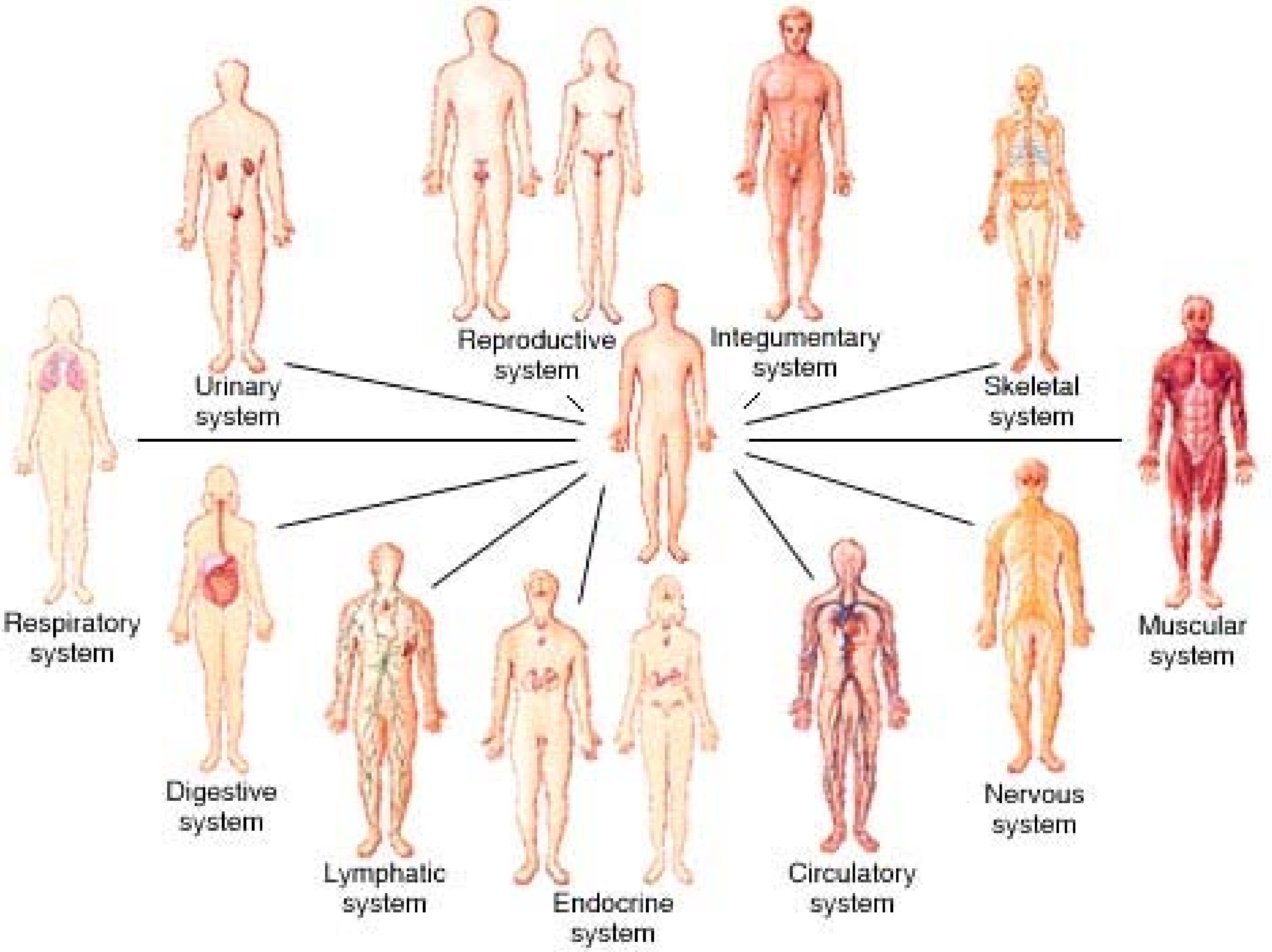
PASCAS CARE

The 10 Human Body Systems



"Peace And Spirit Creating Alternative Solutions"

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PASCAS INTRODUCTION:

Documents assembled by Pascas are provided for your individual assessment and exploration. The contents are sourced from a variety of avenues and publications. Every endeavour is made to determine that the contents are of the highest level of truth and veracity. At all times we ask that you go within yourself, to ascertain for yourself, how the contents resonate with you.

Pascas provides these notes and observations to assist us all in the development and growth of our own pathways and consciousness. Pascas does not hold these contents as dogma. Pascas is about looking within oneself. Much of what we are observing is new to us readers and thus, we consider that you will take on board that which resonates with you, investigate further those items of interest, and discard that which does not feel appropriate to you.

Kinesiological muscle testing, as developed by Dr David R Hawkins and quantified by his Map of Consciousness (MOC) table, has been used to ascertain the possible level of truth of documents. Such tested calibration levels appear within the document. We ask that you consider testing same for yourself. The technique and process is outlined within Pascas documents, such as Pascas Care – Energy Level of Food. From each person's perspective, results may vary somewhat. The calibration is offered as a guide only and just another tool to assist in considering the possibilities. As a contrast, consider using this technique to test the level of truth of your local daily newspaper.

Contents are not to be interpreted as an independent guide to self-healing. The information sourced herein is not from a doctor or doctors, and any information provided in this document should not be in lieu of consultation with your physician, doctor, or other health care professional. Pascas, nor anyone associated with this document, does not assume any responsibility whatsoever for the results of any application or use of any process, technique, compound or potion as described within this document.

The sources of contents are noted throughout the document. In doing so, we acknowledge the importance of these sources and encourage our readers to consider further these sources. Should we have infringed upon a copyright pertaining to content, graphics and or pictures, we apologise. In such cases, we will endeavour to make the appropriate notations within the documents that we have assembled as a service via our not for profit arm, to our interested community.

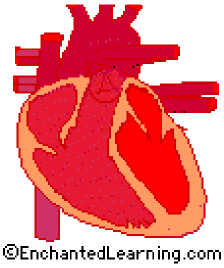
We offer all contents in love and with the fullness of grace, which is intended to flow to readers who join us upon this fascinating journey throughout this incredible changing era we are all experiencing.

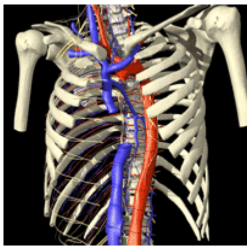
Living Feelings First, *John.*

"Never can one man do more for another man than by making it known of the availability of the Feeling Healing process and Divine Love." JD

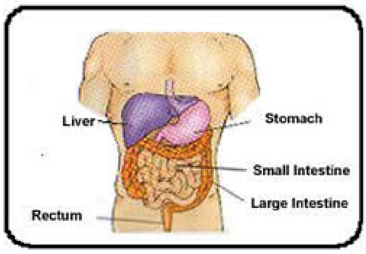
<u>The 10 HUMAN BODY SYSTEMS</u>:

Circulatory System – Cardiovascular





Digestive System

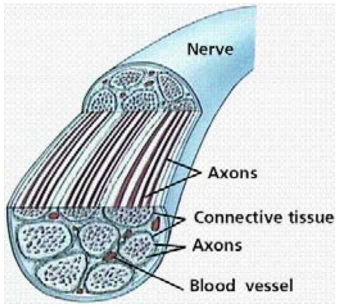


Immune System

- Thymus
- Spleen
- Lymph system
- Bone marrow
- White blood cells
- Antibodies
- Complement system
- Hormones

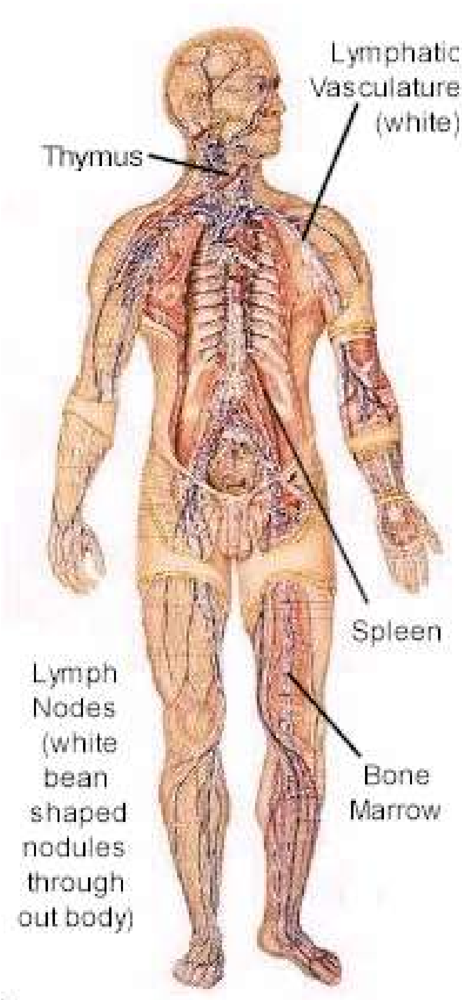
Urinary System

Nervous System

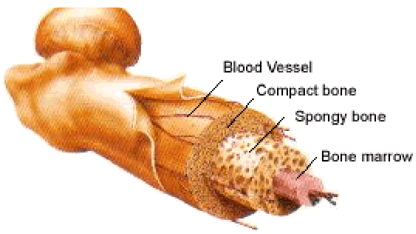


Reproductive System

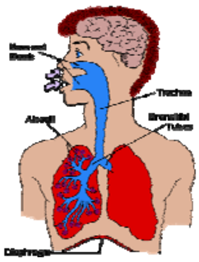
Muscular System



Skeletal System



Respiratory System



Lymphatic System

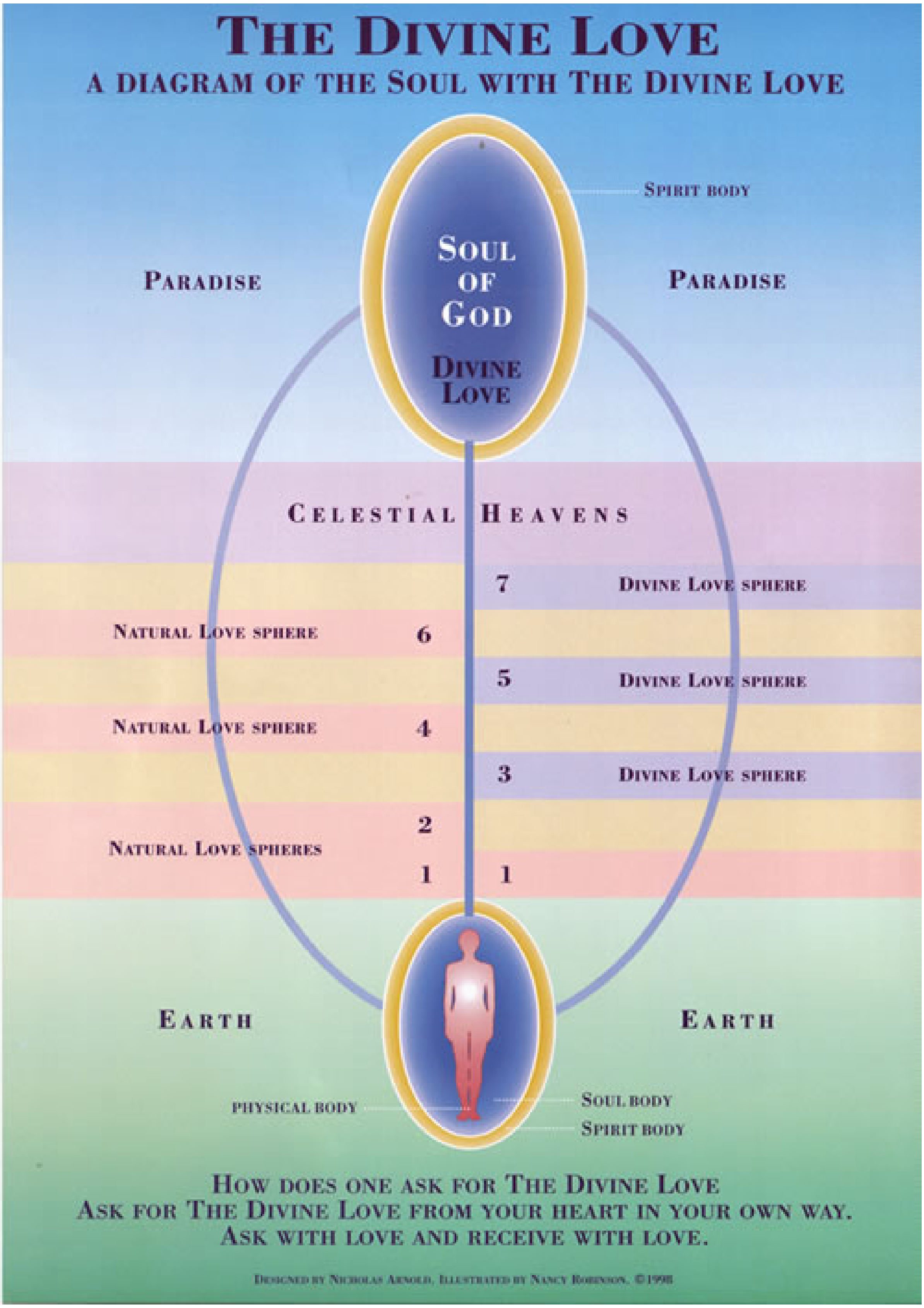
Lymph capillaries → lymphatic → lymph node → lymphatic → cisterna chili → thoracic duct

- The **anatomic response** physically prevents threatening substances from entering your body. Examples of the anatomic system include the mucous membranes and the skin. If substances do get by, the inflammatory response goes on attack.
- The **inflammatory system** works by excreting the invaders from your body. Sneezing, runny noses, and fever are examples of the inflammatory system at work. Sometimes, even though you don't feel well while it's happening, your body is fighting illness.
- When the inflammatory response fails, the **immune response** goes to work. This is the central part of the immune system and is made up of white blood cells, which fight infection by gobbling up antigens. About a quarter of white blood cells, called the lymphocytes, migrate to the lymph nodes and produce antibodies, which fight disease.
- **Skeletal muscles** help the body move.
- **Smooth muscles**, which are involuntary, are located inside organs, such as the stomach and intestines.
- **Cardiac muscle** is found only in the heart. Its motion is involuntary
- The **central nervous system** consists of the brain and spinal cord. It sends out nerve impulses and analyzes information from the sense organs, which tell your brain about things you see, hear, smell, taste and feel.
- The **peripheral nervous system** includes the craniospinal nerves that branch off from the brain and the spinal cord. It carries the nerve impulses from the central nervous system to the muscles and glands.
- The **autonomic nervous system** regulates involuntary action, such as heart beat and digestion.

Live true to your feelings, and you ARE living true, not only to your own soul, but also true to God's soul. So doing your Healing by honouring all your feelings, IS living the will of God. And being fully Healed, IS living even more truly the Will of your Mother and Father.

PASCAS HEALTH

Feeling Healing with Divine Love is the key!


THE DIVINE LOVE
A DIAGRAM OF THE SOUL WITH THE DIVINE LOVE
SPIRIT BODY
PARADISE
SOUL OF GOD
PARADISE
DIVINE LOVE
CELESTIAL HEAVENS
7
DIVINE LOVE SPHERE
NATURAL LOVE SPHERE
6
5
DIVINE LOVE SPHERE
NATURAL LOVE SPHERE
4
3
DIVINE LOVE SPHERE
2
NATURAL LOVE SPHERES
1
1
EARTH
EARTH
PHYSICAL BODY
SOUL BODY
SPIRIT BODY
HOW DOES ONE ASK FOR THE DIVINE LOVE
ASK FOR THE DIVINE LOVE FROM YOUR HEART IN YOUR OWN WAY.
ASK WITH LOVE AND RECEIVE WITH LOVE.
DESIGNED BY NICHOLAS ARNOLD, ILLUSTRATED BY NANCY ROBINSON. ©1998

<u>SOUL</u>:
The Real You is your soul, you are one 'half' of that soul.

Each half of the original soul incarnates a spirit and physical body simultaneously, they being connected. The soul expresses each of its two personalities as a woman and man. True soulmates are always of the opposite sex.

Sexuality is an attribute of the two personalities the soul expresses; the soul itself does not know sexuality.

The soul connects to the two spirit bodies it has created by 'golden cords' of light; and the spirit body is in turn connected to the physical body by 'silver cords' of light.

The spirit body is your astral body. The etheric is really the body that is the template for the physical and one that doesn't hold consciousness.

The soul remains invisible to the spirit and physical bodies, only being discernible by its luminosity through the spirit body.

95%+ of humanity currently are within the 1st sphere of development.

