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101 Facts About the Human Body

Simply Explained and Illustrated!

By Radhika Venkata

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About the Author

Dr. Radhika is a Pathologist by profession and likes to share her medical knowledge with others.

She loves to spend time with family and her computer.

She used many of the questions asked by her own two children as the basis for this, her third book published by eBookwholesaler.

She wrote '101 Facts About the Human Body - Simply Explained and Illustrated!' for you to learn from and to share with your children, so that they have accurate information to help them be comfortable with their own bodies and understand why it is so important to eat the right foods, exercise and generally look after themselves.

Dr Radhika has also studied Web design using the php/MySQL language. Dr Radhika has also studied Web design using the php/MySQL language. Her current project is her website, **http://www.pathology-world.com/**

Dr Radhika's favorite saying is, "God doesn't require us to succeed; he only requires that you try" - *Mother Teresa*

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Part I: Our Senses

Our Eyes and Vision

Why do we have to constantly blink our eyes?

We blink our eyes about once every five to seven seconds. Mostly, we don't even know that we are blinking our eyes.

If you deliberately keep your eyes wide open for a few minutes and stop yourself blinking, your eyes will start to feel like they are dry after a while.

You will feel this dryness when you are watching your TV or computer and forget to blink.

If you do not blink, then your eyelids cannot smear the tears from lacrimal glands and oily secretions from your 'meibomian glands' over the eyeballs to keep them moist.

There are some glands called 'meibomian glands' under your eyelids. The oily secretions from these glands mix with tears and keep a moist layer on the eyes.

This moist layer prevents the surface of your eyes becoming dry. If the eyes are dry, the conjunctiva (white part of the eye) and the cornea (black area in the centre of your eye) may become damaged and get infected.

Also, when we blink, the eyes are protected from dust being deposited on our eyes.

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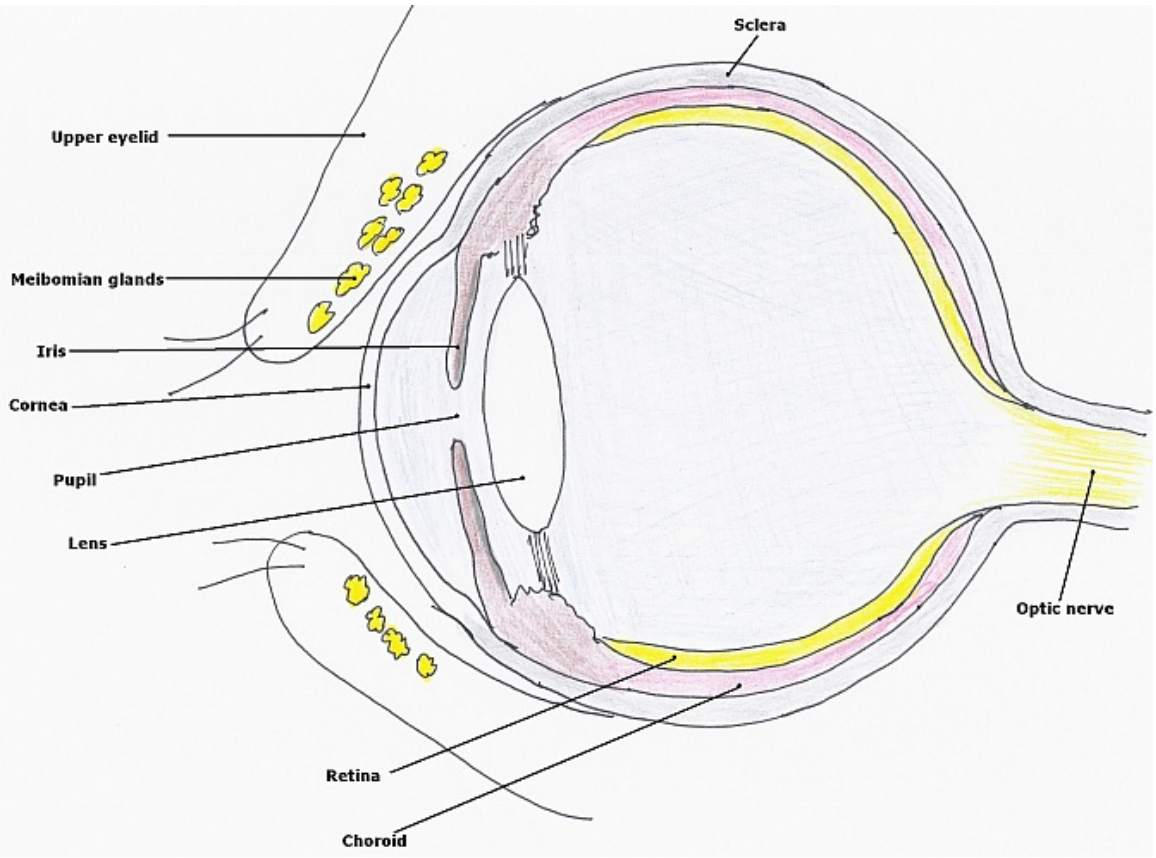


You can see the tiny meibomian glands in both the upper and lower eyelids in my picture. There are more in the upper eyelid.

They keep the eyes moisturized by producing an oily secretion and releasing it onto the eye through tiny ducts.

What happens to the eyes when they are dry? When the conjunctiva and cornea remain dry for some time, small areas of the surface become eroded. If not treated, they will get infected. When the eyes get dry and don't get any tears or secretions, it is called 'xerosis'.

If you stay in open places where there is lot of wind, you need to blink more often than usual to stop the drying effect of the wind on your eyes.

Can our Eye be compared to a Camera?

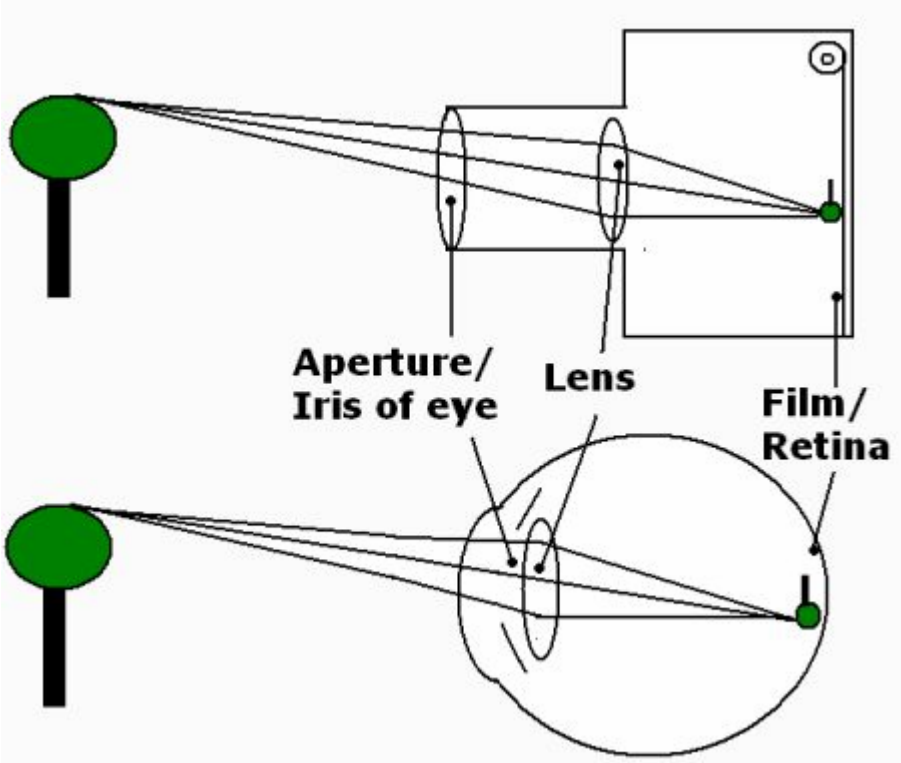
When you go to a picnic or a party, you might take your camera with you to get pictures of you and your friends. Right?

But, do you know you have TWO CAMERAS in your body?

They are your eyes! Each eye acts like a camera. In the same way that you

focus your camera on the subject and click the button to get the image on the film, you focus your eye on the subject and get the image on the retina.

Here is a picture that compares the parts of human eye with a camera:



In the picture, both your eye and your camera focus on the object and get the picture on to the retina (eye) or screen (camera).

1. Light coming from the subject into the camera and eye.

2. Light passing through the camera opening and pupil of the eye.

3. The lens of the camera and the lens of the eye focus the image on to the screen and retina respectively.

4. A picture is created on the film and the retina. This picture will be small and inverted (upside down).

Comparing camera and eye:

Pupil of the eye = Opening of the camera (Light passes through)

Lens of the eye = Lens of the camera (Focuses on the subject. We adjust the camera lens. The lens in the eye is adjusted by the process called 'accommodation')

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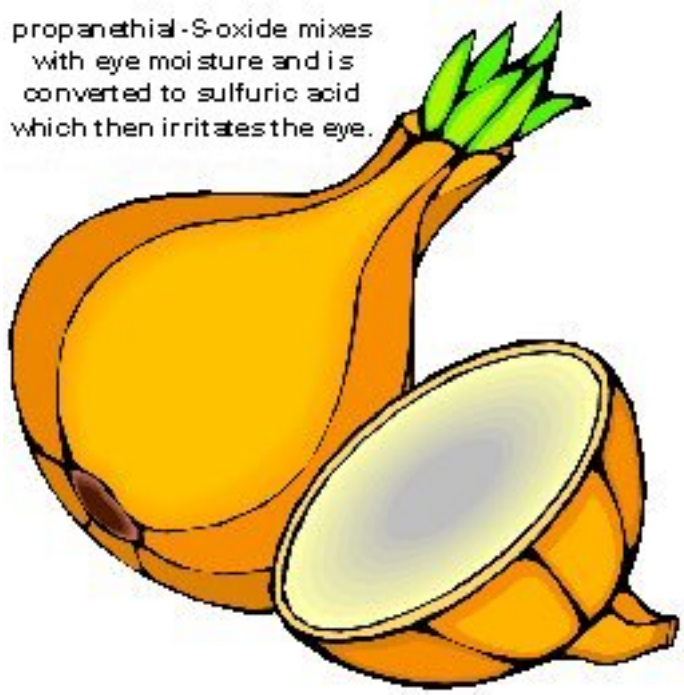
Retina of the eye = Film of the camera (Picture image is created)

Why do our eyes water when we cut onions?

There are sulphur compounds in the onion which irritate our eyes.

When we cut the onions, we damage the cells of the onion. The Synthase enzyme in the onion cells comes in contact with amino acids called sulfoxides. These sulfoxides are converted into Sulfenic acid.



This unstable sulfenic acid changes to propanethiol-S-oxide gas which forms mild sulphuric acid when it mixes with the moisture in our eyes. This acid irritates the eye and our lacrimal glands produce tears to wash out this irritant.

To reduce the irritation, wash your onions under water.

Why can't we see well when we go from bright light to a dark room?

Our eyes have two types of receptors in the retina.

1] Cones for seeing color. When we go into a lighted area, the cones provide our vision; the colors and the objects are bright. This type of vision by the cones is called '**Photopic vision**'.

2] Rods for night vision. When we are in a dark area, the rods provide vision called '**Scotopic vision**'; we see things as grey or black and cannot appreciate the details or colors of objects in the dark.

When we move from bright light to a dark area, we can't see very well for a while because the rods adapt more slowly than the cones. It may take from 25 to 60 minutes for the rods to get their full functionality.

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So, it will take few minutes for us to see well in the dark. This is called '**Dark adaptation**'.

But, cones get to work more quickly. If we move from a dark area to a light area, most people can see well almost instantly.

Why are people with Color blindness advised not to drive vehicles?

A person with color blindness cannot recognize certain colors. The most common color blindness is 'red-green color' blindness. Nine percent of the male population has some sort of red-green blindness.

Red-green blindness is inherited as an 'X-linked' disorder. This means that it only occurs in the male.

An opthalmologist uses a set of color plates, called Ishihara Charts, to detect color blindness. With most of the pictures, people that have normal vision see a particular number in the chart. When someone gets a different result from looking at the plates, the specialist can work out what type of color blindness the patient is showing.

If people have a problem with color differentiation of red and green, it will be difficult for them to see the colors of traffic lights.

Some people think that they can compensate for that deficiency because they are familiar with the position of the lights; red on the top, yellow in the middle and green at the bottom. If the intensity of the light changes, then they will know which traffic light changed.

But, it would be dangerous for them to drive when away from their original surroundings or under stress, and they would be a risk to other drivers too.

Can we walk straight with our eyes closed?

Probably not, unless the person is trained to do so.

A person's balance depends on three factors.

1. **Vision:** Vision helps us to adjust our body to the environment. We use our eyes to see the objects, set a target and direct ourselves on a straight path.
2. **Inner ear:** There is a part called 'vestibular apparatus' in the inner

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ear. It maintains the body balance by sending information of our body position with respect to gravity.

3. **Proprioceptors:** There are many receptors in our joints, ligaments and muscles. These receptors send signals to the brain continuously so that we know the position of our body parts in relation to each other.

These three factors work together to maintain our body balance so we don't fall or do any un-coordinated movements.

Why can't we walk straight?

If any of the above three systems are damaged or not used, the person tends to sway from the straight line. For example, if a person closes his eyes, they cannot walk straight unless they have had special training. Most people tend to move towards the right side of the straight line if they close their eyes and try to walk straight.

How do our eyes interpret a moving object in a movie?

How can our eyes see a person moving on a TV screen or in a movie theatre screen even when the film strip has still images of the person?

This effect is called 'critical fusion frequency'. (Ref. Ganong - Physiology). Critical fusion frequency is the rate at which the frames of a film are interpreted as separate images. When the images are displayed to you more rapidly, you no longer perceive separate frames and the object seems to be in continuous motion.

This principle is used to make movies. The normal rate is 24 frames per second. If we see 24 frames showing a puppy in one second, we will appreciate them separately. If we see 50 photos of a puppy in one second, the retina cannot separate them, so it looks like the puppy is moving.

Where do we get the water for our tears when we cry?

When a person cries or if he laughs too much, tears comes out of the eyes. Where are they coming from?

There are small glands called 'lacrimal glands' on the outer top corner of the

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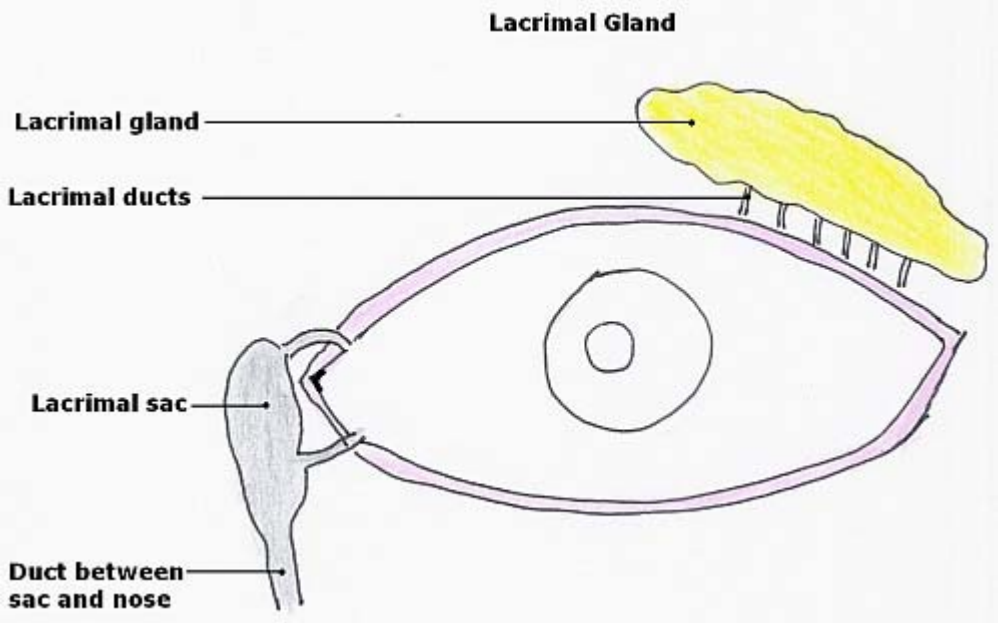
eye. These glands actually produce tears and store them there. When we cry, the muscles around these glands squeeze the glands. The tears are secreted through the fine duct over the eye.



Lacrimal gland that produces tears.

Why are tears useful?

With every blink, tears are spread over the eye surface of our eyes from our lacrimal glands. This keeps the cornea moist and prevents it from drying.

Tears have anti-bacterial properties which keeps the germs away from the eye surface.

Is crying necessary?

Scientists have been doing research on crying for many years, asking questions like;

what are the brain pathways controlling crying?

Why and how has crying developed?

One benefit that is well known is that many people feel calm and relaxed after they cry.

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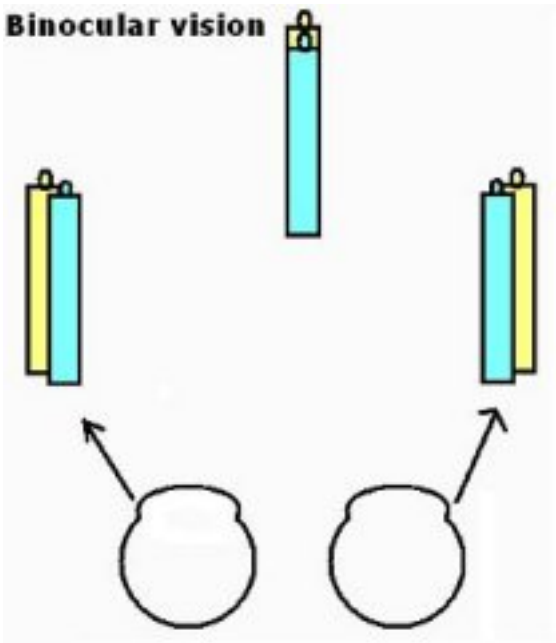

Images formed in two eyes are slightly different. Brain interprets both and forms a single and accurate image.

What is the advantage of having two eyes?

Looking with two eyes is called 'Binocular vision'. ('bi' means two, 'ocular' means eyes). Put a pencil down on the table in front of you.

Gently close only your right eye and look at the pencil.

Now, without moving your head or the pencil, open your right eye and gently close only your left eye.

When you do this properly, it will seem like the pencil appears in a different position when seen by each of your eyes.

Now open your both eyes and look at the pencil. Your brain uses the slightly different image from each of your eyes to locate the pencil's position as accurately as possible.

When the brain receives two images from the two retinas (when both eyes are open), it processes both images and interprets the depth and distance of the object correctly. If one eye is closed, the brain receives only one image from one retina and doesn't have a second image to compare it with. Then, how you see the object is how it looks in that single field.

People who have poor sight in one of their eyes have difficulties with pouring coffee into the cup, picking things up, etc. Binocular vision helps you to know the position of the object correctly.

How do our eyes distinguish different colors?

What happens if we can't appreciate or distinguish different colors? Everything looks grey, like a black and white movie.

There is a thin layer called the 'retina' at the back of our eyes. The retina has

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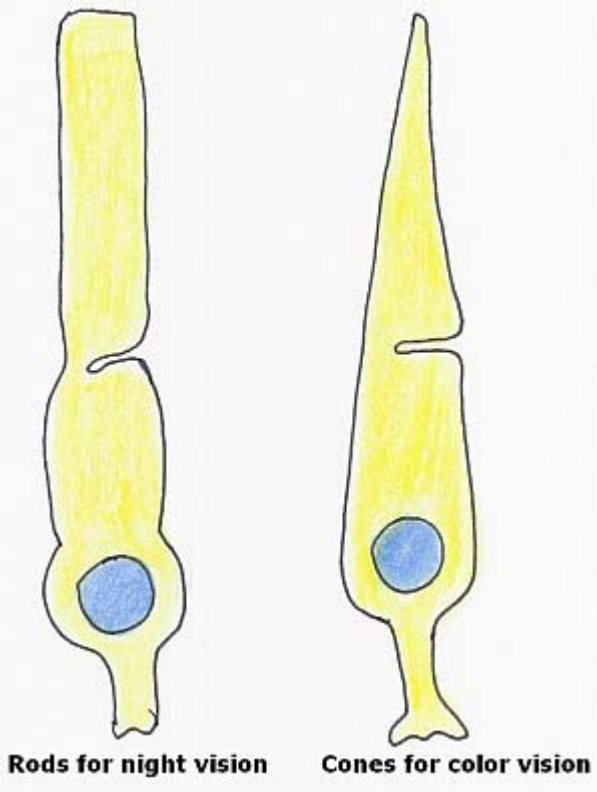
two types of cells called:

1. **Rods:** The rods help you to see when it is dark. There are about 120 million rods in each human eye.

2. **Cones:** The cones are useful for color vision. They help you to appreciate all the colors around you. There are about 6 million cones in each human eye.



The Rods and Cones are activated by light. Once they are activated by receiving the light, they send signals to your brain. The brain interprets what the object is and the colors which are present.

About Cones:

There are three types of cones.

1) Short type, or S type, cones are stimulated by the color **blue** which is made of light rays with a short wavelength.

2) Medium type, or M type. Cones are stimulated by the color **green** which is made of light rays with a medium wavelength.

3) Long type, or L type, Cones are stimulated by the color **red** which is made of light rays with a longer wavelength.

These different types of cones are stimulated at different proportions to get color or color combinations.

A red apple would stimulate L type cones exclusively.

A green apple would stimulate M type cones exclusively.

A yellow apple would stimulate both L type and M type equally.

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What determines your eye color?

Why do some people have brown eyes, some have blue eyes and others have green eyes?

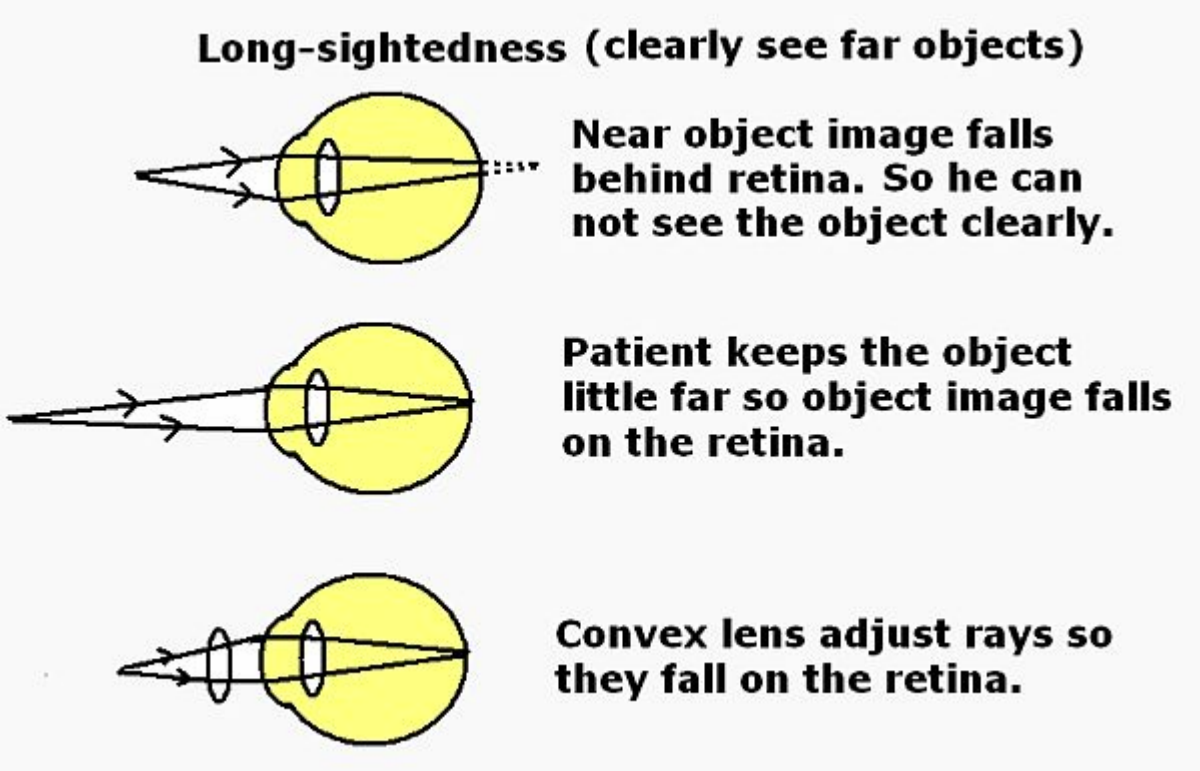
The color of your eye depends on the level of a pigment called 'melanin' in the iris in your eye. Brown eyes have a lot of melanin and blue eyes have only a little melanin.

If there is no melanin at all in the iris, that person will have very pale blue eyes. This condition is called 'Albinism'.

There are also some very complex genetic factors which we inherit from our parents that affect our eye color.

What is long-sightedness?

Long sightedness is one of the common errors with people's sight where the rays of light passing through the cornea (lens of the eye) are not properly focused onto the retina which converts the light into signals which it sends to your brain. People with this condition (called 'hypermetropia' by doctors) can see distant objects clearly, but they cannot see near objects as clearly.

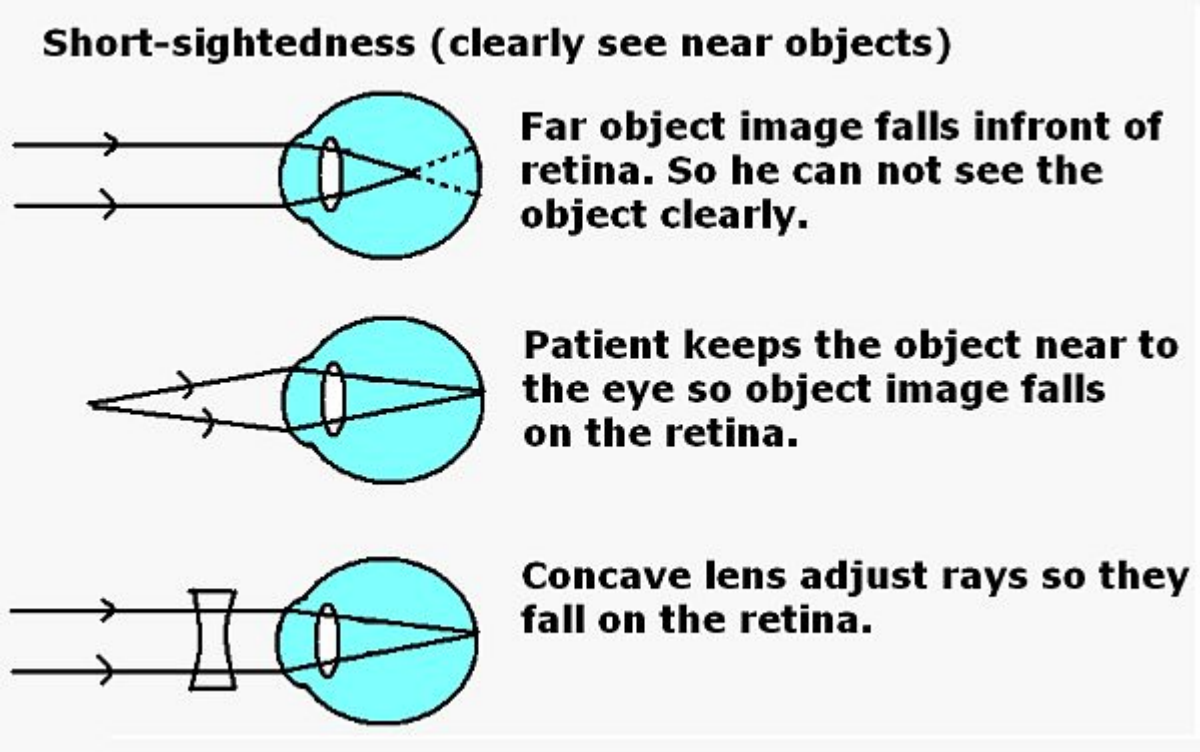


Long-sightedness causes the person's eye to not focus correctly on objects that are close. They need to move the object a little farther away to a point where it will be properly registered on the retina. The picture shows that the near object is focused BEHIND the retina. An ophthalmologist will advise this person to wear a 'Convex or Converging lens' which will help them to focus the light rays from the object properly onto the retina in their eye.

