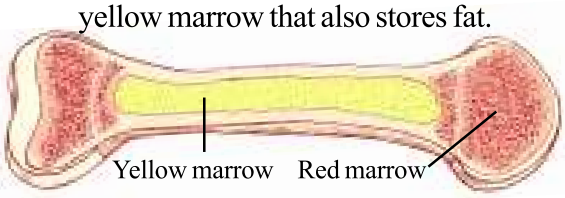
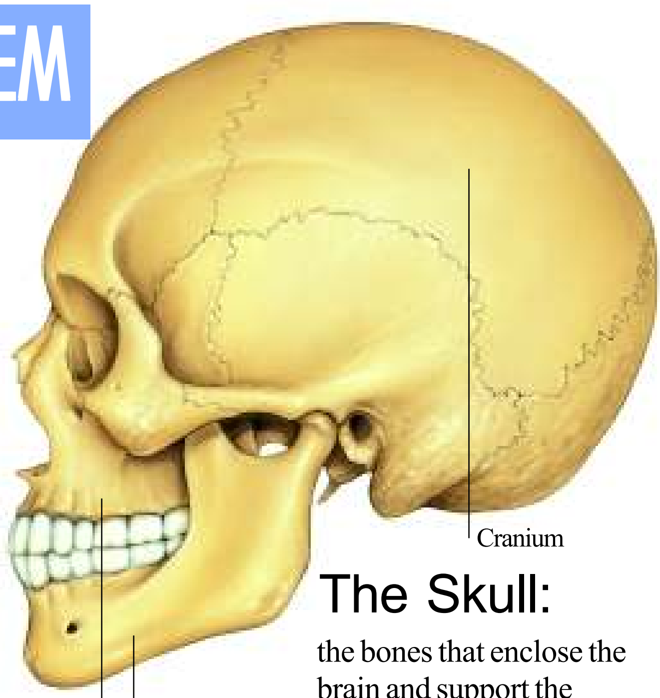
1 OUR SKELETAL SYSTEM

Our skeleton consists of all our bones, teeth, cartilage, and joints. Some bones protect our internal organs. Some bones provide a framework for the body (just as the spokes of an umbrella provide a framework). Some bones contain red marrow that produces blood cells and yellow marrow that also stores fat.



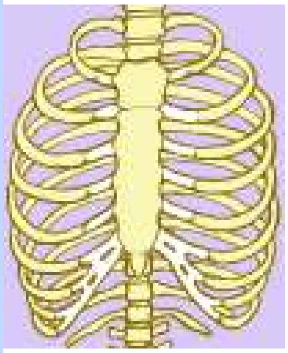


The Skull:

the bones that enclose the brain and support the face and teeth

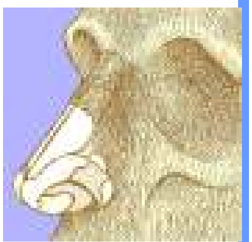
Cartilage

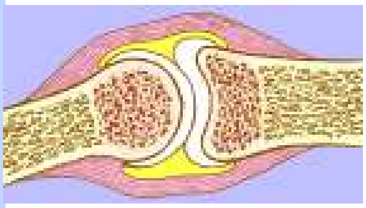
Cartilage is softer than bones and is somewhat flexible, like rubber.



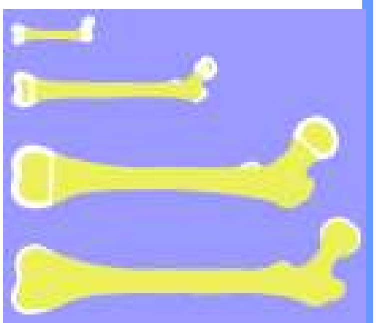
Cartilage (shown here in white) connects the ribs to the sternum, allowing the ribs to move as we breathe.

Cartilage supports our nose and outer ears.





Joints contain some cartillage.



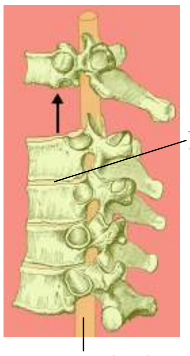
Much of an infant's skeleton consists of cartillage, which is gradually replaced by bone.

The Backbone

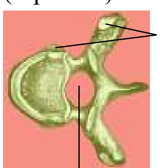
(the spinal column)

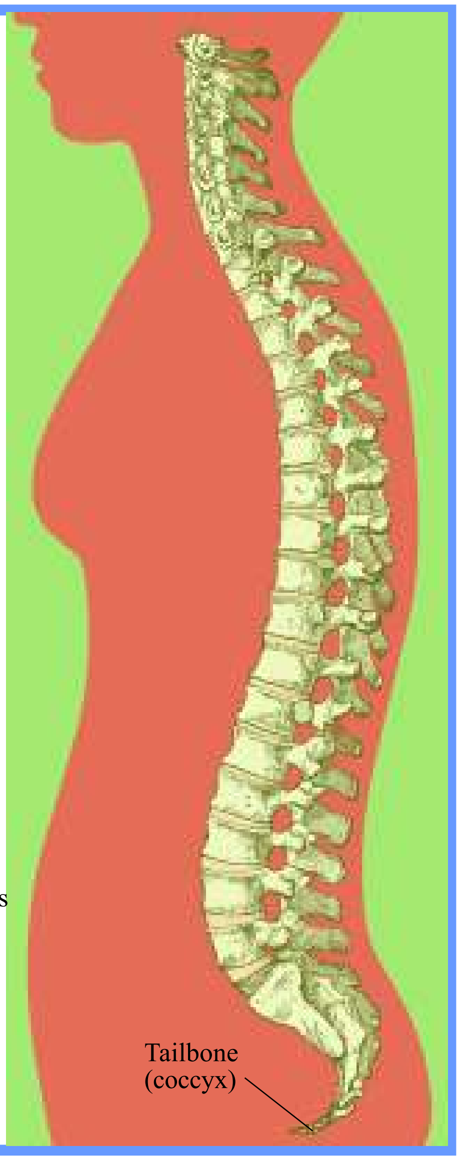
The backbone is made of vertebrae

(side view)



One vertebra
(top view)