PERSONALITY ^ PERSONALITY

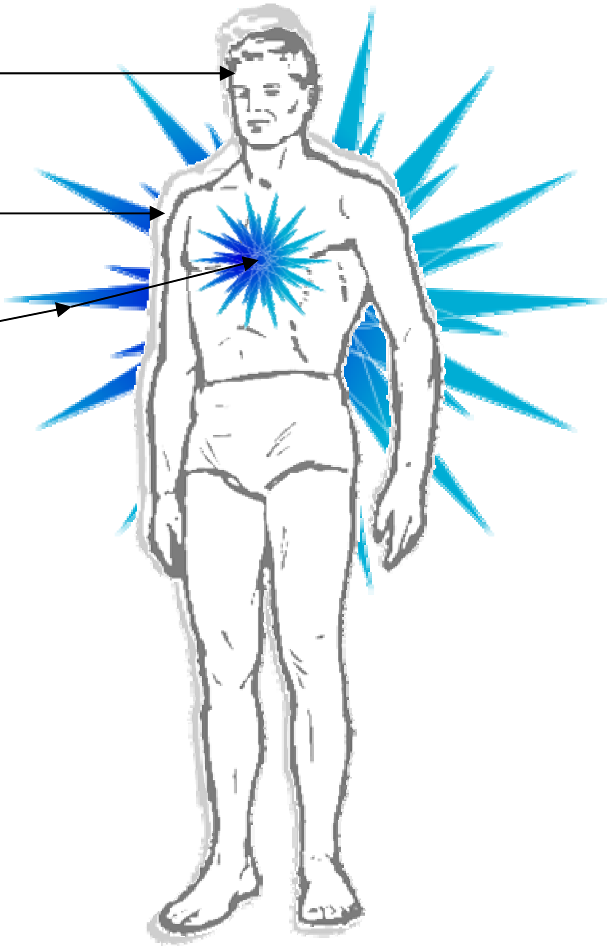
Soul Spirit Body Physical Body Physical Body Spirit Body Soul

ASPECTS of LIFE:

Physical / material body
Brain

Spirit / etheric body
Mind

Soul + Spirit Combination
Senses
Desires
Memory
Passions
Intention
Free Will
Emotions
Creativity
Awareness
Personality
Aspirations
Intelligence
Consciousness
The Real You is your Soul!



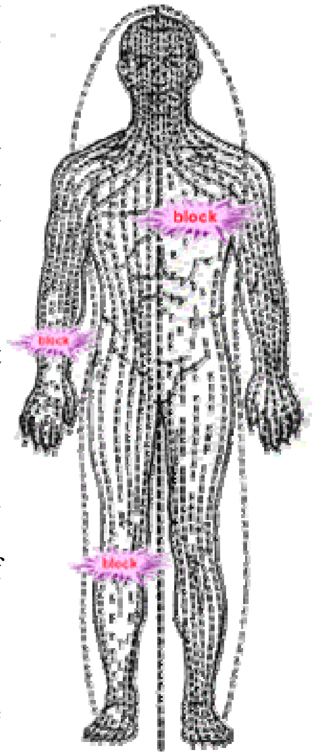
The spirit body is composed of a different kind of matter, "finer" or more "ethereal". The fact that its aspect reflects the condition of soul is a clear indication that the soul influences largely its formation, and even more, the soul is indeed the creator of this body, which covers it and provides it with the characteristic of individuality. The formation of the spirit body begins at the moment of incarnation of the soul in the foetus, incarnation which only takes place should there exist a high probability that the spirit of life has found in the new organism a stable biological structure, allowing it to carry out its life-giving function. P529 Judas of Kerioth 8th May 2002

At the moment of conception, we incarnate, that is, we achieve individualisation and become self aware and we are then able to exercise our free will.

At the moment of conception, our soul, being our real self, is creating the newly forming embryo and everything else every step of the way as Judas says above. And our soul utilises our parents' life forces to achieve incarnation.

At the moment of conception, there is nothing of the Divine within us. Only as we proceed to ask for and receive Divine Love does our soul slowly and progressively change into the nature of that which is Divine. As our soul embraces Feeling Healing, and receives Divine Love, it will grow, and grow, and grow in brilliance and into that which is Divine.

<u>ENERGY DETERMINANTS – Relationship between Body, Mind and Soul</u>:



The physical body calibrates at 200 on Dr David Hawkins' Map of Consciousness. Many people feel and believe that their body is their real self, this is not so.

Further, the brain is not the origin of the mind, as science and medicine had believed, but the other way around. The mind controls the brain. The brain is activated by the mind's intention and not vice versa. Reason, which emanates from the mind, calibrates at 400 to 499, thus controlling the brain.

What is held in mind has the power to alter brain activity and neuroanatomy. Thought is powerful because it has a high rate of vibration. We are subject to what we hold in mind. Errors in belief bring about energy flow blockages.

Superimposed around the physical body is an energy body whose form is very much like that of the physical body and whose patterns actually control the physical body. This control as at the level of thought or intention. This superimposed energy body is one's etheric / spirit body, the template of one's physical body and home of one's mind.

The basic dictum to comprehend is that the body obeys the mind; therefore, the body tends to manifest what the mind believes. Illness is generated in the physical body by erroneous held beliefs within one's mind.

It is the energy level of love that steadily brings about a release from erroneous and harmful man-made emotions and beliefs. The energy level of love calibrates at 500 and higher. One's soul is connected by cords of light to one's spirit body. One's soul is the home of one's personality, natural intelligence and memory, it is our real self.

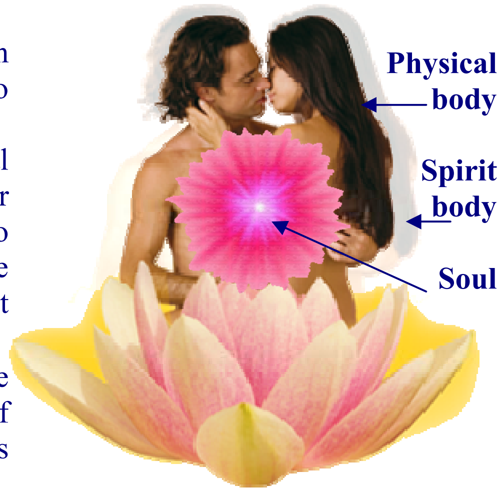
One's soul is always perfect and is made of the energy substance called natural love. It is by growing one's level of love does one enable sufficient energy to flow through one's chakras of the spirit body and subsequently into one's physical body that erroneous and injurious beliefs are dissolved and the potentiality for health of the physical body to become permanently repaired a possibility.

On the Map of Consciousness (MoC), the **charkas** calibrate as follows:

Crown	600	7th chakra
Third Eye	525	6th chakra
Throat	350	5th chakra
Heart	505	4th chakra
Solar Plexus	275	3rd chakra
Sacral or Spleen	275	2nd chakra
Base or Root Chakra	200	1st chakra

With the Feeling Healing process and the greatest infusion of Love, this is the easiest way for one to transcend levels of emotions, that is, to evolve, is to long for, pray for, and ask for our Mother and Father's Love, Divine Love, being a light golden blue energy substance. Try the experiment.

The REAL YOU is the SOUL:



One's personality, natural intelligence, memory and human attributes all are soul based. The soul initiates conception so it can start expressing one of its two personalities in Creation. It creates the will, then 'wills' the spirit body and physical body and all that connects them with the will into being. Our soul constantly sustains or expresses us, one of its two personalities, in Creation. The spirit can't separate from the soul because the soul keeps it in existence. We need our spirit and physical bodies to experience our personality through. When the spirit body separates from the physical body, one continues on living in a different form without losing any of the attributes experienced during physical life. Incarnation is the process of individualisation of the soul.

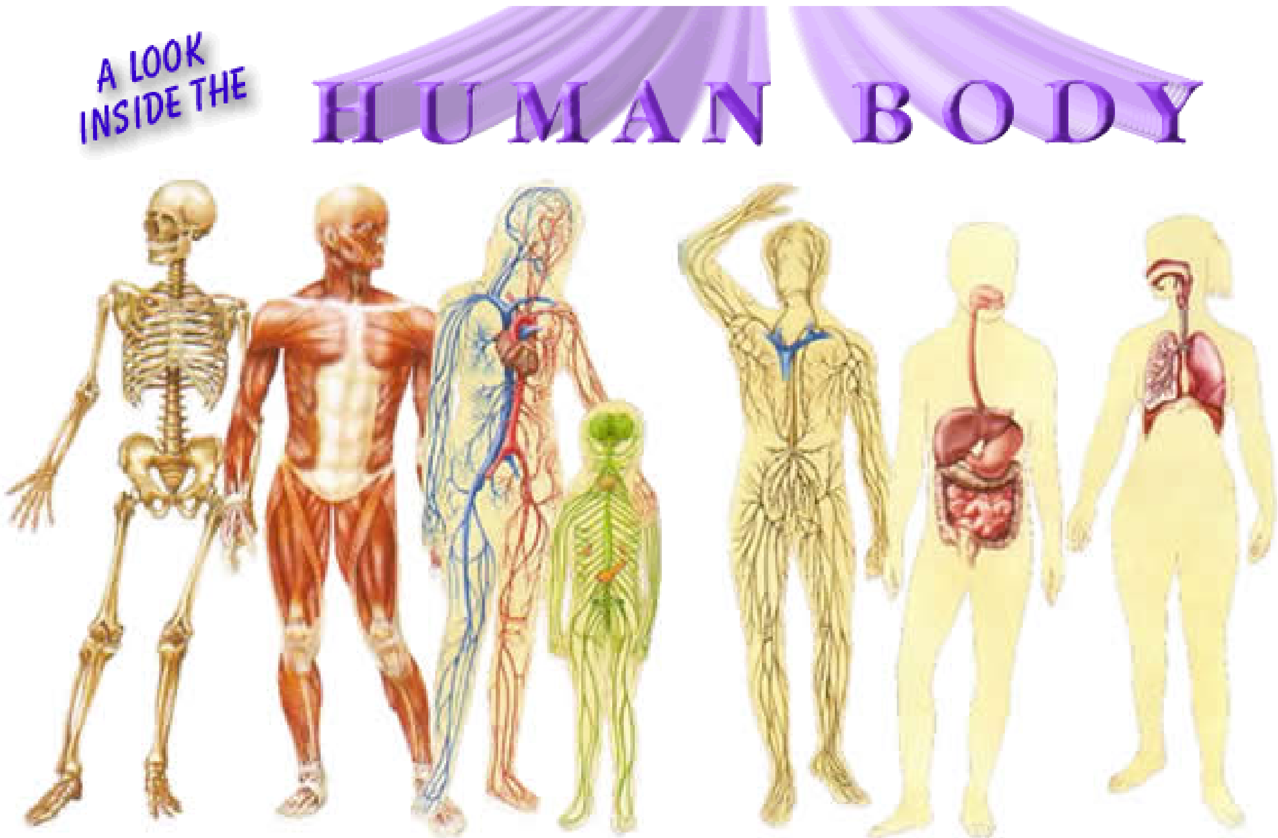
Without a soul, our physical bodies would function and interact similarly to that of a domestic animal. An unsouled human body (thought not possible) would respond like a household puppy! Domestic animals calibrate on Dr David Hawkins' Map of Consciousness between 200 and 250, the human body calibrates at 200. All animals have spirit bodies, these do not survive into the spirit mansion worlds. Our SOUL IS NOT ENSOULED IN OUR SPIRIT BODY. Our soul exists existentially in a whole different level or plane or place or dimension of being – 'soul land'. It doesn't exist in Creation, it's not experiential like Creation is. The soul, all souls, help create their part of Creation by expressing their personalities into Creation, and then by having their personalities do things (further create) in Creation.

Our first parents, Andon and Fonta (also called Aman and Amon), were the first to exhibit human perfection hunger some one million years ago. Adam and Eve, Adamite bestowals, arrived some thirty eight thousand years ago – or earlier.

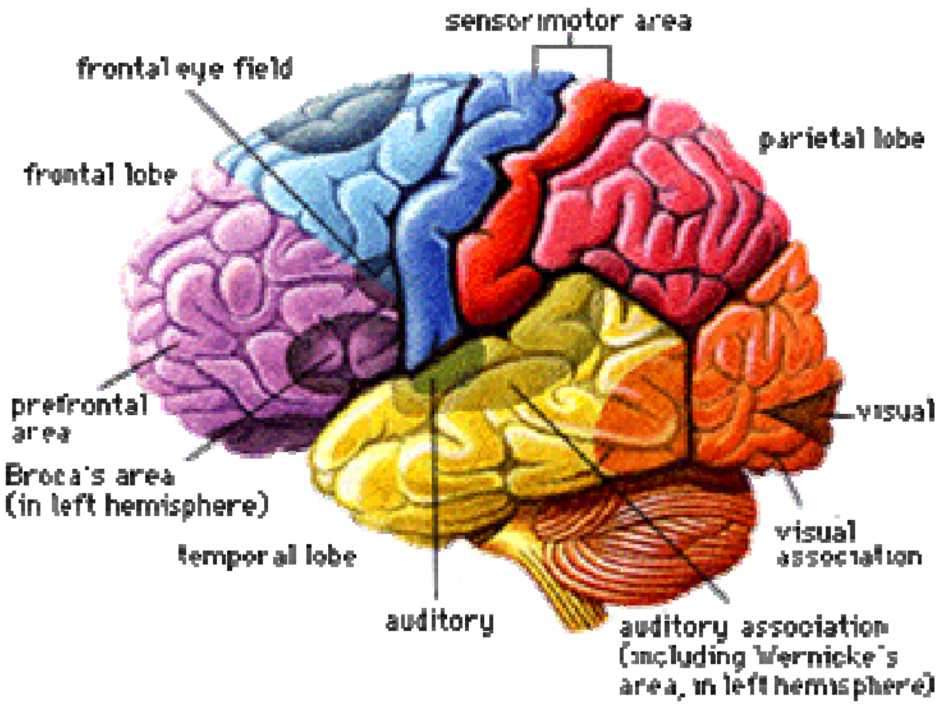
Aman and Amon were the first True Humans, which means, the first soul expressing its soulmate pair, its two personalities, in Creation – on Earth. From which came forth the rest of us. So they had a soul from the start, which separated them from their animal parents. It's the soul that wants to fully express itself through its two personalities perfectly in Creation, which is the so-called 'human perfection hunger'. It, our soul, wants to be Perfect like its Heavenly Parents, the Soul that Created it. We, focused as personalities, want to be perfect, like the Personalities of our Mother and Father that are Perfect. Our soul wants to be like Their Soul. Our soul wants to ascend us to Paradise so we can be with Them, as physically close to Them on a personality level that we can be, and then see what happens.

There were aunts and cousins, parents and grandparents. But they were not human like Aman and Amon – they were really animals, though of the same species. Aman and Amon wandered off from the family, since they could find no way of relating to them at all. How could they? They were incapable of rational thought, speech, or anything human. Aman and Amon knew that forevermore that they were apart.

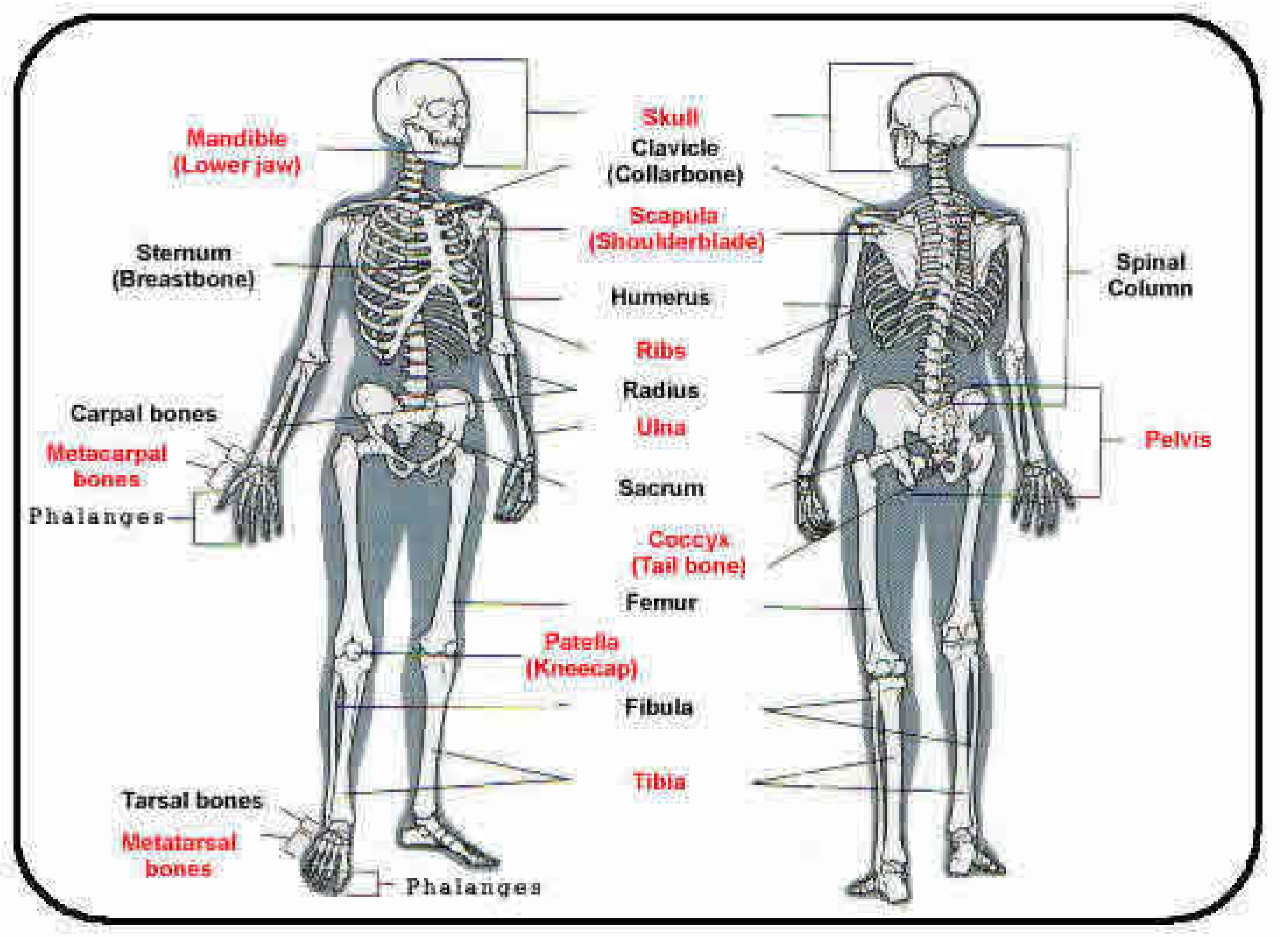
Aman and Amon may have been twins. They were indeed a primate species of humanoids. But they, themselves were more beautiful than their animal relatives, and they knew, even from their very appearance, that they were marked even by Nature to be different.



http://www4.tpgi.com.au/users/amcgann/body/



The Skeletal System

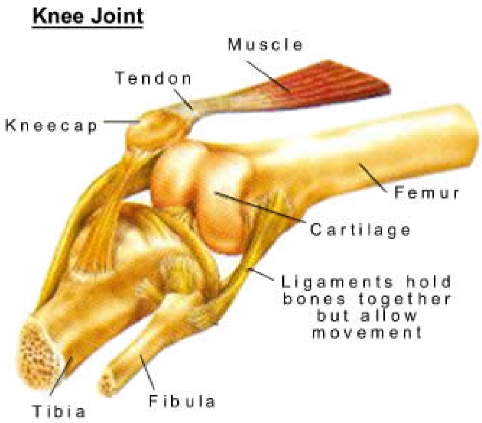


The Skeleton is the name given to the collection of bones that holds the rest of our body up. Our skeleton is very important to us. It does three major jobs.