We think that long sightedness may happen when a person's eyeballs are shorter from front to back than normal, so that the image does not focus properly onto the retina. Another possibility is if the lens of a person's eye is thinner than normal.

What is Short sightedness?

Short sightedness is, like long sightedness, a type of refractive error. It is also called 'myopia' by doctors. People with this condition can see objects which are near them clearly, but cannot see distant objects as clearly.



When a person is s**hort-sighted**, near objects are focused correctly on the retina in their eye but not distant objects. So, they will move that distant object a little closer to help it be properly focused on the retina.

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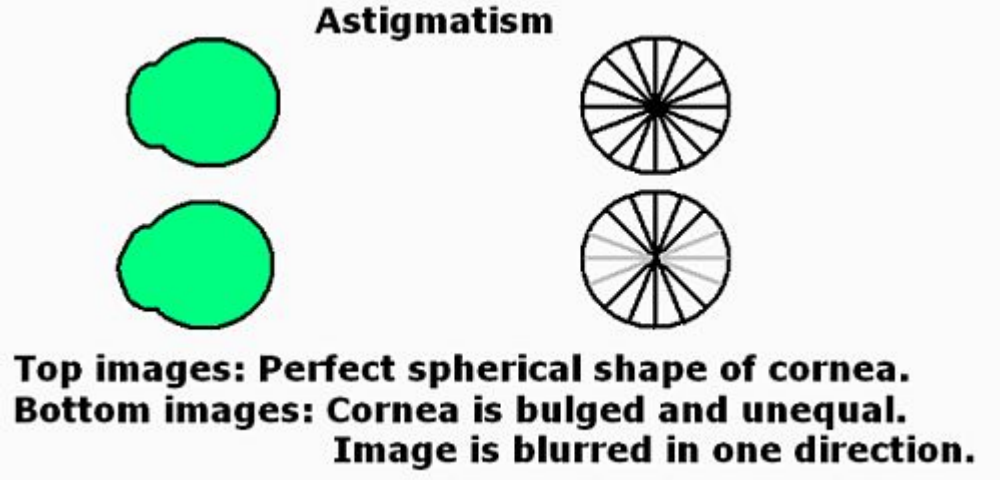
In the picture, the distant object is focused short of the retina. So, the ophthalmologist will advise the patient to wear a 'Concave' or 'Diverging' lens, which will help to properly focus the image on their retina.

We think that near sightedness might be caused when a person's eyeballs are longer from front to back than normal or when the lens of their eye is more curved than usual.

What is Astigmatism?

Astigmatism is another refractive error of the eye. The surface of the cornea (clear domed structure at the front of the eye) or the lens will have a different curve to normal and images are not focused properly on the retina. With this condition, rays from the vertical plane are focused properly on the retina, but the rays from the horizontal plane are not, so the image which their brain produces is blurry.



Specialists use specially shaped lenses to correct this error. Most people will have mild astigmatism that can be easily corrected by a properly prepared lens.

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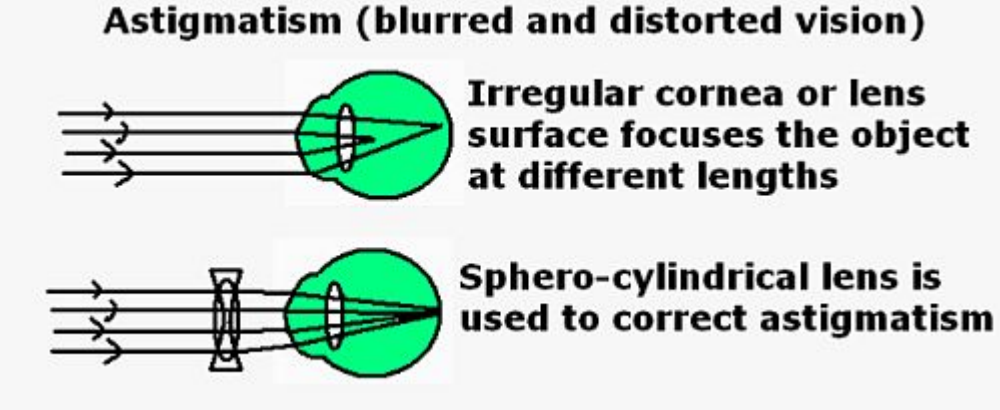

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Our Senses

Our Ears and Hearing

Why do some people get pain in their ears in an aircraft?

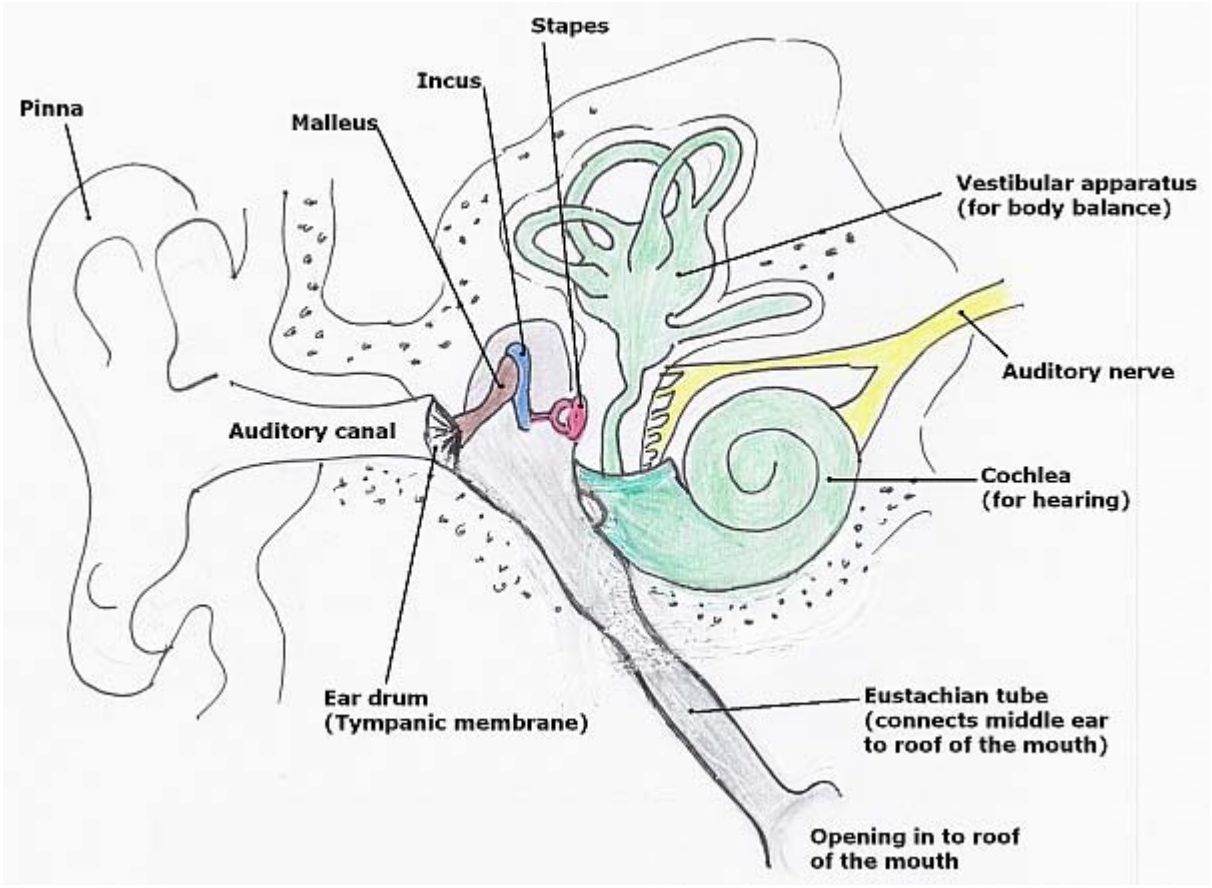
Have you experienced pain in your ears during a flight or have you seen somebody with that condition?

Children may cry a lot if they suffer because of this as it is very uncomfortable.

There is always some air in the middle ear cavity. The pressure of this air is equal to the pressure of the air in the environment around the person.

The pressure is kept that way by a connection called 'eustachian tube' between your middle ear and the roof of your mouth.

When we swallow or yawn, our eustachian tube opens up and air goes into the middle ear.



The eustachian tube connects the middle ear and the roof of the mouth. It

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opens up during yawning, so pressure in the middle ear is equalized with that of your surroundings.

The pressure in an aircraft changes rapidly, especially when taking off and landing.

The difference in pressure between the middle ear cavity and your surroundings makes the tympanic membrane stretch. That causes the pain.

So, you might yawn or swallow several times while your plane is taking off or landing. People also chew gum or suck on a piece of candy so the eustachian tube keeps opening and shutting.

Is there a Hammer in our body?

You know that a hammer is a tool used to hit nails in the walls, don't you?

You might have seen a relative using something to push a nail into the wall or some wood. That is the hammer.

Is there a hammer in our body? Yes, but it's not much like that big hammer your relative was using. It is a small, hammer-shaped bone in your ear.

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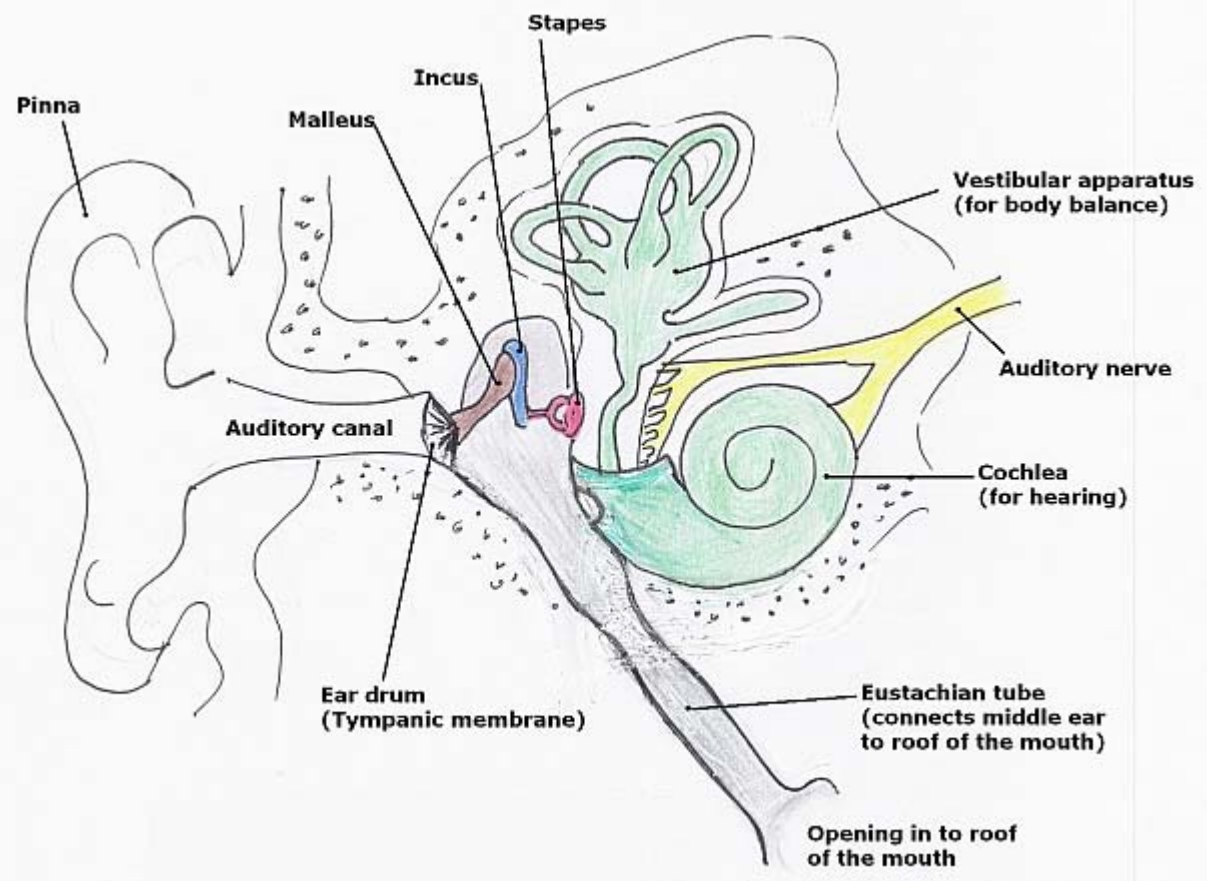

How do we hear?

1) Sound goes through the auditory canal.

2) That causes the tympanic membrane to vibrate.

3) The tympanic membrane vibrates the three small bones called ossicles

4) The stapes transmits the vibrations to the cochlea

5) The cochlea sends the signals to the brain through the auditory nerve.

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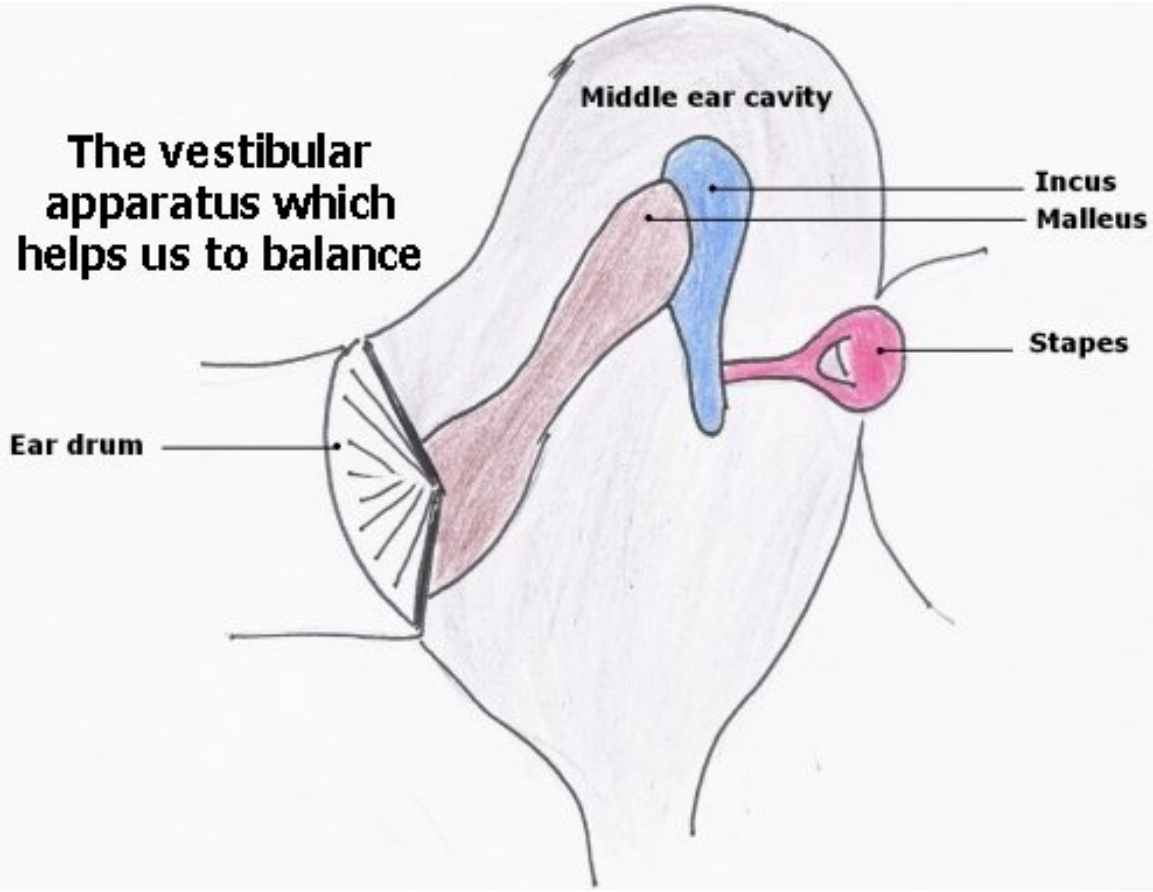

Here is a picture of the ear. Inside the middle ear, you can see THREE small bones called 'ossicles'.

Malleus: (hammer shaped) bone

Incus: (anvil shaped) bone

Stapes: (stirrup shaped) bone

These three small bones unite with each other to transmit the vibrations from the tympanic membrane to the inner ear.

The Malleus is attached to the tympanic membrane on one side and the Incus on the other side.

The Incus is the middle bone between the Malleus and the Stapes.

The Stapes is attached to the Incus on one side and an oval window of the inner ear.

In the inner ear, the vibrations are processed. Then, signals are sent to the brain for further interpretation of the sound.

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If these ossicles are damaged by infection or injury, an 'ear, nose and throat surgeon' will operate to replace the damaged bone with a new piece of bone taken from elsewhere in the body.

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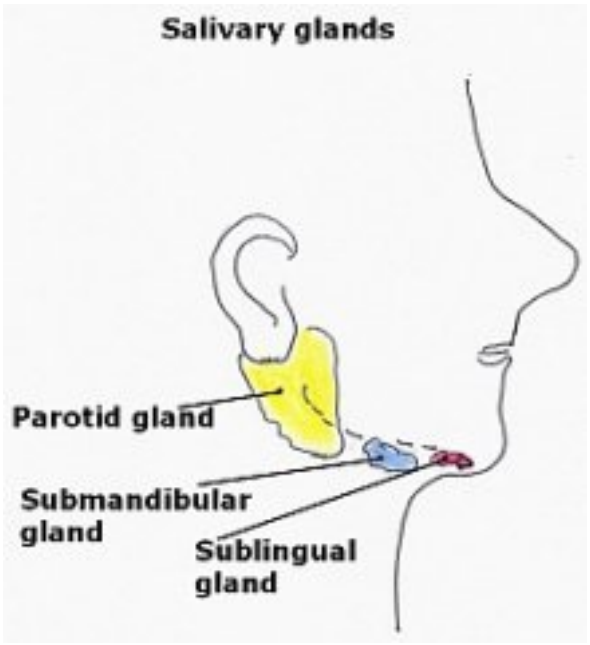
Our Senses

Taste

Why can't we appreciate tastes if our mouth is dry?

Our tongue has around 10,000 taste buds which are the sensory organs which detect how things we consume taste. The taste buds are 'chemoreceptors' that detect four kinds of taste; sweet, bitter, salty and sour in their response to the chemicals in our food.

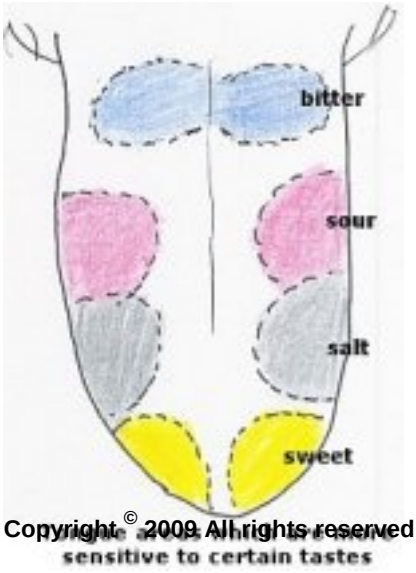


The receptors need the substance to be at least partly dissolved in our saliva which fills the pores of our taste buds and activates them.

When you have a dry mouth, there is not enough saliva to bring the food molecules into contact with the receptors, so you cannot properly appreciate the taste of what you are eating.

The three major salivary glands are called the parotid, submandibular and sublingual glands. Most saliva comes from the submandibular and parotid glands to help keep the mouth moist and assist digestion.

Which part of the tongue is sensitive to different tastes?



Taste buds are distributed throughout the surface of the tongue, so any part of the tongue can appreciate every taste. Certain areas of the tongue are believed by many experts to be more sensitive to certain tastes, but this map is not accepted by some authorities.

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Our Senses

Smell

Why can't we smell the same odour after a while?

When you enter the kitchen, you can smell your mother's hot baking cookies. After staying for some time in the kitchen, you may notice that you cannot smell the cookies anymore.

The nose has 'olfactory receptors' (smell detectors) in the nasal mucosa on the roof of the nose. When an odour molecule dissolves in the mucosal fluid, it stimulates the olfactory receptors which send signals to the brain.

Your brain interprets the type of smell you are experiencing.

Olfactory receptors are so sensitive that as few as eight odour molecules dissolved in the mucosal fluid can trigger them.

Humans can detect some thousands of smells. But, this is nothing when compared to the olfactory sensitivity of a dog. Your dog can detect millions of smells!

The olfactory receptors are 'phasic' or 'dynamic' receptors. This means that when they continue to detect the same smell continuously, they decrease the signals which they send to the brain. After a while, they slowly stop sending signals about that smell to the brain.

This is why we stop smelling the same odor after a while.

When we move away from the source of that smell, the olfactory receptors slowly regain their sensitivity to the odour for the next time you encounter it.

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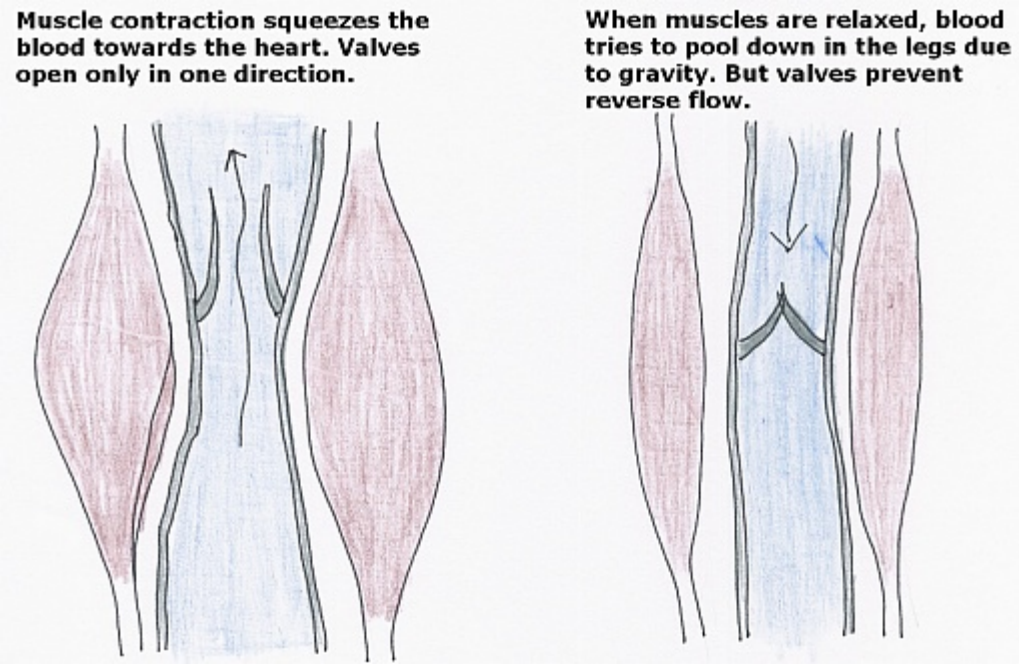
Blood and Circulation

Why should we avoid sitting too long?

The human body is designed to be upright and active. We stand on our legs and move around.

When we stand, the pressure in the blood vessels in the lower body is higher than that in the blood vessels near our heart. Since the blood can't move from higher pressure to lower pressure, we need some mechanism that pushes the blood towards the heart.



Venous system of the leg – Some call it a 'SECOND HEART'.

There is a pumping system in our legs. It is provided by our leg muscles which squeeze the deep veins between them when we walk or run, and that causes the blood to be pushed up toward the heart.

Our veins have flaps, called 'valves' that stop the blood flowing backwards after the muscles relax. These valves close when the muscles relax and that stops our blood pooling in the lower legs.

When we sit for long hours, this pumping mechanism does not operate and we feel heaviness in the legs. This can cause blood pooling and damage to valves. People who sit for long hours should take regular breaks and move

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about for at least a few minutes each time.

Why do you sometimes feel dizzy when you get up?

If you are lying down and get up suddenly, you may feel dizzy or light-headed for a few seconds. This is called 'postural' or 'orthostatic' hypotension.

It is caused by low blood pressure. Our blood vessels usually start to tighten when we get up, to help maintain the supply of oxygen-rich blood to the brain.

If we get up so suddenly that they do not tighten enough, less blood is available to our brain and symptoms like mild dizziness or blurred vision may happen.

This is common. But, if it occurs frequently, even when we get up more slowly, then we should consult our doctor because it may be a symptom of a treatable condition such as loss of fluids from the body, fever or heart problems.

What are the Odd Artery and the Odd Vein in our bodies?

Put your left hand on a table with palm facing up. Now, put your right index and middle finger just above the wrist (1 or 11/2 inch above wrist line) a little left to the center. Press lightly. Do you feel pulsations from an artery?

When your heart beats, it pumps blood in to arteries so whole body is supplied with oxygen. All body tissues need oxygen to live.