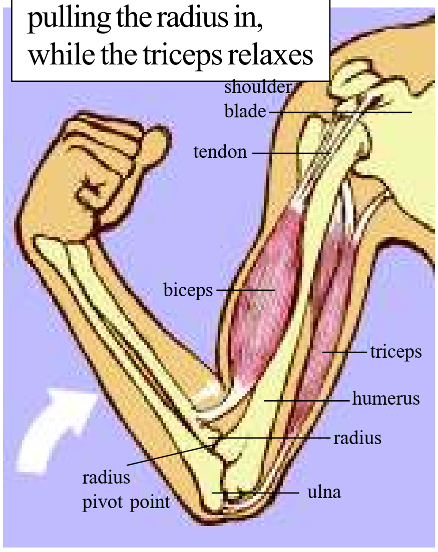


2 OUR MUSCULAR SYSTEM

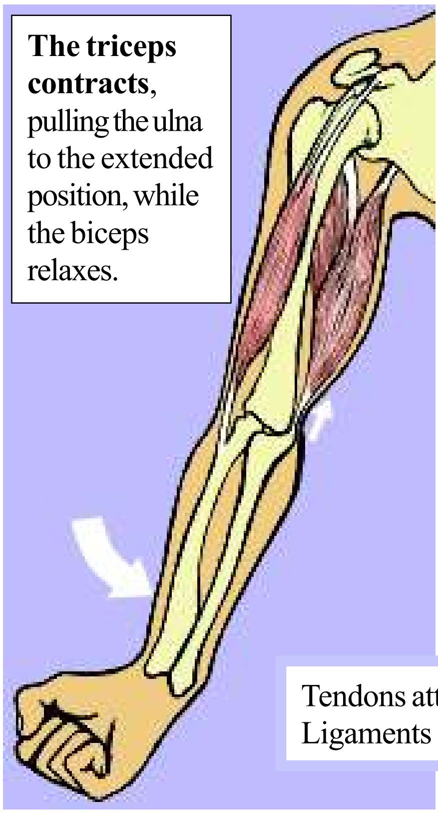
How do muscles make us move?

Tendons attach one end of the biceps and triceps to the shoulder blade and the other end to the radius or ulna. Each muscle can pull, but it cannot push. That is why two muscles are needed to bend the arm back and forth at the elbow.

The biceps contracts, pulling the radius in, while the triceps relaxes



The triceps contracts, pulling the ulna to the extended position, while the biceps relaxes.



There are three kinds of muscles:

1 Skeletal muscle

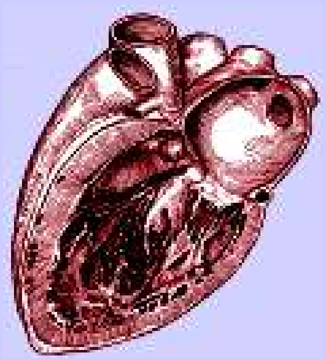
These muscles are attached to bones. They are also called 'voluntary muscles' because we can consciously contract them. (shown at right and on the facing page)

2 Smooth muscle

These are found in the walls of the digestive tract, urinary bladder, arteries, and other internal organs. They are 'involuntary muscles' because we do not consciously control them.

3 Cardiac muscle

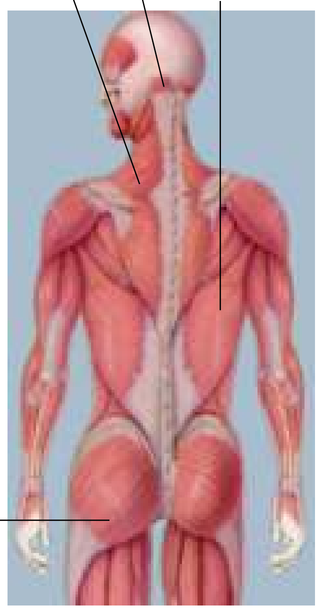
These are the muscles of the heart. Their contraction is involuntary and continues in a coordinated rhythm as long as we live.



Ligaments attaching the wrist bones to each other.

Tendons attach muscles to bones.
Ligaments attach bones to bones.

Some muscles of the back



3 OUR DIGESTIVE SYSTEM

Every cell in our body does work. Work requires energy, which is supplied by the food we eat. Food also supplies the small moNew Texthat are the building blocks for cell maintainance, growth, and function.

Digestion breaks down food into materials the body can use:

1. Your sense receptors work together with your brain to make you hungry. Saliva increases (you produce more than 1 litre/day), and helps digest food while it is mechanically torn, cut, crushed, and ground in your mouth.

2. The passages of your digestive system are lined with involuntary muscles that contract in waves to squeeze food along.

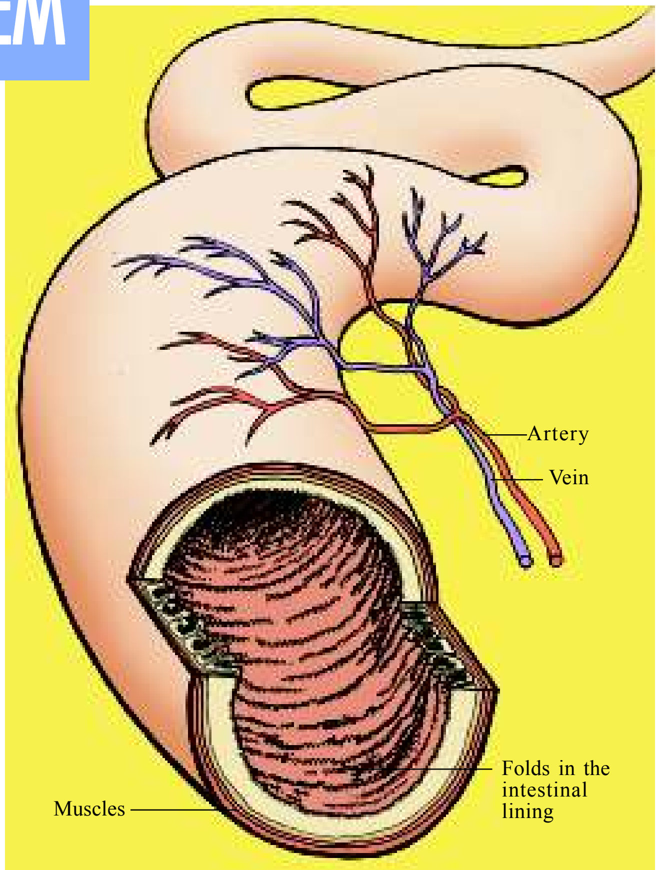
3. Your stomach stores food so that you need not eat con-tinously. It also breaks down food with acid and enzymes.

4. The salivary glands, pancreas, liver, and gallbladder secrete and store digestive juices.

5. The small intestine is where most of the chemical digestion and nutrient absorption into the bloodstream takes place.

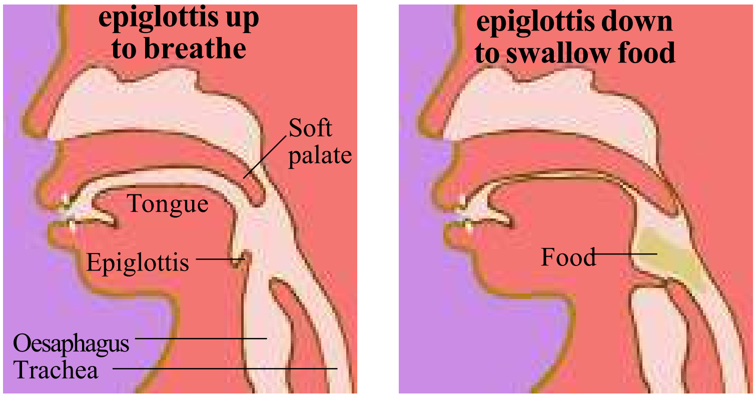
6. The large intestine reclaims water and releases waste.