1. It protects our vital organs such as the brain, the heart and the lungs.

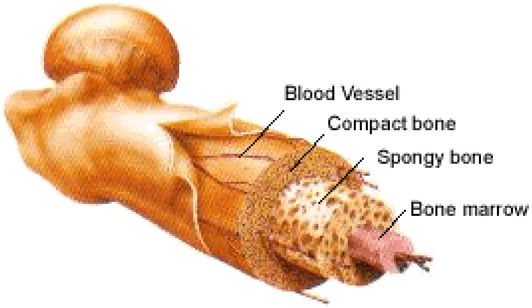
2. It gives us the shape that we have. Without our skeleton, we would just be a blob of blood and tissue on the floor.

3. It allows us to move. Because our muscles are attached to our bones, when our muscles move, they move the bones, and we move.



When you were born, your skeleton had around 350 bones. By the time you become an adult, you will only have around 206 bones. This is because, as you grow, some of the bones join together to form one bone.

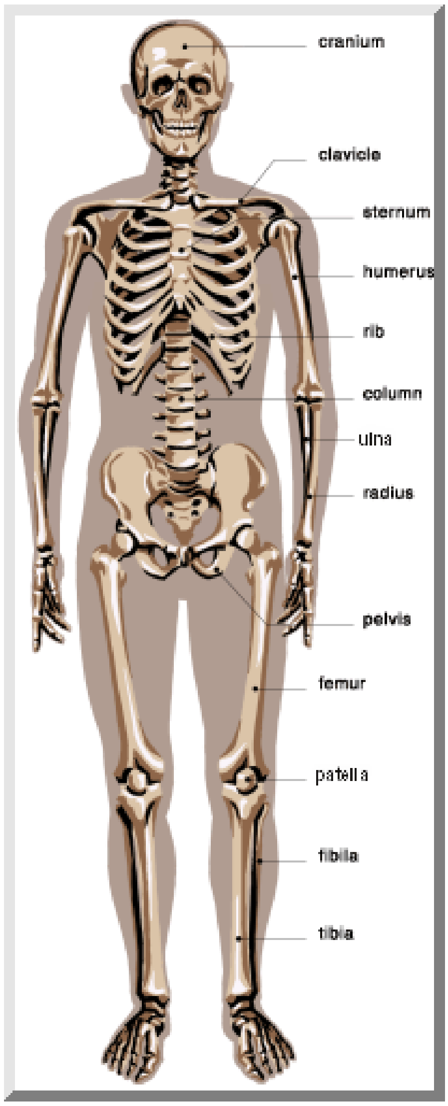
Our bones don't simply work on their own. The bones join together to form joints. The end of each bone is covered by a tough, smooth shiny substance called cartilage. The cartilage-coated bone-ends are kept apart by a thin film of slippery fluid that works like oil in a car. All of this is so your bones won't scratch and bump against each other when you move. Our bones are held together by strong stretchy bands called ligaments.



Inside a Bone

Old bones are dead, dry and brittle. But in the body, bones are very much alive. They have their own nerves and blood vessels, and they do various jobs, such as storing body minerals.

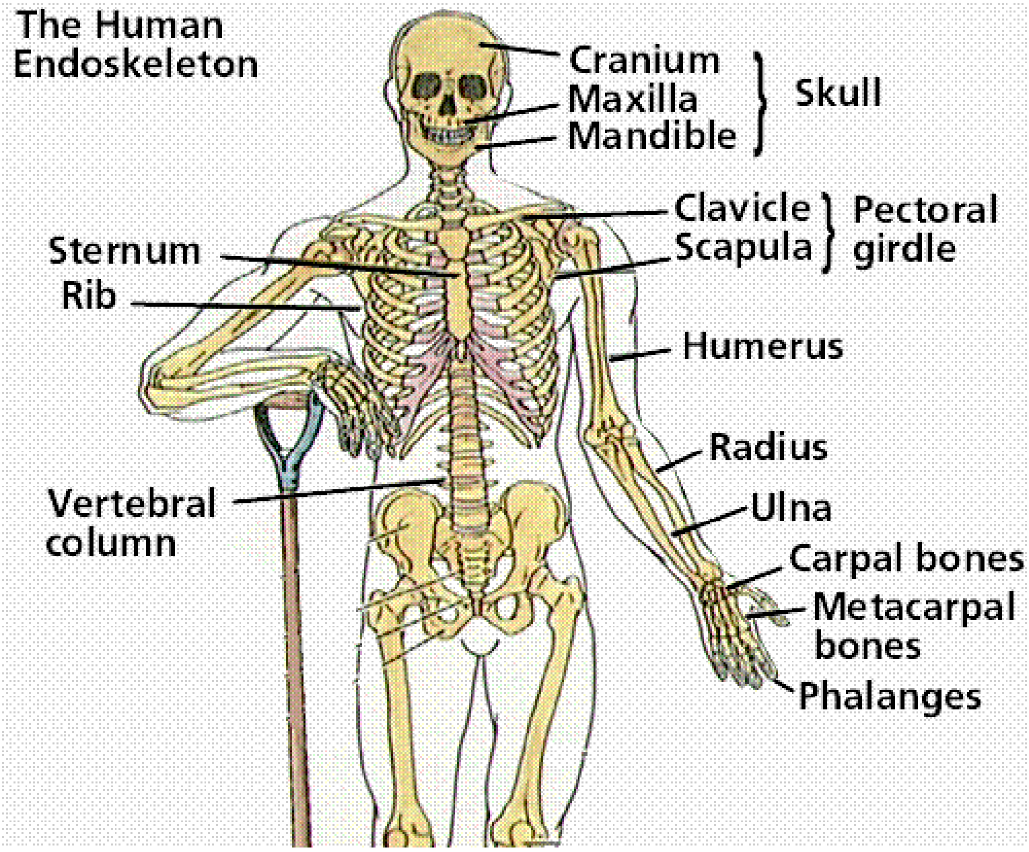
A typical bone has an outer layer of hard or compact bone, which is very strong, dense and tough. Inside this is a layer of spongy bone, which is like honeycomb, lighter and slightly flexible. In the middle of some bones is jelly-like bone marrow, where new cells are constantly being produced for the blood.

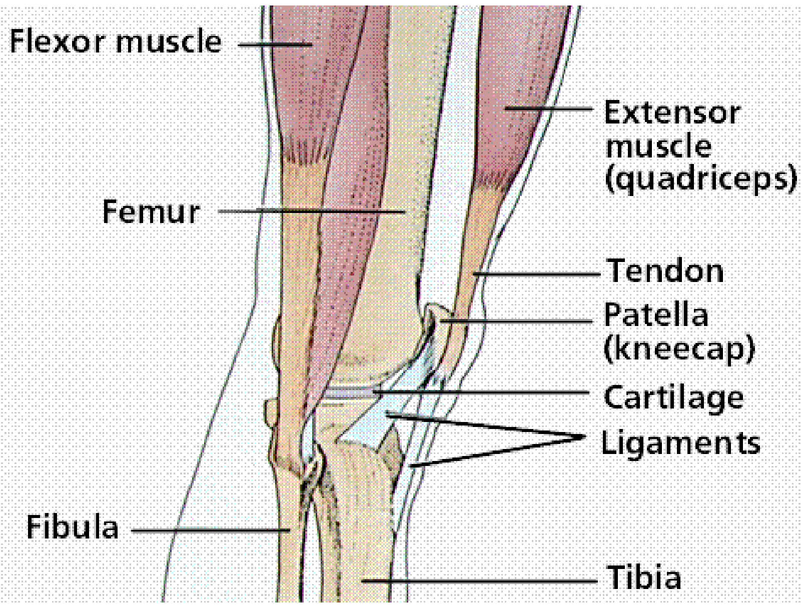


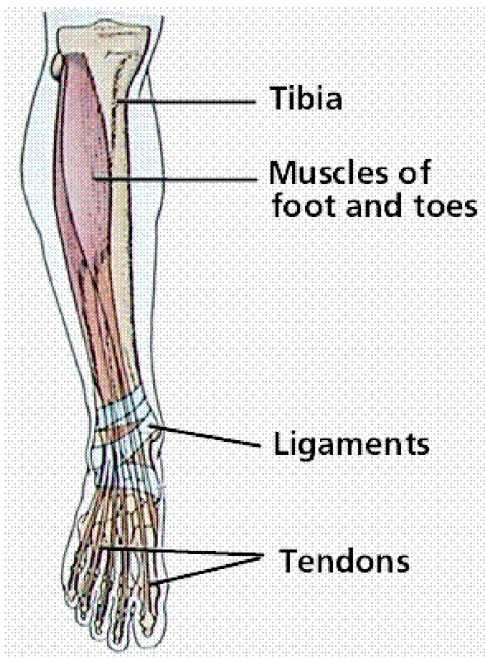
How Many Bones?

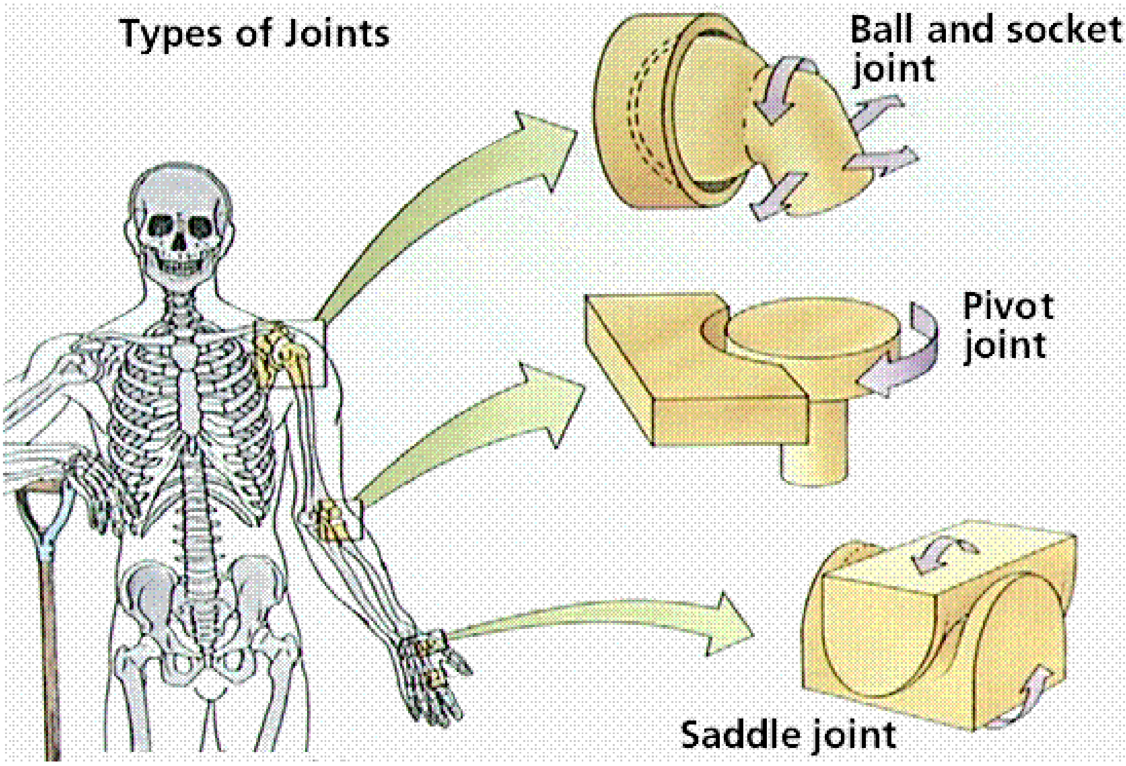
- Skull and upper jaw 21 bones
- 3 tiny bones in each ear
- Lower jaw (mandible)
- Front neck bone (hyoid)
- Backbone or spine (26 separate bones or vertebrae)
- Ribs (12 pairs – same number for men and women)
- Breastbone
- Each upper limb has 32 bones: 2 in shoulder, 3 in arm, 8 in wrist, 19 in hand and fingers.
- Each lower limb has 31 bones: 1 in hip (one side of pelvis), 4 in leg, 7 in ankle, 19 in foot and toes.

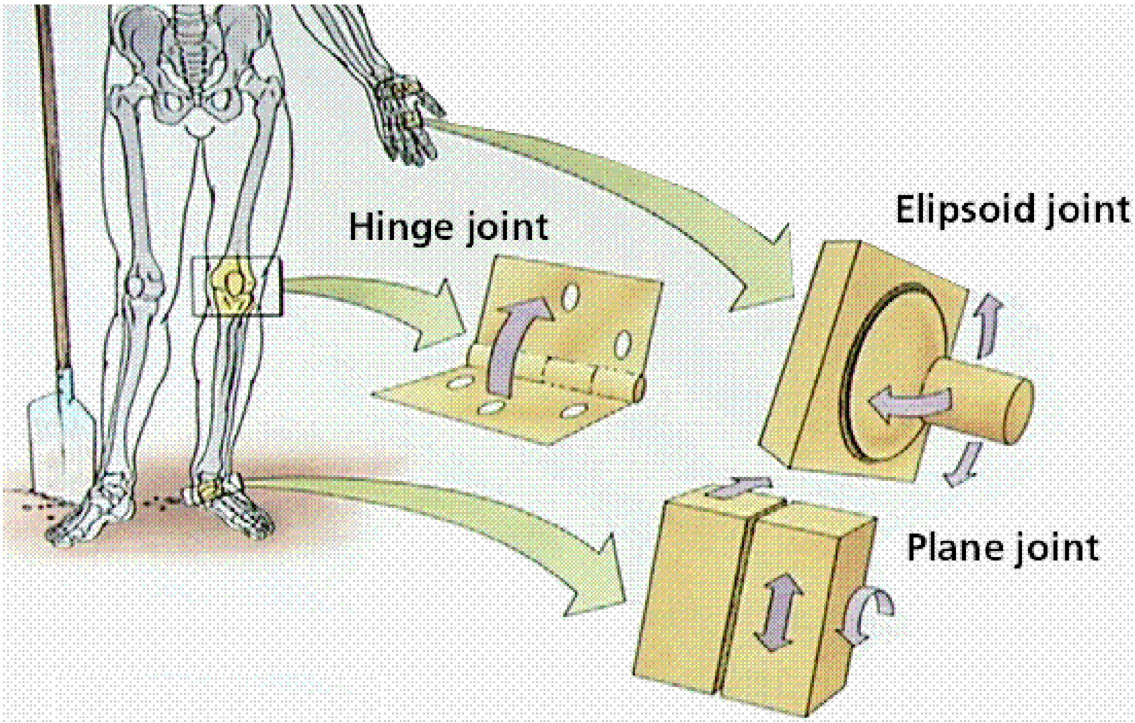
Total = 206 bones

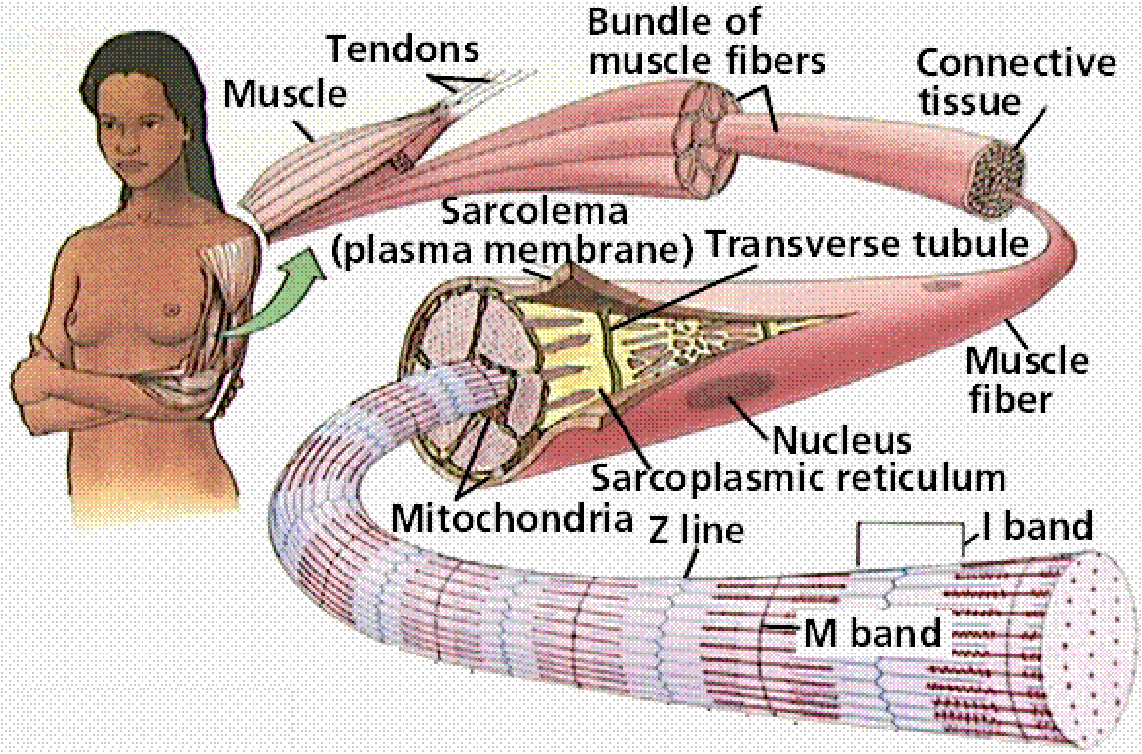

The Human
Endoskeleton
Cranium
Maxilla
Mandible
Skull
Clavicle
Scapula
Pectoral
girdle
Sternum
Rib
Humerus
Radius
Vertebral
column
Ulna
Carpal bones
Metacarpal
bones
Phalanges