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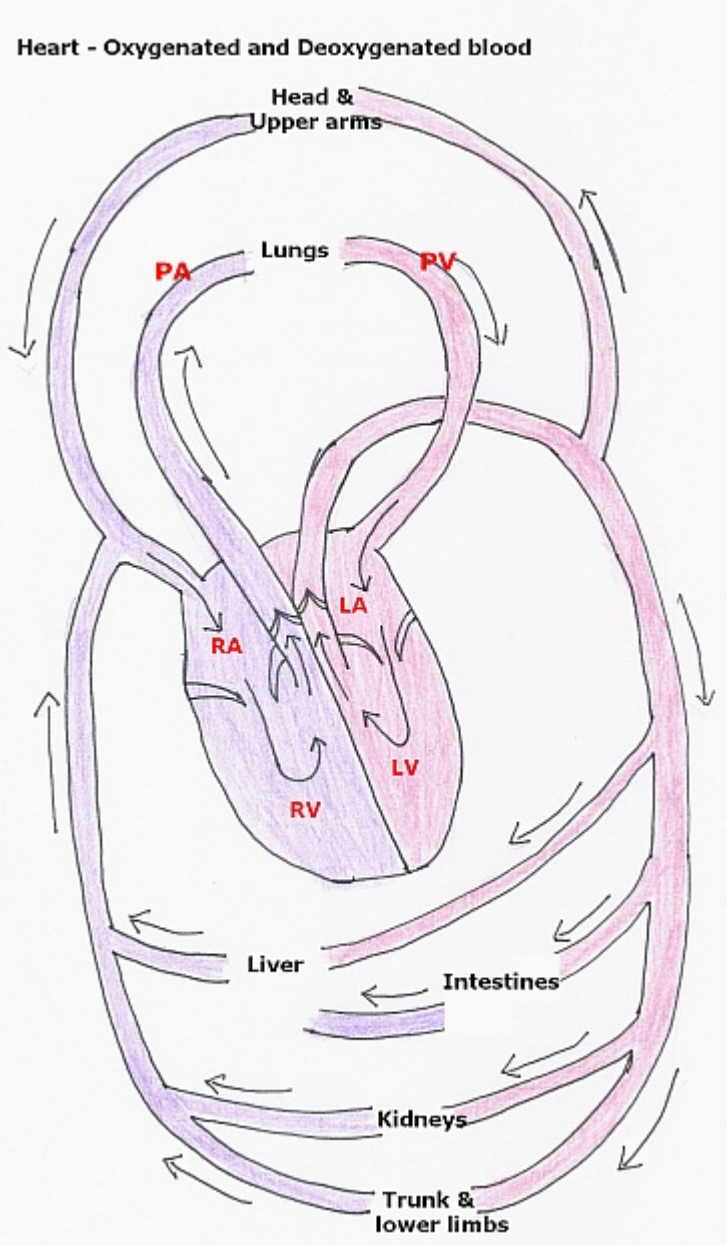

Circulation of blood:

Point #1: All arteries carry oxygenated blood and are shown in **red**. All veins carry deoxygenated blood and are represented by **blue**.

Point #2: Arteries ALWAYS carry blood from heart to body and body organs. Veins ALWAYS carry blood from body and body organs to heart.

Point #3: This is a simplified diagram. The arteries and veins in the body are NOT separated left and right side. In most cases each artery is accompanied by a related vein. e.g.: The artery which carries blood to the liver is called

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the 'hepatic artery'. It is accompanied by a 'hepatic vein' which carries blood towards the heart.

Point #4: The direction of the arrows shows the blood flow.

In the image, **PA** represents the pulmonary artery. It is supposed to carry oxygenated blood as it is an artery, but it carries de-oxygenated blood to the lungs to get oxygen from the lungs.

PV means pulmonary vein. It is supposed to carry deoxygenated blood as it is a vein, but it carries oxygenated blood to the heart.

Circulation: Oxygenated blood goes from left ventricle (LV) to the body and organs. The body uses oxygen and gives off carbon dioxide into the blood. This deoxygenated blood flows back to the right atrium (RA) and then to right ventricle (RV).

It goes from there to the lungs to get rid of the carbon dioxide and get oxygen.

Then, it travels from the lungs to the left atrium (LA) and to the left ventricle (LV).

Then, the cycle repeats.

An *Artery is a blood vessel that carries blood from the heart to the body organs.* Arteries carry 'oxygenated blood' (blood rich in oxygen). Your tissues need plenty of oxygen.

But, Yes - there is an odd artery!

It is called the 'pulmonary artery'. Though it is an artery and carries blood from the heart to the lungs, it carries poorly-oxygenated blood.

Once the artery supplies oxygen to tissue, the blood becomes less oxygenated. The de-oxygenated blood then travels through small vessels, called venules, in the tissues. The venules slowly merge to become veins which carry to blood back to the heart.

A Vein is a blood vessel that carries 'de-oxygenated blood' from body tissues (that used up the oxygen) *to the heart.*.

What is this odd vein?

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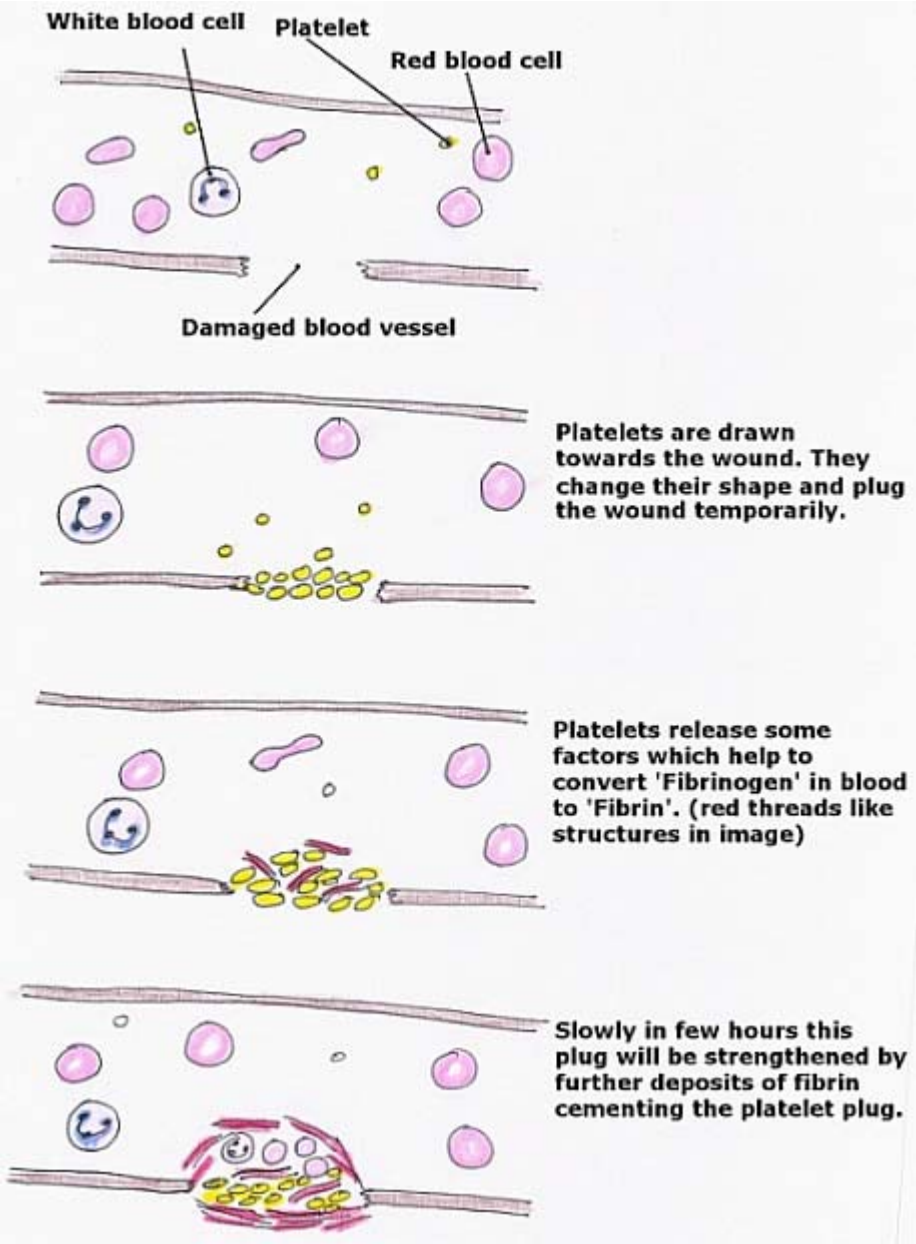
It is called 'Pulmonary vein'. It carries blood from the lungs to the heart but, unlike other veins, it carries blood that is rich with oxygen.

How does our body stop bleeding from a cut?

If there was no protective mechanism to stop the bleeding, we would bleed continuously from any cut to our skin. When there is a cut, blood pours out from the blood vessels under the skin.



Blood clotting near the damaged blood vessel.

There are tiny cells called 'platelets' in the blood. The platelets clump

together when they are exposed to air in the cut, forming a loose plug.

Some chemical substances from the damaged tissue change a blood protein called ‘prothrombin' to an enzyme called 'thrombin'. The thrombin, in turn, changes a protein called 'fibrinogen' to 'fibrin', which forms a strong plug over the leaking blood cells.

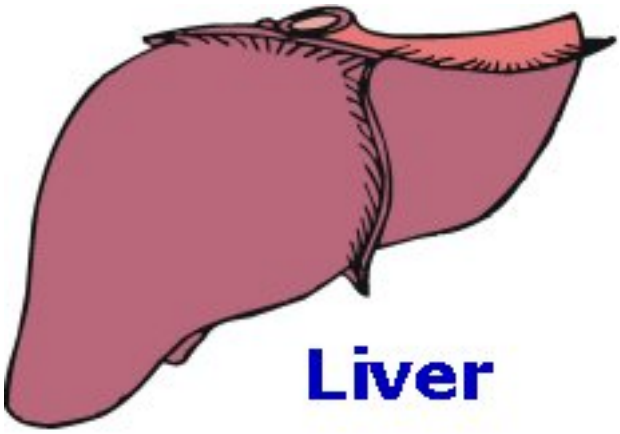
Did you know that you need Vitamin K and calcium for the blood to clot properly?

Keep your supply of these essentials at proper levels by eating green, leafy vegetables like spinach and broccoli as well as liver and cereals. For calcium, drink milk regularly!

Which organs in our body get the most blood?

BLOOD SUPPLY PER MINUTE:

Liver: 1500 ml per minute.



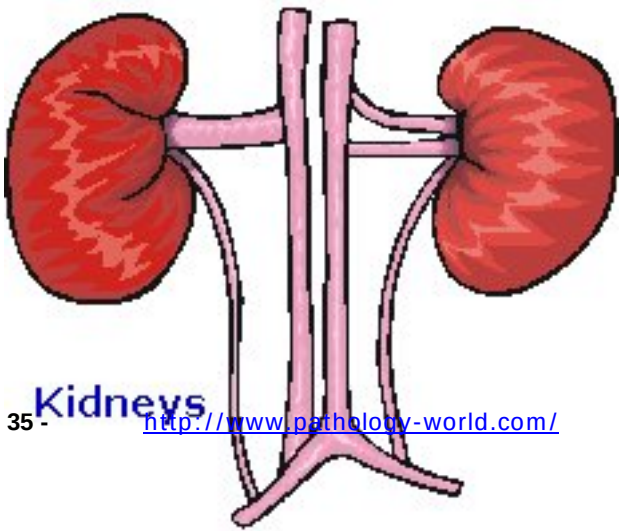
The liver is the organ with the highest blood flow per minute. It is around 1500 ml/min. (Ref. Ganong) The peculiarity of the blood supply to the liver is that 2/3 of the blood is venous blood and it is from the digestive tract (stomach, intestine, colon, spleen). The remaining 1/3 is arterial blood from the hepatic artery.

The liver participates in important body functions like storage, synthesis, modifying harmful substances to less harmful ones and cholesterol metabolism.

BLOOD SUPPLY BY WEIGHT:

Kidney: 420 ml per 100 gm weight per minute.

If we take the weight of the organ into consideration, the



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kidney receives more blood than the liver. The kidney is the organ which filters blood and absorbs vital substances from the filtered fluid and forms urine. Urine contains nitrogenous waste that needs to be eliminated from the body.

Whole blood in our body passes through the kidneys once within every 5 minutes to ensure that the blood is clear of nitrogenous wastes.

Why does your heart beat faster when you run?

When you run, your body needs more oxygen and energy, especially the leg muscles. The heart has to pump faster to satisfy this increased demand.

During running, hormones called epinephrine and norepinephrine are released from a gland called the 'adrenal gland' in our body. These hormones increase our heart rate and the strength of its contractions.

When you finish running, the heart rate of a healthy person should return to normal with just a few minutes of rest.

Why is Blood red in Color?

Our blood contains many cells; red blood cells, white blood cells and platelets.

The red blood cells are dumb-bell shaped when looked at from the side and look like discs from the front. There are millions of them in each drop of blood.

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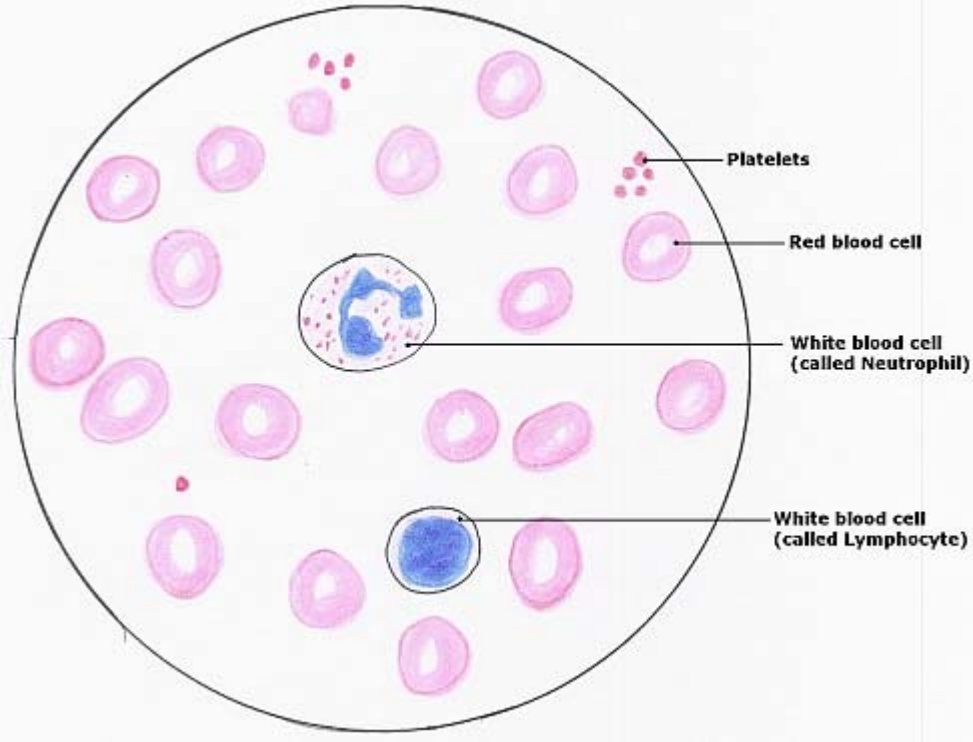

The red blood cells contain a protein called 'hemoglobin'. This hemoglobin is a combination of 'Heme', which binds oxygen to it and a 'globin chain' which is the protein part of the hemoglobin.

Hemoglobin contains elemental iron in the center.

The hemoglobin helps to carry oxygen from your lungs to the your body tissue and then carry the carbon dioxide back from the tissue to your lungs so that it can be breathed out.

When blood goes to your lungs and gets oxygen, it becomes bright red. You will see this bright red blood in arteries. Once the blood gives the oxygen to the tissues and takes back the carbon dioxide, it becomes dark red or bluish. You will see this dark red or bluish-red blood in veins.

What do I need to know about Hemoglobin?

The normal hemoglobin content in blood is about 16 grams per deciliter in men and about 14 grams per deciliter in women.

16 grams is about .56 (a little over half) of an ounce.

14 grams is about .49 (just under half) of an ounce.

A decilitre is about 3.4 (just under three and a half) fluid ounces.

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0.3 grams of old Hemoglobin is destroyed and 0.3 grams of new hemoglobin is synthesized (produced) every hour.

Each red blood cell has 97% of hemoglobin by dry weight.

Hemoglobin synthesis is very important and it relies on you eating food which contains iron. Meat, green vegetables and enriched cereals are rich sources of iron. You should get enough of the right foods every day to ensure the iron you need for making hemoglobin.

People are likely to get 'anemia' when the level of hemoglobin decreases in their blood.

Who are the universal donors and universal recipients?

Doctors test blood types before giving blood from the blood banks to patients. They do this to prevent any incompatibility reactions in patients because these may cause death.

There are 4 blood groups:

1) A

2) B

3) AB

4) O

The blood group names are based on the 'antigen' present on the red blood cell. If a person has an 'A' antigen on their red blood cell surface, he belongs to the 'A' blood group.

Like the antigen is on the red blood cells, antibodies are present in the liquid part of the blood (called 'plasma'). These antibodies are different to the antigens. If a person is in 'A' blood group, he has 'b' antibodies in his plasma.

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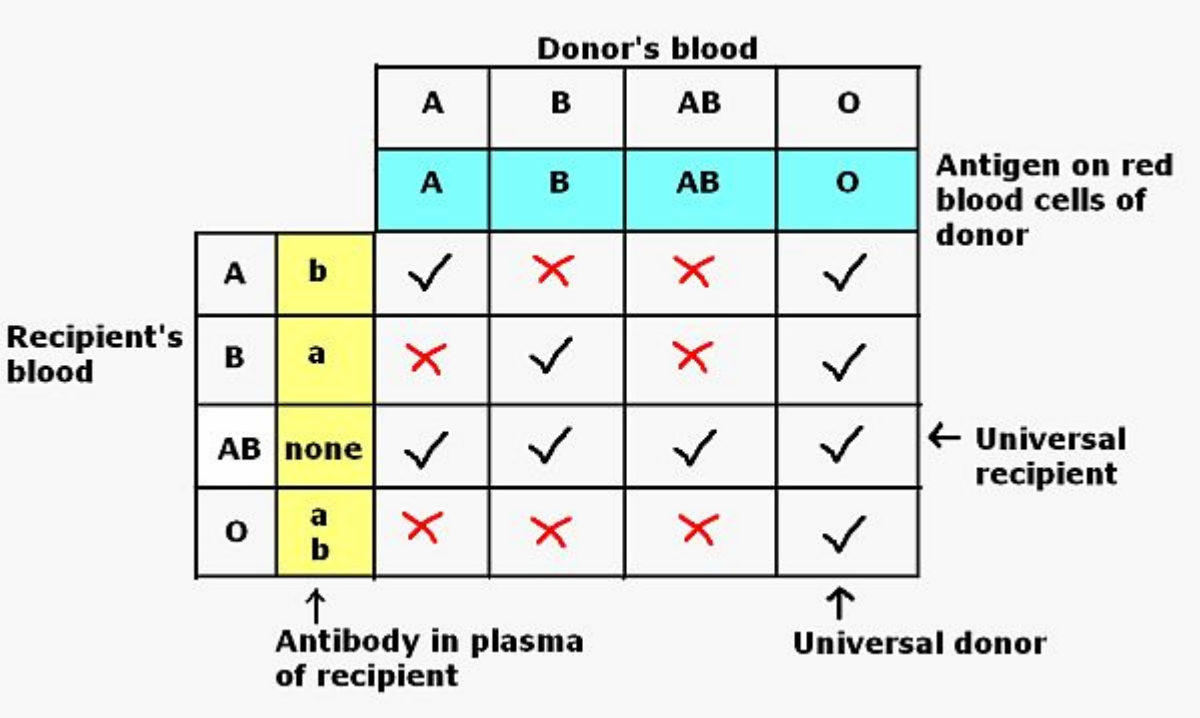

During a transfusion, the donor's antigen on his red cells reacts with the antibody present in the patient's plasma. If the donor has blood group A (which has antigen A) and their blood is given to a person with blood group B (who has antibody 'a' in their plasma), the red cells of donor and the antibody of the recipient will stick together and cause an allergic reaction.

The picture shows you that a person with blood group O is a universal donor. He can give blood to anybody because he has no antigen.

Someone with blood group AB is a Universal Recipient; they can receive blood from any donor because he has no antibodies to react with the antigens of the donor's red cells.

Why do we feel 'pins and needles' are in our arms and legs?

When you have been sitting on a couch with your both feet up for a long time, maybe watching TV, you might feel some prickly sensations in your feet. Or, perhaps you have fallen asleep while sitting at your computer and your head fell onto your hand and pressed it against the desk. Then, you got that same feeling in your hands. We call this sensation, 'pins and needles'.

It results from the blood vessels in your feet or hands being unable to get

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sufficient oxygen because of the abnormal position of your limbs.

Your head pressing against your hand reduces the flow of blood through the blood vessels there.

When you legs are raised and unmoving for a long period, less blood reaches your feet and so they get less oxygen for the cells in them.

These positions also cause pressure on nerves in those areas and, when they cannot transmit their impulses properly, you get the feeling of pins and needles.

When you take off the pressure on your blood vessels or nerves, that pins and needles feeling will slowly go away.

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Breathing and Related Topics

Why can't people breathe and swallow at the same time?

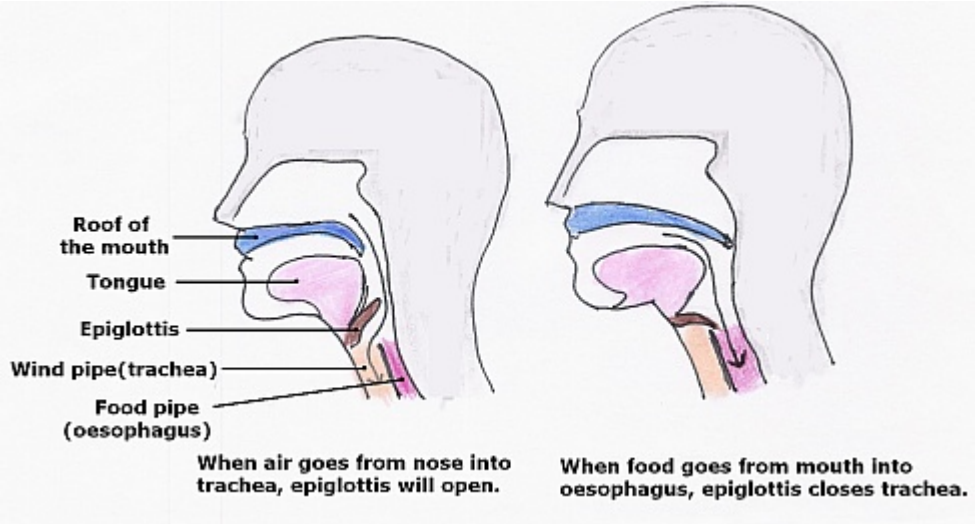
Food travels from the mouth food into the food pipe on its journey to our stomach.

Air that we breathe in goes from our nose goes into the wind pipe on its way to our lungs.

Both pipes are next to each other in the neck. But the food won't go into the wind pipe. Why?

First image: Breathing opens the epiglottis. Air goes into trachea (wind pipe - brown colored tube)

Second image: Swallowing the food closes the epiglottis and food goes into esophagus (food pipe - dark pink tube)



In the above picture, you will see the food pipe and the wind pipe next to each other. And there is a thin membrane called 'epiglottis' which closes the wind pipe when we swallow the food doesn't enter the wind pipe.

If a person is eating, talking and laughing at the same time, food can get stuck in the trachea and make the person choke.

So kids, be careful while eating!

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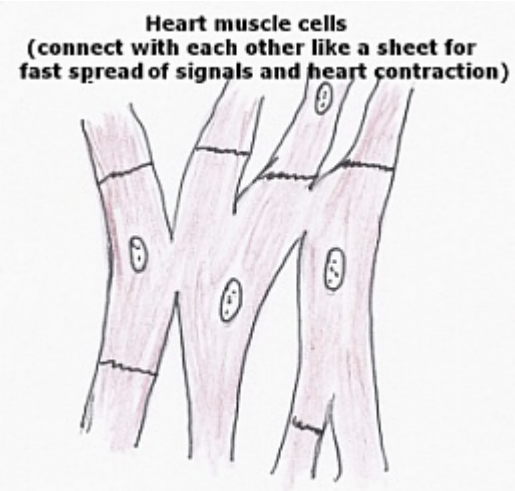
Cells

Are all cells in our body the same?

The cell is the basic building block of the body. A simple cell has some common features:

- A cell membrane
- A nucleus
- Cytoplasm (the contents of a cell, excluding the nucleus), mitochondria (the part of the cell which generates energy for cell) and
- Endoplasmic reticulum (a network of membranes where proteins are produced).

All of the cells in all the organs in your body have this basic structure but there are many different types of cells with special features that help them do the special task which each particular type of cell does.



Heart muscle: The heart muscle is made of 'cardiac muscle cells'. Each cardiac muscle cell has fine lines called striations in the cytoplasm (the part of the cell outside of its nucleus).

The cells are connected with each other so that the heart can smoothly contract as a single unit.

Neuron: A neuron is a nerve cell. It has a round cell body with many thin fibres projecting from it called dendrites. These dendrites receive impulses from the other neurons.

Each neuron also has an elongated thick fiber called an 'axon'. The signal received from dendrites is passed on to the next cell through the axon.

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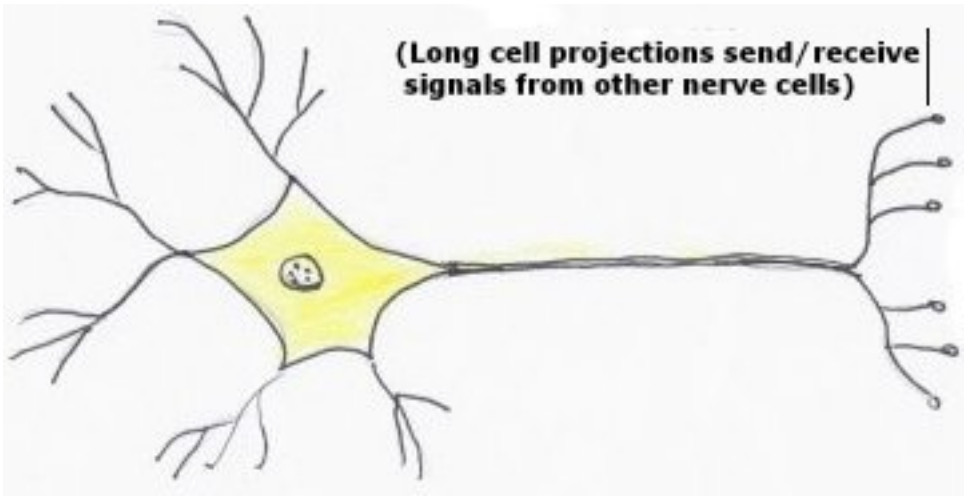
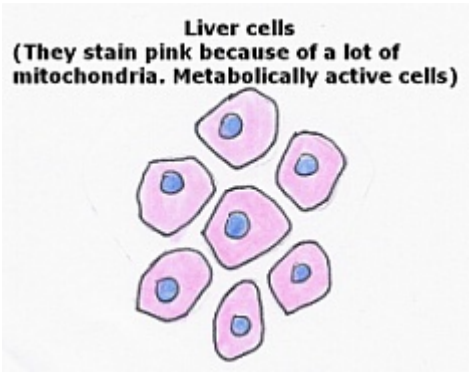


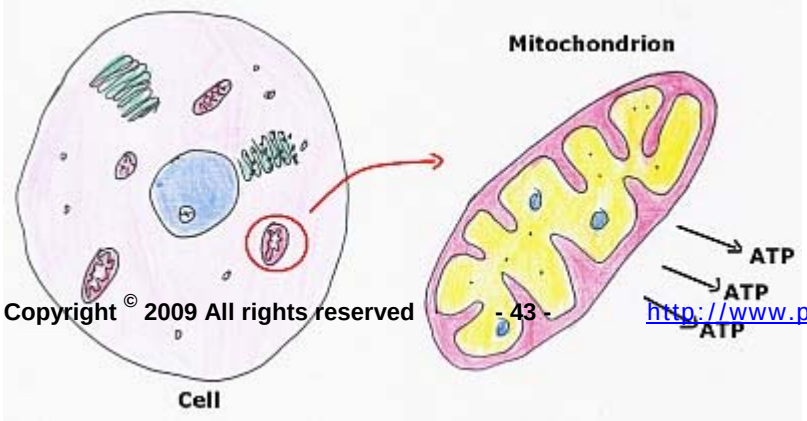
Liver cell: A Liver cell is a hexagonal (six-sided) cell with lots of mitochondria (that part of the cell which generates energy for the cell) and an endoplasmic reticulum (network of membranes where proteins are produced).