SMALL INTESTINE



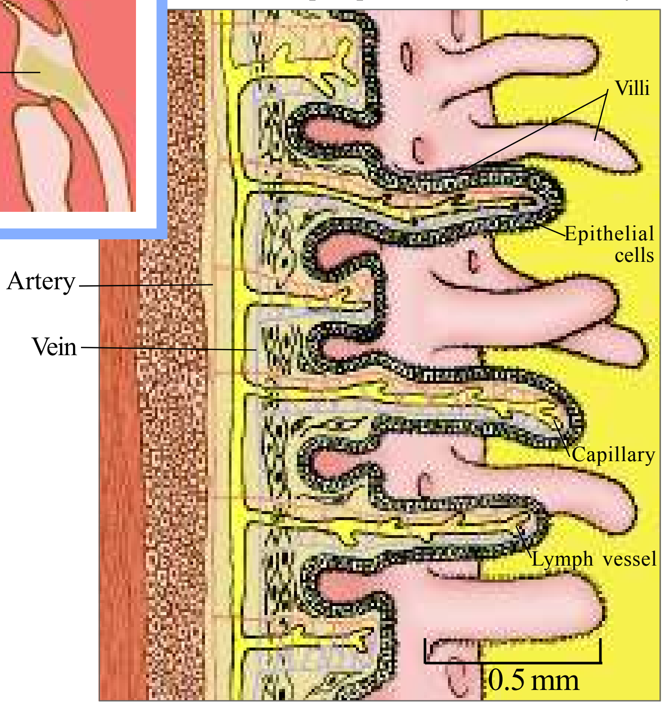
SWALLOWING

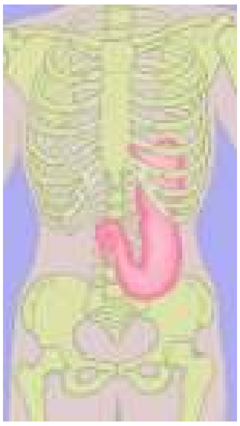
When swallowing, muscles move the epiglotis down to close the opening to the trachea, so that food and drink do not enter the lungs. The soft palate also moves up, so that food does not go up the nasal passage.



The Intestinal Wall

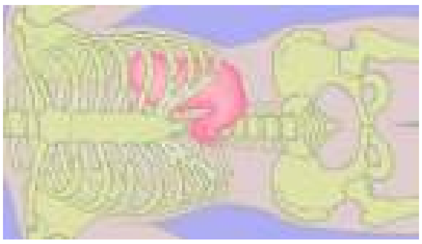
In order to increase its surface area, the intestinal wall is folded, and each fold is lined with villi. This way, more cells come into contact with nutrients in the digested food. Nutrients enter the epethelial cells that line the villi, either by diffusion or active transport. They are then absorbed by capillaries and lymph vessels. Capillaries transport the nutrients to larger blood vessels, then to the portal vein,which goes to the liver. Then the nutrients go to the heart, to be pumped to the rest of the body.





The stomach does not have one fixed shape

Everyone's internal organs are slightly different. The shape and position of your stomach also depends on how much food it contains, and whether you are standing or lying down.



4 OUR RESPIRATORY SYSTEM

Through respiration we exchange gases with our environment. Our cells require a continuous supply of oxygen (O_2) in order to obtain energy from food molecules. Cells would also die if they were not able to get rid of the carbon dioxide (CO_2) they produce.

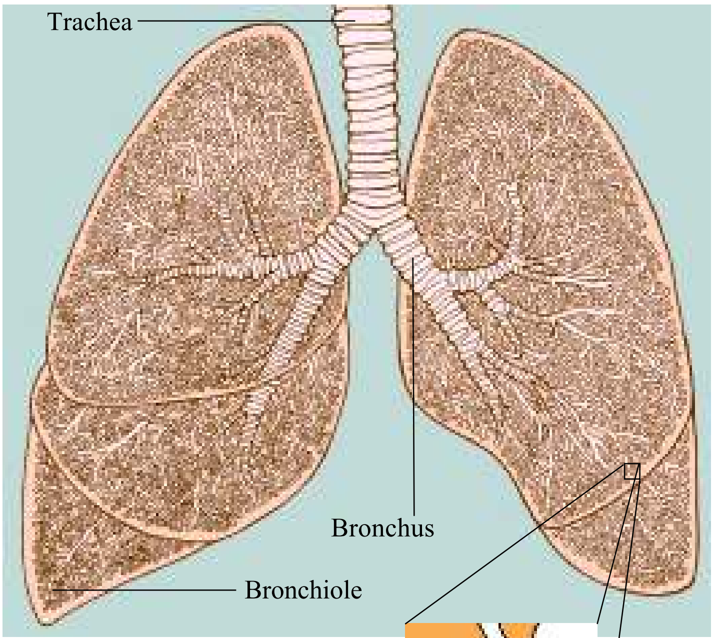
The 3 Processes of Gas Exchange:

1. In our lungs, O_2 passes from the air into our blood, and CO_2 passes from our blood into the air. Some water vapour is also released into the air.

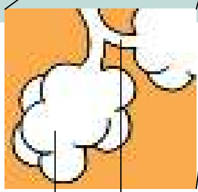
2. Our circulatory system transports O_2 and CO_2 to and from all the parts of our body. Haemoglobin molecules in our red blood cells transport O_2.

3. Cells take up O_2 and release CO_2

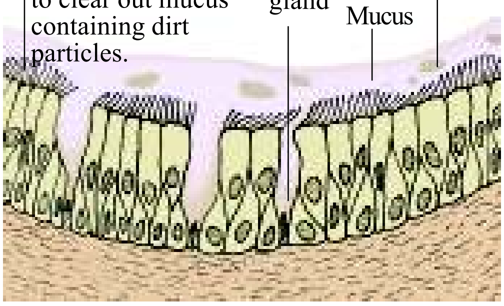
THE LUNGS



The lungs are sacs made of pleural membranes, containing a dense lattice of tubes: bronchi, and the smaller bronchioles. When we inhale air, it travels through this network and fills the tiny air sacs called alveoli. That is where gas exchange with the blood in capillaries takes place.



Mucus membranes line air passages



Hairs in our nostrils, as well as mucus and cilia throughout our air passages help remove dirt that enters the respiratory system in the air we breathe. Most of the mucus and dirt is swallowed and passes into the oesophagus and out through the digestive system.

When we inhale, where does the air go?