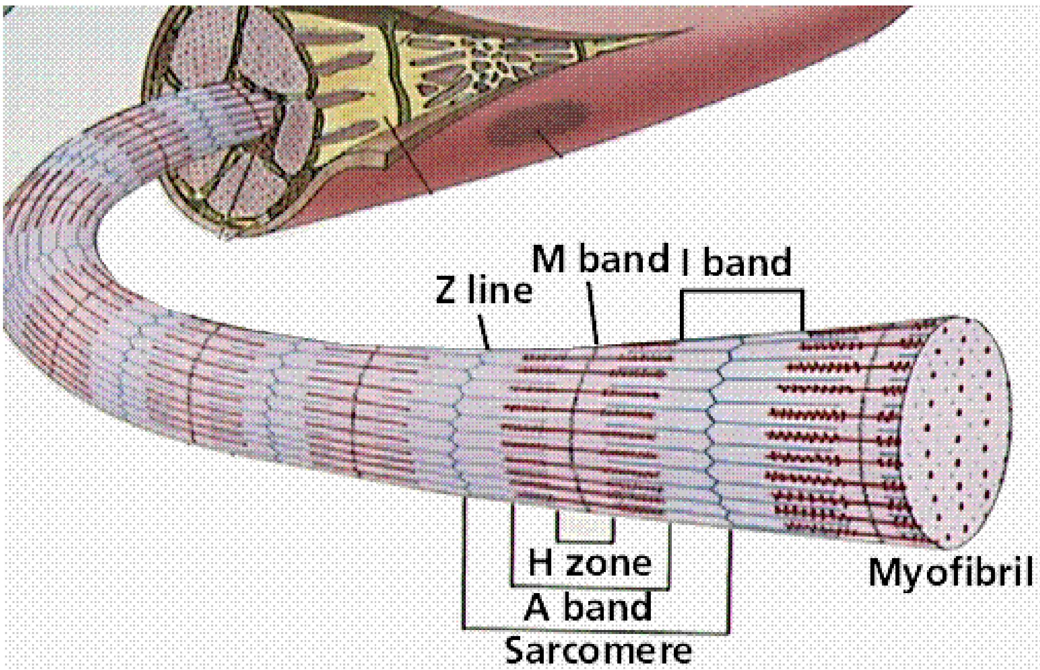

Flexor muscle
Extensor
muscle
(quadriceps)
Femur
Tendon
Patella
(kneecap)
Cartilage
Ligaments
Fibula
Tibia


Tibia
Muscles of
foot and toes
Ligaments
Tendons

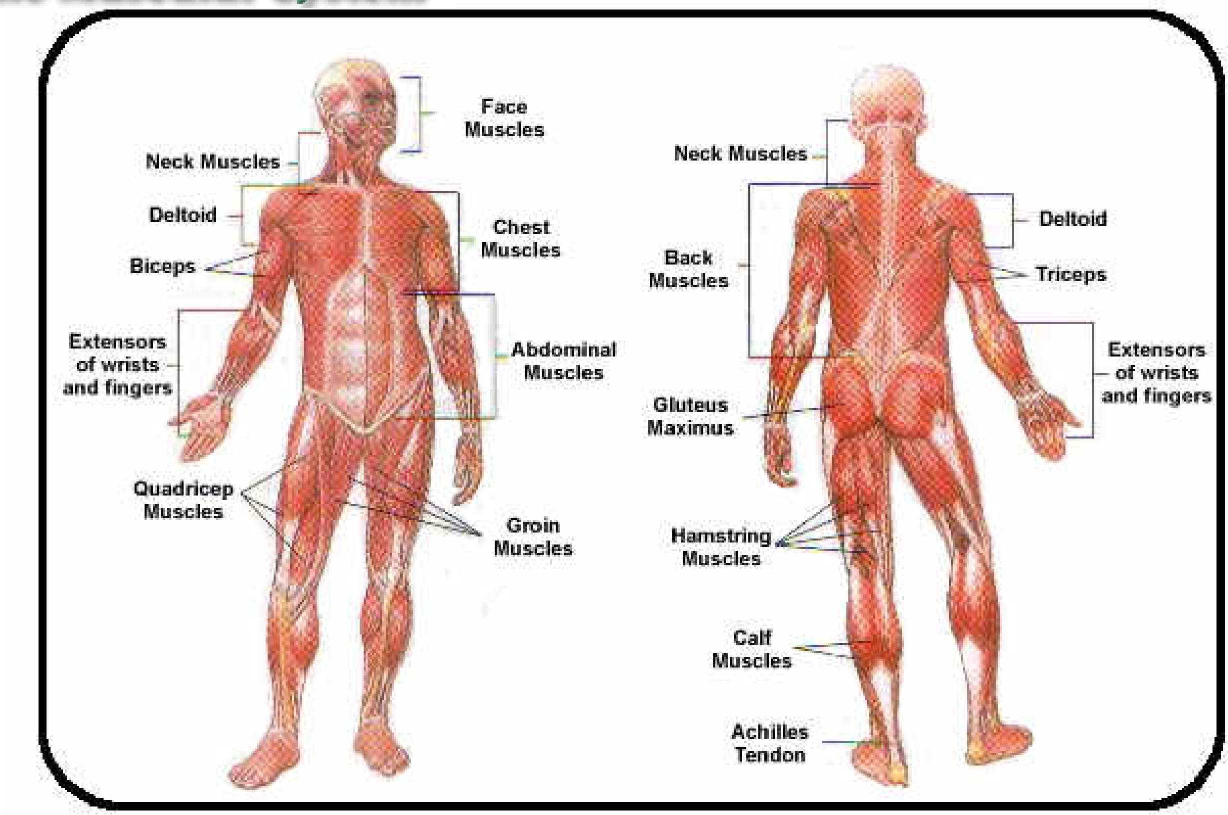

Types of Joints
Ball and socket joint
Pivot joint
Saddle joint


Hinge joint
Elipsoid joint
Plane joint


Tendons
Bundle of muscle fibers
Connective tissue
Muscle
Sarcolema (plasma membrane)
Transverse tubule
Muscle fiber
Nucleus
Sarcoplasmic reticulum
Mitochondria
Z line
I band
M band


M band
I band
Z line
H zone
A band
Sarcomere
Myofibril

The Muscular System



Almost half the body's weight is muscle. Muscles are the part of our body that allow us to move. They are made up of special tissues that can contract, or shorten, when they receive a signal from the brain. The muscles are attached to bones by stretchy tissue called tendons. When the muscles contract, they pull on the tendons which pull on the bones and cause our limbs to move.

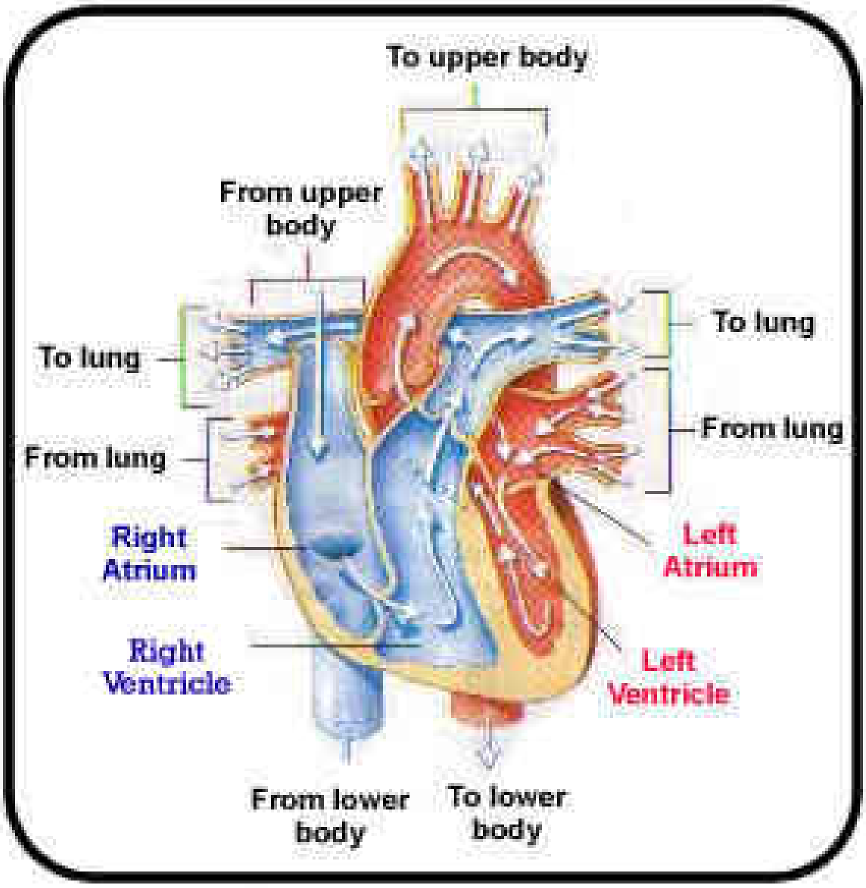
There are more than 640 muscles, and they hardly ever work alone. Muscles can get shorter and pull, but they cannot push. So most muscles are arranged in opposing teams. One team pulls the body part one way, then the other team pulls it back again. As each team pulls, the other team relaxes and gets stretched. Muscles band together to form muscle groups which work together.

Voluntary muscles, such as your arms and legs can be controlled by your thoughts.

All this muscle action is controlled by your brain, which sends and receives signals through your nervous system.

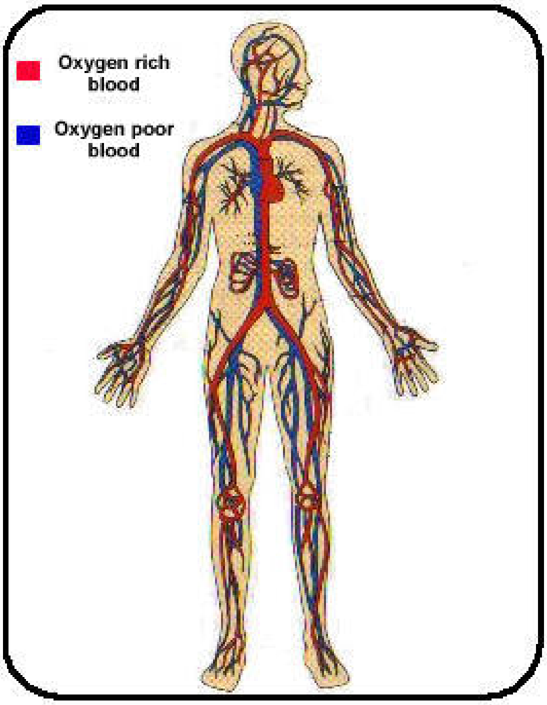
Muscle actions can be voluntary or involuntary. Involuntary muscles, such as the heart, diaphragm and intestines, are automatically controlled by the brain. You don't have to think about making them work. For example the heart beats between 60 and 80 beats every minute without you having to think about it.

The Circulatory System



A typical person has around 4-5 litres of blood. The blood is the transport system by which oxygen and nutrients reach the body's cells, and waste materials are carried away. In addition, blood carries substances called hormones, which control body processes, and antibodies to fight invading germs. The heart, a muscular organ, positioned behind the ribcage and between the lungs, is the pump that keeps this transport system moving.

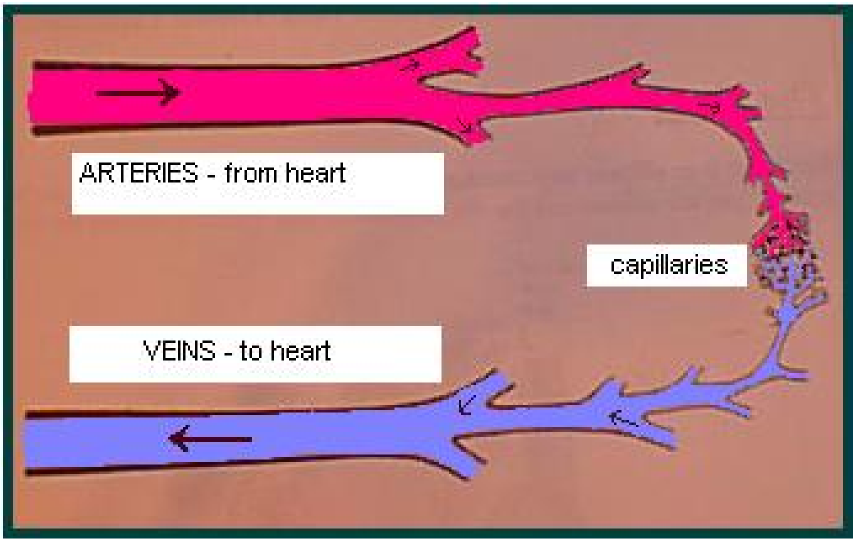
Your heart is about the size of your clenched fist. It has thick muscular walls and is divided into two pumps. Each pump has two chambers. The upper, smaller, thin-walled atrium receives blood coming in from the veins. The blood flows through a one-way valve, which makes sure it always moves in the correct direction, into the larger, lower chamber called the ventricle. It has thick strong walls that contract to squeeze blood through another valve, out into the arteries.



Two-part Circulation

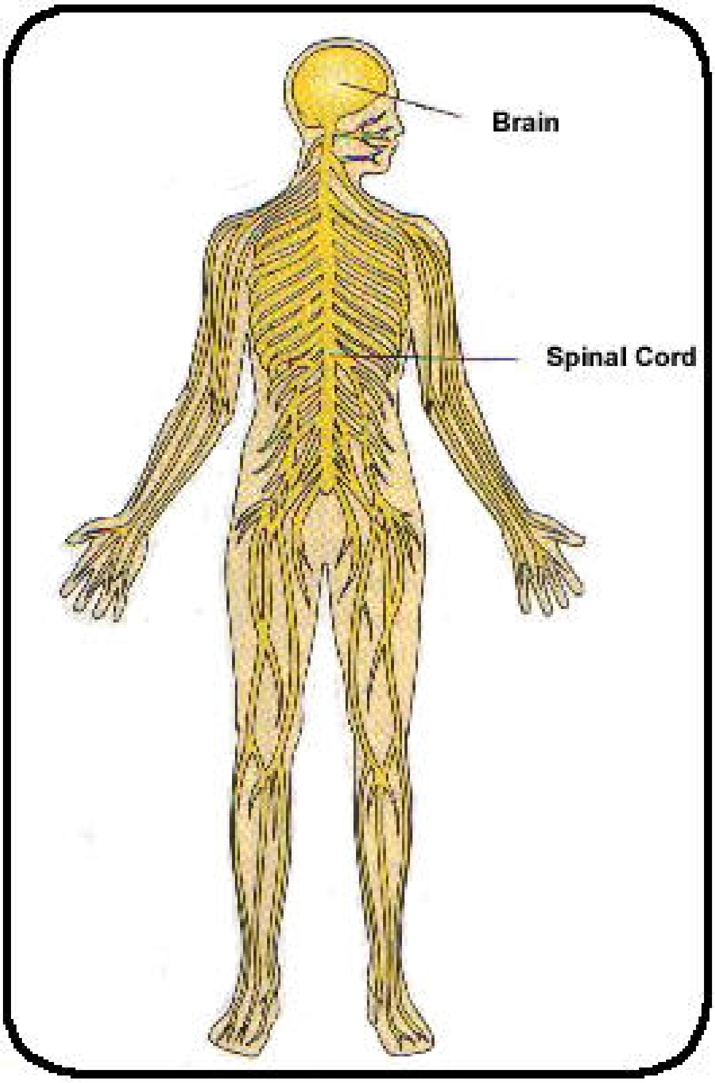
The body's circulation has two parts, with the heart acting as a double pump. Blood from the right side pump is dark red (bluish) and low in oxygen. It travels along pulmonary arteries to the lungs where it receives fresh supplies of oxygen and becomes bright red. It flows along pulmonary veins back to the heart's left side pump.