These liver cells specialize in protein synthesis, glycogen storage (your Liver stores glucose as 'Glycogen'. If you miss a meal, it slowly breaks down glycogen to glucose and releases it into your blood), producing bile from simple chemical compounds (bile synthesis), storage of Vitamin A and other vital substances, and converting toxic substances to less toxic and soluble substances so they can be excreted from the body.

Which specialized part of a cell is called the 'Powerhouse"?

Our body is made up of millions of cells. These cells are the same in basic structure but they differ in certain aspects. Every cell in the body needs energy for its metabolic activities like respiration, storage, synthesis and maintaining a normal internal environment.



Mitochondrion -

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The energy factory of the cell.

The organelle (specialized part of a cell) that produces the energy for a cell is called a **Mitochondrion** ('Mitochondria' are more than one Mitochondrion).

They have round or oval bodies, about one micrometer wide and 2 to 4 micrometers long. A micrometer is one millionth of a meter. A meter is about 36.4 inches.

Mitochondria create 'ATP' (Adenosine Tri Phosphate) molecules, which are used as energy in the cell, from cellular citric acid.

Can the cells in our body talk to each other?

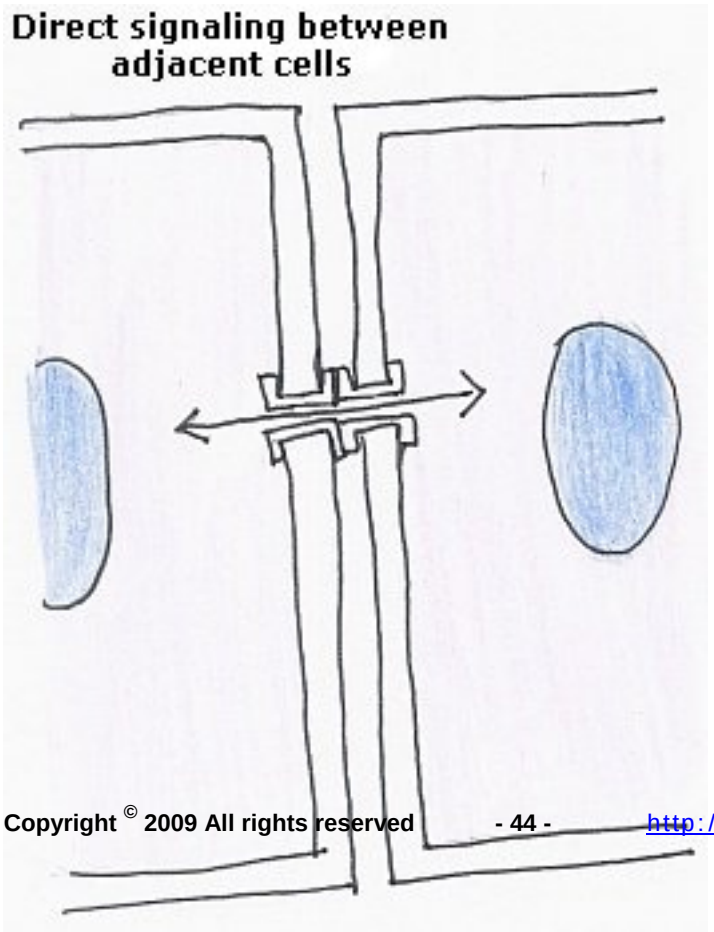
Yes. That's surprising, isn't it?

How can a cell talk to other cells?

We have a mouth and words to communicate with each other.

Cells can communicate with each other by means of 'cell signaling':

1. They communicate directly by contact
2. They release some short-lived chemicals which communicate with neighbouring cells
3. They release some long-lived chemicals which communicate with cells that are some distance from the cell which created the chemical in the body.

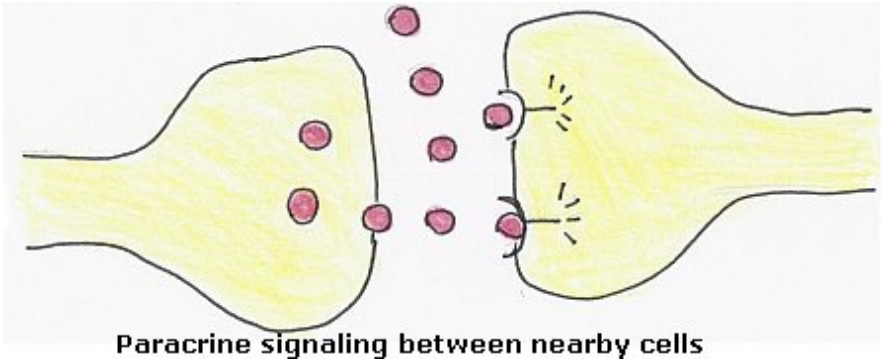


Direct contact:

(Signalling through cell junctions) See the image here. Two cells that are next to each other connect by means of junctions so chemicals pass through this channel and transfer the message. Example: Cells in

our heart (heart muscle cells). It helps in contracting heart muscle to pump the blood.

Short lived chemicals (called Paracrine signalling): Short lived chemicals just act on a few other cells near them. They are rapidly destroyed. Example: Cells in the nerve (nerve cells) and brain cells (neurons). The chemical substance called 'acetylcholine' is released by one cell and binds to nearby cells to start the desired action.



Paracrine signaling between nearby cells

Long lived chemicals: (Called Endocrine signaling) Some chemicals are released by cells in one organ. They get into the blood stream, go to one or more different organs in the body and act there. Example: Insulin is secreted by the pancreas, and then travels through the blood to the liver as well as muscle and fat cells in the body. Then, it acts on many tissues like muscle, liver and fat cells.

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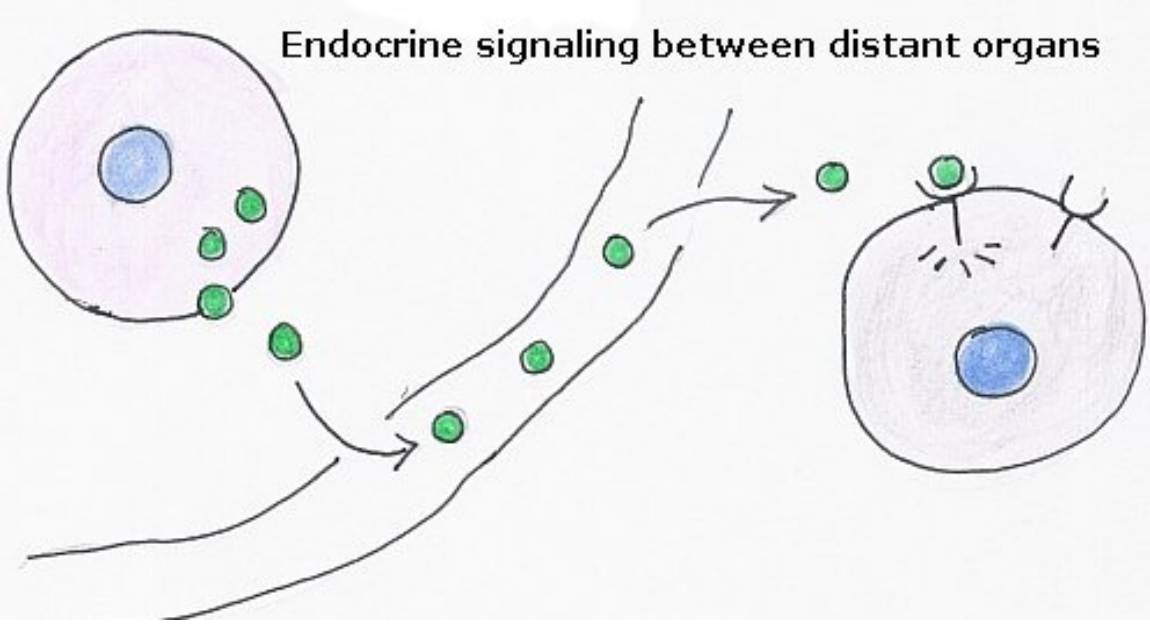

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Digestion and Nutrition

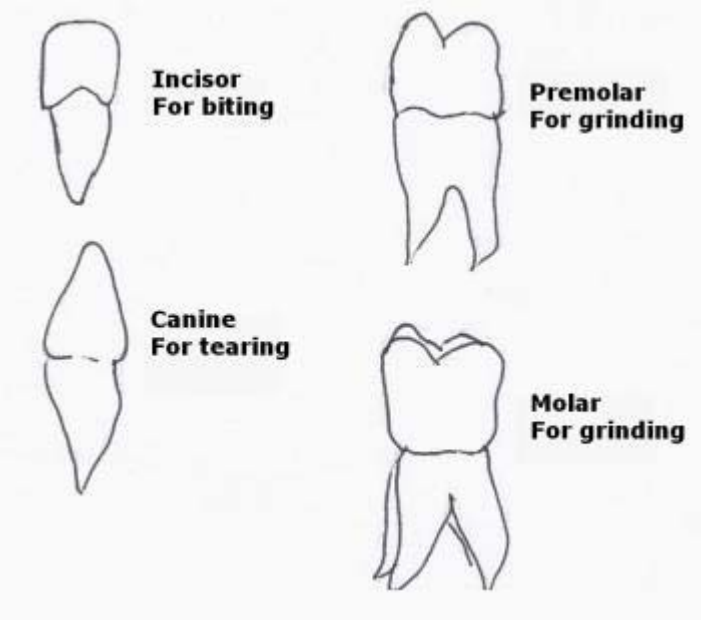
Why are some of our teeth shaped differently from others?

If you have a baby brother or baby sister, look at their teeth. How many do they have?

A baby's teeth are called 'deciduous teeth' because they fall out (like leaves from a deciduous tree) when they get a bit older. Babies usually start getting these teeth by the age of 5 months. By their third birthday, they will have about 20 deciduous teeth.

Remember that they are not strongly fixed into the jaw, so they start falling out from the age of 7.

Once they start falling, new permanent teeth will replace them. Most of the permanent teeth will appear by the age of 17 years. A person will usually have a total of 32 teeth.



Incisors: 8 (4 upper and 4 lower)

Canines: 4 (2 upper and 2 lower)

Premolars: 8 (4 upper and 4 lower)

Molars: 12 (6 upper and 6 lower)

Why do the 4 types of teeth have different shapes?

We eat different types of food including fruits, meat, bread and vegetables. They have different textures and consistency. So, we need different types of teeth to deal with different types of foods.

Our incisors are chisel-shaped for cutting and biting, like when we eat an apple or banana.

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Our canines are dagger shaped for grasping and tearing like when we eat chicken.

Our premolars are broad with a flat or bumpy surface for crushing and grinding like when we chew meat that was torn apart by our canines.

Our molars are like our premolars; broad with a flat or bumpy surface for crushing and grinding like when we chew meat that was torn apart by our canines.

Should you take water soluble vitamins every day?

Your body needs vitamins every day for body metabolism, cell growth and cell repair. You just need them in minute quantities, but they have an essential role in your body's health.

- Vitamin A is needed for good vision
- Vitamin B helps respiration, building red blood cells and normal activity of your nervous system
- Vitamin C can assist the healing of damaged tissues
- Vitamin D is believed important for maintaining the strength of your bones.

Vitamins are divided into two groups:

Fat soluble vitamins: These include the vitamins A, D, E and K. They are soluble in fats, so they need a complex mechanism for absorption in the small intestine. Once they are absorbed into the body, they can be stored in the body organs like your liver. A healthy human body can use fat-soluble vitamins it has stored for a few days if fresh supplies are limited, so a daily supply is not essential.

Water soluble vitamins: These include the Vitamin B-Complex; includes Thiamine(B1), Riboflavin(B2), Niacin(B3), Pantothenic acid(B5), Pyridoxine(B6), Biotin(B7), Folic acid(B9) and Cobalamin(B12), and Vitamin C.

These are soluble in water, so they are easily absorbed in the small intestine. They cannot be stored in the body; you need to get a supply of these

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vitamins every day.

So kids, ask your mother to give you green vegetables, liver, meat and citrus fruits for a good supply of the B-complex group of vitamins and vitamin C.

You can get fat-soluble vitamins from carrots, eggs, dairy products, liver and green vegetables.

Consuming too much of some vitamins, maybe in the form of supplements, can be risky so always check with your doctor before adding supplements to your diet to ensure that you really need them.

Why do we have to chew our food properly?

Your parents have said that you must chew your food well, right?

They are absolutely right; you need to chew the food properly before swallowing it and for proper digestion.

Why?

That's because chewing your food breaks the food into many smaller pieces which increases the surface area of the food.

That greater surface area means that, after you swallow it, much more of the food's surface can be worked on by your gastric juices and that helps with better digestion.

Your saliva has an enzyme called 'salivary amylase' which starts digesting the complex carbohydrates from your food while it is still in your mouth.

There is also another enzyme called 'Lingual lipase'. This helps your body to start digesting the fat in your mouth itself.

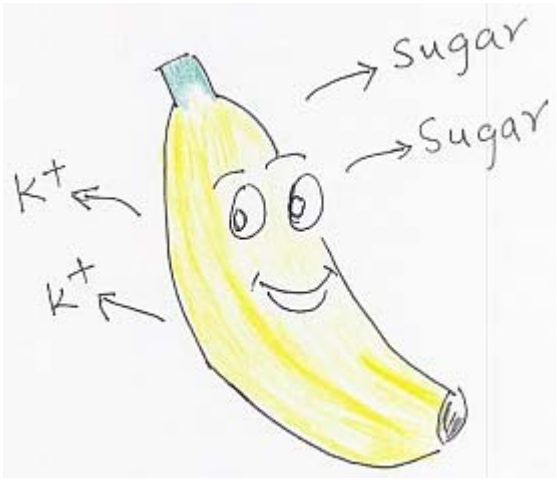
Your saliva also lubricates your food and helps you to swallow it more easily.

When you chew properly, you are helping your digestive system to digest your favorite food easily! You use less energy processing the food and get more value from the food you eat!

Why do sportsmen eat bananas during their strenuous activity?

Banana is a delicious fruit that can be used in many ways. You can eat it regularly. You might have seen many athletes eating bananas and wondered

whether they could help you during your school sports?



Bananas are rich in sugars, including glucose, fructose and sucrose.

Glucose and fructose provide instant energy. They don't need much effort to digest as they are just simple sugars and are quickly absorbed into your blood stream.

Sucrose is a complex carbohydrate and needs a little more effort to digest. It will become available a little later and be an energy source after the glucose and fructose are exhausted.

Bananas have about 450 mgs of potassium which is very useful during exercise to replace the potassium you lose when you sweat. Potassium helps with your blood pressure and smooth operation of your muscles. It also helps your body to change glucose to glycogen who gives you energy.

Why can't some people eat dairy products?

Dairy products contain a type of sugar called 'Lactose' which is a 'disaccharide'. That means it contains two simple sugar molecules (Galactose and Glucose) attached to each other.

If someone's intestine does not have a special enzyme called 'Lactase', they cannot digest lactose. Lactose cannot be absorbed in its original form. The lactase, which is produced by intestinal brush border cells, breaks the lactose into two simple sugars which the body can use.

For people with lactase deficiency, the undigested lactose is fermented by the bacteria in their intestine. They feel like their abdomen is bloated, they feel pain and may start to break wind.

Some people have this intolerance since they were babies. Others may get it when they are adults.

If a person gets gastroenteritis (infection of the intestinal epithelium and diarrhea), they will have a temporary lactase deficiency because of damage

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to the epithelial covering of their internal organs.

Where do we get our energy if we skip our breakfast and lunch?

Sometimes we rush to work or school and, because of our busy schedule, we often miss our breakfast or lunch, or both.

So, where do we get the energy to do our work if we don't eat a regular meal?

1) **Breakdown of stored glycogen:** Our liver stores glucose (sugar) in the form of '**Glycogen**'. When our blood glucose levels drop, our liver starts breaking down the glycogen into glucose and slowly releases it into the blood. But, these glycogen stores won't last long.
2) **Breakdown of stored fat:** Next, our liver starts synthesizing (producing) glucose for our body by the process called 'gluconeogenesis' from fatty acids and glycerol that were stored in our body's fat deposits.
3) Ketone bodies: Then, the liver starts producing another major energy source called 'ketone bodies' from those fatty acids.

If people fast for a long time, their muscle protein starts breaking down to supply amino acids to the liver for the glucose synthesis. So, it is advisable to eat your food at the usual times and not skip meals.

Why do you hear growling sounds when you are hungry?

Those sounds are called 'hunger contractions' or 'hunger pangs'. When your stomach is empty, it contracts significantly. This produces that noise and mild discomfort in your stomach area.

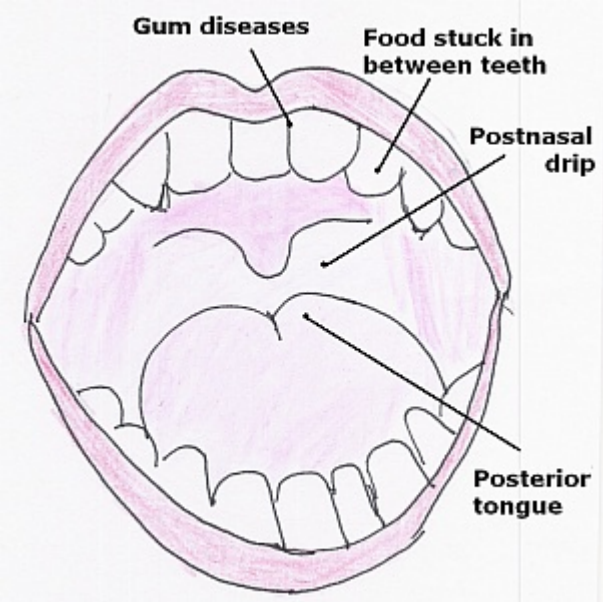
These hunger pains occur after 12 to 24 hours of fasting and when your blood glucose is low.

Once you eat some food, these hunger contractions disappear. Food moves down to the stomach by 'peristaltic movement'. The hunger sensation is controlled by our brain (hypothalamus area).

Peristaltic Movement - Peristalsis: Contraction of muscles around the

digestive tract which gently moves food to the stomach after it has been eaten and prevents it from going back up to the mouth.

What causes bad breath?



Bad breath from the mouth is called '**Halitosis**' by doctors.

Millions of bacteria live and flourish in our mouths. Bad breath can come from diseased gums and decaying deposits of waste material in our mouths.

It is more common at night because we produce less saliva and our mouths are dry, so the bad material is not flushed down to our stomach. That's why you feel the need to brush your teeth and rinse your mouth early in the morning.

Did you know that about seventy percent of bad breath comes from the back part of the tongue? That happens because we cannot get our tongue clean in that area. So, the bacteria build up there in deposits from postnasal drip and dead epithelial cells that flake off surfaces in the mouth and stick there. All these increase the bad odor.

Diseases of the mouth, including gum diseases, are another cause of bad breath. Food particles that get stuck in between our teeth when we eat food and decay if we don't brush and floss make the problem worse.

Here are a few simple steps to reduce possible embarrassment from bad breath:

1) Brush after eating any food
2) Clean your tongue gently with a tongue cleaner, especially the back part of the tongue
3) Drink more water, especially in hot weather ,to keep your mouth moist and wash away any left over particles

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4) Have regular dental check-ups. Dentists are very good these days at keeping their patients comfortable and pain-free.

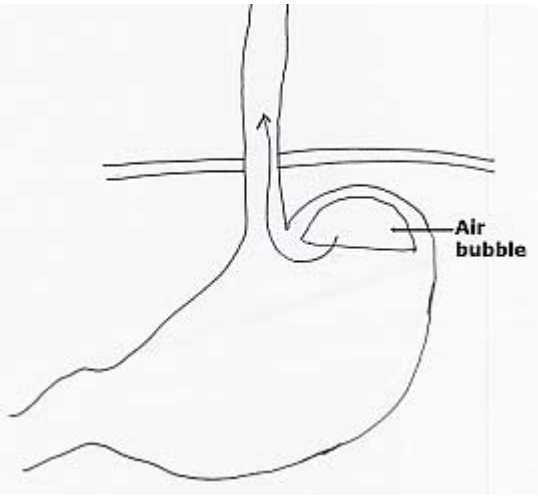
Is belching inevitable after eating?

Not every person belches after eating food.

Those who do, have swallowed some air while eating. So, drinking gassy soda drinks with your food could cause you to belch as well.

Some adults have 'acid reflux disease', where the stomach acids are pushed into the lower oesophagus (food pipe), and this can cause them to belch.

Air that is collected will be pushed out as a belch.



If you ask your doctor about how to stop belching, he will say:

1) Eat food slowly and chew properly.

2) Don't drink gassy liquids with your food.

3) Avoid swallowing air if you drink through a straw.

If you belch at the dinner table, just say 'excuse me!' It is good manners. In some countries, belching after eating food may be thought of as a sign of satisfaction.

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Skin and Related Topics

Why do we get pimples?

Pimples are small bumps on the face which most people get, especially during puberty. Most teenagers get them and many become depressed because of the effect on their appearance.

What causes pimples?

We all have tiny ‘sebaceous’ glands under our skin. They produce an oil-like substance called 'sebum'. This oil is secreted through thin ducts on to the skin and keeps the skin smooth.

But, dirt and flaking dead skin cells can block the tiny openings of the ducts in the sebaceous glands. As more sebum is produced, it builds up in the glands and pimples develop.

Other factors which affect their development may include fatty food, genetics, stress, hormones and drugs etc.

Why does our skin wrinkle in our old age?

Our skin is the biggest organ in our body. It is divided into three layers; the epidermis, dermis and subcutaneous layer.

The dermis has two connective tissue proteins called 'Collagen' and 'Elastin' which are present around the cells and support them.

Collagen gives tensile strength to the skin which is what allows it to be stretched or twisted.

Elastin helps your skin to regain its shape after stretching and pulling. It also supports the cells in the dermis layer of our skin.

With old age, we have less 'Collagen' and 'Elastin' in our skin, so the skin loses much of its tensile strength and lines and wrinkles increase.

What is the largest organ of the human body?

Our skin is the largest organ of the human body. It is estimated to weigh as much as sixteen percent of your body weight.

The surface area of an adult’s skin is about two square meters

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(approximately twenty-one and a half square feet).

The thickness of your skin varies with different body parts. It is thinner in areas like eyelids and the tip of your nose, but thicker in areas like the palms of your hands and the soles of your feet.

Your skin has many functions:

- It protects your body's internal organs.
- It helps to keep many germs and other harmful things from affecting your body.
- Your skin regulates your body temperature as it is rich in blood supply.
- Your skin can alter the blood circulation by dilating (relaxed) and constricting (narrowed) the blood vessels. This regulates your body heat.

If you have a fever, blood vessels in the skin dilate and heat escapes from your body. At the same time, more sweat is produced which helps to cool the skin.

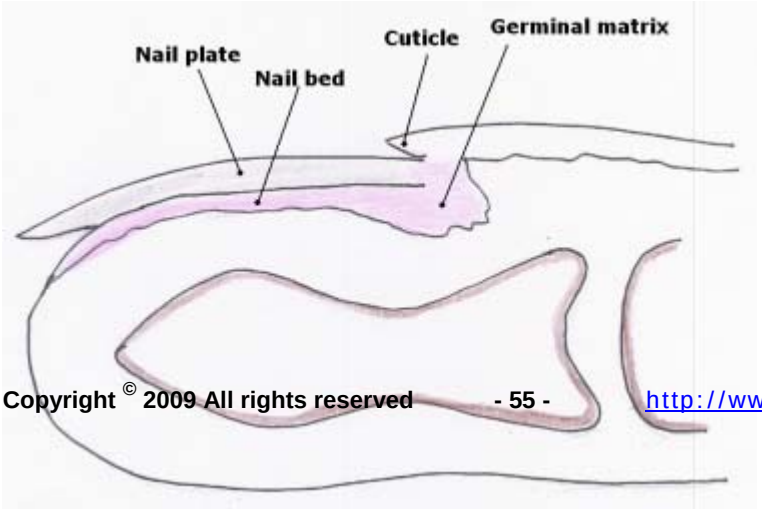
Skin has melanin, a black pigment which absorbs harmful rays from the sun.

So, you need to take care of your skin by:

- Keep it clean with regular bathing.
- Use good sun protection methods like carrying umbrellas while you are in the sun and applying moisturizers to keep it smooth.

Why is clipping our nails painless though it is growing tissue?

Clipping nails is painless because there are no nerve endings in our nails.



Nail structure.

Most people clip their finger and toe nails about every week. Would you do it if it was painful?

A nail has two parts; the nail plate and the nail bed.

A nail plate is the hard plate that we clip. It has no nerve endings, so it's not painful to clip it.

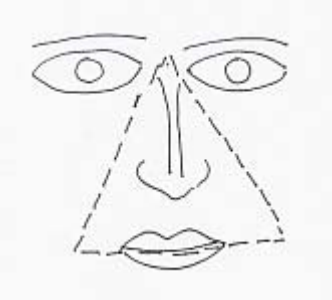
The nail bed is the soft part below the nail plate. The nail plate is attached to the nail bed. It has a **germinal matrix** at the back of it, from which the nail grows.

In contrast to the nail plate, the nail bed is rich in nerve endings. So, any pin prick or damage to the nail bed is very painful!

So, be careful not to contact the nail bed when you clip your nails.

Why are boils dangerous in the central area of the face?

The central area of the face around the nose is called the 'danger zone of the face'. You shouldn't squeeze the boils or pimples there.



The danger zone of the face is a triangular area from the bridge of the nose on both sides with the upper lip as a base.

The veins of the face are connected to the big venous pool of blood inside the skull called '**Cavernous sinus**'. It can be very dangerous if an infection from the skin passes to this venous sinus unless you get proper treatment as soon as possible. So, avoid picking or squeezing the pimples or boils on the face.

Why do hot things burn the skin?