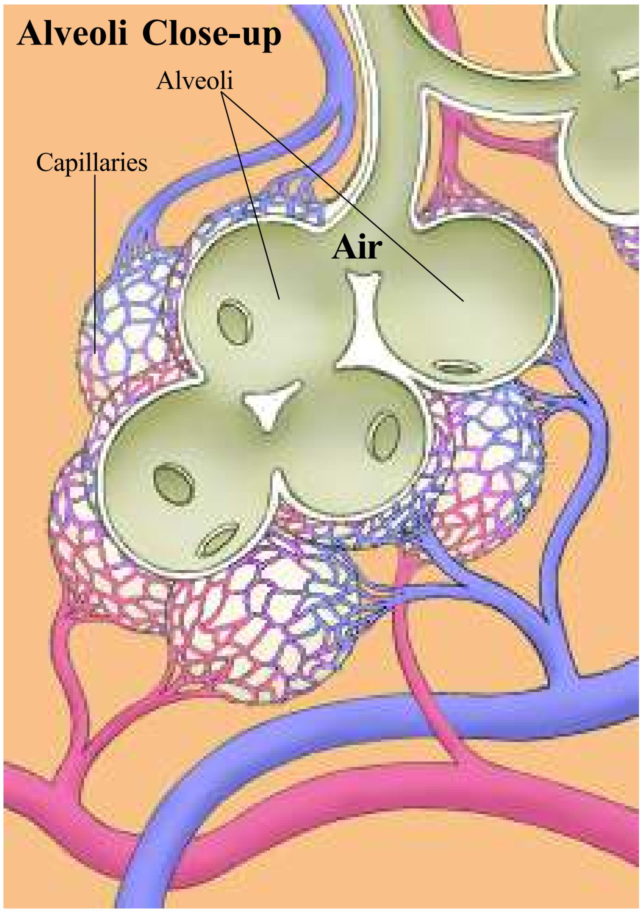
Nostrils
↓
Nasal cavity
↓
Pharynx
↓
Larynx
↓
Trachia
↓
Bronchus
↓
Bronchiole
↓
Alveolus

What happens in the aveoli?

O_2 from the air diffuses through the thin layer of cells that forms the aveoli walls. Then it enters the web of capillaries that surround each aveoli. CO_2 goes in the opposite direction, from the capillaries to the air.

In the capillaries, O_2 diffuses into red blood cells. Red blood cells contain protein molecules called haemoglobin, which contain iron atoms. Each iron atom can carry an O_2 molecule. When haemoglobin binds O_2 it turns red. Blood without oxygen looks bluish - after passing through the lungs it turns red.

Alveoli Close-up

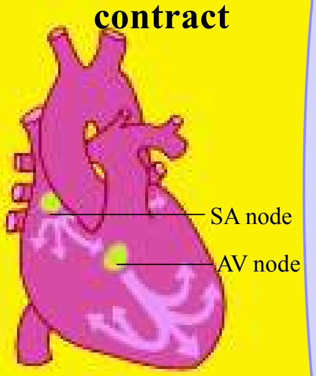


5 OUR CIRCULATORY SYSTEM

The circulatory system transports respiratory gases, nutrient molecules, wastes, and hormones throughout the body. These materials are carried by an intricate network of blood vessels, which follow continuous circuits from the heart through arteries, capillaries, and veins back to the heart.

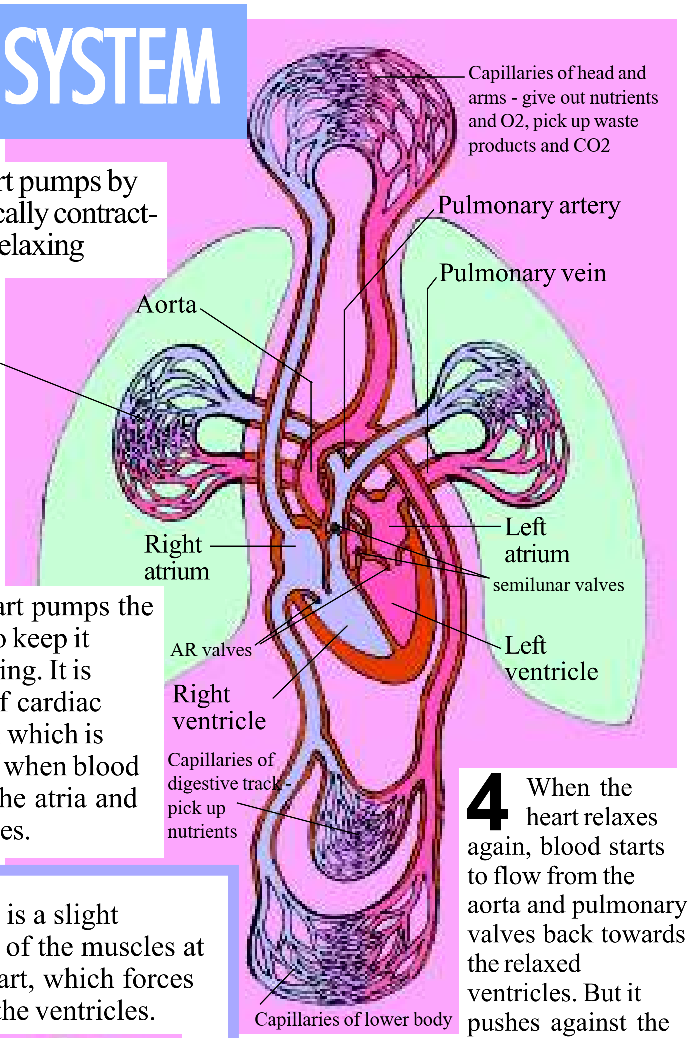
The circulatory system also regulates our body temperature.

Electrical signals make the heart rhythmically contract



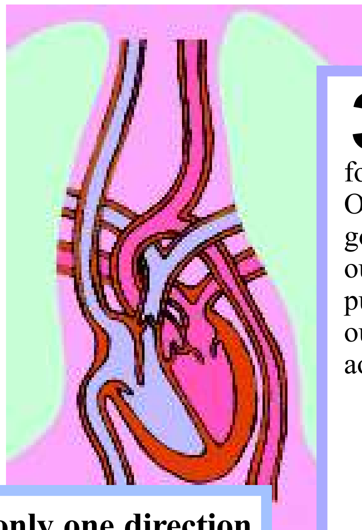
An electrical signal is generated by the SA node, and it makes the muscles of the atria contract. The signal spreads, but is slightly delayed in the AV node, which allows the atria time to empty. Then it reaches the bottom of the heart and travels up the sides of the ventricles, causing them to strongly contract.

The heart pumps by rhythmically contracting and relaxing

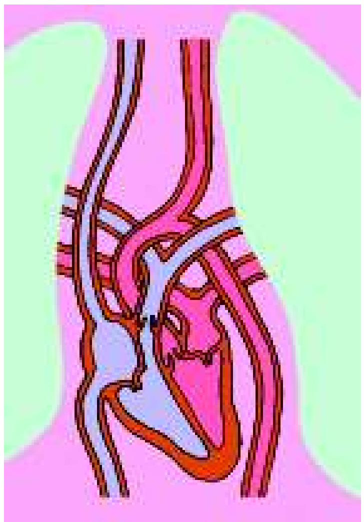


1 The heart pumps the blood to keep it circulating. It is made of cardiac muscle, which is relaxed when blood enters the atria and ventricles.

2 Then there is a slight contraction of the muscles at the top of the heart, which forces more blood into the ventricles.



3 The main heart muscles (at the bottom of the heart) contract to force blood out of the ventricles. One-way valves prevent blood from going back into the atria. Blood flows out of the right ventricle through the pulmonary arteries into the lungs, and out the left ventricle through the aorta to the rest of the body.



4 When the heart relaxes again, blood starts to flow from the aorta and pulmonary valves back towards the relaxed ventricles. But it pushes against the semilunar valves, which snap shut.

