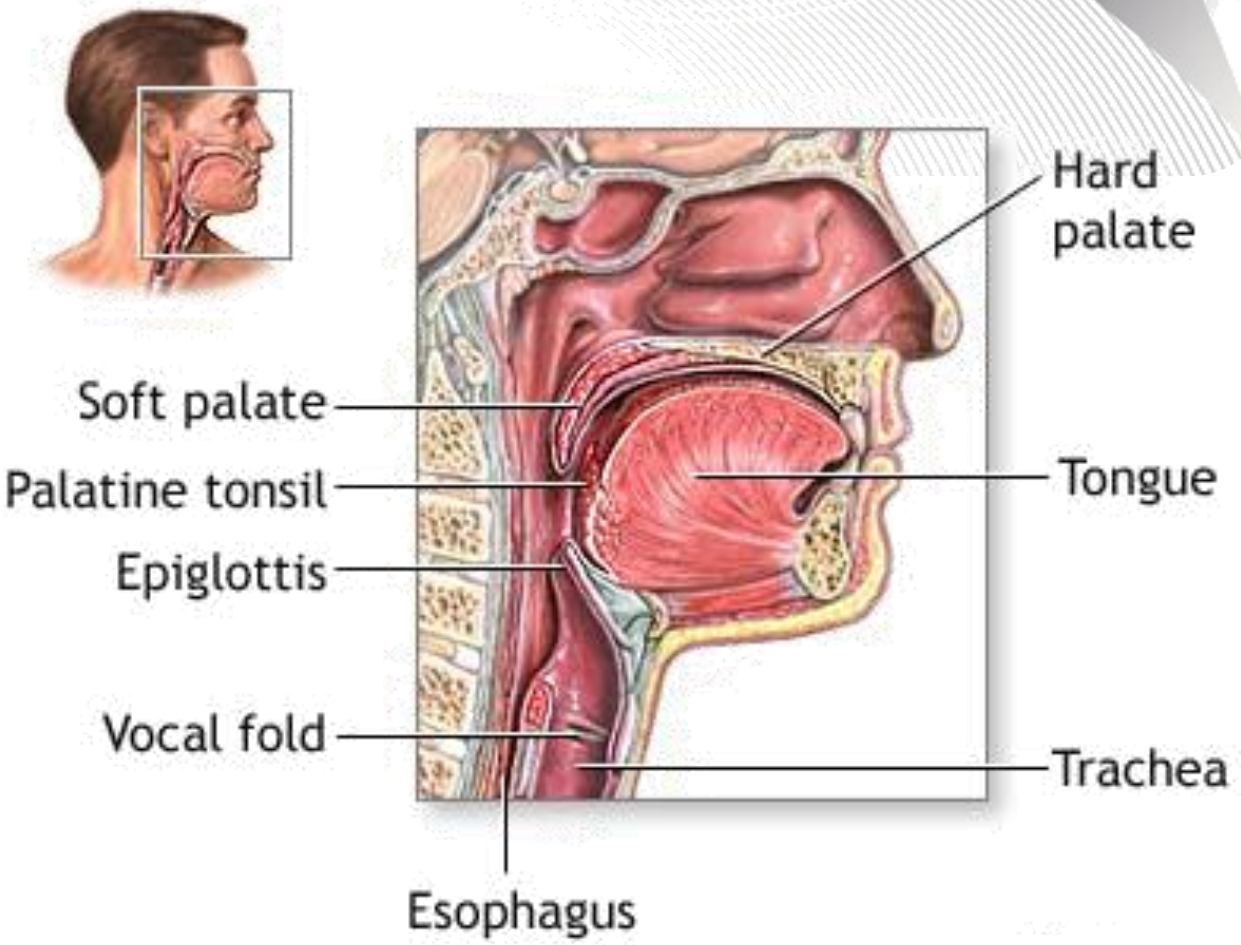
The structure of the Human Respiratory system

The human respiratory system consists of the nose, pharynx, larynx, trachea, 2 bronchus, and lungs (composed of bronchioles and alveoli). The lungs are housed in an airtight pleural cavity framed by the rib cage and diaphragm.