Blood leaves the left side of the heart and travels through arteries which gradually divide into capillaries. In the capillaries, food and oxygen are released to the body cells, and carbon dioxide and other waste products are returned to the bloodstream. The blood then travels in veins back to the right side of the heart, and the whole process begins again.



By living true to ourselves, true to our feelings, we are living true to God. It's that simple.

The Nervous System



The Nervous System is the most complex and delicate of all the body systems. At the centre of the nervous system is the brain. The brain sends and receives messages through a network of nerves. This network can be explained as similar to a road network.

The spinal cord is a thick bundle of nerves which runs down the centre of the spine. This is like a freeway.

Along the spinal cord smaller bunches of nerves branch out. These are like highways.

From these bundles, smaller bundles of nerves branch out again. These are like main roads.

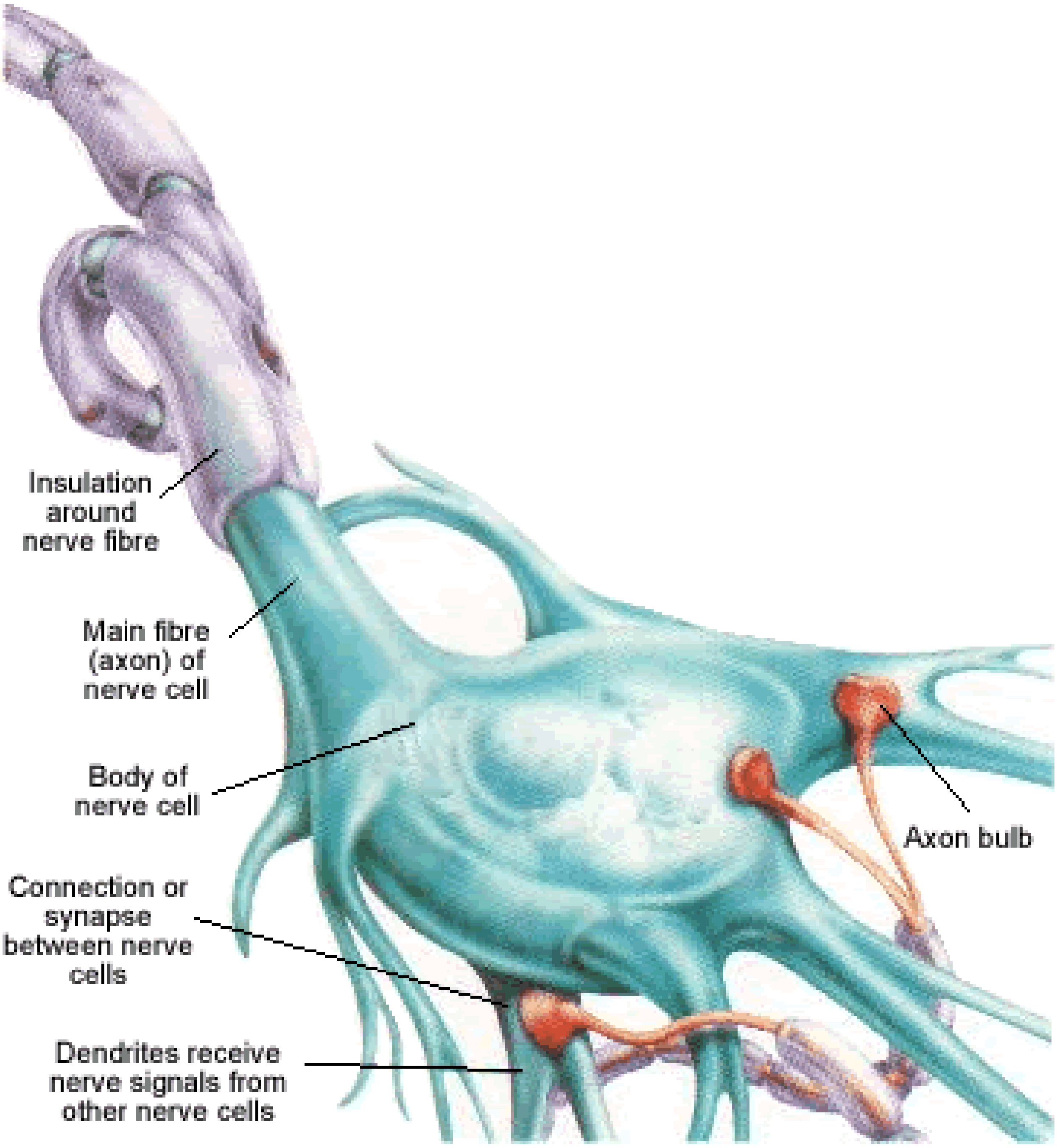
Finally, individual nerves branch out to every part of the body. These are like normal roads.

This network of nerves allows the brain to communicate with every part of the body. Nerves transmit information as electrical impulses from one area of the body to another. Some nerves carry information to the brain. This allows us to **see, hear, smell, taste and touch**. Other nerves carry information from the brain to the muscles to control our body's movement.

Many drugs, such as alcohol and cigarettes, affect the way that our nerves work. This can result in us not being able to control our body, as well as we should.

Each microscopic nerve cell, or neuron, has a blob shaped main part, the cell body, with thin, spider-like dendrites and one much longer, wire-like nerve fibre or axon.

The axon's branched ends have button shaped axon bulbs, which almost touch other nerve cells, at junctions called synapses. Nerve signals travel along the axon and 'jump' across synapses to other nerves cells, at speeds of more than 100 metres per second.


Insulation
around
nerve fibre
Main fibre
(axon) of
nerve cell
Body of
nerve cell
Axon bulb
Connection or
synapse
between nerve
cells
Dendrites receive
nerve signals from
other nerve cells

The Immune System

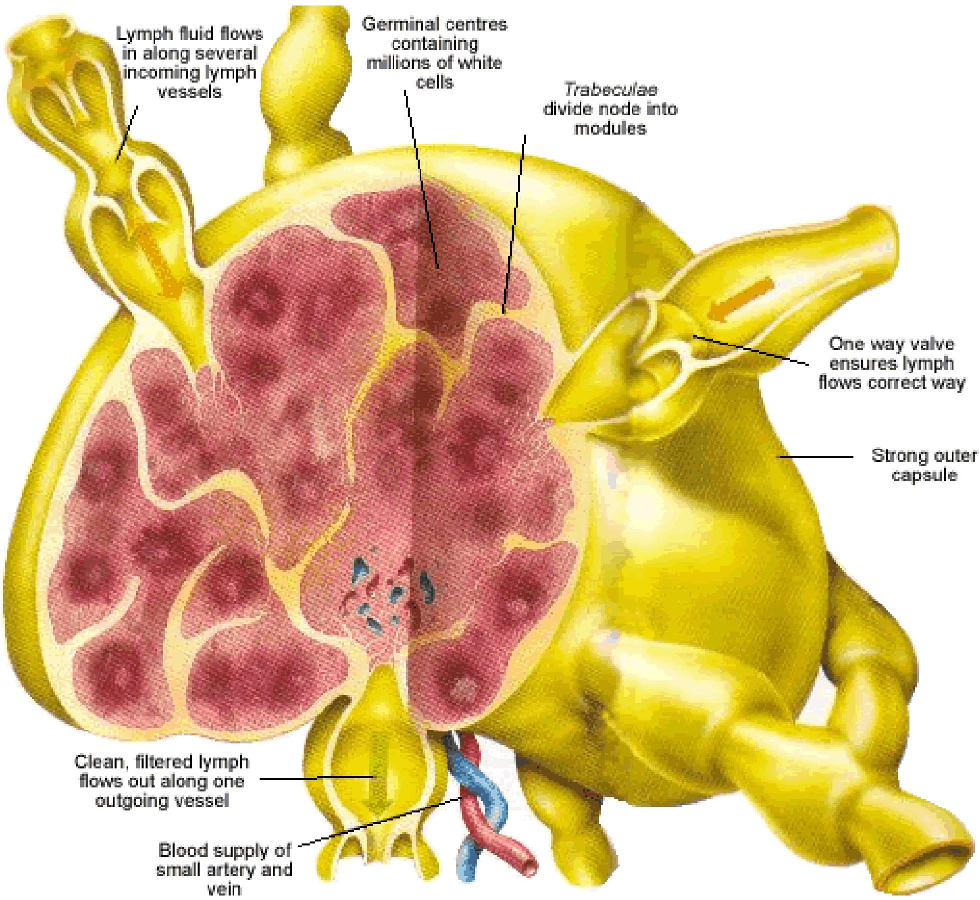
Even in a clean and spotless place, there are probably a few germs. These microscopic living things, such as bacteria and viruses, get on to our skin, into the food we eat, the drinks we consume and even the air we breathe. They may also get into our body through a cut or wound. If enough germs get into the body, they can start to multiply and cause problems. This is an infection.

But the body has several sets of defences against germs. These include the skin, the moist germ-trapping linings of the breathing and digestive passageways, the way blood clots to seal wounds and leaks, white cells and other substances in the blood, the thymus gland in the chest, and small lymph nodes or glands spread all over the body. Together, all these parts form the body's immune defence system.

The body's immune system includes several kinds of white cells in blood, body fluids, and lymph nodes. These white cells attack any germs that are in the body.

When the body is ill with an infection, various glands swell up. Many of these are lymph nodes. When you are healthy they are about the size of a pea or grape, but during illness they can be as big as golf balls.

Lymph nodes contain billions of white cells, multiplying rapidly to fight the invading germs. During illness they fill with millions of extra white cells and also dead germs.



Tonsils and Adenoids

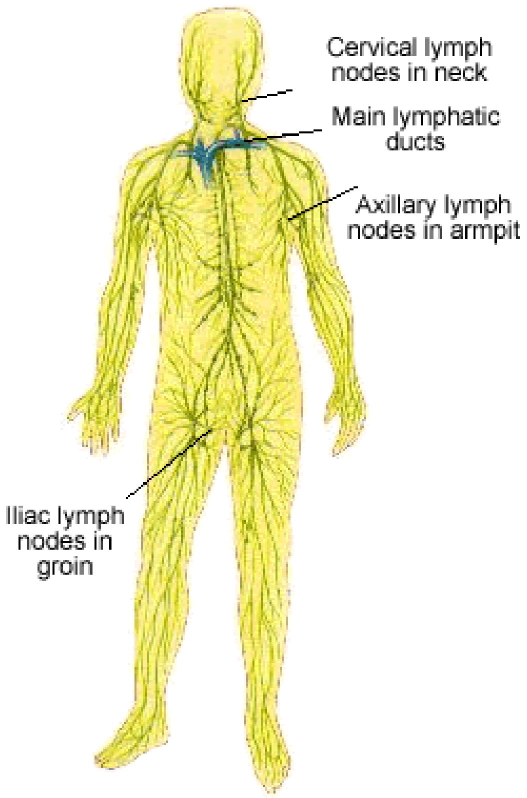
The tonsils are patches of lymph tissue at the upper rear part of the throat. They help to destroy foreign substances that are breathed in or swallowed. The adenoids are similar patches at the rear of the nasal cavity in the nose.

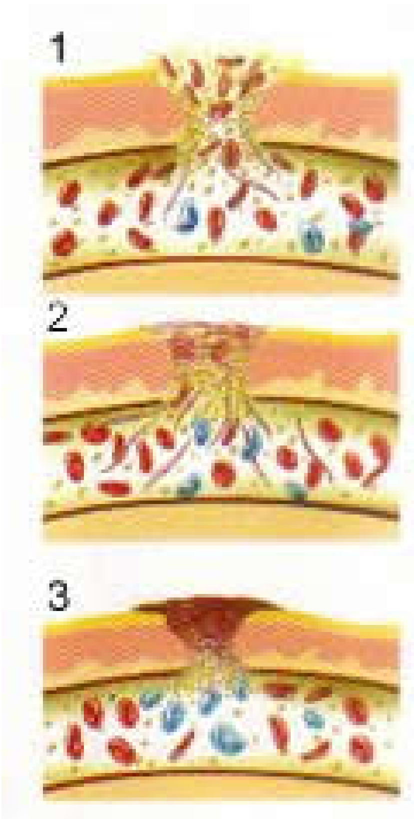
Thymus

The thymus gland in the front of the chest is large during childhood, but shrinks away during adulthood. It helps certain white cells of the immune system to develop and play their part in the body's defences.

Spleen

The spleen is just behind the stomach on the left side. It makes and stores various kinds of white cells, especially the *phagocytes* that "eat" germs. It also makes and stores red cells for the blood, and generally cleans and filters blood.





Cuts and Clots

A wound or cut in the skin leaks blood from the damaged blood vessels **(1)**.

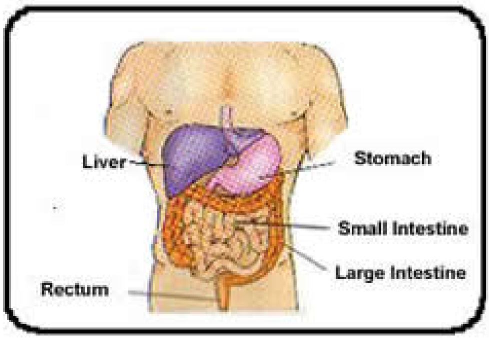
Chemicals released from damaged cells and platelets make dissolved substances in the blood turn into a meshwork of microfibres, of the substance fibrin. This network traps blood cells **(2).**

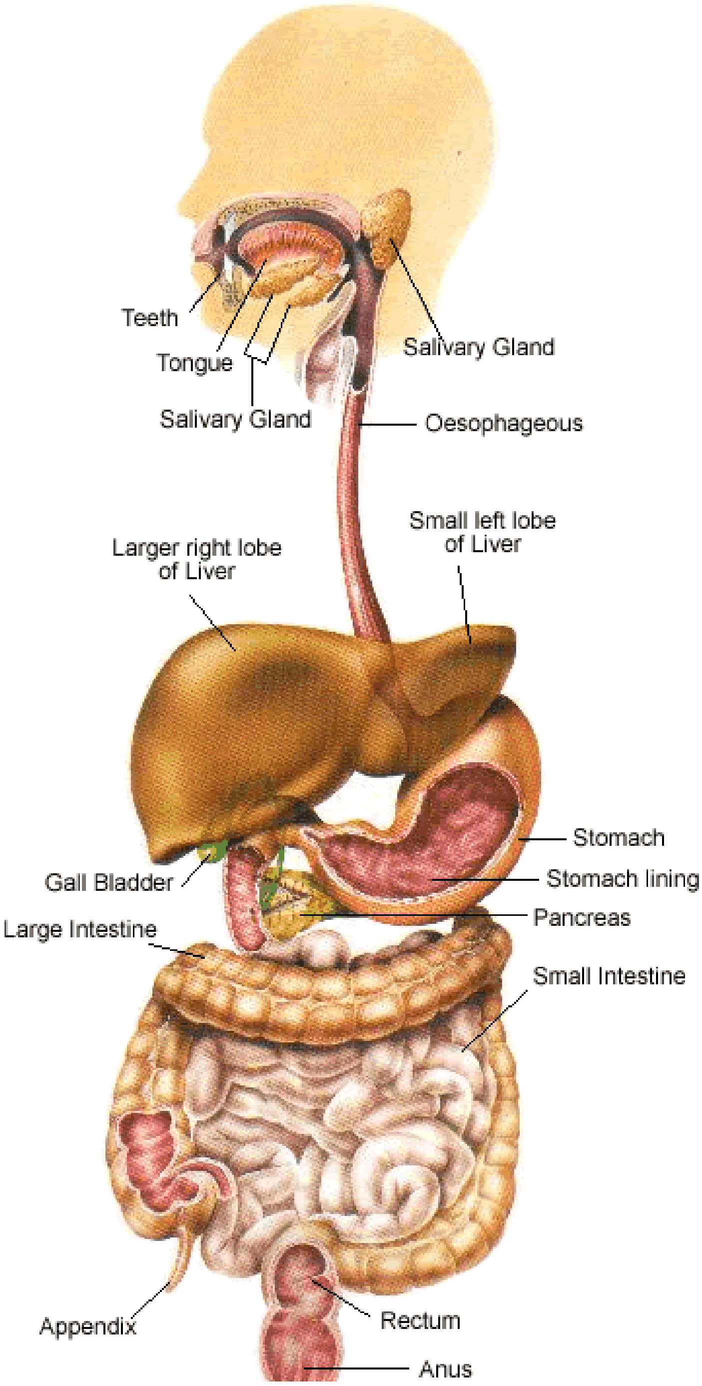
Gradually the meshwork hardens into a clump or clot that seals the leak. The clot then hardens and dries further into a protective scab **(3).**

White cells arrive to attack any germs, and the skin begins to re-grow and heal.