Valves allow blood to flow in only one direction

Blood flows from left to right

Blood cannot flow from right to left

Valves automatically close when blood pushes in the wrong direction.

Your heartbeat sounds like lub-dup, lub-dup, lub-dup... The sound lub comes from blood in the ventricles pushing against (and closing) the AV valves to the atria. The dup comes from the semilunar valves snapping shut after blood is forced out of the ventricles.

Valves similar to these are found in some veins, and in the lymphatic system, as well as in the heart.

6 OUR LYMPHATIC SYSTEM

To remain healthy, our bodies must be regulated in a state of internal balance, under ever-changing conditions.

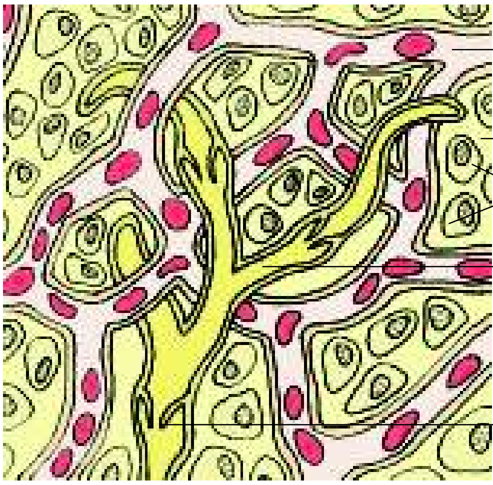
All the cells in our body live in an interstitial fluid, which supplies their nourishment and carries away waste products. This fluid leaks out from the circulatory system. The lymphatic system provides a way to return excess fluid to the circulatory system, thus keeping fluids in balance.

The fluid which is carried by the lymph vessels is called lymph. It is similar to interstitial fluid, but it has less O_2 and protein, and more fat.

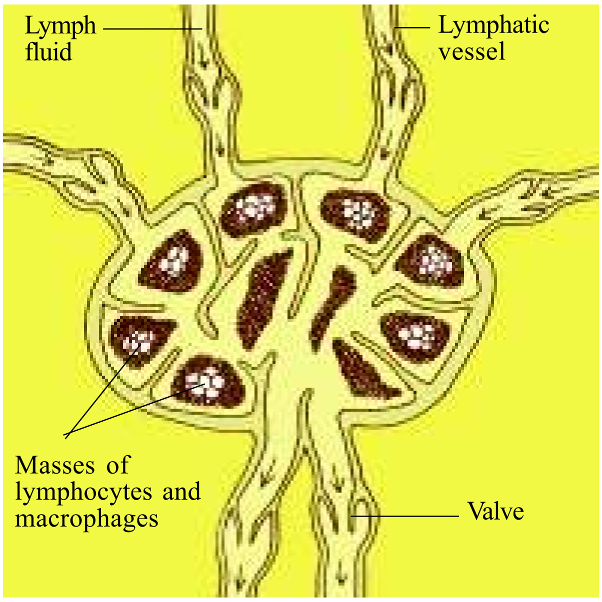
The lymphatic system also plays a role in defending the body from infection. The fluid that is picked up is taken through larger and larger lymph vessels to lymph nodes. Lymph nodes contain lymphocytes and macrophages, which attack microbes and even cancer cells that may be in the lymph.

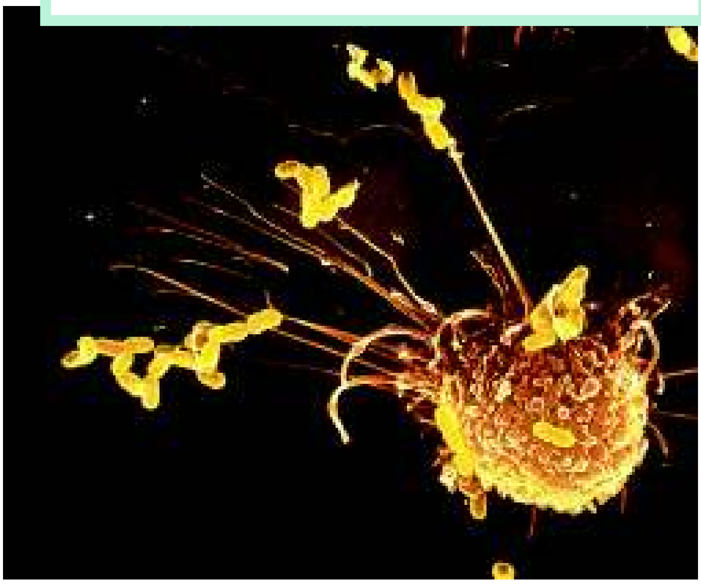
Finally, lymph re-enters the circulatory system through the thoracic duct and the right lymphatic duct, which drain into veins in the shoulders.

Lymph vessels and capillaries



A LYMPH NODE





White blood cells in the lymphatic system fight disease

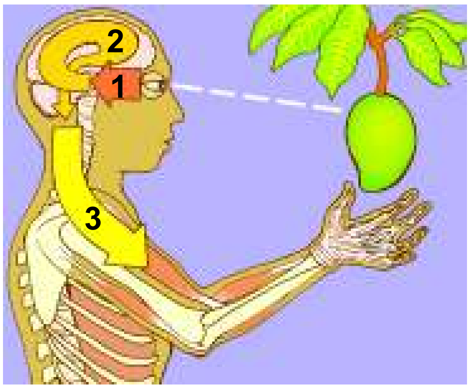
The immune response: lymphocytes are white blood cells that defend the body from viruses, bacteria, and even cancer cells. These invaders are neutralised when their antigens (proteins on their surfaces) are recognized by antibodies made by **T-cells** and **B-cells** (types of **lymphocytes**) .

The inflammatory response: damaged cells release chemicals that signal blood vessels to dilate and release fluid and white blood cells such as **macrophages**, which attack any foreign body.

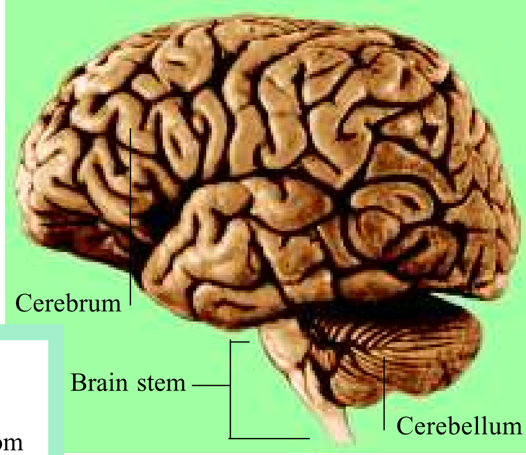
7 OUR NERVOUS SYSTEM

The nervous system consists of the structures and processes that make up the brain, the spinal cord, and the peripheral nerves distributed throughout the body.

The Functions of the Nervous System:



1. **Sensory Input**
   the conduction of signals from sensory receptors
2. **Integration**
   the interpretation of the sensory signals and the formulation of responses
3. **Motor output**
   the conduction of signals from the brain and spinal cord to effectors, such as muscle and gland cells.