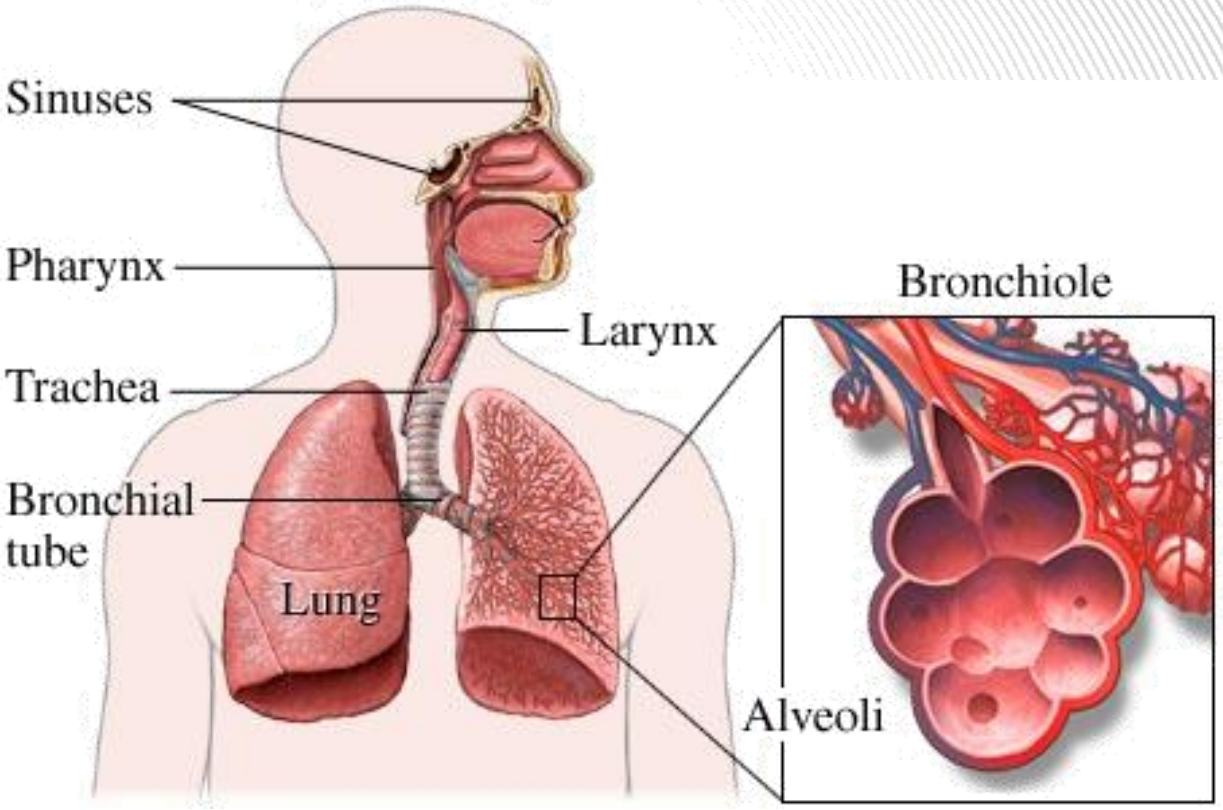
The structure of the Human Respiratory system

Air (comprised of about 21% **oxygen**) enters the nose, where tiny hairs filter out dust and particles. Tissues moisten and warm the air, making it more suitable for **gas exchange** in the lungs. Air passes from the pharynx to the larynx (containing vocal cords) and into the trachea.



The structure of the Human Respiratory system

The **trachea** divides into the left and right bronchi which subdivide into smaller and smaller tubes called bronchioles. These airways are lined by mucous membranes and many **cilia** hairs which trap and remove particles from the lungs. Bronchioles open into the **alveoli** which are clustered like grapes.



The structure of the alveoli and blood capillaries enable gaseous exchange to occur.