The Digestive System

Food provides us with fuel to live, energy to work and play, and the raw materials to build new cells. All the different varieties of food we eat are broken down by our digestive system and transported to every part of our body by our circulatory system.





The Digestive Tract

The main part of the digestive system is the digestive tract. This is like a long tube, some nine metres in total, through the middle of the body. It starts at the mouth, where food and drink enter the body, and finishes at the anus, where leftover food and wastes leave the body.

Mouth

Teeth bite off and chew food into a soft pulp that is easy to swallow. Chewing mixes the food with watery saliva, from 6 salivary glands around the mouth and face, to make it moist and slippery.

Oesophagus

The oesophageus, or gullet, is a muscular tube. It takes food from the throat and pushes it down through the neck, and into the stomach. It moves food by waves of muscle contraction called peristalsis.

Stomach

The stomach has thick muscles in its wall. These contract to mash the food into a sloppy soup. Also the stomach lining produces strong digestive juices. These attack the food in a chemical way, breaking down and dissolving its nutrients.

Pancreas

The pancreas, like the stomach, makes

powerful digestive juices called enzymes which help to digest food further as it enters the small intestines.

Gall Bladder

This small baglike part is tucked under the liver. It stores a fluid called bile, which is made in the liver. As food from a meal arrives in the small intestine, bile flows from the gall bladder along the bile duct into the intestine. It helps to digest fatty foods and also contains wastes for removal.

Small Intestines

This part of the tract is narrow, but very long – about 20 feet (6 metres). Here, more enzymes continue the chemical attack on the food. Finally the nutrients are small enough to pass through the lining of the small intestine, and into the blood. They are carried away to the liver and other body parts to be processed, stored and distributed.

Liver

Blood from the intestines flows to the liver, carrying nutrients, vitamins and minerals, and other products from digestion. The liver is like a food-processing factory with more than 200 different jobs. It stores some nutrients, changes them from one form to another, and releases them into the blood according to the activities and needs of the body.

Large Intestine

Any useful substances in the leftovers, such as spare water and body minerals, are absorbed through the walls of the large intestine, back into the blood. The remains are formed into brown, semi-solid faeces, ready to be removed from the body.

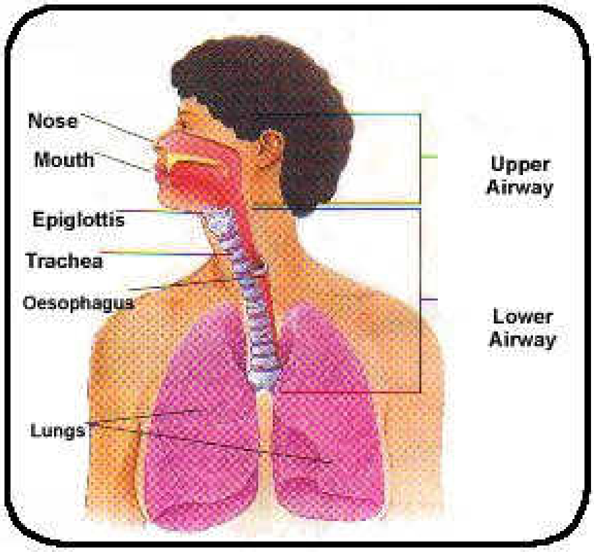
Rectum and Anus

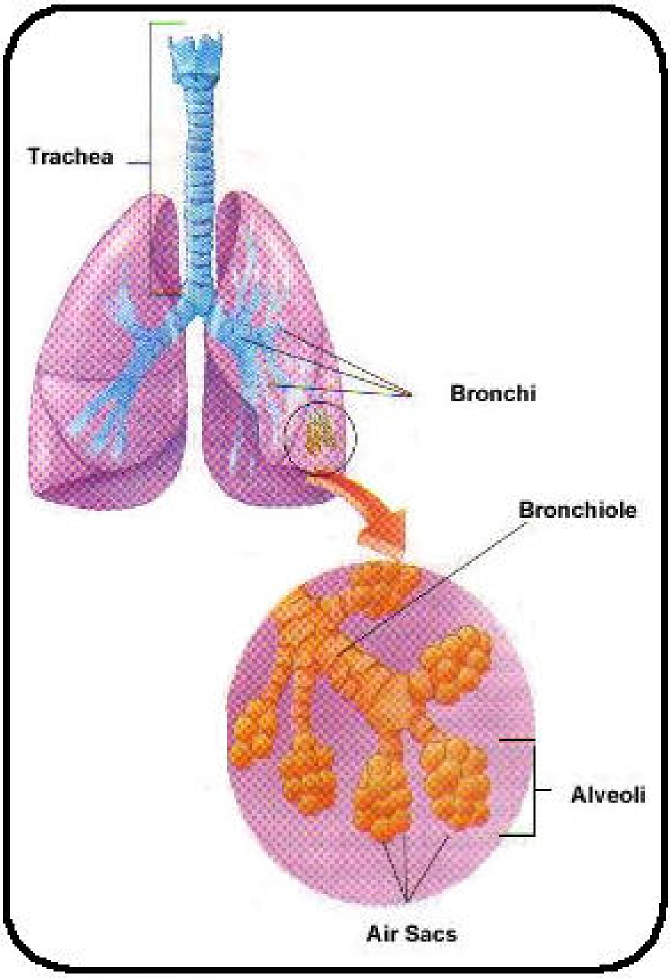
The end of the large intestine and the next part of the tract, the rectum, store the faeces. These are finally squeezed through a ring of muscle, the anus, and out of the body.

The Respiratory System

The respiratory system is the system of the body that deals with breathing. When we breathe, the body takes in the oxygen that it needs and removes the carbon dioxide that it doesn't need.

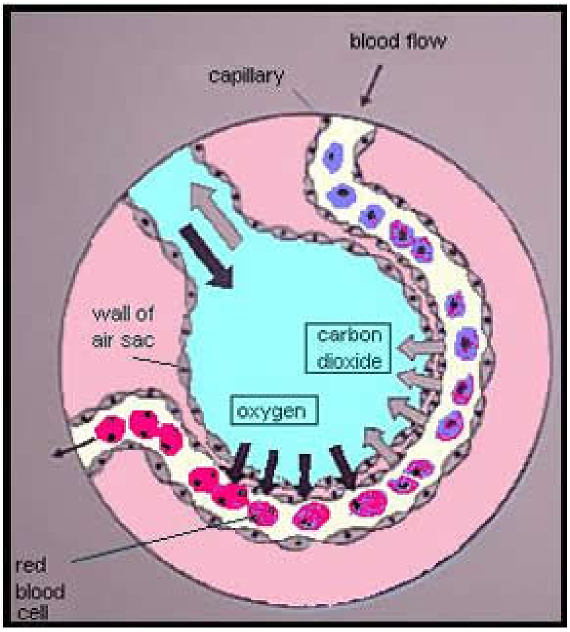
First the body breathes in the air which is sucked through the nose or mouth and down through the trachea (windpipe). The trachea is a pipe shaped by rings of cartilage. It divides into two tubes called bronchi. These carry air into each lung.

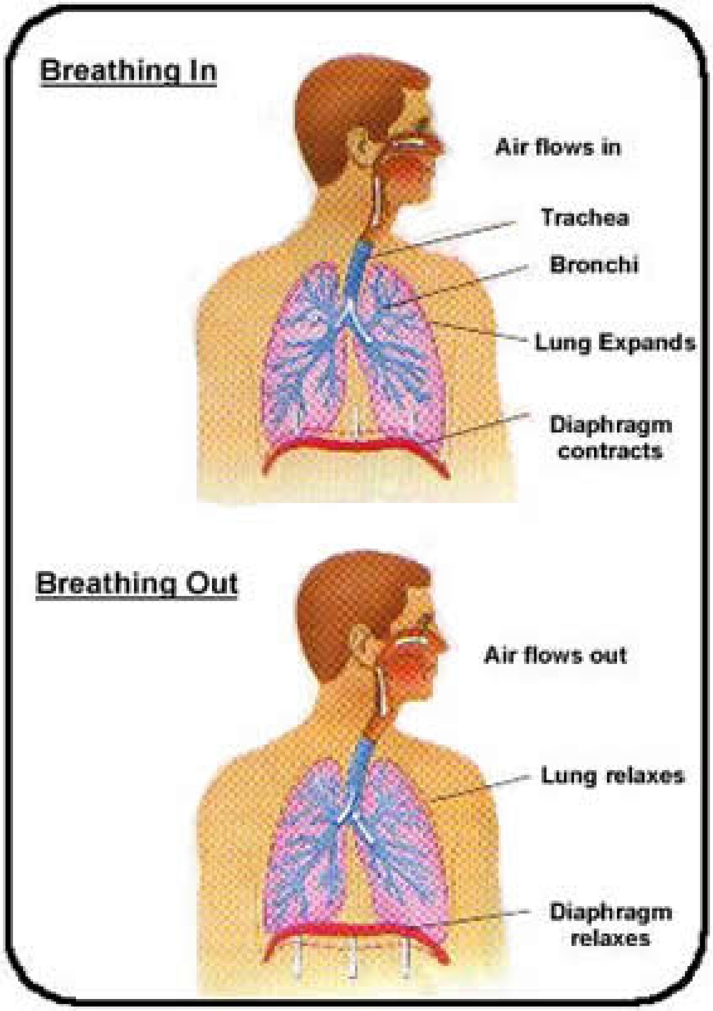




Inside the lung, the tubes divide into smaller and smaller tubes called bronchioles. At the end of each of these tubes are small air sacs called alveoli.

Capillaries, which are small blood vessels with thin walls, are wrapped around these alveoli. The walls are so thin and close to each other that the air easily seeps through. In this way, oxygen seeps through into the bloodstream and carbon dioxide, in the bloodstream, seeps through into the alveoli, and is then removed from the body when we breathe out.





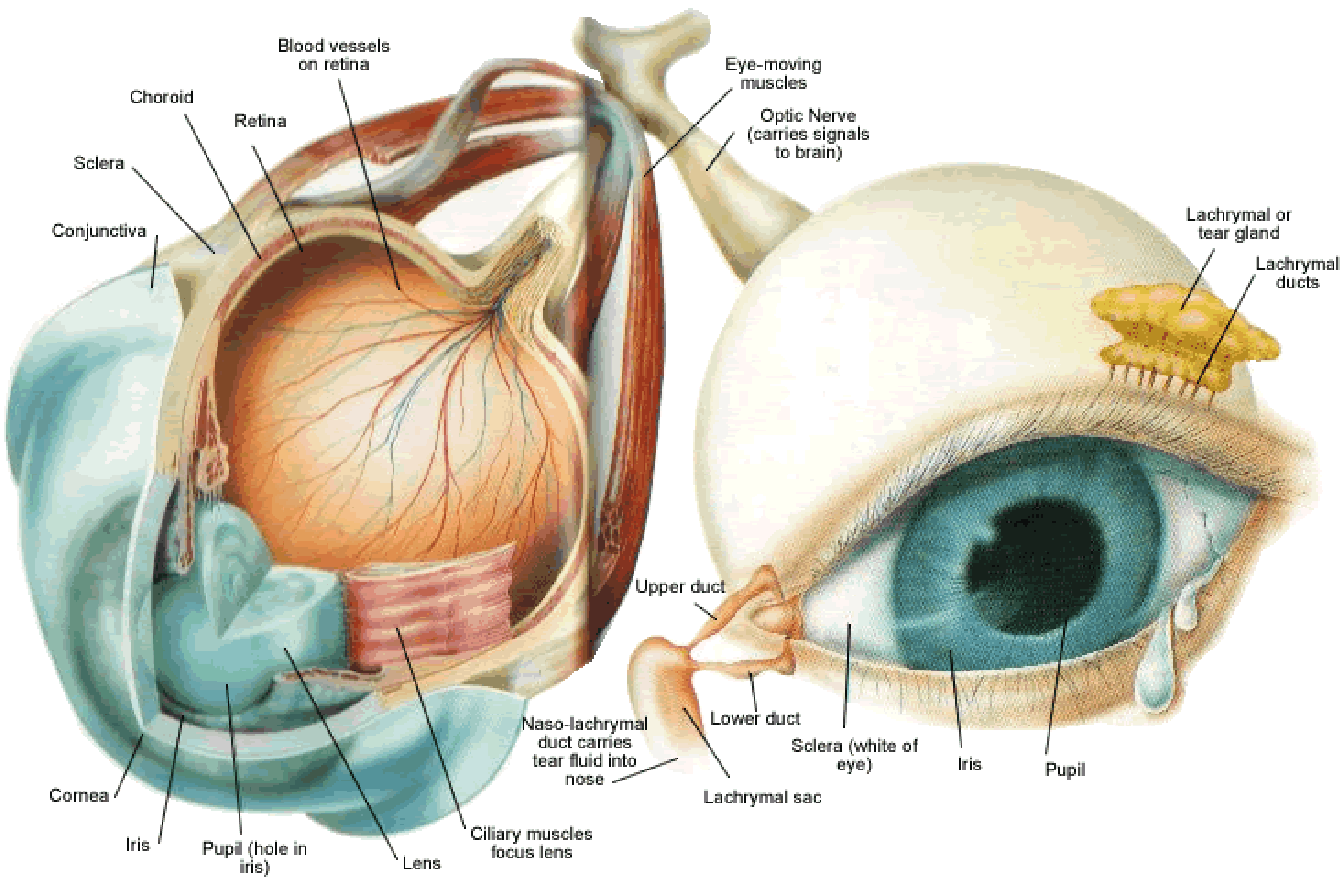
The diaphragm is the muscle that controls the breathing process. As the diaphragm flattens it causes the chest to expand and air is sucked into the lungs. When the diaphragm relaxes, the chest collapses and the air in the lungs is forced out.

THE SENSES

The Human Body has five main senses; **Sight, Smell, Taste, Hearing and Touch**. Each of these senses detects a feature of the environment and produces nerve signals to carry this information to the brain.

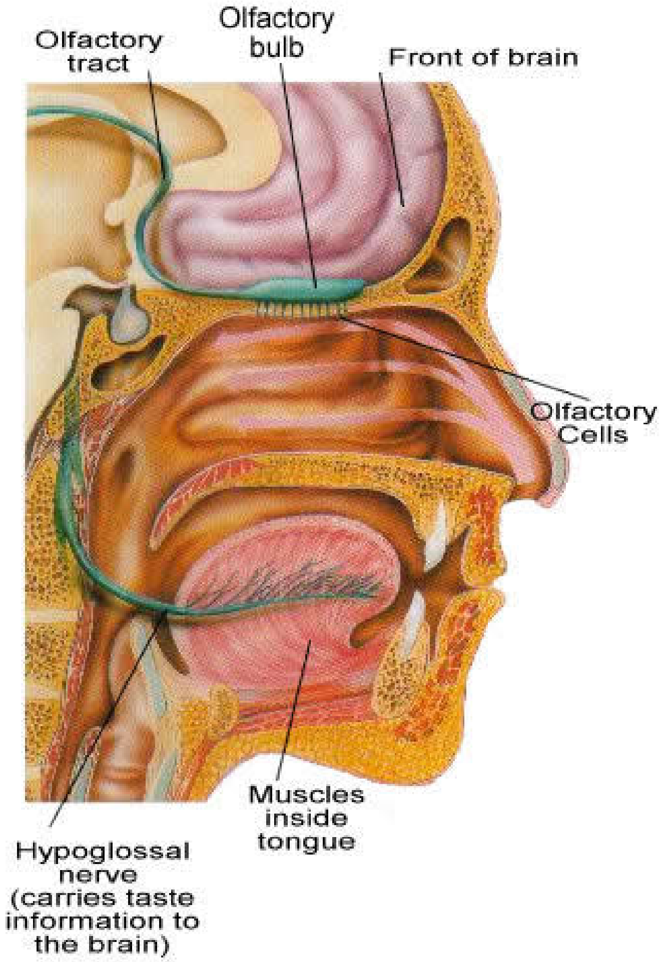
Inside the Eye (Sight)

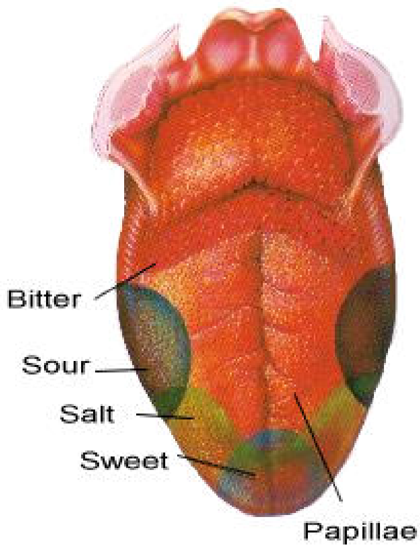
The eyeball's tough, white outer layer is the sclera. Inside this is a soft, blood-rich, nourishing layer, the choroid. Within this, around the sides and back of the eye, is the retina. This layer detects patterns of light rays and turns them into nerve signals, which travel along the optic nerve to the brain. The bulk of the eyeball is filled with a clear jelly called vitreous humour. At the front of the eye is the dome-shaped cornea, through which light rays enter. They pass through a hole, the pupil, in a ring of muscle, the iris. Then the rays shine through the bulging lens, which bends or focuses them to form a clear picture on the retina.