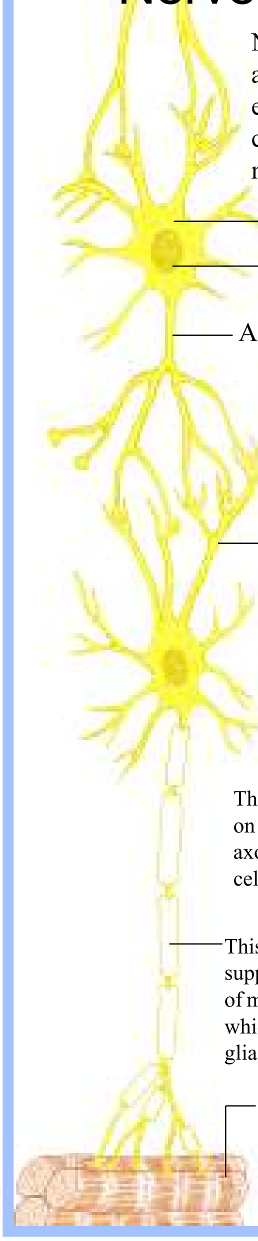
The Brain

The brain is the site of consciousness. It produces thoughts, feelings, memory, and creativity. It monitors and controls our unconscious and well as conscious actions.

The brain is an exceedingly complex organ, made up of billions of interconnected and interacting nerve cells. An intricate network of blood vessels bring a constant supply of oxygen and glucose, from which these nerve cells get the energy they need to function.

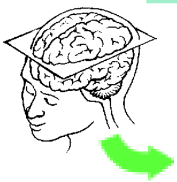
Nerve cells

Neurons receive and/or transmit electrical and chemical messages

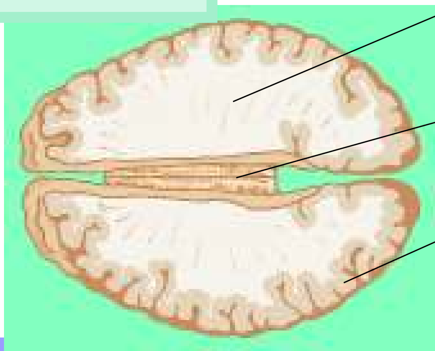


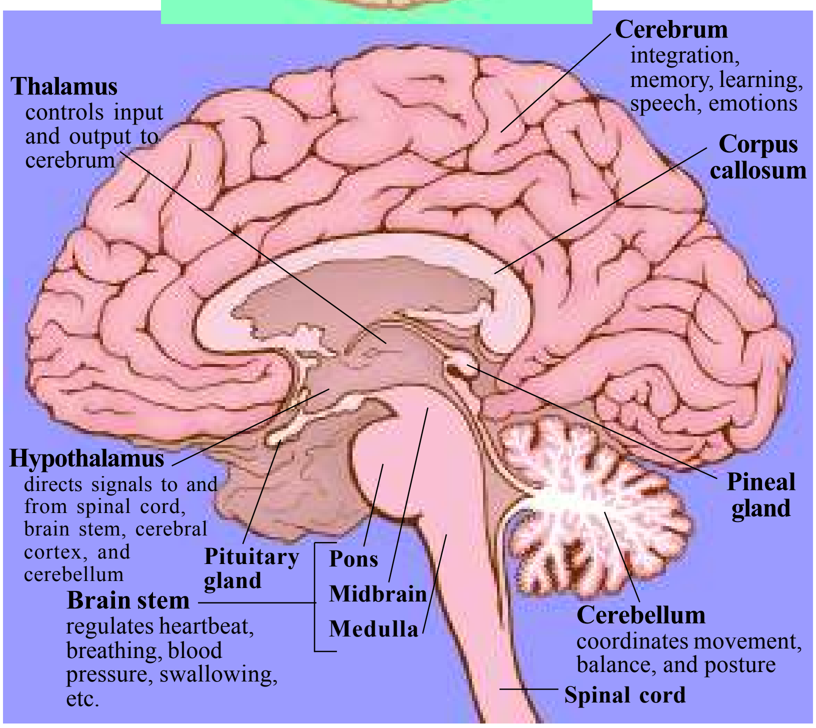
There are two types of nerve cells: neurons and glial cells.

The major nerves are bundles of axons. One axon may be more than 1 metre long.



This section through the brain is shown here





8 OUR ENDOCRINE SYSTEM

Many of our body's functions are controlled by the endocrine system, which consists of glands that make and secrete regulatory chemicals called hormones.

Molecular messengers: Hormones are molecules that are secreted in one part of the body and travel through the bloodstream to control what happens in another part. Endocrine glands secrete hormones directly into the bloodstream.

There are two main kinds of hormones:

(1) Hormones made from amino acids

These hormones may be modified amino acids, peptides, or proteins. They work by binding to and activating specific receptors on cell membranes. This causes a series of events inside the cell.

Examples: epinephrine, norepinephrine, insulin, melatonin, LH, FSH

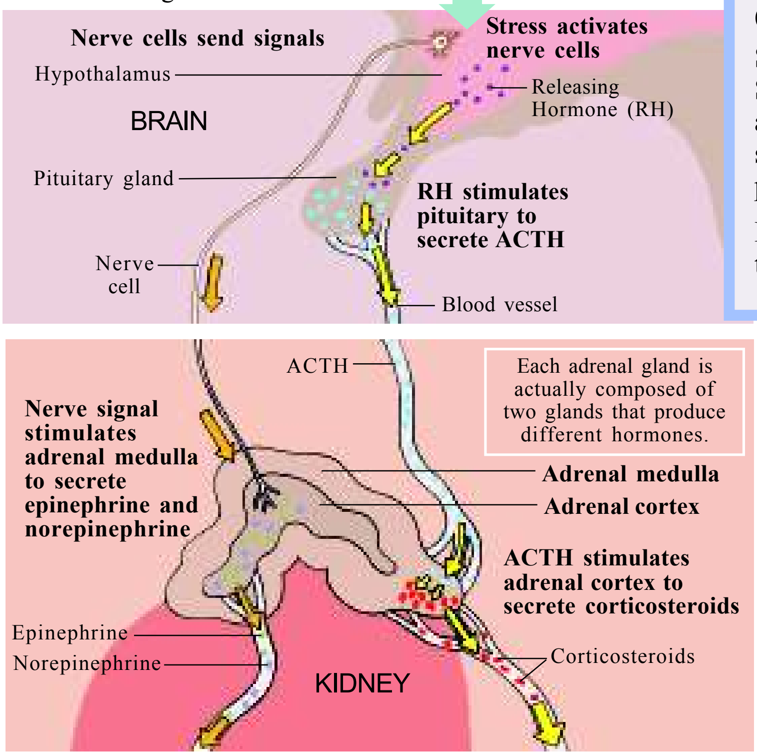
(2) Steroid Hormones

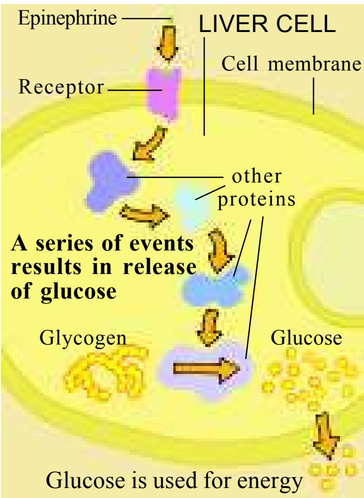
Steroids are lipids made from chloresterol. Steroid hormones enter target cells and attach to the cell's DNA to either start or stop production of a protein (the gene product).