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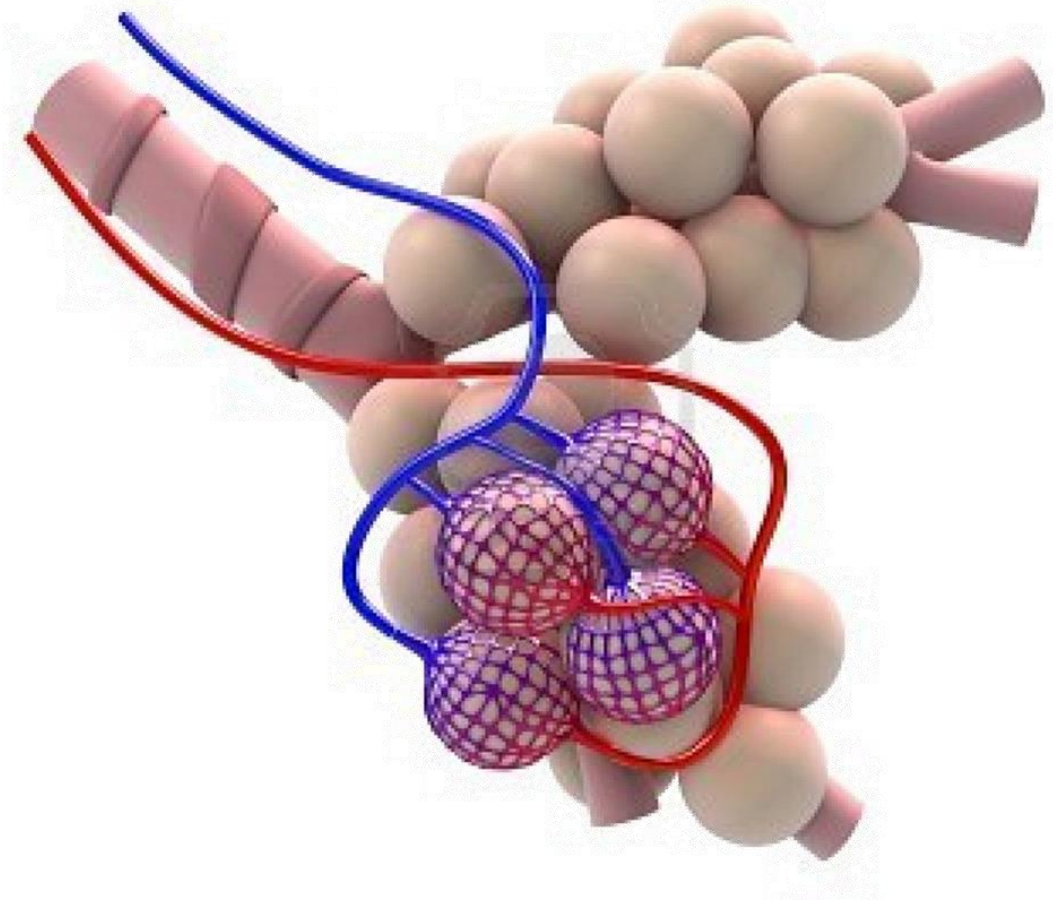
Only one cell thick, **alveoli** have direct contact with capillaries for gas exchange. The grapelike arrangement of alveoli creates an enormous surface area sufficient for exchanging enough oxygen and carbon dioxide for the entire body.



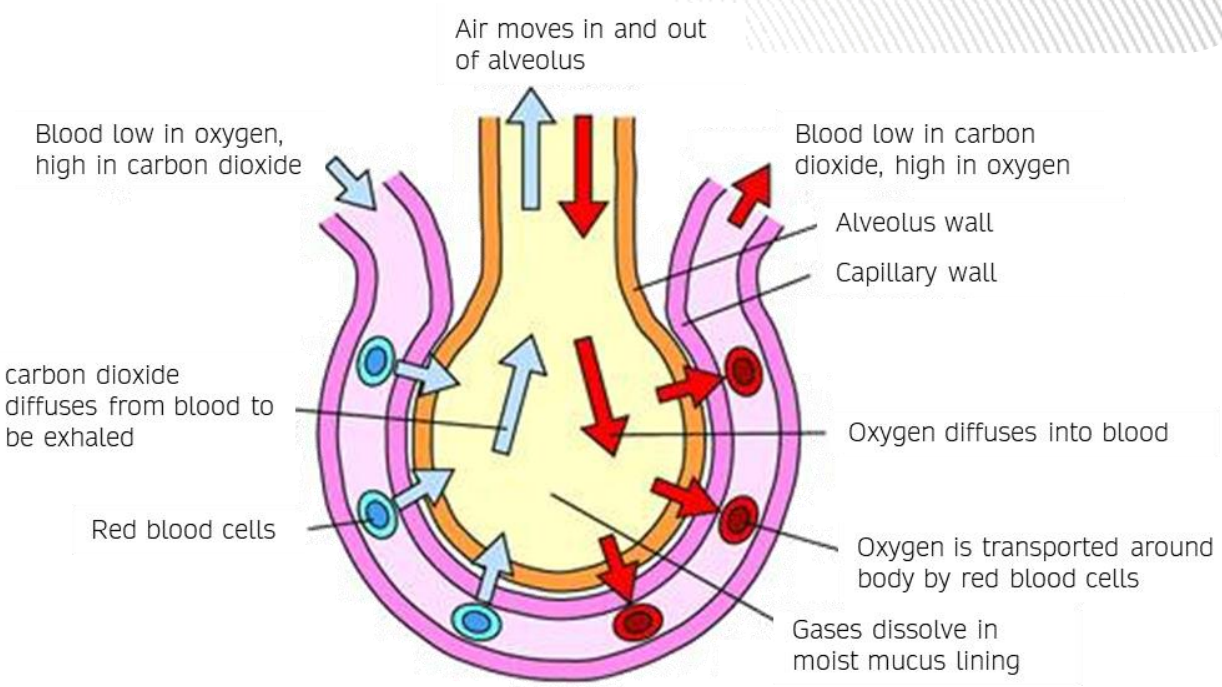
Gas exchange across the alveoli.