Up the Nose (Smell)

Inside each side of the nose is an air chamber, the nasal cavity. Air comes in through the nostril and flows down, around the rear of the roof of the mouth, into the throat. But when you sniff, air swirls up into the top of the cavity. Here is a small patch of about 10 million specialised olfactory (smelling) cells. They have long micro-hairs, or cilia, sticking out from them. Odour particles in the air stick on to the cilia and make the olfactory cells produce nerve signals, which travel to the olfactory bulb. This is a pre-processing centre that partly sorts the signals before they go along the olfactory tract to the brain where they are recognised as smells.



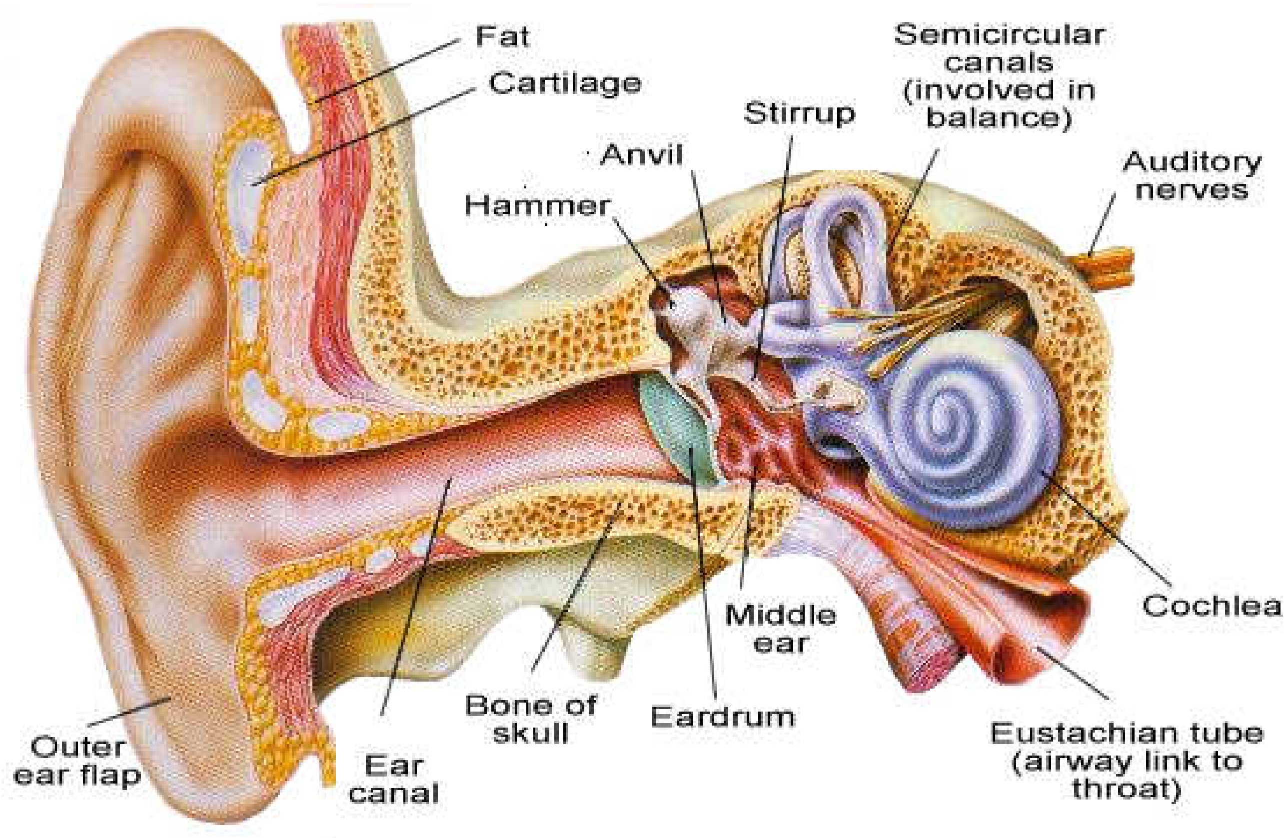


On the Tongue (Taste)

The tongue is covered with dozens of pimple-like projections called papillae. These grip and move food when you chew. Around the sides of the papillae are about 10,000 microscopic taste buds. Different parts of the tongue are sensitive to different flavours: sweet, salt, sour and bitter.

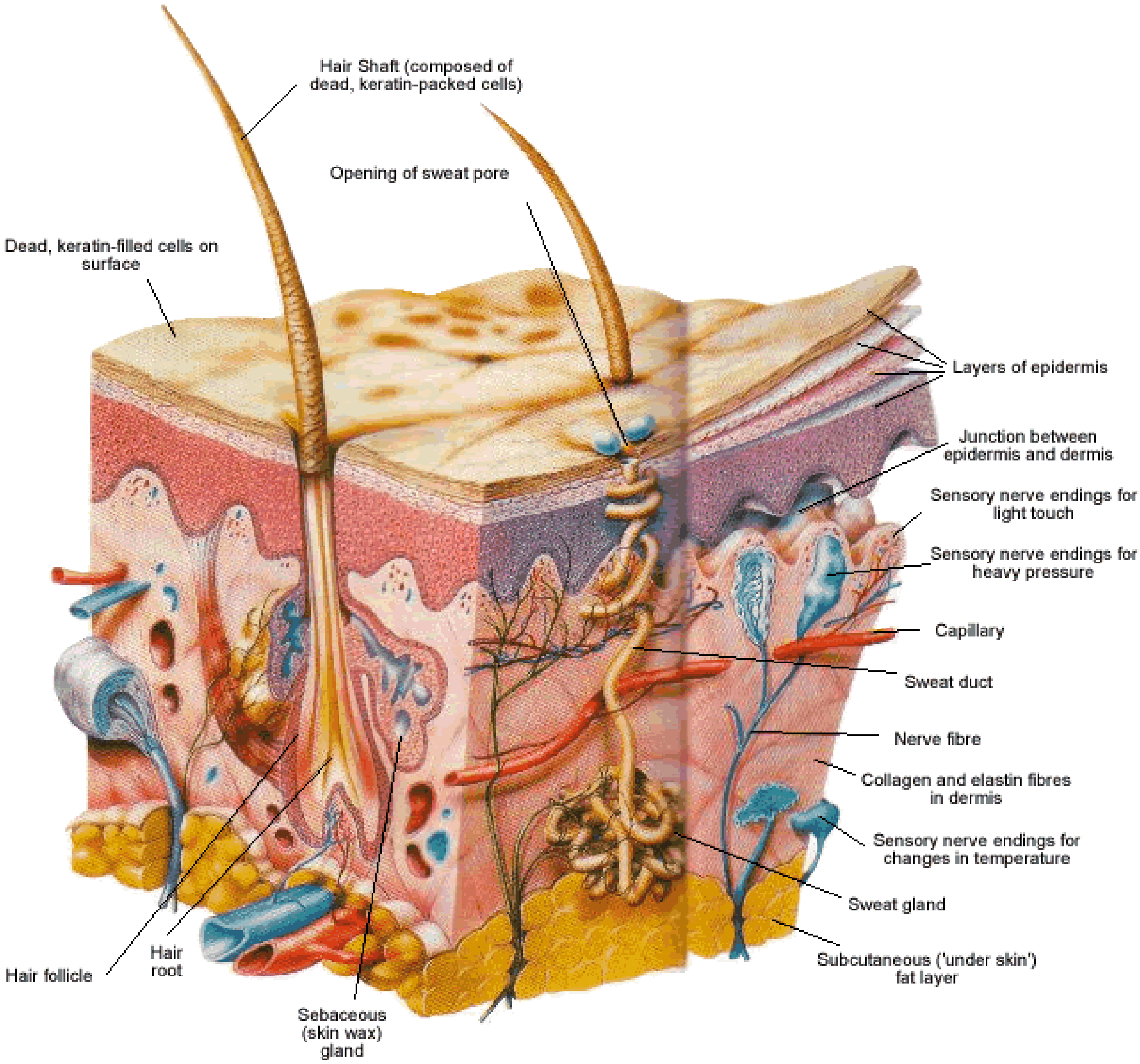
In the Ear (Hearing)

Sound waves funnel into the outer ear – the flap of skin and cartilage on the side of the head. They pass along a narrow tube, the ear canal, to a small patch of rubbery skin at its end, the eardrum. The sound waves bounce off the eardrum and make it shake to and fro, or vibrate. The eardrum is connected to a row of three tiny bones linked together, the hammer, anvil and stirrup. The vibrations pass along these bones. The stirrup presses against a small, fluid-filled, snail-shaped part, the cochlea, deep inside the ear. The vibrations pass as ripples into the fluid inside the cochlea. Here, they shake thousands of tiny hairs that stick into the fluid from hair cells. As the hairs shake, the hair cells make nerve signals, which go along the auditory nerve to the hearing centre of the brain.

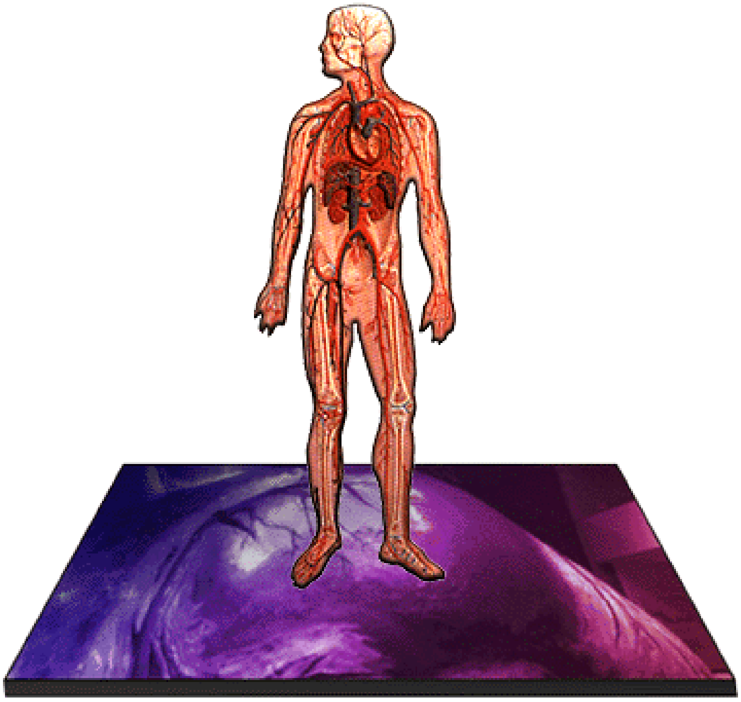


Under the Skin (Touch)

The sense of touch is the name given to a network of nerve endings that reach just about every part of our body. These sensory nerve endings are located just below the skin and register light and heavy pressure on the skin and also differences in temperature. These nerve endings gather information and send it to the brain.



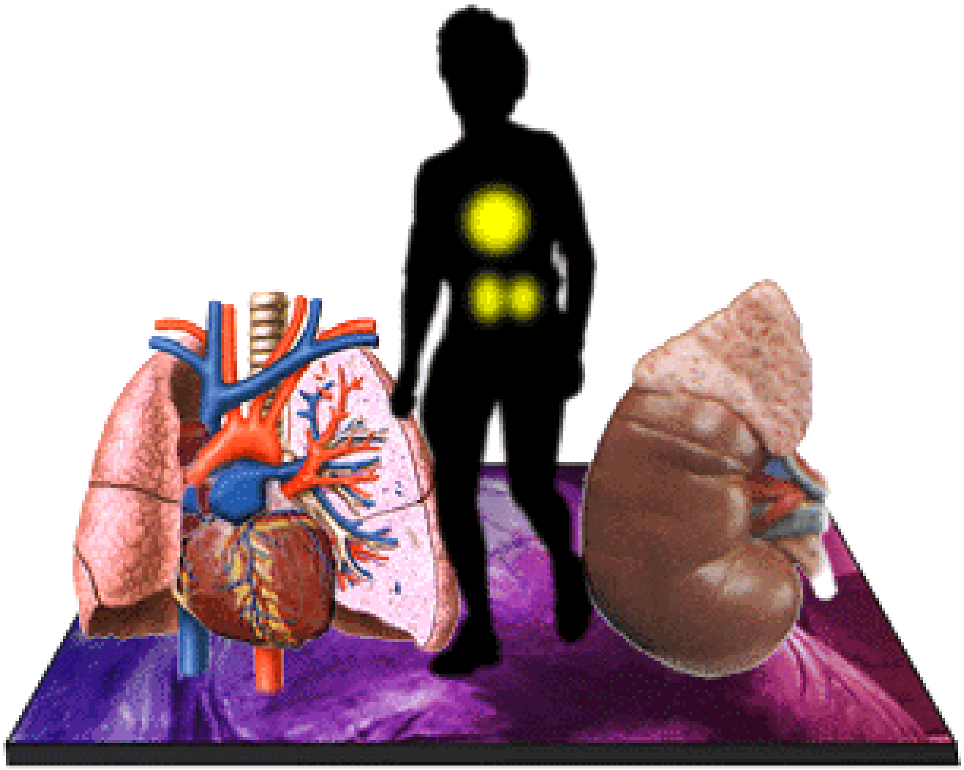
BODY SYSTEMS



The human body is like a complex organization that has an important job to get done on a tight deadline. In order to get everything done perfectly and on time, it has to use a system. Actually, the human body uses many systems that work side by side.

DIGESTIVE SYSTEM

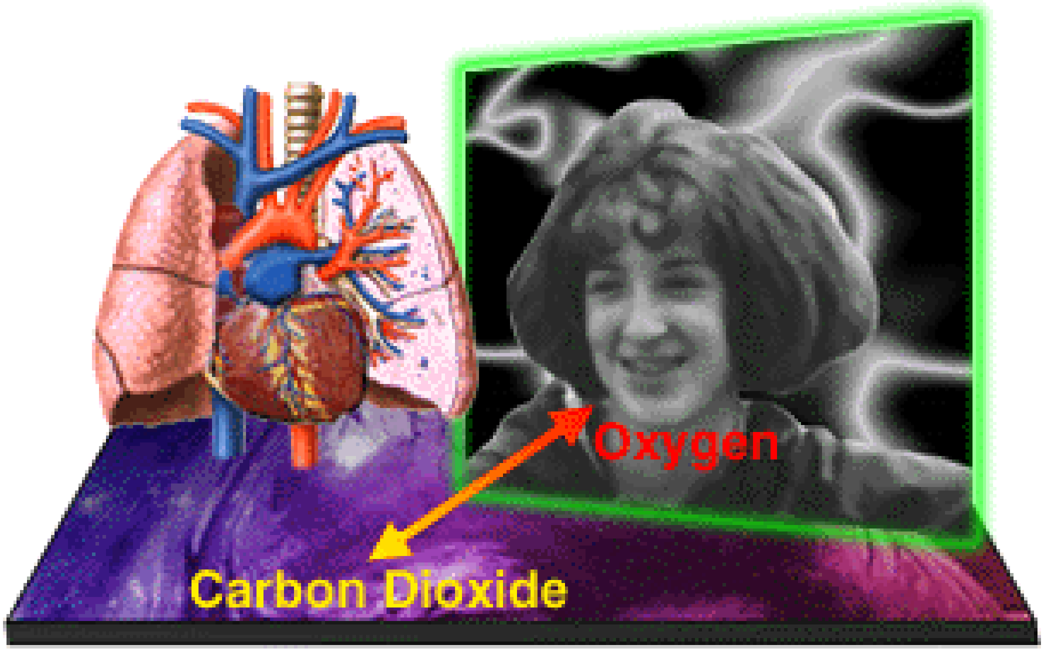
Poison
Protection



If you knew there was poison hidden in your house, you would surely do everything possible to find and remove that poison. If you didn't, you and your family would slowly die. How would you find it? How would you remove it? You would probably figure out a system of searching and removing. That would be an excretory system.

RESPIRATORY SYSTEM

Oxygen Delivery System

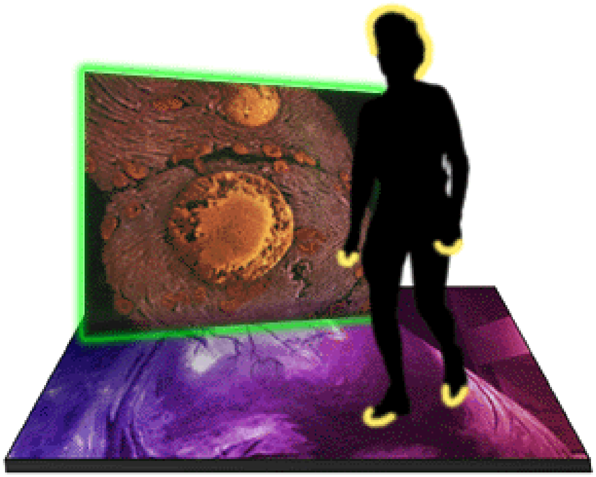


The primary function of the respiratory system is to supply the blood with oxygen in order for the blood to deliver oxygen to all parts of the body. The respiratory system does this through breathing. When we breathe, we inhale oxygen and exhale carbon dioxide. This exchange of gases is the respiratory system's means of getting oxygen to the blood.