Examples: corticosteroids, oestrogen, testosterone, androgen

How do hormones help us respond to stress?

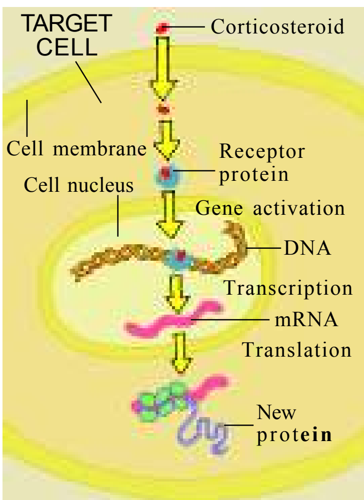
Upon sensing stress, the brain responds, sending signals to the adrenal glands





Immediate response:

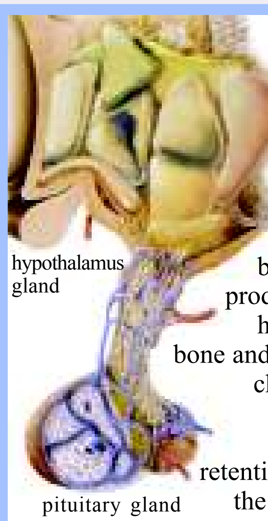
Increased blood glucose, blood pressure, breathing rate, and metabolic rate



Long-term response:

Kidneys retain sodium and water, increased glucose, increased blood volume and blood pressure, immune system may be suppressed

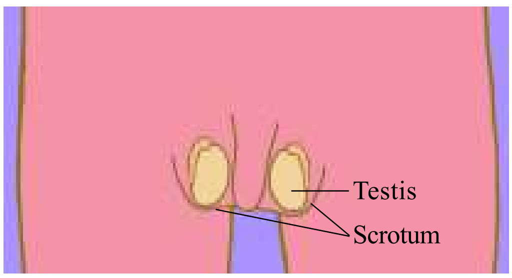
The Pituitary Gland



The pituitary gland, located in the brain, produces hormones that regulate hormones produced by other glands. It also produces several different hormones that regulate bone and muscle growth, body changes at puberty, the menstrual cycle, child birth, lactation, water retention in the kidneys, and the male sexual response.

Males have testes instead of ovaries

A testis gland hangs inside each scrotum. After puberty, in addition to producing sperm, the testes produce testosterone, the hormone that stimulates growth of facial and genital hair, a deeper voice, and muscle and bone growth.



9 OUR URINARY SYSTEM

The urinary system regulates fluids in the body. The kidneys help maintain the amount, chemical composition, and acidity of fluids. They do this by collecting water and wasteproducts from the blood and excreting them in the form of urine. Urine is stored in the urinary bladder before it is excreted through the urethra.

Why do we drink water?

Our body is about 70% water. Some parts are more or less watery: the grey matter of the brain is about 85% water; fat cells contain only about 15% water.

A person normally takes in between 1.5 and 3.5 litres of water each day (in both food and drink), depending on how hot and dry the weather is. Obviously we cannot keep accumulating all that water - our body gets rid of the same amount of water as it ingests.

So why do we need to keep taking in water each day?

(1) To sweat. When we sweat, water evaporates from our skin, which removes excess heat from our body. So the hotter we get, the more water we need to drink. About 40% of the water we take in leaves as sweat.

(2) To wash the insides of our bodies - to remove waste products. This is what the urinary system does. About 60% of the water we take in leaves as urine.

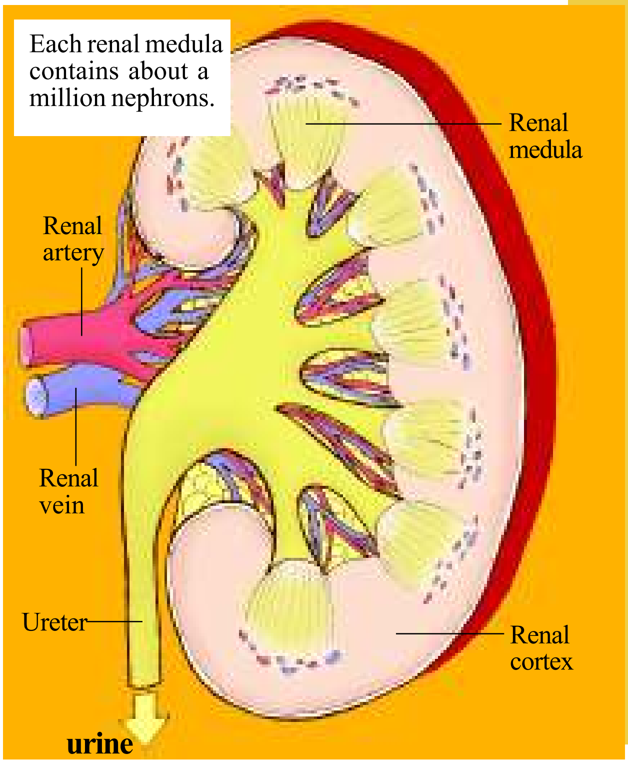
How do the kidneys remove wastes from the blood?