When you touch a hot object which is hotter than your body, the heat from that object flows into your skin. The skin has cells in it. These cells contain many molecules. At body temperature, these molecules are in continuous motion.

When heat flows through the cells, these cell molecules move much faster. This fast movement damages the cells and nerve endings at that local area. This sensation is felt like 'burning' by our brain.

Why does burnt skin become white?

If heat is applied a little longer, the cells in the area become damaged and

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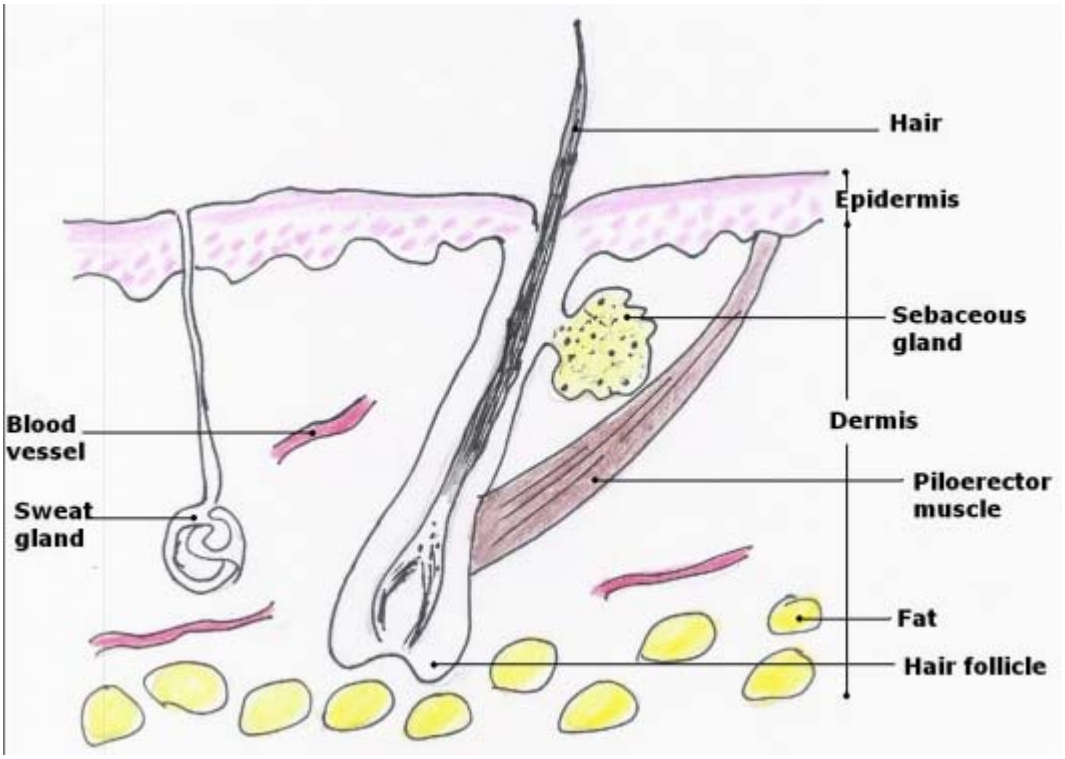
dry up. This causes the white and charred appearance. Blood circulation increases to the burnt area, so the surrounding area looks reddish.

Why do we get "goose bumps"?

Have you felt small bumps on your skin when you go out in cold weather or feel scared while watching a scary movie? They are called 'goose bumps' because the fine bumps resemble the skin of a goose after the feathers are removed.



Piloerector muscle that causes goose bumps.

We get them because of a tiny muscle, called the 'erector pili', which is attached to the follicles of the hairs on our skin.

This tiny muscle contracts in response to cold or fright response making the hair stand up on the skin.

When we feel cold or frightened, the impulses go to the brain through sensory nerves. Then, the brain sends signals to the appropriate muscles and the erector pili muscle, making it contract. The process where the hair stands up on the skin is called 'piloerection'.

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This lasts for only a few seconds. If you gently rub your goose bumps and make them feel a little warmer, they will go away.

Why do our lips, palms and soles get chapped in cold weather?

There are small glands called 'Sebaceous glands' in our skin. The glands are attached to the hair follicles.

These glands produce an oily material called 'Sebum' which helps to keep our skin smoother.

There are a lot of sebaceous glands on our scalp, neck, chest and other parts of the body.

But, there are no sebaceous glands in the skin of our palms, soles or the lower lip. So these are the first areas to dry out in cold weather.

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Hygiene and Related Topics

Why should we wash our hands with soap before eating?

There are millions of germs on the surface of our skin. Our hands touch many surfaces while we do our routine work and germs are transferred on to our hands.

If we eat without first washing our hands properly, these germs will cause many diseases like gastroenteritis, fevers etc.

Simply washing just with water is not enough. You have to wash your hands properly with soap to lift the dirt and grease from our hands and make them clean.

The soap is acting as a 'surfactant', lowering the surface tension of the water.

Did you know that our body has a surfactant too? It is called the 'pulmonary surfactant' and is seen in the lungs. This pulmonary surfactant covers the alveoli of the lungs where air exchange takes place. It prevents our lungs from collapsing.

How are germs killed in our body?

Every minute we breath germs, swallow germs, hosts germs on our skin. But, not all germs are harmful. The harmful germs can be stopped from invading our body by many protective mechanisms like:

* Lining of the respiratory tract is covered with the mucus and the cilia to trap germs.

* Saliva in the mouth stops growth of the bacteria and keeps the mouth clean.

* Acid in the stomach kills many harmful germs.

If the germs get past the above barriers, there are other methods that kill them and protect the body.

In the blood there are two types of cells called -

- Lymphocytes
- Macrophages

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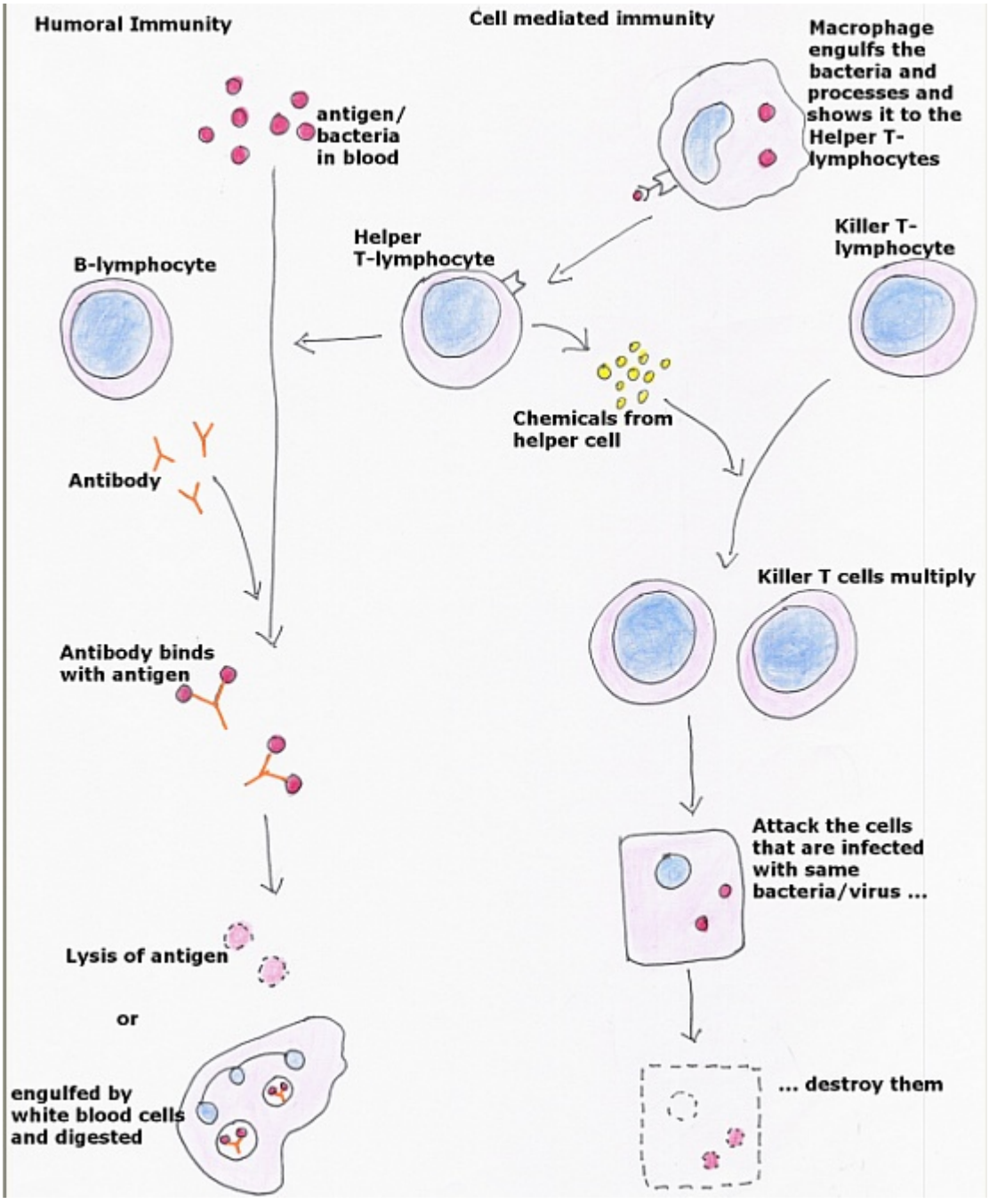
Lymphocytes are classified as:

- T-lymphocytes

  Helper T-lymphocytes

  Killer T-lymphocytes

- B-lymphocytes



The left side of the image explains 'humoral immunity'. Harmful antigens IN

OUR BLOOD are dealt by this immunity.

The right side of the image explains ‘Cell mediated immunity’. Harmful antigens INSIDE OUR CELLS are dealt by this immunity.

How do B-lymphocytes protect us? B-lymphocytes provide a type of immunity called 'humoral immunity'. When germs (like bacteria) invade our blood, B-lymphocytes recognize the protein molecules on the surface of the bacteria as foreign material. We call these foreign proteins as 'antigens'. B-lymphocytes produce 'antibodies' against the antigens. These antibodies bind with the antigens on the bacterial surface like a coating. Macrophages engulf the antibody-coated bacteria and kill them!

(Lysis means “destruction”).

How do T-lymphocytes protect us? T-lymphocytes provide a type of immunity called 'cell-mediated immunity'. T-lymphocytes are very useful against germs that are inside the cells. When our body cells are infected with germs, 'helper T-lymphocytes' are activated by macrophages. These helper T-lymphocytes produce some substances which activate 'Killer T-lymphocytes'. Killer T-lymphocytes attack our body cells that are infected by the germs and destroy the cells, so the infection doesn't spread to normal cells.

Pretty cool ... huh? We have to be thankful to our immune system that protects our body from many harmful germs.

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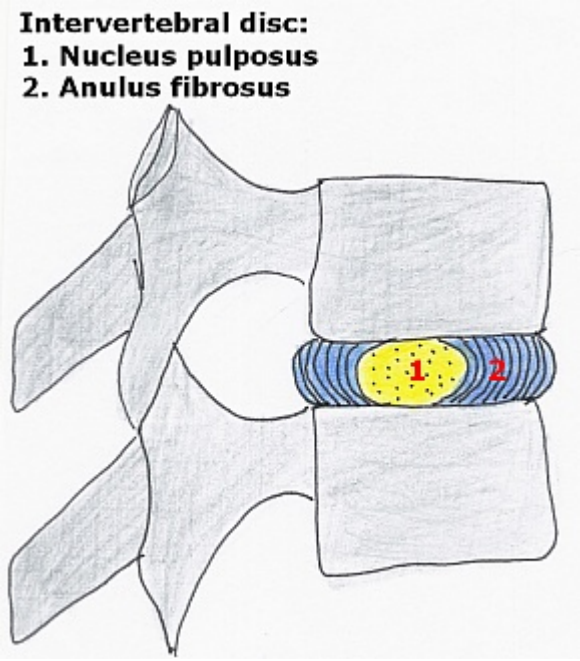
Skeleton and Related Topics

Can people get shorter in the evenings?

It may seem unbelievable, but it is true. People can become shorter by an average of 6 to 20 mm in the evening.



Intervertebral disc: The jelly like structure between vertebrae which acts like a shock absorber.

Our back bone is called a spinal column. It protects our spinal cord. The spinal column is not a single bone. It is made up of 'vertebrae' (vertebra; singular). Each vertebra is a ring-like bone. They are arranged one above another and all are separated by an 'intervertebral disc'.

This intervertebral disc is made up of a jelly like center with surrounding tough fibrocartilage. The disc acts like a shock absorber and prevents the vertebrae clashing with each other. The central jelly-like substance is made up of water, proteinaceous components and collagen.

These intervertebral discs get compressed as we stand and walk. They go back to normal while we lie down. This changing state of the discs causes the height difference in a person. Each person may get up to 1% shorter.

Why are bone fractures more common in old people?

Falls and fractures are common in old people, especially hip fractures.

Bone density: As people get older, their bones lose some of their density and strength, and tend to fracture more easily.

This is called 'osteoporosis'. The effects of osteoporosis may be reduced by regular exercise, and eating a diet that is high in calcium and vitamin D from an early age.

Bone collagen: Bone collagen also becomes more brittle and gets damaged

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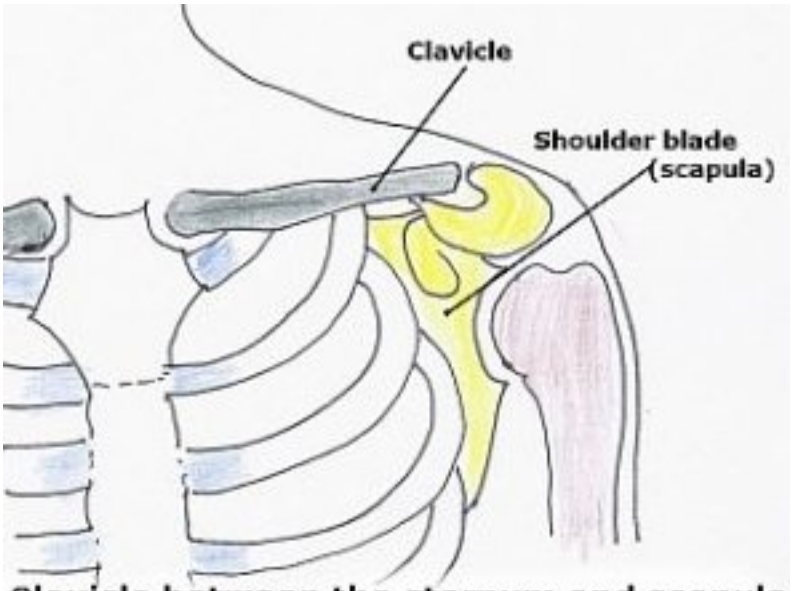
more easily as we get older.

In many countries, accidental falls by elderly people may cause serious injury or even death.

What is a collar bone?

The collar bone is a flat bone near the shoulder called the 'clavicle'. The word clavicle comes from a Latin word 'Clavicula', which means 'little key' because the clavicle rotates like a key when we move our arm away from our body.

The main function of the clavicle is to keep the arm away from the body so that our arm movements are not restricted.



Clavicle between the sternum and scapula

You can feel your clavicle by passing your fingers from your shoulder toward your neck. It is just below the skin. A child's clavicle can be easily fractured as it is still developing until we are almost 25 years of age.

Why are our bones so strong?

Bones form our skeletal system which supports the softer parts of our body. The compressional strength of a human bone is up to forty times greater than concrete! Why are bones so strong?

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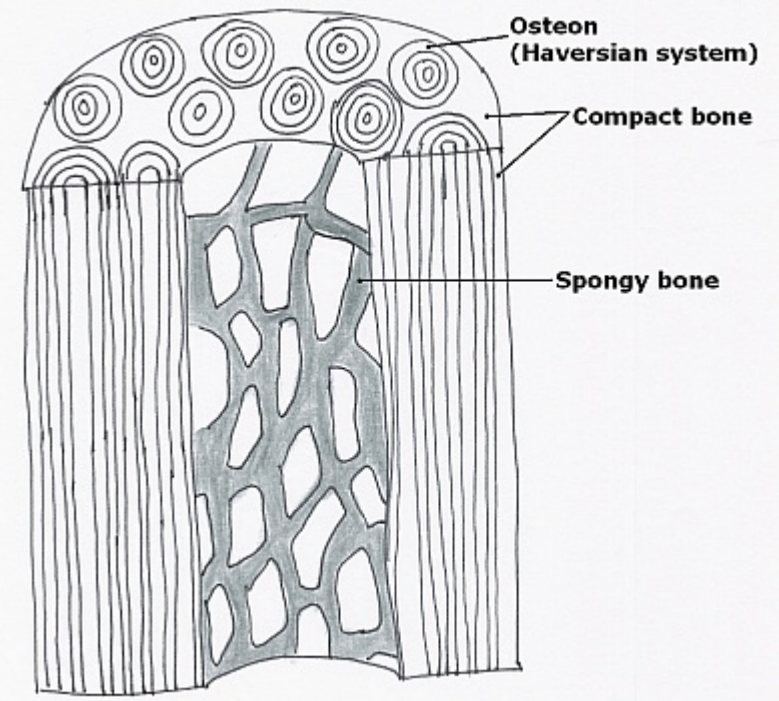
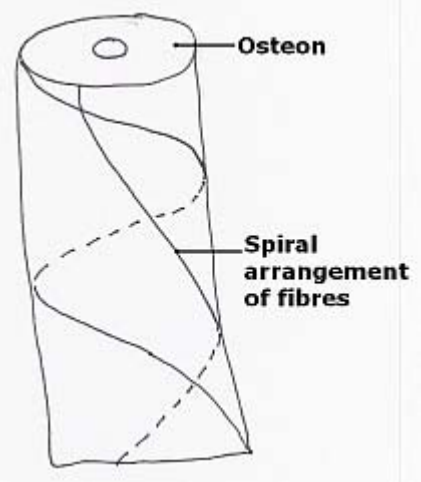


Cut section of long tubular bone

Bone and Osteon.

Bones contain a lot of calcium as 'hydroxyapatite crystals' and collagen. Both make bones strong. 99% of our body's calcium is in our bones.

Our bones are actually made up from two types of bone; compact bone and spongy bone. The compact bone is made up of 'Haversian canals', or 'Osteons', which are narrow channels containing blood vessels. The collagen fibres in the osteons spiral around the osteon axis giving more strength to the compact bone.



The spongy bone is called that because of its honeycomb appearance.

Bone (especially spongy bone) constantly rearranges itself to a form which can best support the stresses on it over a period of time. This continuous adaptation makes it stronger for any particular stress or weight.

To keep your bones healthy, you need to drink milk every day, eat food which is rich in Vitamin D and exercise regularly through sport, running and other activities.

Why is the first vertebra called the 'Atlas'?

Bend your neck and put your fingers on the midline across the back of your neck. Gently press with your fingers and move them slowly down.

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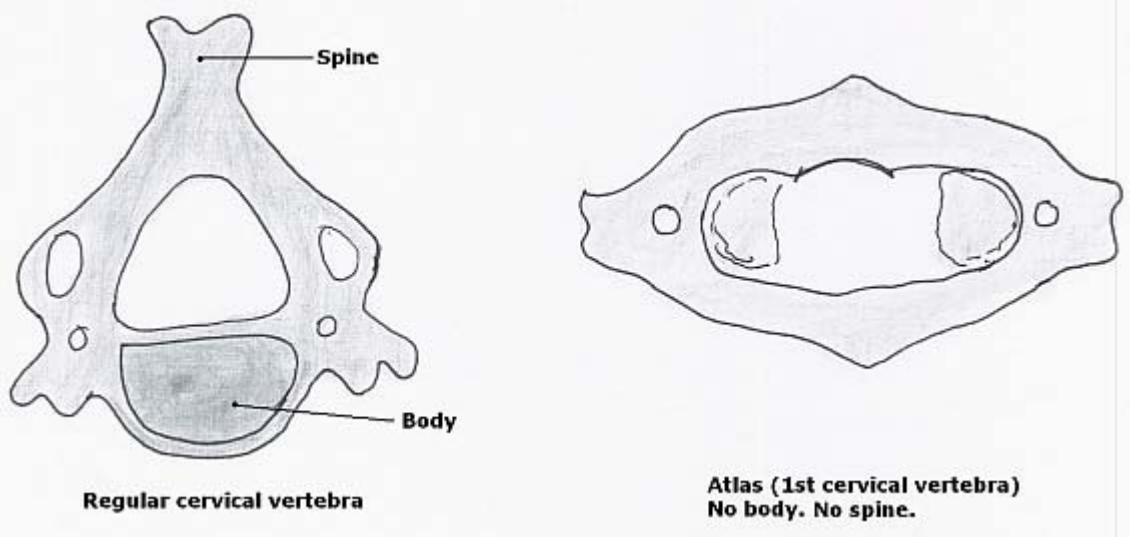
You will feel bony projections. This central bony column is called your 'vertebral column'. It protects the spinal cord and is made up of many vertebrae.

The top vertebra (singular) is called 'Atlas' because Atlas was a deity in Greek mythology who held all the heavens above with his shoulders and hands. The Atlas vertebra holds the weight of your head and all the valuable parts inside it.



The Atlas vertebra doesn't have a body like other vertebrae. This makes it easy for us to bend and nod our head.

A fracture of the Atlas is very dangerous because that can cause paralysis of the body from the neck down.

What are Sesamoid bones?

The sesamoid bones are sesame-shaped bones in the muscle tendons near your joints. They protect the tendons when the muscles are working and reduce any friction during movements. They may look a bit different but they are real bones.

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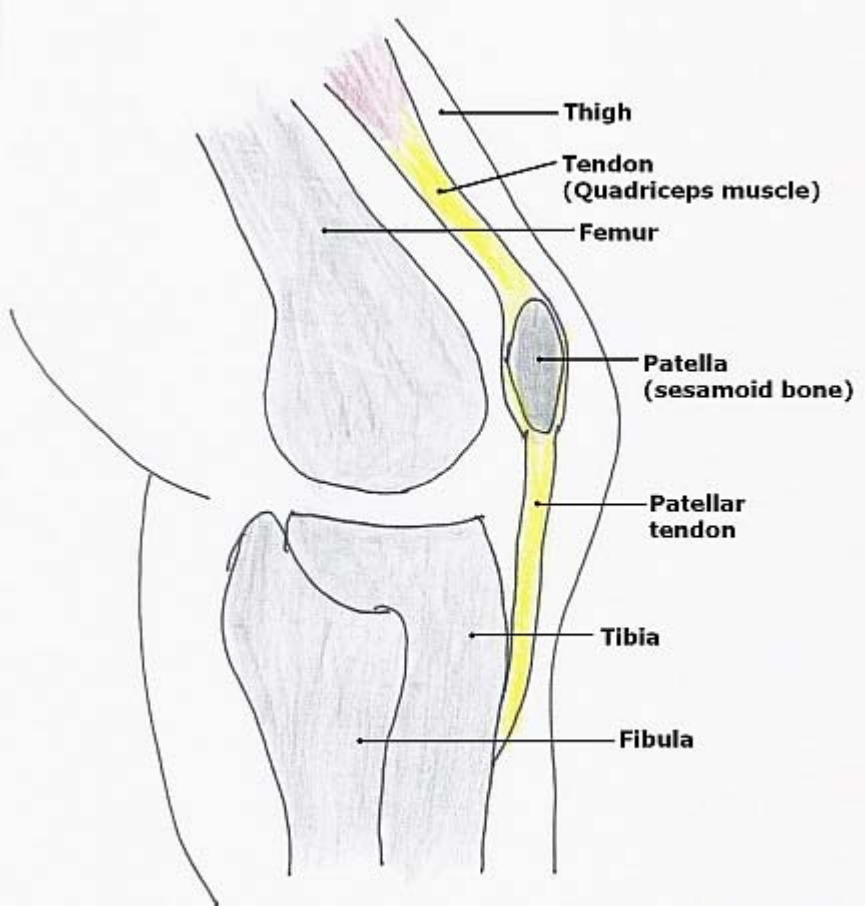

The patella is the biggest sesamoid bone in the body.

There are many sesamoid bones in our body. Most of them are small; less than an inch long.

The biggest sesamoid bone in your body is called the 'patella' which is in front of the knee joint. It is a little less than 2 inches wide and about one and a third inches long in an adult person. The patella is also called the 'kneecap'. It helps to maintain proper movement of your knee.

What might happen if we didn't have a skeleton in our body?

If we didn't have our skeleton supporting us, we would be a loose mass of cells or a mass of muscles.

Our skeletal system is divided into an 'axial skeleton' and an 'appendicular skeleton'.

The axial skeleton is the central skeleton (skull, vertebral column and rib cage).

The appendicular skeleton is the peripheral skeleton (upper limbs, lower limbs as well as our shoulders and pelvic bones).

Our skeletal system protects the organs within our body. For example, the rib

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cage protects our lungs and heart while our skull protects our brain.

Our muscles are attached to the bones of our skeleton. Muscle and bone movement lets us move around and do things.

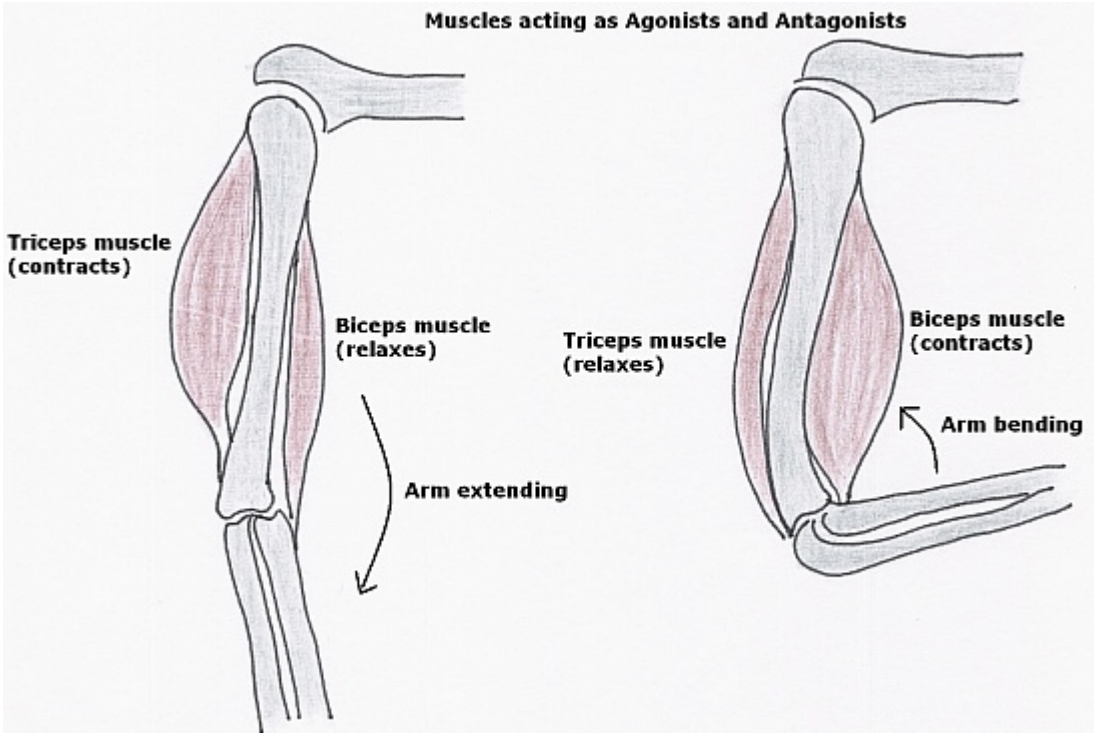
Our skeletal system supports the body positions we can use. If we stand, it is the bones within our skeleton help us to remain upright.