Oxygen is transported to the cells of the body mainly by binding to **haemoglobin** which is found within red blood cells. Carbon dioxide is transported by diffusion into the plasma.

Diffusion occurs because the oxygen is in higher concentration in the alveoli and moves to the lower concentration in the blood of the capillary.

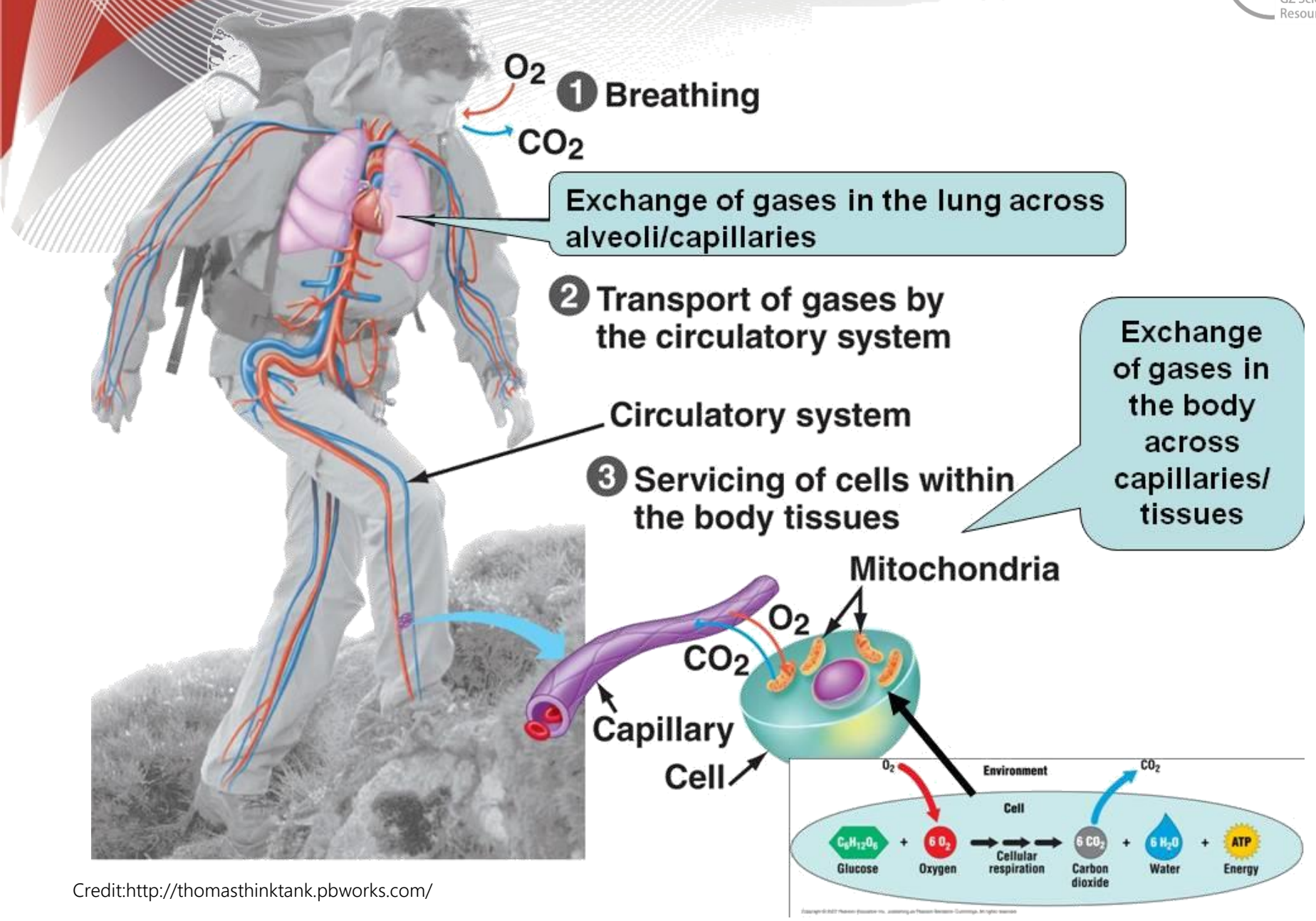
The **CO2** in the blood diffuses into the alveoli and out of the body because it also moves from high to low concentration.

Oxygen enters into alveoli from bronchioles



The oxygen molecules must diffuse through both the lining of the alveolus and the lining of the blood capillary and is eventually picked up by red blood cells

The Big Picture



Credit:http://thomasthinktank.pbworks.com/