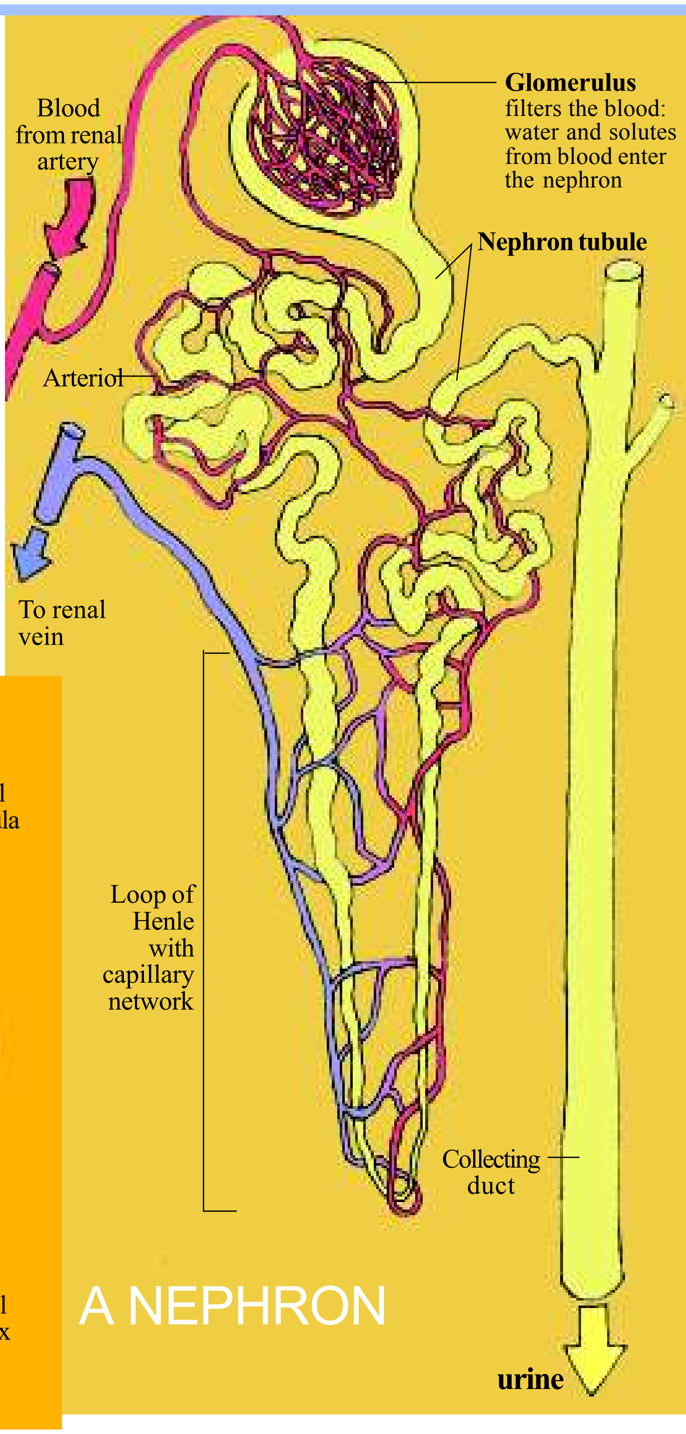
Each kidney contains millions of nephrons, which filter the blood that passes through them. In the nephron, capillaries pass through the glomerulus. Slits in the glomerulus prevent blood cells and larger molecules from passing out.

The acidity and concentrations of various substances in the blood are maintained by diffusion and active transport of excess amounts into urine collecting tubules.

The urine is composed of water (about 95%), potassium, bicarbonate, sodium, glucose, amino acids, and the waste products urea and uric acid.

THE KIDNEY





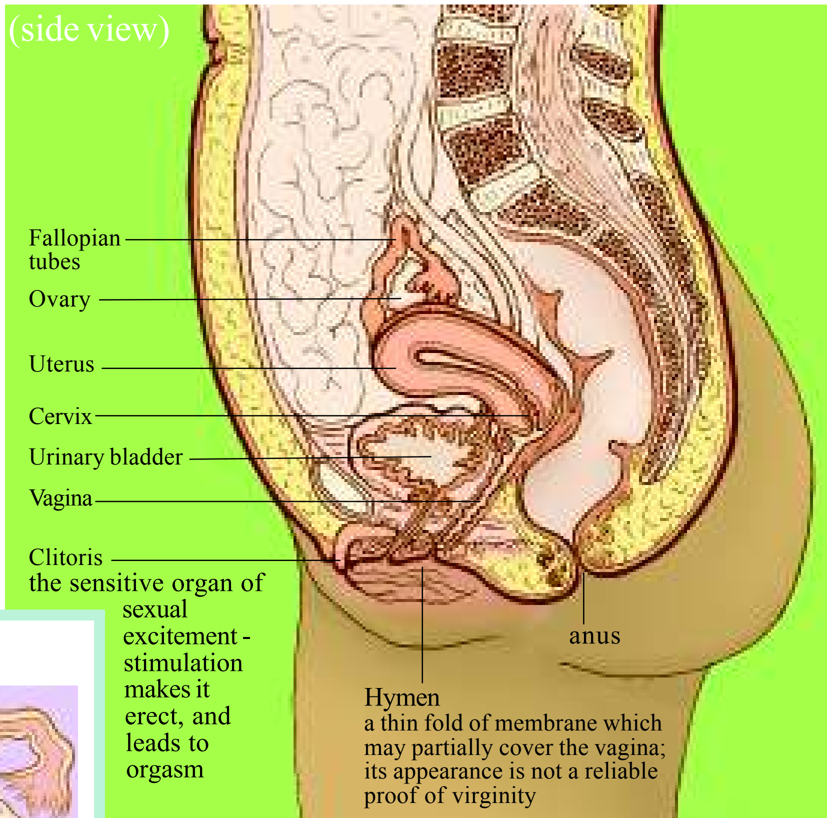
A NEPHRON

10 OUR REPRODUCTIVE SYSTEM

In this drawing, the uterus has been cut open to show the developing fetus it protects and nourishes

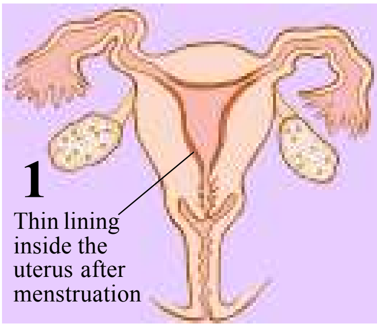
The survival of the human population is maintained by reproduction. In order for sexual reproduction to occur, a woman's ovaries produce ova (eggs) and a man's testes produce sperm. After an egg has been fertilised by a sperm, it grows inside the woman's uterus to produce a new human being.

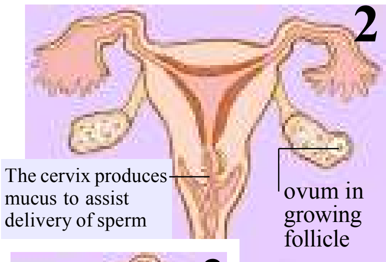
Female Reproductive Organs



The Menstrual Cycle

Between the ages of about 12 and 50, a woman produces one ripe ovum about every 24-30 days. The ova are all present in the ovaries at birth, but they are not ready to be released.



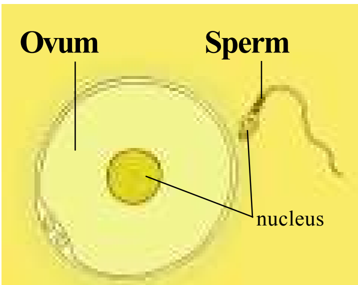


Now one ova is almost ready. The lining of the uterus has also thickened in order to get ready to nourish a fertilized ovum.

Ovulation: the ova is released, to go into the fallopian tube, where it may be fertilized by a sperm.

In case fertilisation does not occur, the lining is shed (menstrual bleeding).

...then a new cycle begins.



Each consists of a single cell, although the egg is much larger than the sperm.

At **conception**, a female egg, or ovum, is fertilized by a male sperm. The DNA in the head of the sperm enters the ovum, to be combined with the DNA in the nucleus of the ovum.

Male Reproductive System

Men produce sperm in their testes. During sexual stimulation, sperm travel through the vas deferens and are added to the fluids produced by the prostate gland and seminal vesicles, to make semen. Semen is ejaculated through the erect penis into the woman's vagina in order to fertilise an ovum.