Some long bones have bone marrow in them. This is where we produce red blood cells and white cells that fight invading germs.

What does, "Muscles act as Agonists and Antagonists to carry movements" mean?

We do a lot of different movements with our body like running, jumping, sitting etc. For smooth co-ordinated movements, you have different muscles which either work together or in opposition to each other.

A group of muscles that make a specific movement possible are called 'agonists'. A group of muscles that oppose the movement carried by the agonists are called 'antagonists'.



When you bend your elbow, the 'triceps' muscle behind your upper arm acts as an agonist by contracting (pulling), while the 'biceps' muscle in front of

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your upper arm acts as an antagonist by relaxing.

Why does a child have more bones in their body than an adult?

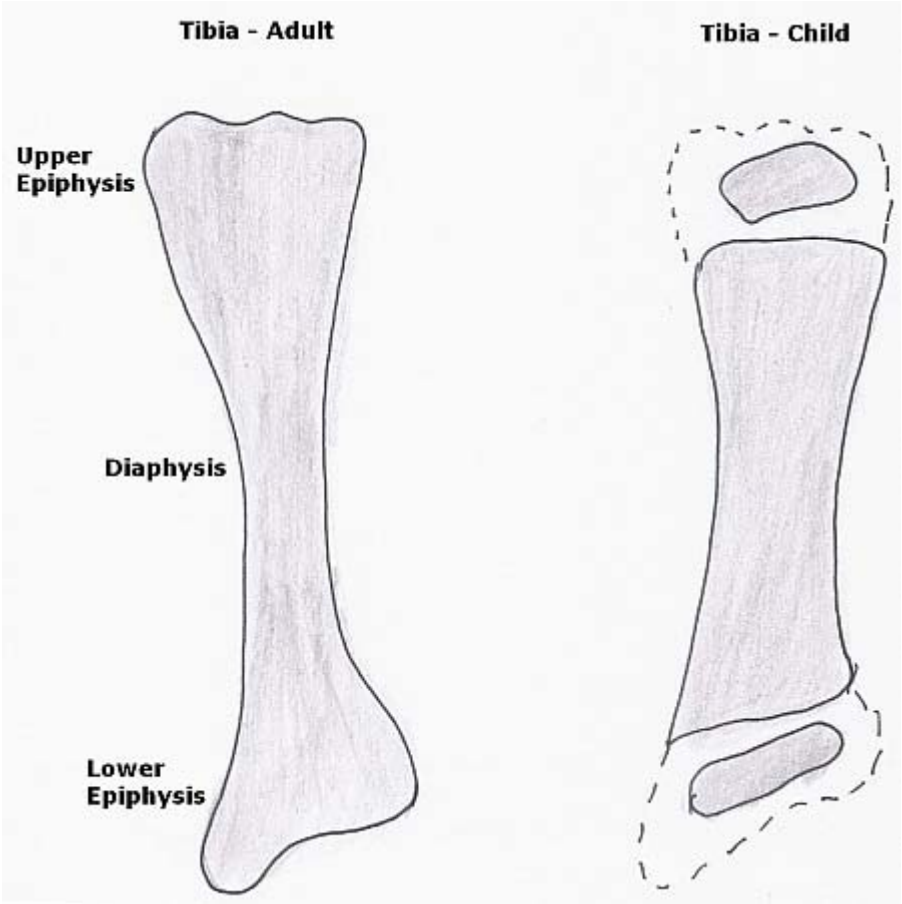
Children have 300 bones in the body while an adult has only 206! We humans have long bones in our bodies. Long bones are longer than they are wide and they grow in their length. Some of the longest bones are in your upper arm, lower arm, upper leg, lower legs and your hands and feet.

Each long bone has three parts:

1) Upper 'epiphysis'

2) Middle 'diaphysis'

3) Lower 'epiphysis'



Long bones have two epiphyseal ends with a center diaphysis.

In a newborn baby or a small child, the epiphysis at each end is separated from the diaphysis in the middle by growth plates.

This makes it look like they have three separate bones on X-rays, so people makes the count of bones in a small child higher than in an adult. The cartilage in the two ends will change as the child grows and all three parts will fuse to be a single bone.

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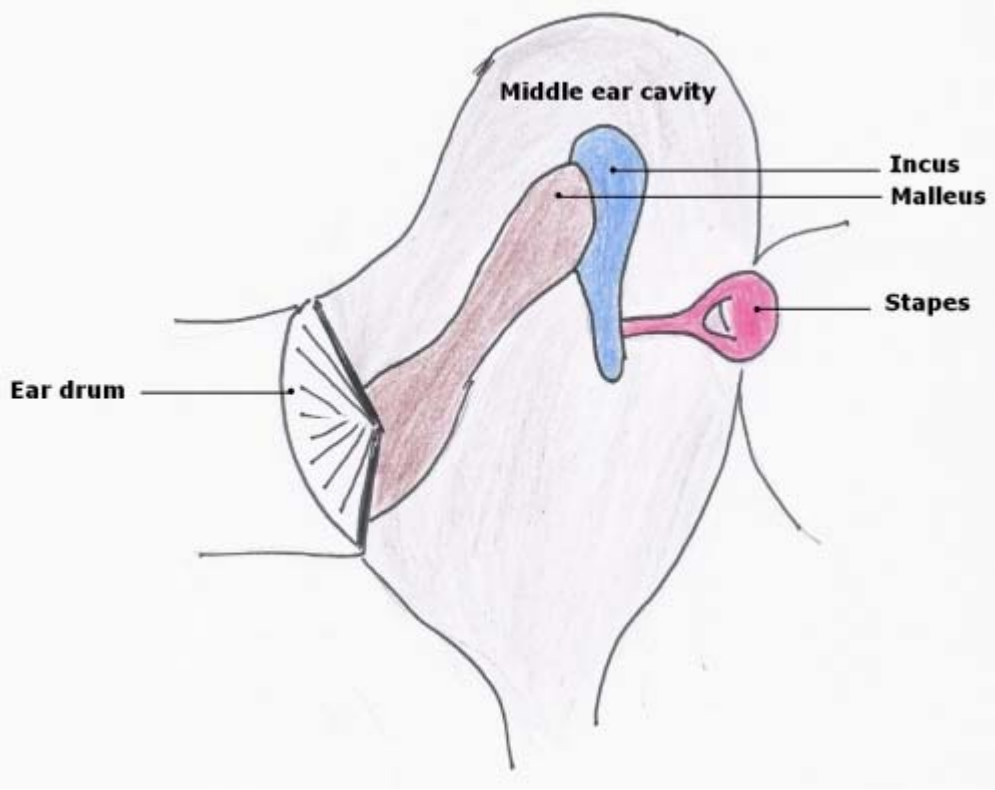
In the picture above, which is a diagram of a long bone called the 'tibia', you can see three separate areas in the child's bone. These look like three bones. By the time the child becomes an adult, all three bones fuse together to form a strong single bone and the bone count slowly comes down to the usual adult number.

What is the smallest bone in the body?

Your middle ear has three small bones called ossicles.

1. Stapes (stirrup)
2. Incus (Anvil)
3. Malleus (Hammer)



The Stapes is the smallest bone in the body.

Size: 3.5 mm height, 3 mm long and 1.4 mm wide

Weight: 3 - 4 mgs

Shape: Stirrup shaped.

The Malleus is the bone attached to the ear drum on one side and the Incus on the other side.

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The Incus, in turn, articulates with the Stapes.

The other side of the Stapes is attached to the round window of the inner ear.

When sound waves vibrate the ear drum (tympanic membrane), the malleus vibrates first.

These vibrations are transmitted through the three ear ossicles. From there, the vibrations are carried to the inner ear fluid and cochlea. From here the signals go to the auditory center of the brain for further interpretation of the sound.

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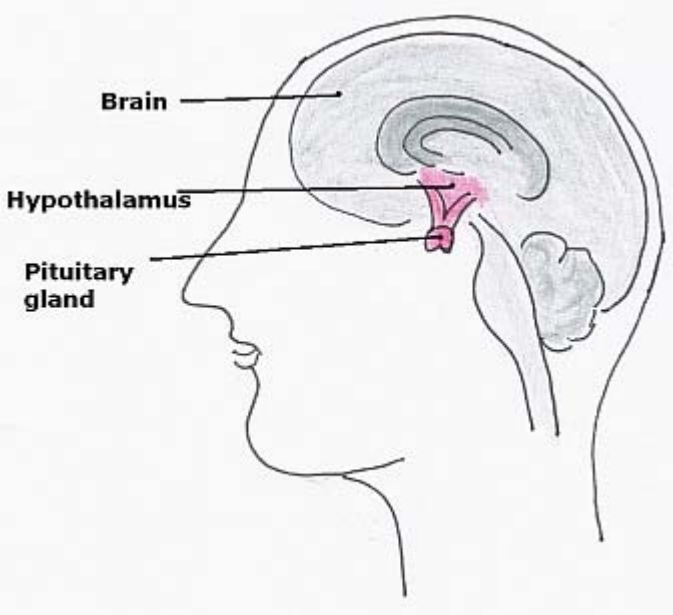
Internal Organs and Related Topics

What is 'The Master gland' in the human body?

The pituitary gland is a small **endocrine** (meaning that it secretes hormones that are carried through the blood stream and act on distant organs) gland at the base of the brain. It is about the size of a garden pea (approximately 1.5 cm) and weighs about 1 gram.

This tiny gland controls many other endocrine glands in the body, so it is called the 'master regulator' of the endocrine system.



The pituitary gland affects the following functions in the body:

- Growth of the body
- Milk production in females
- Sexual function in both males and females
- Blood pressure regulation
- Body metabolism

If the pituitary gland is not functioning or over-producing its secretion, it can have serious effects which require prompt medical treatment.

Why is our urine sometimes yellow?

The color of our urine depends on how much water we drink and the type of

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the food we eat. Yellow urine is produced when we drink little water on hot and sunny days.

Our kidneys have a major role in removing the nitrogenous waste products from metabolism via the urine. Kidneys have many glomeruli, which are the basic working structures that filter blood and form urine.

If you don't drink enough water, especially in a hot climate, the water content in your blood will be decreased. The hypothalamus (a part of the brain) detects this low blood water level and sends signals to the pituitary gland.

The pituitary gland releases a hormone called the 'antidiuretic hormone' (ADH). This hormone acts on the glomerulus (a ball of capillary blood vessels) and tells it to absorb water because there is not enough water in the blood.

So, the kidneys absorb more water, and concentrated yellow urine is produced.

If you drink enough water (most doctors recommend a minimum of 8 glasses spread through your day), then the urine color will probably be colorless or pale yellow.

Other foods and vitamins we consume can also color our urine when they are eliminated from our bodies.

How does a doctor measure your heart rate?


Feeling the pulse

Put your left hand flat on the table with the palm facing up. Put the index and middle finger of your right hand on the outside of your arm just above the wrist. Press gently ... Can you feel a steady throbbing?

These 'pulsations' are from the radial artery. When the heart pumps blood, the artery gives you one pulsation. So, the number of pulsations in a particular time period are equal to the number

of heart beats. This is called the 'heart rate'.

The heart rate can vary from 60 to 120 in a healthy person based on their activity level, emotions, body temperature etc., but the usual rate is about 70 beats per minute, which means your heart is beating at 70 times per minute to pump blood through the body.

How and why does your doctor listen to our heart sounds?

When you go to your doctor's office, your doctor uses a stethoscope to listen to your heartbeats. Ask your doctor if he or she can put the ear-pieces in your ears while they keep the flat plate chest piece of the stethoscope on your chest so that you can hear the sounds which your own heart makes? You will hear the alternate sounds which are something like *lub* and *dub*.

Did you know that doctors figure out many heart diseases by listening to these heart sounds? What causes these sounds?

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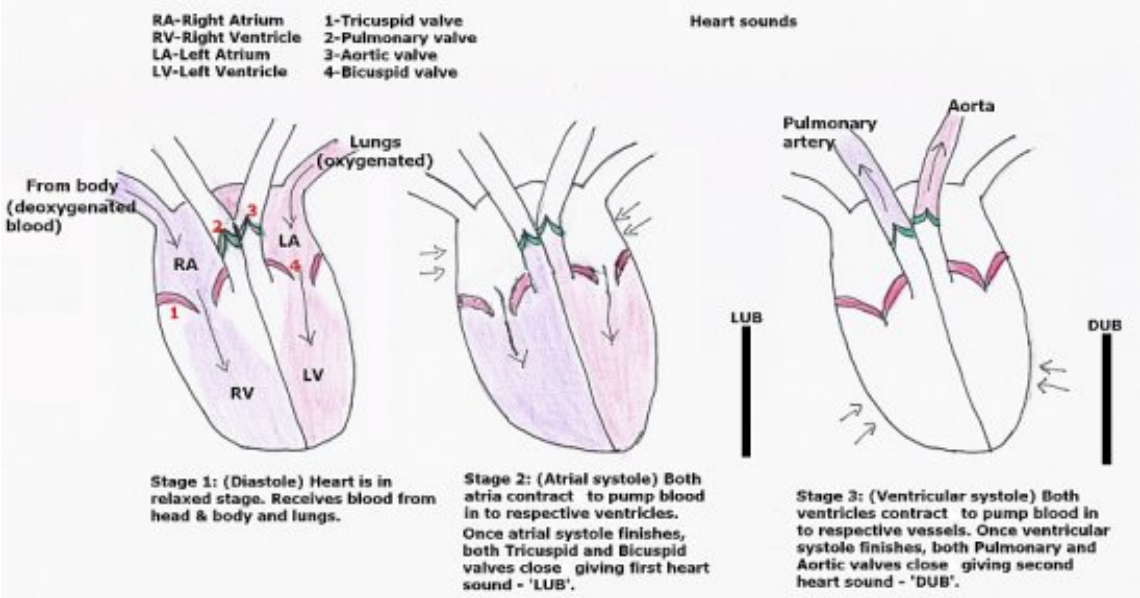

The black vertical bars indicate heart sounds. The first heart sound is after the **atrial systole**, where the myocardium in the left and right atria (chambers) contract. This causes more blood to flow into the respective ventricles.

The second heart sound is after the **ventricular systole** by which blood pumps into major arteries to our body.

You should also look at the picture in the question, 'What is an odd artery and odd vein in the body?' That picture will show you more about the circulatory path of your blood.

There are four valves in the heart; two between the two atria and the two ventricles, and two between the two ventricles and the pulmonary artery and the aorta.

1. The tricuspid valve is on the right side of the heart between the right atrium and right ventricle

2. The bicuspid valve is between the left atrium and left ventricle

3. The pulmonary semilunar valve is between the right ventricle and pulmonary artery

4. The aortic semilunar valve is between the left ventricle and aorta.

***Lub* sound:** When blood is collected into the right atrium (from the body)

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and the left atrium (from your lungs), they contract to push the blood into the respective ventricles. Now, the ventricles start contracting to push blood into the pulmonary artery and aorta. The tricuspid and bicuspid valves both close to stop the blood going back into the atria. This produces the '***lub***' sound.

Dub* sound:** After the right ventricle pumps blood into the pulmonary artery and the left ventricle pumps blood into the aorta, they start to relax and start to widen (the first stage of diastole) so they will be ready to receive more blood. To stop the blood from going back into the ventricles from both arteries, the two semilunar valves close, which produces the 'dub***' sound. So, these sounds are produced by alternate closing of valves between atria and ventricles and semilunar valves.

Are there millions of germs in our intestines?

Yes. Our small and large intestines are home for millions of germs. But, don't feel scared. About 80% of these germs are harmless to us and most are helpful to us in many ways.

All these germs (bacteria) are called '**intestinal flora**'. They help us to digest certain types of food like complex carbohydrates.

Some also bind to the surface of our intestines to help prevent harmful bacteria attaching themselves to and damaging the epithelium tissue which covers and protects those surfaces.

The harmless intestinal flora can help our immune system to develop resistance in the intestinal wall to harmful bacteria.

When a baby is born, its intestines are sterile. Later, babies slowly get their own internal bacteria (gut flora) as they grow, especially when they are weaned (change from their mother's milk to other food types).

Antibiotics that we are prescribed for medical conditions such as fever may also kill some helpful bacteria.

Your doctor will advise you about this.

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How are waste products removed from the body?

Our body removes waste products through three mechanisms:

1. Respiration: Each cell in our body uses oxygen and creates carbon dioxide after absorbing it.

This carbon dioxide could be dangerous to our body if it remained in it, because it could increase the acidity of our body fluids. That increased acidity would affect other body functions.

2. Waste products from the intestines: These are excreted as feces.

One way to keep your stomach healthy is eating fresh green vegetables and fruit. This will help you to avoid problems like constipation which can develop into something more serious.

3. Kidneys: Protein is a part of our diet. After the body processes the protein, the remainder is nitrogenous waste. Your body converts this waste into 'urea' which your kidneys will remove.

Your body has other minor ways of removing waste, including our sweat glands and our liver which also removes waste products which are produced when old red blood cells break down.

Are stones actually formed in the body?

Yes, stones can be produced in our 'gallbladder' and our 'kidneys'.

The gallbladder is a small sac-like pouch under the liver. The gallbladder stores bile that the liver produces. When we eat, this bile is released into the duodenum (the first part of the small intestine) by an automatic mechanism where it helps in the digestion of fat.

Stones in the gallbladder are more common in females, mostly those who are overweight are fat and in their forties. Some gallstones are caused by genetic factors and rapid weight reduction.

Gall stones contain cholesterol, bile pigments and calcium.

Kidney stones are more common in men than gallstones.

There are different types of kidney stones. They contain calcium, oxalate and cystine.

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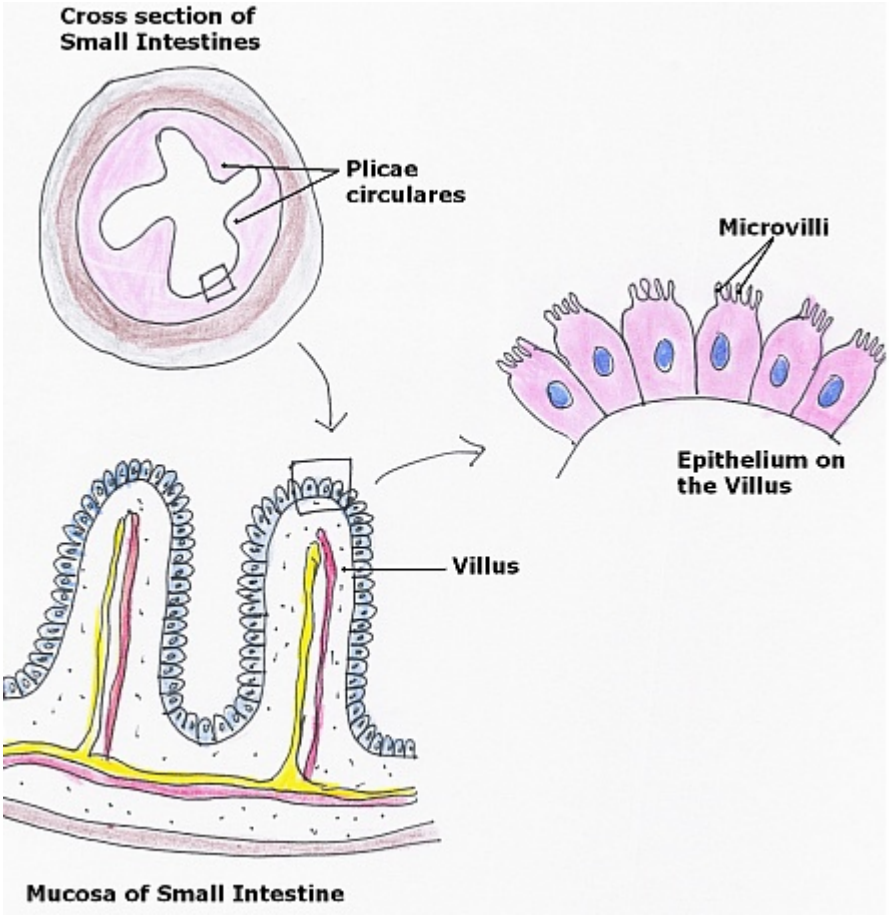
Your doctor's advice and medical treatment is essential for both gallstones and kidney stones.

Is the absorption surface of a small Intestine as big as a Tennis court?

The length of our small intestine is about seventeen feet. But, the whole absorptive surface of the average small intestine is big enough to cover the area of a tennis court!

We need that much because food passes through the small intestine within two to five hours, so it has to be digested and absorbed quickly.



First image: A cut section of the small intestine with deep mucosal folds, called 'plicae circulares'.

Second image: Mucosa thrown into villi (tiny folds that project from the surface) to increase the surface area.

Third image: The cells on the villi show microvilli which help to further

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increase the total surface area.

What increases the surface area of the small intestine so much?

1. Folds on the mucosa: Mucosa folds on itself to form folds called 'plicae circulares'. These folds are like incomplete circles on the wall.

2. Villi: These are finger like projections of the mucosa.

3. Microvilli: The epithelial cells on the mucosa throw it's membrane into tiny projections.

All these increase the absorptive surface of the small intestine enormously to help the greatest amount of nutrients, water and vitamins to be absorbed into the small intestine.

Can the acid in our stomach dissolve razorblades?

Our stomach produces an acid called hydrochloric acid ('Hcl'). This acid is very strong and can corrode metals.

Our gastric acid pH is 1 while the pH of our blood is 7.4. This means that the gastric juice is very acidic because of the high concentration of hydrochloric acid in it.

Metal of any kind that is swallowed would always cause serious injury or even death before the stomach acid could dissolve it, but a study done by scientists indicates that razorblades would be melted down by stomach acid by 63% in 24 hours. (*Li P. K.; Spittler C.; Taylor C. W.; Sponseller D.; Chung R. S. ; Department of Surgery, Meridia Huron and Hillcrest Hospitals, Cleveland, Ohio, Gastrointestinal endoscopy ISSN 0016-5107*)

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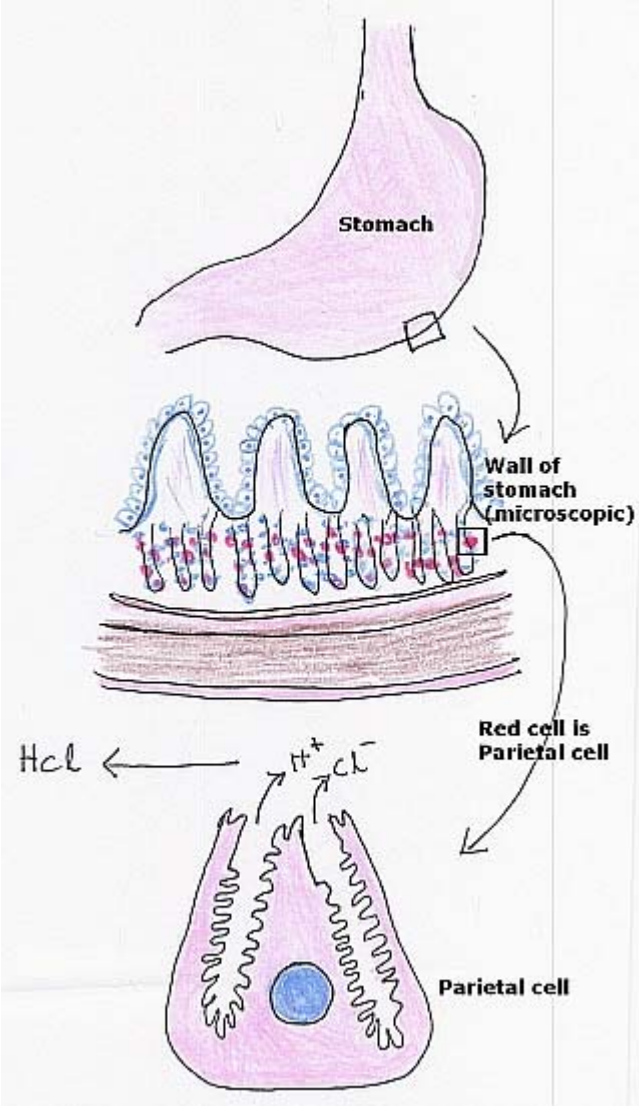


So, how does our delicate stomach protect itself from such a dangerous acid?

The stomach lining is covered with a mucus layer which protects the stomach epithelium from damage by the hydrochloric acid. Also, the rich blood flow in the stomach removes any hydrochloric acid that leaks through the mucus barrier.

Any damaged cells will be quickly renewed as the stomach's whole epithelium is replaced within one to three days.

What is an Appendix?

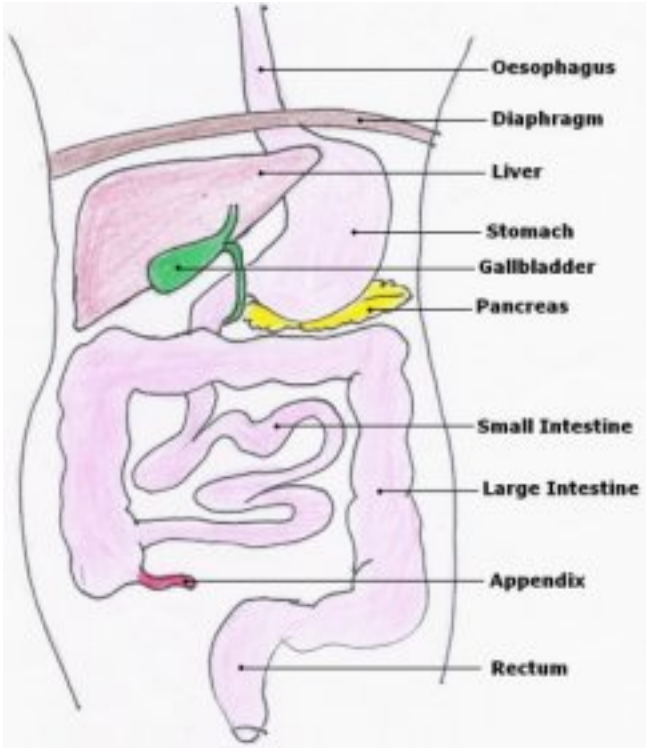
If you ever go to your doctor with a pain in your belly and fever, the doctor will put you on the bed and check your belly on the right side. He checks your 'Appendix'.

Your appendix is a worm-like sac that hangs from the side of the cecum (the first part of the large intestine.)

The appendix (doctors also call it the vermiform appendix) is on the right side of the belly below the navel. Doctors call that point "McBurney's Point". They press gently on this point to see if you have pain there.

If you do, he will check your blood and belly to see if you have appendicitis. This is an infection in your Appendix which will cause you to get fever, a pain in your belly and to vomit.

In the picture, the appendix is the red worm-like extension on the



large intestine.

If the doctor thinks it is necessary to remove your appendix, you will probably wonder, 'What happens if I don't have my precious appendix?'

Don't worry. Ask your family and friends; one of them will probably have had their appendix removed. The operation, called an "appendectomy" is very common.

Is your friend or relative having problems because their appendix was removed? That's very unlikely.

Your appendix is a **vestigial** organ. This means that it is a rudimentary organ that serves no purpose in humans. It is useful in some animals like monkeys as part of their immune system. So, it is OK for humans to have their appendix removed.

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Health and Related Topics

Is sun light enough for your daily dose of Vitamin D?

Many doctors advise their patients to get at least five to ten minutes of sunlight if they are light skinned, and thirty to sixty minutes if they are dark skinned people, every day.

Sunlight stimulates the Vitamin D synthesis in the skin and most people may get enough vitamin D from this source with that amount of exposure.

But, people are afraid of getting skin cancers through exposure to the ultra-violet rays from the sun.

Vitamin D is very essential for strong bone development. New research says that Vitamin D helps to prevent cancer. It is sometimes called the 'sunshine vitamin'.

People from cold areas like Alaska and northern Canada, who see less sunshine, probably won't get enough vitamin D because of less exposure to the sun.

Exposure to the sun without sun screen for 30 minutes can synthesize approximately 10,000 to 20,000 IU of vitamin D in the skin. This is more than adequate when compared to the daily requirement.

But, you should always use an appropriate sunscreen preparation when you are in the sun.

Each person needs 400 to 600 IU (International Unit) of vitamin D through their diet per day and 800 or more IU/day if sun exposure is inadequate. Some people that cannot get their Vitamin D requirement from the sun, use vitamin D supplements like cod liver oil or vitamin tablets.

You should consult your doctor or pharmacist for advice about what might be the most appropriate ways for you to ensure that you get the Vitamin D which your body requires.

Should you take water soluble vitamins every day?

Your body needs vitamins every day for body metabolism, cell growth and cell repair. You just need them in minute quantities, but they have an

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essential role in your body's health.

- Vitamin A is needed for good vision
- Vitamin B helps respiration, building red blood cells and normal activity of your nervous system
- Vitamin C can assist the healing of damaged tissues
- Vitamin D is believed important for maintaining the strength of your bones.

Vitamins are divided into two groups:

Fat soluble vitamins: These include the vitamins A, D, E and K. They are soluble in fats, so they need a complex mechanism for absorption in the small intestine. Once they are absorbed into the body, they can be stored in the body organs like your liver. A healthy human body can use fat-soluble vitamins it has stored for a few days if fresh supplies are limited, so a daily supply is not essential.

Water soluble vitamins: These include the Vitamin B-Complex; includes Thiamine(B1), Riboflavin(B2), Niacin(B3), Pantothenic acid(B5), Pyridoxine(B6), Biotin(B7), Folic acid(B9) and Cobalamin(B12), and Vitamin C.

These are soluble in water, so they are easily absorbed in the small intestine. They cannot be stored in the body; you need to get a supply of these vitamins every day.

So kids, ask your mother to give you green vegetables, liver, meat and citrus fruits for a good supply of the B-complex group of vitamins and vitamin C.

You can get fat-soluble vitamins from carrots, eggs, dairy products, liver and green vegetables.

Consuming too much of some vitamins, maybe in the form of supplements, can be risky so always check with your doctor before adding supplements to your diet to ensure that you really need them.

Why is cigarette smoking bad?

Cigarettes contain substances, including nicotine, tar and carbon monoxide

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that will damage our health.

Nicotine is an addictive compound which causes damage to the cilia in the respiratory tract. These cilia and the mucus in that area are vital for trapping dust particles and germs so they don't get to our lungs.

People that have damaged cilia get frequent lung infections.

Nicotine raises our blood pressure and also increases our risk of getting osteoporosis which causes our bones to become brittle and fracture very easily.

Tar damages the lung tissue and is a cause of lung cancer.

Carbon monoxide binds with the haemoglobin in our blood and reduces the amount of oxygen which it can carry. So, smokers can become short of breath from only a small level of activity and find more strenuous exercise much more demanding.

Is sneezing a good thing?

Yes, it is. When the mucosa in your nose gets irritated by strong smell, pollen or dust etc., you sneeze to get rid of whatever irritating things landed on the nasal mucosa.

This is a simple protective mechanism to get rid of foreign bodies from there.

How we sneeze: When our nasal mucosa gets irritated, it sends signals to the brain stem through the sensory nerves of your Trigeminal nerve.

The brain stem tells the muscles of the face, chest and diaphragm to contract.

First, you inhale deeply, and then push the air out with force through your nose. This pushes the irritating substance from the nasal mucosa.

You might expel air at a speed up to 160 miles per hour from your nose when you sneeze. Your body may vibrate and your eyes close while you are sneezing to reduce any bad effects of that rush of air.

But remember to always cover your nose when you sneeze! People who have a cold, fever or a viral infection push germs into other people's faces when they sneeze.

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Covering your nose is safer, and it's also good manners!

Are Hiccups dangerous?

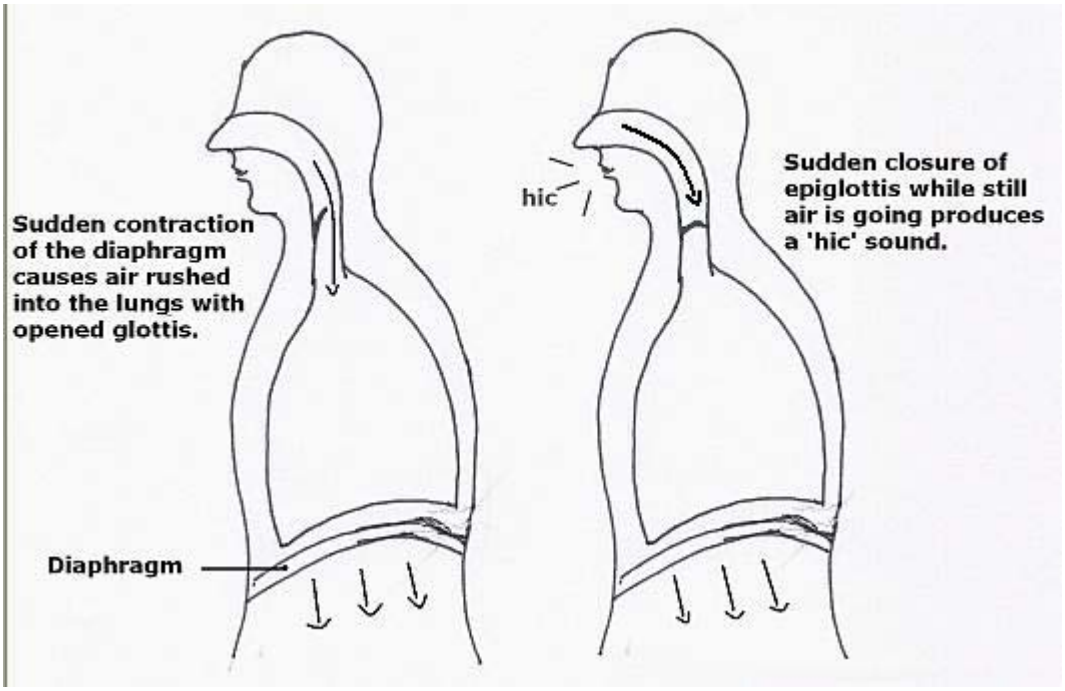
There is a big, flat muscle called the 'diaphragm' below the lungs and heart which separates the chest from the abdomen.

The diaphragm is very important in our breathing. It contracts to increase the space in the thorax (chest) and reduces the pressure in the thorax so that air is sucked into the lungs. This is called 'inspiration'.

When the diaphragm relaxes, it pushes itself upwards so the space in the thoracic cavity decreases and the air in the lungs is pushed out. This is called 'expiration'.

If the diaphragm is irritated by a full stomach or for any other reason, it contracts suddenly and air rushes into the lungs. While this 'inspiration' is happening, the epiglottis (an elastic flap of cartilage that acts as a lid over our windpipe when we are swallowing) closes suddenly.

The expelled air strikes the epiglottis surface and produces the 'Hic' sound in our hiccups.



These hiccups usually go away in a few minutes. If they are still there for, say, more than 48 hours, get further advice from your doctor.

Why do you get Vaccinations (shots) from your doctor?

Vaccinations are injections against common diseases that people can get. Different vaccinations will protect us against particular diseases.

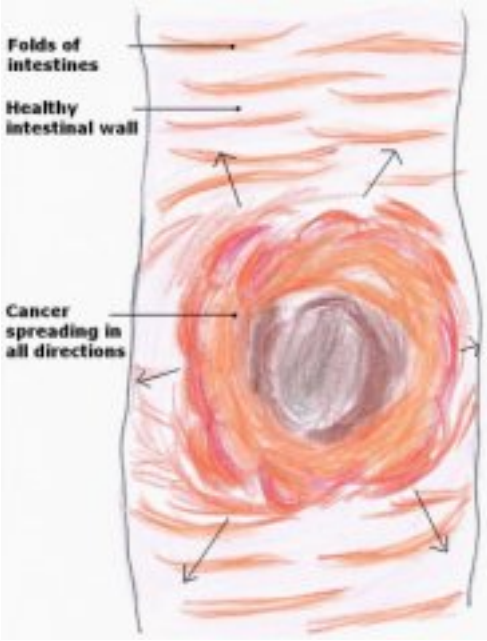
When we get an infection, our body fights against it and gets rid of it by producing a protein substance in our blood (called an 'antibody') that fights against the germ protein (an antigen).

If we are infected by the same type of germ later on, our body remembers it from the earlier infection and stops further spread. (See the question; '**How germs are killed in our body?**')

But, this does not happen with some infections which are more dangerous. So, scientists produce antibodies in laboratories against these germs that can be safely injected into us before we have that first attack.

Cool, huh?

You should be thankful to Dr. Edward Jenner, the British physician who discovered a vaccine against 'smallpox', which was once a deadly disease.



Why is Cancer compared to a Crab?

What is cancer? Cancer is when a normal cell changes to an abnormal cell and grows in the body to be a mass of cells.

Why is cancer is compared to a crab? Because of the way that a crab moves.

When you go to the beach, look for a crab under the rocks. You will see that it moves sideways because of the way that its leg joints are arranged and its tough exoskeleton.

When a crab moves fast, it looks like it is

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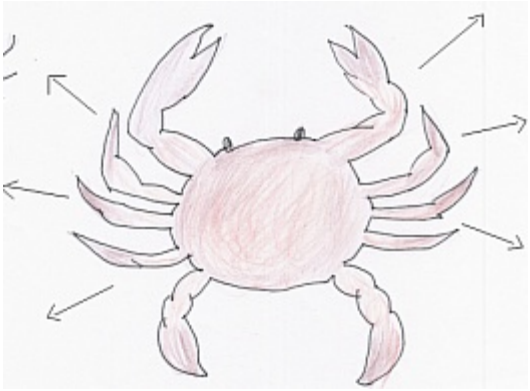
moving in all directions at once!

That is like the way that cancer moves (spreads) through someone's body; in all directions.

Also, 'carcinos' means crab in Greek and carcinos is a type of cancer.



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Men, Women and Related Topics

Why are men affected by baldness more than women?

Usually, men will show signs of baldness after the age of 30. Their hair line slowly recedes as they lose some hair. There are both genetic and hormonal reasons which play a role in male pattern baldness.

Men have hormones called 'androgens', including 'dihydrotestosterone'. Dihydrotestosterone is responsible for male-type baldness.

There will be thinning of a woman's hair as she ages but it will not be like typical male pattern baldness.

Do men have a uterus (the sac that holds a developing baby)?

Yes, all males have a rudimentary uterus called the 'prostatic utricle' near the prostate, but it is really just a small sac that is not any use.

When the fetus develops normally in the mother's belly, its organs develop slowly as the fetus approaches full term.

In a female baby, the uterus and the fallopian tubes develop from a tube-like structure called the 'paramesonephric duct'.

With male babies, most of this duct disappears because of the hormonal influence. But, both ends of the paramesonephric duct remain as small, useless sac-like structures.

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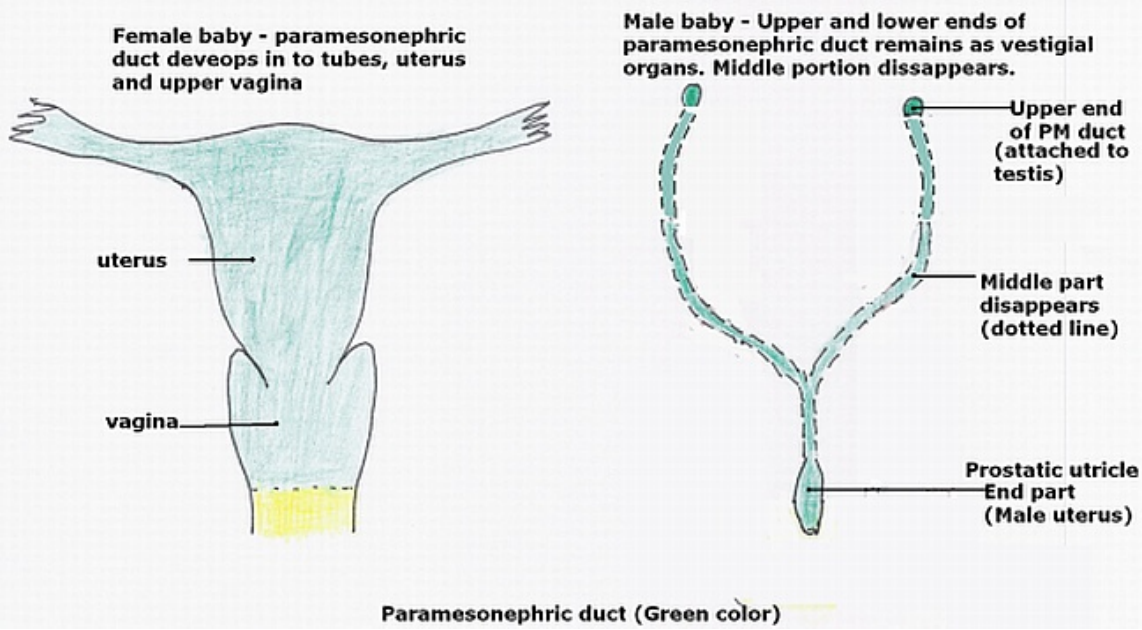

Paramesonephric duct - Part of it is like the uterus in a woman.

The end part of the duct will become a non-working, small sac-like structure attached to the prostate and called the 'prostatic utricle'. It is only rudimentary and equivalent to the uterus in a female.

The beginning part of the paramesonephric duct becomes another small sac-like structure attached to the testes.

What determines the sex of a person?

A baby is conceived after the fertilization of an ovum from the mother by a sperm from the father. When the sperm fertilizes the ovum, a zygote (fertilized cell with two sets of chromosomes) is formed. This zygote gets chromosomes from both the ovum and the sperm.

All ova only have X chromosomes, but sperm can have either X or Y chromosomes. A baby always gets one X from the mother. The baby's sex depends on whether the sperm which fertilizes the ovum has X chromosomes (so it will become a female) or Y chromosomes (so it will become a male).

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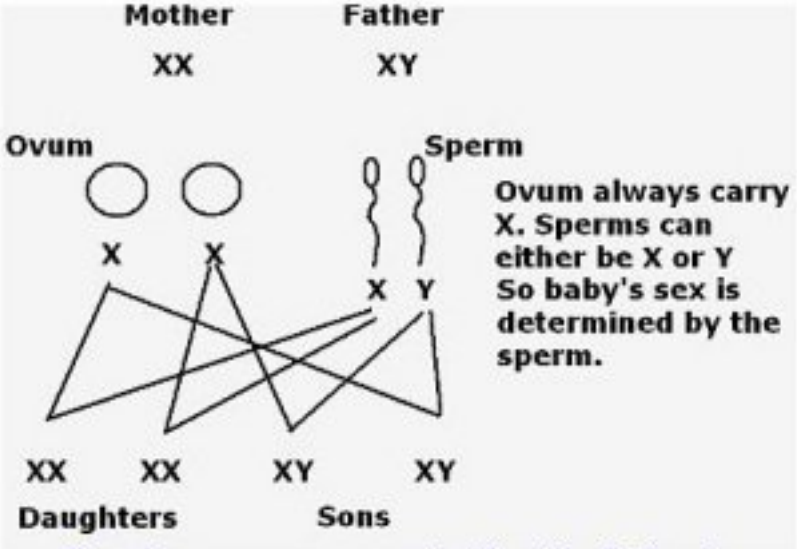

The chromosomes carried by the father's sperm determines the sex of the baby

Why are children's and women's voices softer than males?

The Larynx

Our voice is produced by the 'larynx' which is part of the trachea (wind pipe). It has two thin membranes called 'Vocal cords'. These vocal cords are protected by the cartilages that form the 'Adam's apple' in the neck.

When the air from the lungs is pushed against the closed vocal cords, they vibrate in a rhythmic manner to produce the sound. This sound is converted to actual words and speech by our pharynx, larynx and the oral cavity (space behind our lips).

The vocal cords are controlled by the laryngeal muscles which open, close and alter the length of the vocal cords which affects the loudness and pitch of the sound produced.

Children and women have thinner and shorter vocal cords which vibrate more when compared to the thick and long vocal cords of men. The more vibrations; the sweeter the voice. After puberty, a boy's voice changes as his

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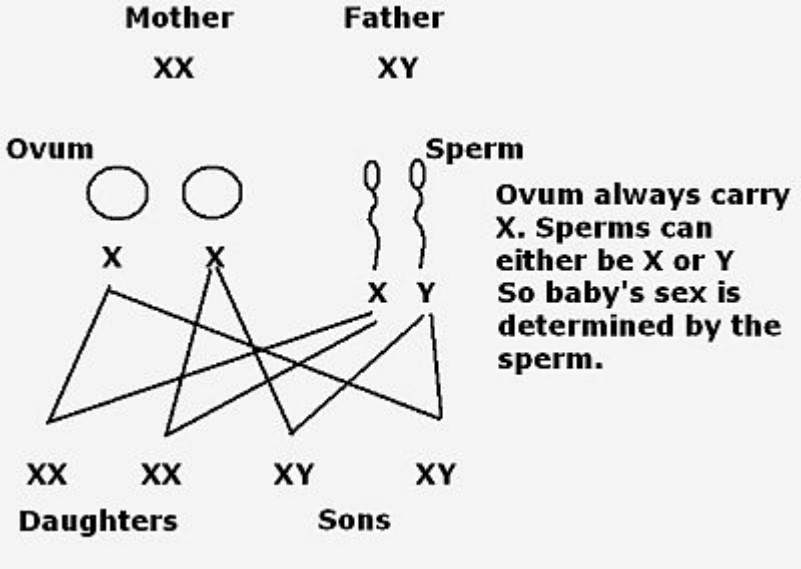
vocal cords become thicker and longer.

Can some diseases affect only boys and men?

Yes, there are some diseases that can only be seen in the male population.

When a baby is born, it gets genes from both parents. The sex of the baby is determined by the 'Y chromosome' from the father.



In the picture, the mother has two sex chromosomes (X and X). The father has two sex chromosomes (X and Y).

The mother produces ovum that carry only X chromosomes.

The father produces sperm that may carry either X chromosomes or Y chromosomes.

If an ovum (all X chromosomes) combines with an 'X' sperm, the baby will be a girl.

If an ovum combines with a 'Y' sperm, the baby will be a boy.

So far, so good!

But there can be problem if the X chromosome that the boy gets has a disease carrying gene. There is no other X gene in boys (like girls), so they will be affected by that particular disease.

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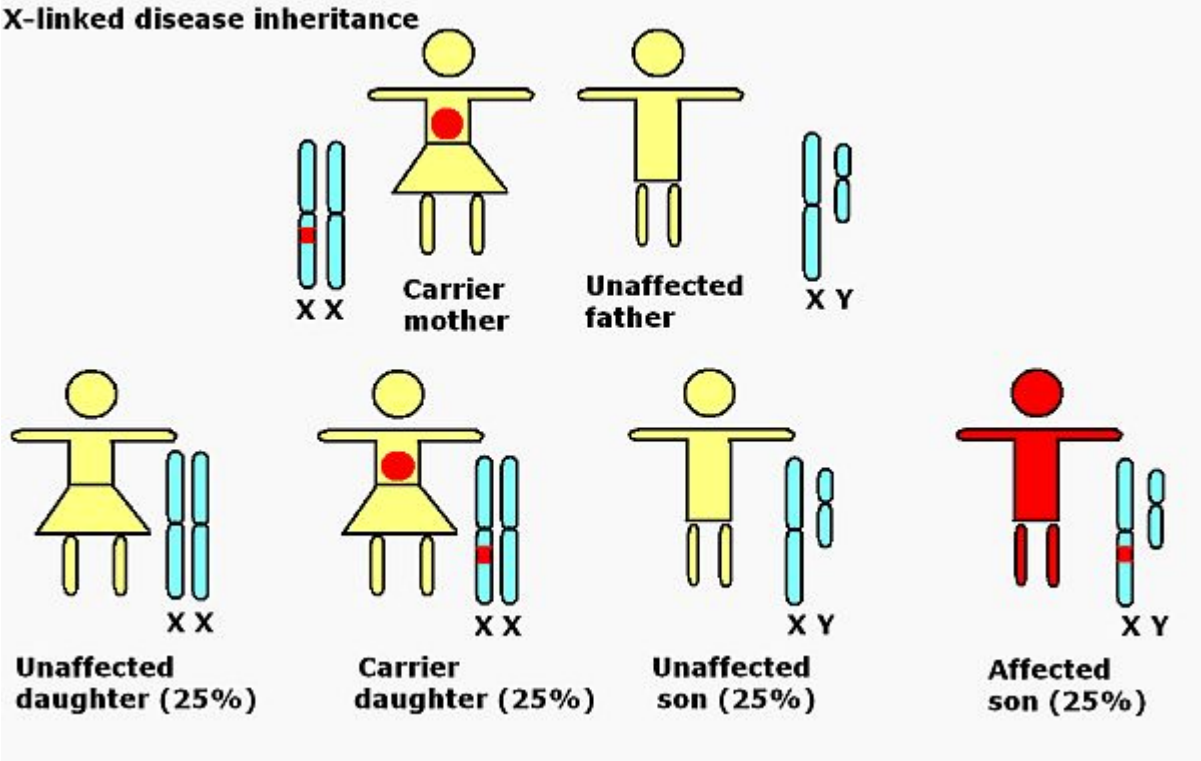

In our example, let's say that the mother is a carrier of the gene for the disease hemophilia (Hemophilia is a bleeding disorder where the affected person bleeds longer time after an injury when compared to a normal person) on one of her X chromosomes. If she conceives a boy, there is an approximately fifty percent chance of him getting that carrier gene and the disease.

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Our Brain and Related Topics

Why does the brain use a larger area for hands than our whole trunk?

When you read the question, ' Which part of the brain determines your personality? ', you see that sensations from the whole body are received by our parietal lobe by the 'sensory cortex' and all of our body movements are controlled by the frontal lobe through our 'motor cortex'.

The most important feature of the 'motor cortex' is that the muscles which make fine movements are represented by a larger area in the cortex than the rest of the body. The whole face is represented by almost half of the motor area. The whole trunk is represented by a much smaller area because the muscles of the trunk only perform crude movements, unlike the face.

Our thumb and face muscles are represented by larger area than the muscles of the trunk or the arm.

This representation is called 'motor homunculus'.

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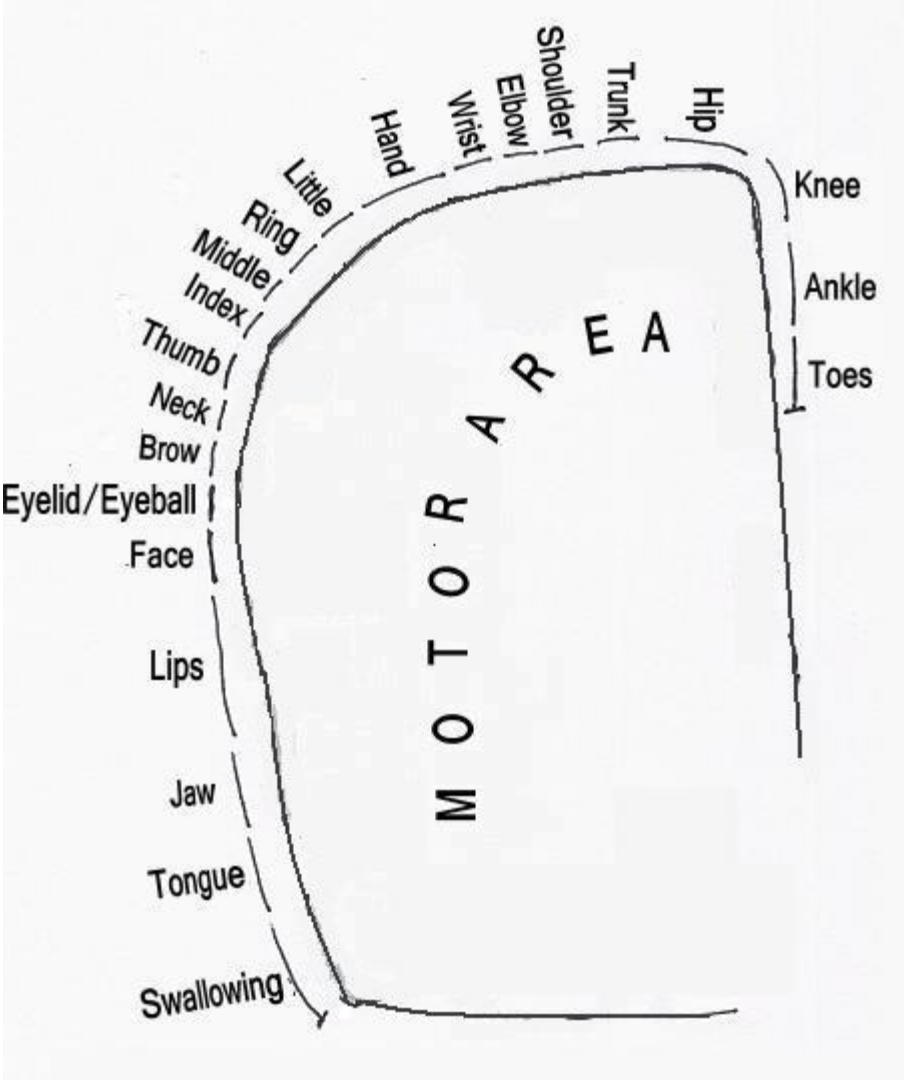

Why cannot our brain feel pain?

Though the brain is the main center for the sensation of the pain from different parts of the body, the brain itself doesn't have any pain receptors.

If somebody pricks you with a pin on your hand, you will feel pain. You feel pain when you get a belly ache. Pain receptors in all other parts of the body send signals to the brain so we feel the pain.

But, if a neurosurgeon (brain surgeon) opens up the skull and cuts the brain, we don't feel any pain because the brain doesn't have any nerve receptors to 'feel' the pain.

So, why do we get headaches?

A headache comes from the blood vessels, nerves and meninges (meninges

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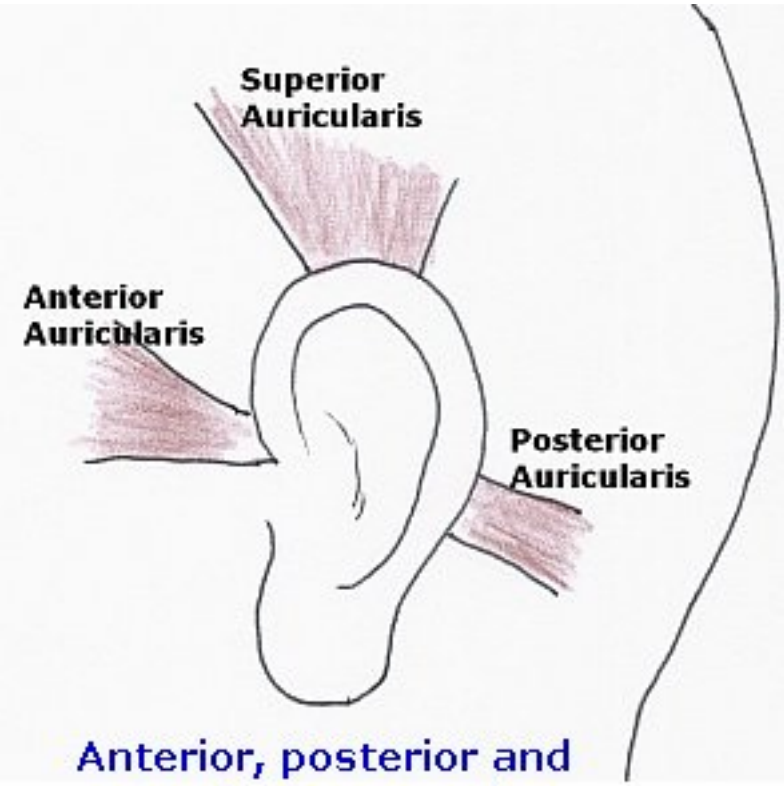
are the brain coverings) surrounding the brain, not from the brain itself. These have many pain receptors.

Why can't we move our ears towards a sound like animals do?

The outer part of the human ear gets sound waves and directs them into our ear canal.

Animals can move their ears backwards and even upward to collect sound waves but we can't.



Anterior, posterior and superior ear muscles

This picture shows the three main external ear muscles in humans. You can see that they are rudimentary (not well developed). Some people have a little more control of these muscles and can wiggle their ears a little bit to the front and back independently without any scalp or forehead movements.

Which part of our Brain determines our personality?

People are very different in their emotions, personality and social behavior; the so-called 'higher intellectual functions' or 'cognitive functions'.

The front part of the brain is called the 'frontal lobe'. Our frontal lobe controls cognitive functions like:

- Memory
- Impulse

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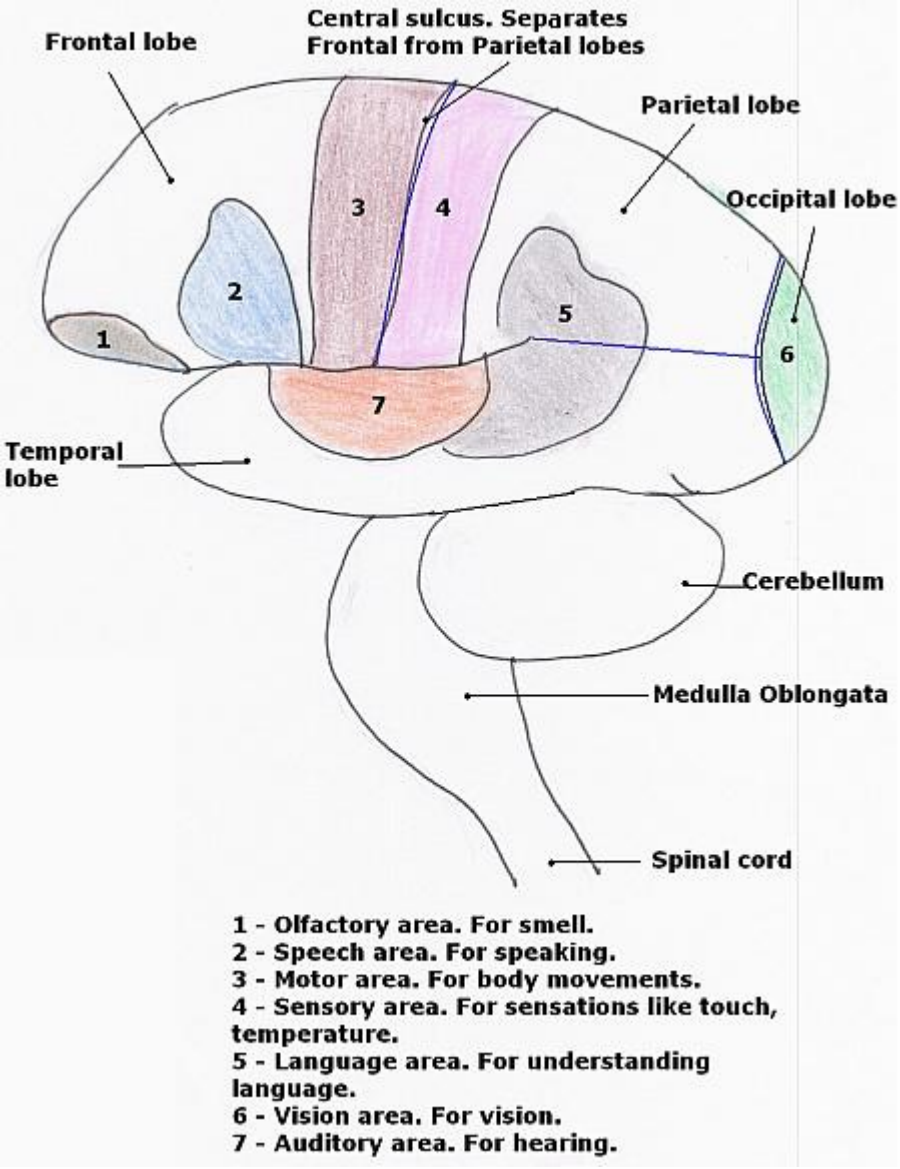
- Social Behavior
- Planning
- Judgement
- Problem solving
- Emotions

Motor movements: All your body movements are controlled by the frontal lobe through the 'motor cortex/motor area'.



Functional areas of brain: Imaginary Blue lines are drawn to show frontal, parietal, occipital and temporal lobes separately.

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Other parts of brain and how they affect you :

- **Cerebrum:** Consists of the frontal lobe, parietal lobe, occipital lobe and temporal lobe.
- **Frontal lobe**: Its functions are listed above.
- **Parietal lobe:** Sensations from your body by 'sensory cortex/sensory area'.
- **Occipital lobe:** Vision
- **Temporal lobe:** Hearing
- **Cerebellum:** Controls body balance and co-ordination
- **Medulla:** Controls involuntary actions like your heartbeat, blood pressure and breathing etc.

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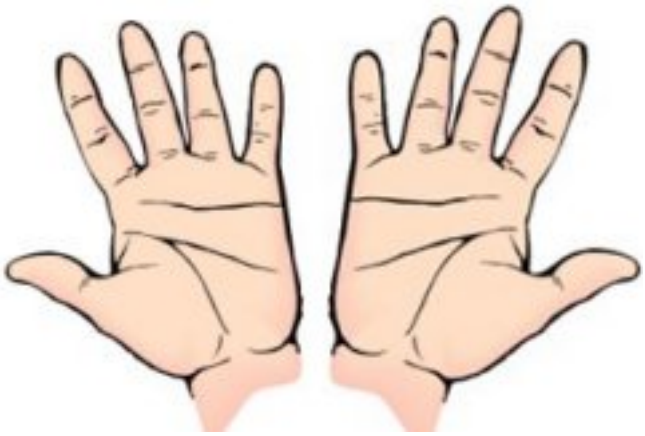
Other Questions

Is the right side of our body bigger than the left side?

Most people's bodies are not exactly symmetrical (both sides exactly the same). The right side of the body is often a little bigger than the left. Scientists think that the reason for this difference is more usage of the right side.



To test this, ask for permission from your parent to make prints of your hands on a piece of paper. They may like to help you with the experiment.

Take a large sheet of white paper and put it onto an area which won't be harmed if any of the color gets on it. Rub some removable paint on to the palms of your hands and then press them on to a large sheet of paper.

Now you can check if you have one hand slightly bigger than the other.

Why are our fingers not equal in size?

Look at your fingers. All five of them are:

- different lengths
- different shapes

This helps us to do many different tasks like:

Picking up a small needle from the floor

squeezing a grape or

holding and playing a musical instrument.

These tasks would be much harder or even impossible if our fingers were all the same.

Our thumb is a very powerful finger with a movement called 'opposition'. Your thumb would not be as useful if it was the same as your other fingers.

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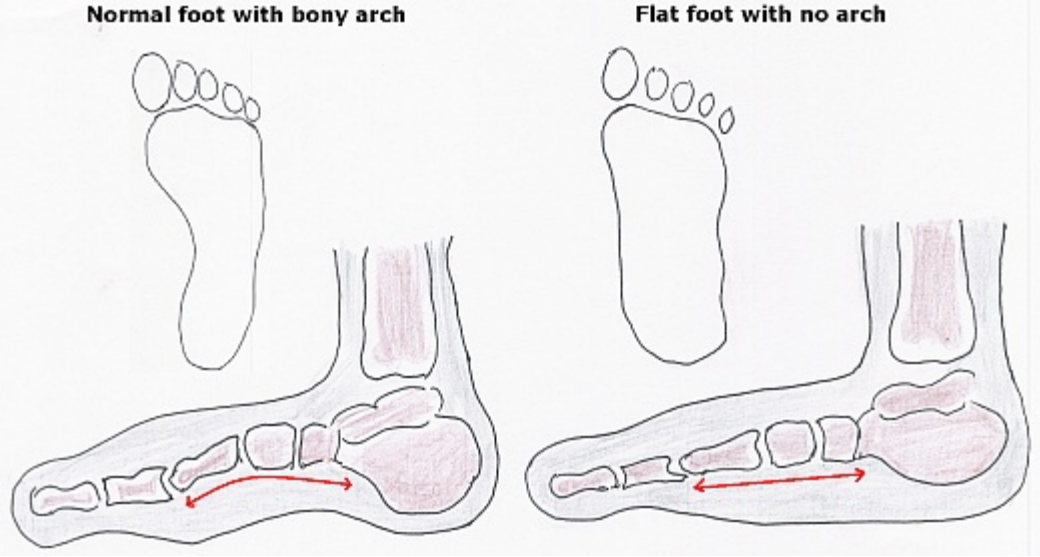
Why do some people have flat feet?

If you have a baby sister or baby brother, look at the soles of their feet. They look flat. Now, sit down, then lift your feet and look at your own soles.

They have a little gap (arch) on the instep where the surface of your foot doesn't touch the ground.

Your baby sister or baby brother has flat feet.



Compare the arch of the bony skeleton in normal and flat feet.

Take a large sheet of white paper, wet the sole of your foot and the baby's foot. Take prints on the paper. Compare both of them and see how much of each foot's bottom surface comes in contact with the paper.

Don't worry, most babies have flat feet but, once they start walking, the bony arch develops in their feet.

What happens if the flat foot persists?

About twenty percent of all adults have flat feet to some degree because their arches have not fully developed. These people may feel pain every time they walk.

It is important that they visit their doctor so that they find out what help is available for their condition.

Why do we stop growing at a certain age?

When a baby is born, it is about twenty inches long. By the age of eighteen

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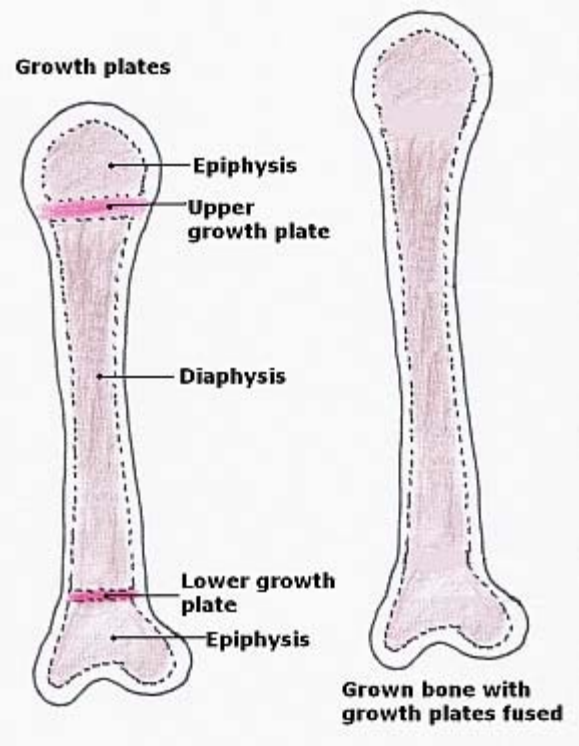
to twenty years, he or she may be three times as tall or even bigger. Most young people grow about two inches taller each year from when they are three years of age.

What affects your growth?

A. Well balanced nutrition - You need enough protein and vitamins from what you eat.

B. Genes - the genetic material that we inherit from our parents.

C. Hormones - Three main hormones affect our growth – the 'growth hormone', 'thyroid hormones' and 'sex hormones'.



Growth hormones are produced by the 'pituitary gland which is at the bottom of your brain.

1) Thyroid hormones are from the 'thyroid gland' which is in your neck.

2) Sex hormones (androgens and estrogens) from the 'ovaries' in a woman or the 'testes' in a male.

These hormones help us to grow until puberty. This is called 'linear growth'.

After puberty, the 'growth plates' of your long bones fuse and no longer respond to these hormones. So, we stop growing after the growth plates are

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fused.

Why do we feel sleepy after a meal?

We don't feel like studying after a good meal and a delicious desert! Why is that?

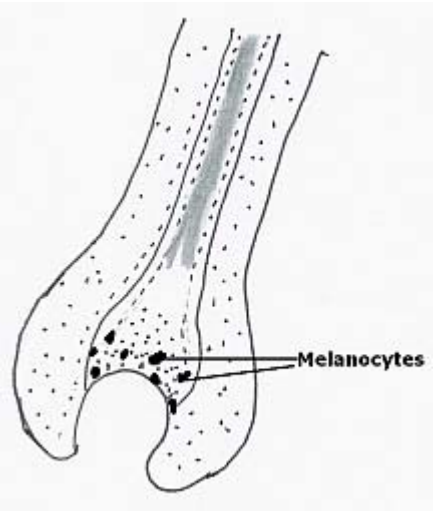
After a meal, your blood sugar level will increase. This turns off some special neurons in the brain called 'orexin neurons' which help to keep you awake. As their functioning is reduced, we start to feel sleepy after a heavy meal.

(**Reference article:** Published in June 1, 2006, **Neuron**. "Denis Burdakov of the University of Manchester and his colleagues pinpointed that glucose inhibits neurons which are key to regulating wakefulness".)

Other researchers have other explanations about this. Some are:

1) Increased blood sugar levels cause the release of the insulin from our pancreas. The insulin causes tryptophan (an aminoacid in protein) to enter our brain cells. Tryptophan produces 'serotonin', a chemical transmitter in brain that causes sleep.
2) After a heavy meal, the blood circulation to our brain slows and more is diverted to our intestines. This causes a slowing of our brain functions.

Why do your grandparents have gray hair?



Hair has two parts; the shaft and the root. A layer of cells, called the 'hair follicle', surround the root. Hair follicles have matrix cells from which the root grows and melanocytes which have melanin in them. The melanocytes transfer melanin into the matrix cells and in turn grow as hair. Our hair color depends on the amount of melanin in this area. As people grow older, the number of melanocytes in the hair follicle reduce, so there is less melanin. This causes colored hair to become gray.

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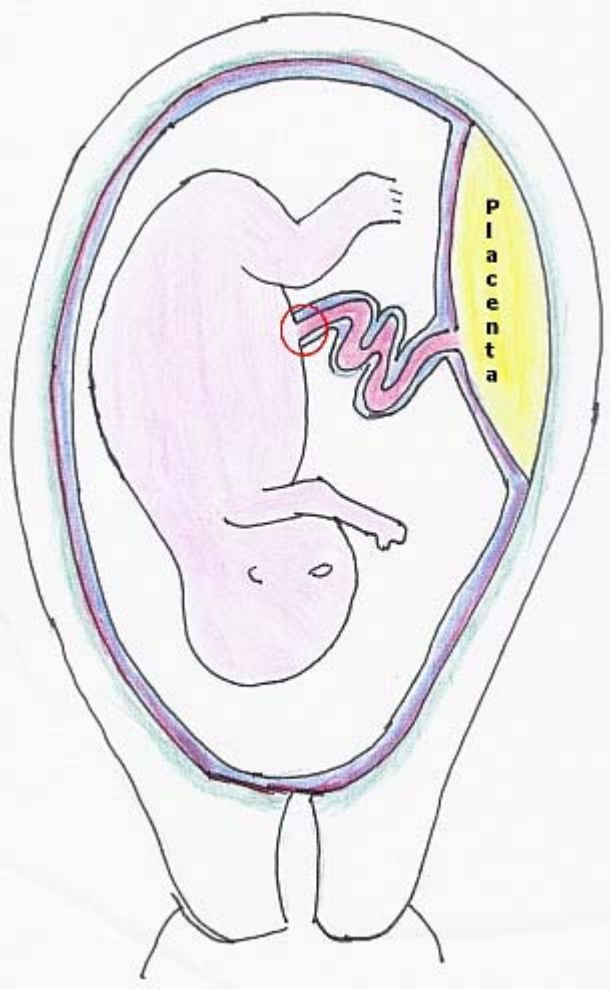
Do we need our belly button?

We all have a little depression on our lower belly which we call our 'navel' or 'belly button'.

Do you know what it is and why it is there?



While a baby is growing in its mother's belly, it cannot breathe or eat by itself. The mother sends all the nutrients and oxygen which her baby needs to the baby through a tube-like connection called the 'umbilical cord' which connects the mother's placenta and her baby's belly.

When the baby is born, it no longer needs this cord. So, the obstetrician carefully cuts the umbilical cord near the baby's belly and leaves a small stump. This slowly dries up and falls off the baby's belly. The place where the tube from the mother had been connected forms the depression which we grow up calling our belly button.

Does the human body generate electricity?

Yes, the human body does produce electricity. But, it's not the same as the electricity that you know is in the electrical wires around your home.

The charge that is carried in the body (especially in nerve cells) is in the form of 'action potential'.

This is how an electric impulse is produced in a nerve cell:

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Usually the nerve cell is slightly negative inside and slightly positive outside. When an impulse is needed (maybe to send a signal to a muscle to contract or to send a signal to a nearby neuron), a small channel opens up in the membrane.

This channel lets the sodium and potassium ions move in and out of the cell, which changes the charge inside and outside the cell, and an electric impulse is generated. The electric impulse opens up more channels further down the membrane and changes the electric charge there. So a message is passed down the membrane as an electrical impulse.

This continuous movement of electric impulses in our nerve cell is very important for our body to work properly.

Why do people shiver in cold weather?

Humans are warm blooded creatures which means that we can usually keep our body temperature at about 98.6 F. (F is short for Fahrenheit) with a variation of about one degree either way. If we don't maintain our body temperature in this range, we feel uncomfortable and may become ill.

When we feel cold, signals from our skin go to the hypothalamus, which is a part of the brain that controls shivering. Muscles of the body start shivering which produces some heat and that, in turn, raises our body temperature.

Muscles will become tired after shivering to produce heat for some time. So, you need to move to a warmer area or take other action that will warm you up as soon as possible.

Which of our five fingers is most important?

Humans have 5 fingers on each hand:

1) Thumb

2) Index finger

3) Middle finger

4) Ring finger

5) Little finger

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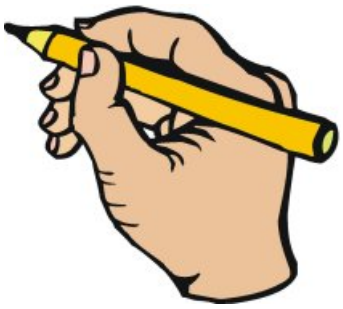
When we count our fingers, we start with the thumb and count across to the little finger. So, the thumb is 1, the index finger is 2, the middle finger is 3 and so on.



Now, pretend for a second that you don't have a thumb.

1) Try to hold a pen and write on a piece of paper ...
2) Try to hold a piece of fruit and eat it ...
3) Try to comb your hair ... all without using your thumb.

You will find it very difficult to do all these tasks. Right?

The thumb is a very important finger because it has a function called 'opposition'; the movement by which your thumb can touch the pads of the other four fingers. This powerful movement of the thumb is a vital part of many actions that your hand does.

This opposition movement is also seen in some animals like apes, gorillas and chimpanzees that also need to hold and pick fruits.

Why are some Twins not identical?

Most people think that twins are supposed to be identical in all aspects, but that is not true. The degree of similarity between twins depends on the type of fertilization between the ovum and the sperm.

The usual type of baby develops when one ovum from the mother and one sperm from the father forms a 'Zygote' which develops into a baby.

But, the story is different with twins.

Twins are of TWO types:

1. Monozygotic twins
2. Dizygotic twins.

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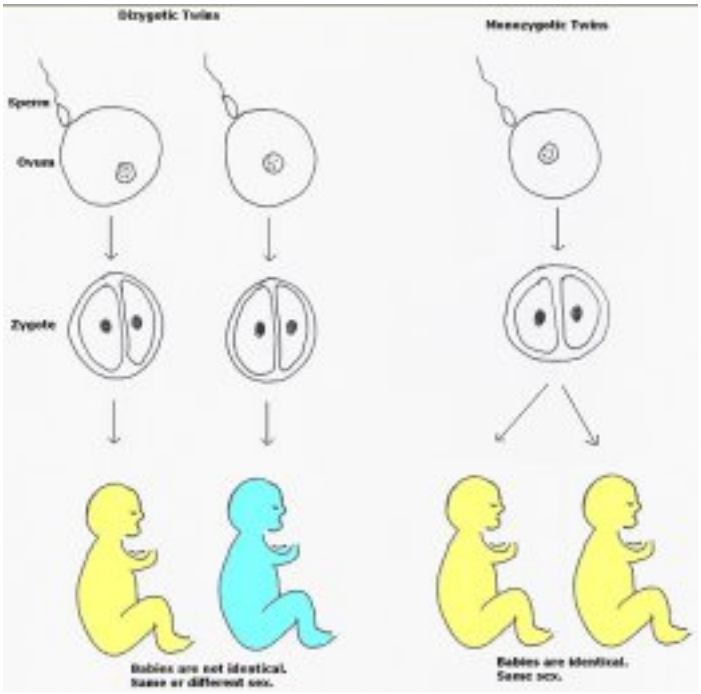
Monozygotic twins (identical twins):

Here one zygote is formed in the normal way, but the zygote divides into two halves. These two halves develop into two babies. Here the twins are of the same sex and look similar in features.



Dizygotic twins (fraternal twins):

Here two zygotes are formed from two ova and two sperms separately. Each zygote develops into a different baby. Here there is no division of zygote. Each zygote grows into a baby. These twins may be the same or different sexes and may not resemble each other because they are from completely different zygotes.

Does our body have Living tissue with NO Blood supply?

All the living tissue in our body needs blood supply to survive. Tissue gets its nutrition and oxygen from blood and carbon dioxide diffuses back into the blood. Simply put, the tissues will die without a blood supply.

But, not the cornea. It is a very thin and transparent membrane in the front and center of the eye. It covers the pupil. If there are blood vessels are in the cornea, it becomes hazy and white and we cannot see. To maintain the essential transparency, the cornea has no blood vessels.

Though the cornea doesn't have a single blood vessel, it is rich in nerves. So any small scratch on the cornea is much more painful than you might expect from the size of the lesion.

The cornea is still a living tissue, so it needs nutrition and oxygen. It gets

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them from aqueous humor (fluid that is in contact with the cornea in the eye) and lacrimal fluid (tears).

The cornea is very important for focusing the object you are looking at on the retina. It works along with the lens to focus the object.

Why is it easy to wake people in early mornings?

While a person is sleeping, he sleeps in a rhythm. There are two types of sleep which repeat one after another until the person wakes up.

1) **Non-Rapid Eye Movement sleep (NREM Sleep):** This is deep sleep and people are hard to awaken during it. Their heart rate is slow, their body temperature decreases, there are no eye movements and muscle tone is high.
2) **Rapid Eye Movement Sleep (REM Sleep):** This is light sleep and people in this state are easy to awaken. Their heart rate and respiration rate increase. There are rapid eye movements and their muscles are relaxed. In this stage, their brain is active and the body is inactive.

So, why is a person is easy to wake up in the morning?

Usually sleep starts with the NREM stage, then a REM stage follows. This cycle repeats about five times during one night. As early morning approaches, the duration of the REM stages increase and they are more likely to be in this state in the morning rather than the NREM state. So, it is usually easy to wake up a person in the morning.

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A Few Words from the Author

I wrote this book as a simple and interesting, but accurate publication about various aspects of the human body, using my answers to many medical questions from my two kids, in a way that is understandable for everyone.

I want this book to help you and other parents answer their children's questions on medical matters in a way that helps them to be comfortable with their own bodies and encourages them to look after their health.

I made every effort to put colorful pictorial illustrations to explain the medical content. I shall consider this work very rewarding if every reader finds it useful and also helpful in teaching their kids a few fun facts about human biology.

My other ebooks are 'Your Diet and Cancer' (pdf format) and 'Absolute Beginners Guide to CGI' (Windows only), which can both be obtained from the eBookwholesaler Member that supplied this book to you.

My sincere thanks to Tom Hua, the Owner of ebookwholesaler, for accepting my work, '101 Facts About the Human Body - Simply Explained and Illustrated!', for publication and John Williams for helping me in editing and compiling the content of my ebook.

I would like to thank my family and kids for encouraging me to write this ebook.

Also, I want to thank you, my readers, for buying my book and making the effort to help your children understand and look after themselves.

Dr Radhika Venkata

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