PASCAS HEALTH

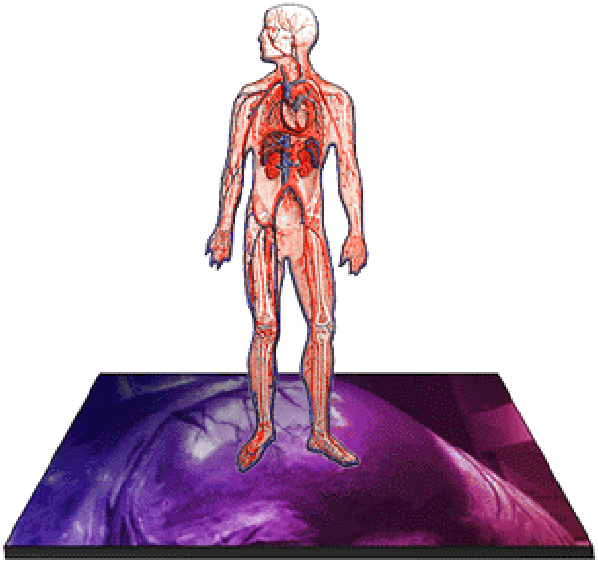
Feeling Healing with Divine Love is the key!

Cutting Dead Cells



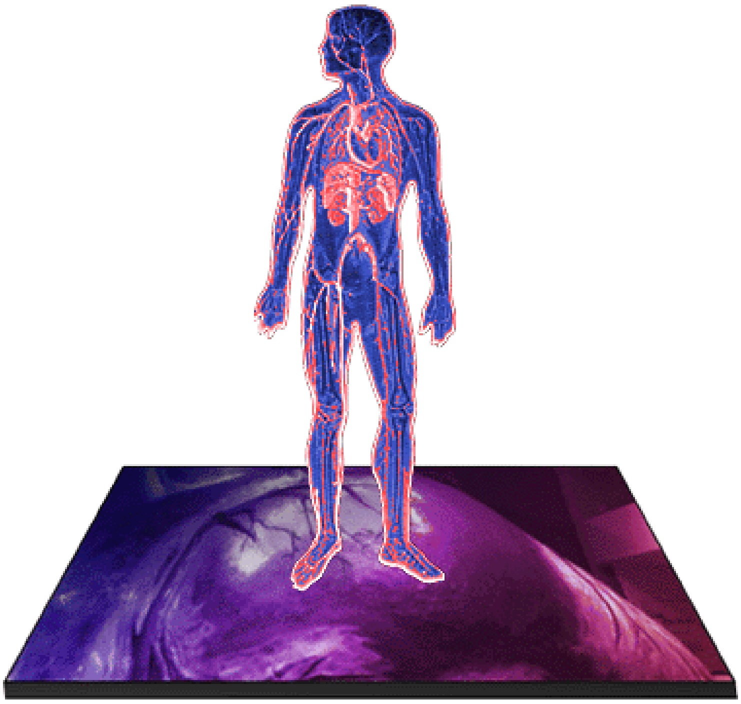
The body's integumentary system supports the excretory system in the removal of waste. Skin, hair, fingernails and toenails make up the system by which surface level wastes are removed.

The Circle Of Blood



On average, your body has about 5 litres of blood continually travelling through it by way of the circulatory system. The heart, the lungs, and the blood vessels work together to form the circle part of the circulatory system. The pumping of the heart forces the blood on its journey.

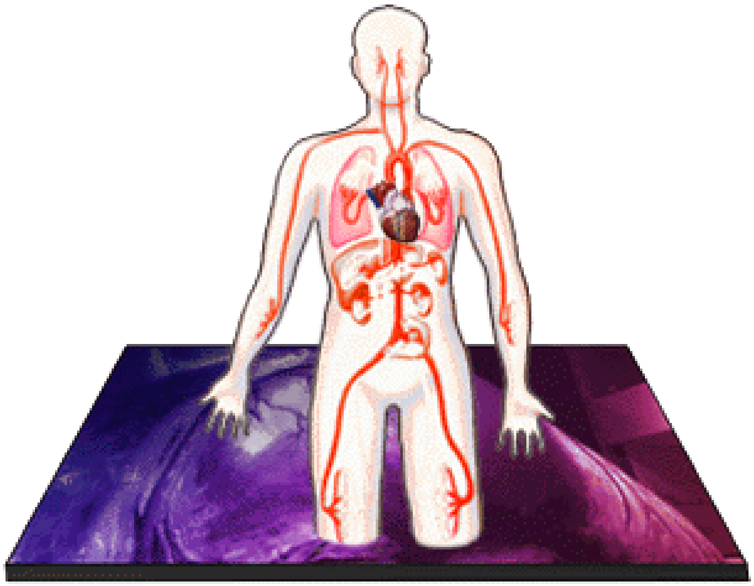
Tubular Circulation



In a general sense, a vessel is defined as a hollow utensil for carrying something: a cup, a bucket, a tube. Blood vessels, then, are hollow utensils for carrying blood. Located throughout your body, your blood vessels are hollow tubes that circulate your blood.

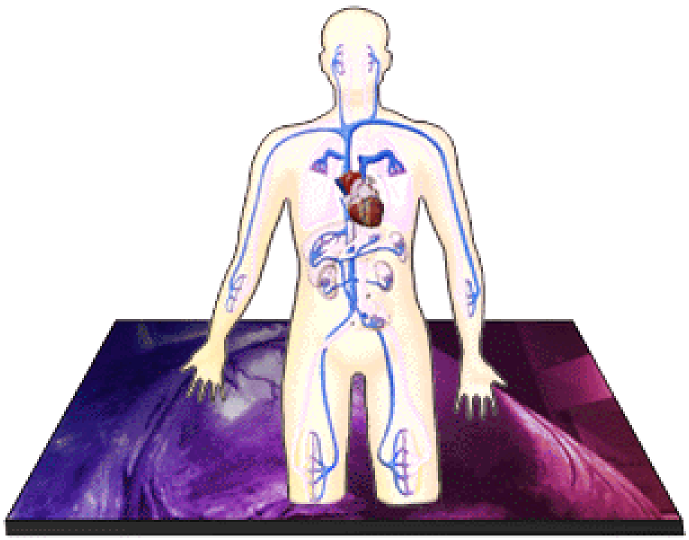
Pulmonary circulation is the movement of blood from the heart, to the lungs, and back to the heart again. This is just one phase of the overall circulatory system.

Arteries Carry Away



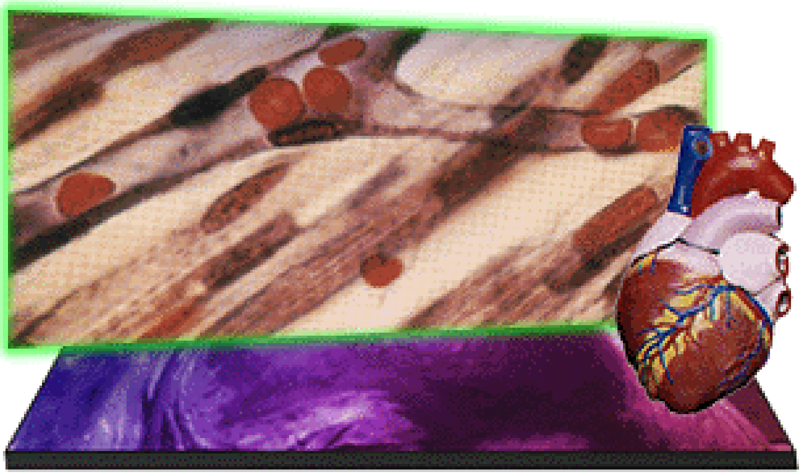
The heart pumps blood out through one main artery called the dorsal aorta. The main artery then divides and branches out into many smaller arteries so that each region of your body has its own system of arteries supplying it with fresh, oxygen-rich blood.

All in Vein



Veins are similar to arteries but, because they transport blood at a lower pressure, they are not as strong as arteries. Like arteries, veins have three layers: an outer layer of tissue, muscle in the middle, and a smooth inner layer of epithelial cells. However, the layers are thinner, containing less tissue.

Capillary Connections

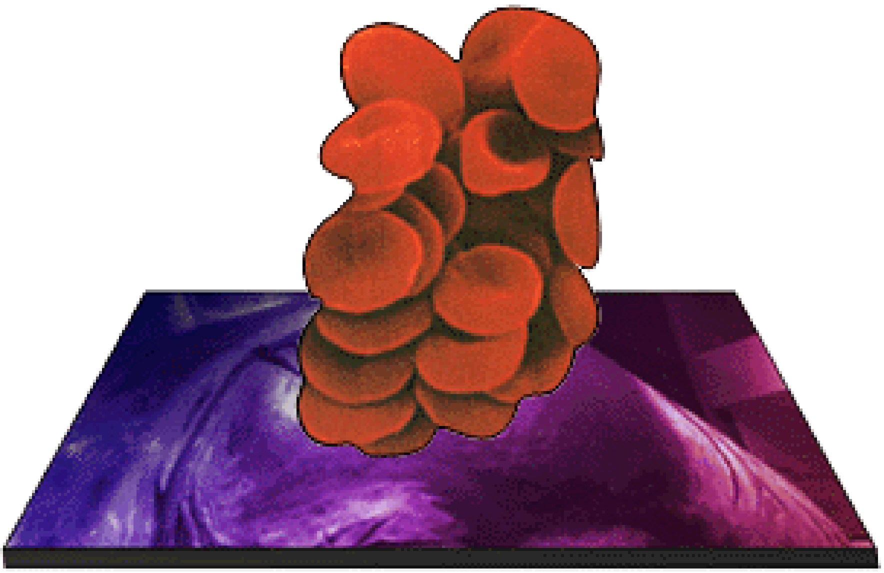


Unlike the arteries and veins, capillaries are very thin and fragile. The capillaries are actually only one epithelial cell thick. They are so thin that blood cells can only pass through them in single file. The exchange of oxygen and carbon dioxide takes place through the thin capillary wall. The red blood cells inside the capillary release their oxygen which passes through the wall and into the surrounding tissue. The tissue releases its waste products, like carbon dioxide, which passes through the wall and into the red blood cells.

Lifeblood

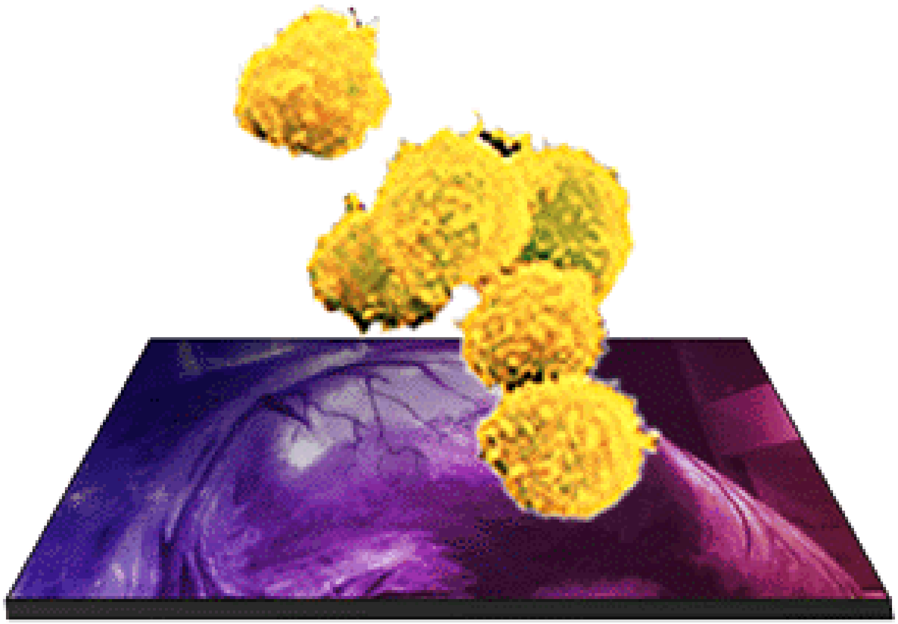
The average adult has about five litres of blood living inside of their body, coursing through their vessels, delivering essential elements, and removing harmful wastes. Without blood, the human body would stop working.

Riding On The Red-road



Red blood cells perform the most important blood duty. A single drop of blood contains millions of red blood cells which are constantly travelling through your body delivering oxygen and removing waste. If they weren't, your body would slowly die.

Battling Blood Cells

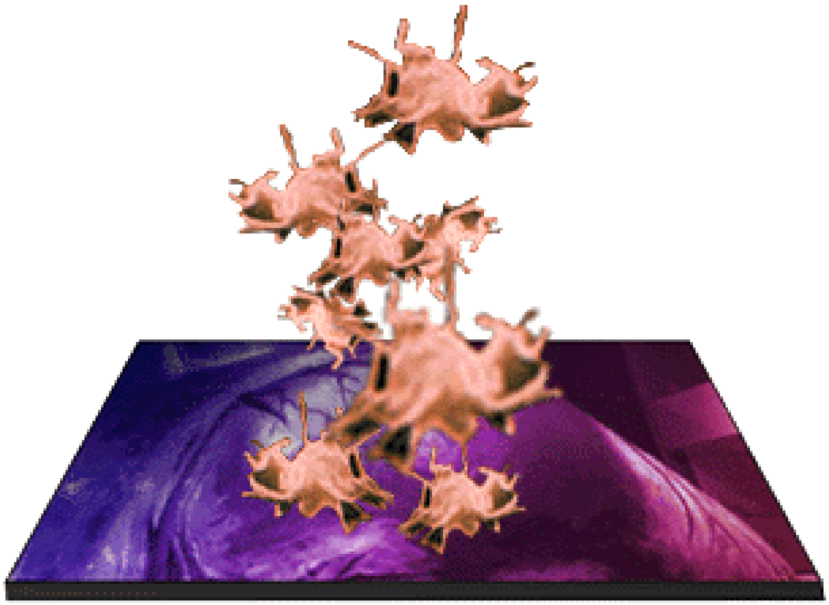


Whenever a germ or infection enters the body, the white blood cells snap to attention and race toward the scene of the crime. The white blood cells are continually on the lookout for signs of disease. When a germ does appear, the white blood cells have a variety of ways by which they can attack. Some will produce protective antibodies that will overpower the germ. Others will surround and devour the bacteria.

The Importance Of Plasma

It's a straw-coloured, clear liquid that is 90 percent water, and it is an essential ingredient for human survival.

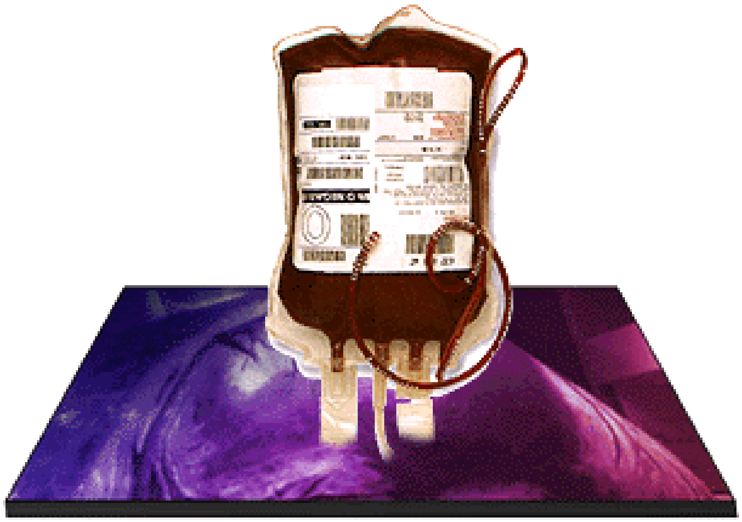
Sticky Situations



The human body does not handle excessive blood loss well. Therefore, the body has ways of protecting itself. If, for some unexpected reason, sudden blood loss occurs, the blood platelets kick into action.

In some ways, every person's blood is the same. But, when analyzed under a microscope, distinct differences are visible. In the early 20th century, an Austrian scientist named Karl Landsteiner classified blood according to those differences. He was awarded the Nobel Prize for his achievements.

Are You Positive or Negative?



Scientists sometimes study Rhesus monkeys to learn more about the human anatomy because there are certain similarities between the two species. While studying Rhesus monkeys, a certain blood protein was discovered. This protein is also present in the blood of some people. Other people, however, do not have the protein. The presence of the protein, or lack of it, is referred to as the Rh (for Rhesus) factor.

AUTOLOGOUS BLOOD TRANSFUSION TERMS

Alloimmunization – development of antibodies in response to foreign substances such as antigens, i.e. transfusion reaction.
Autotransfusion – A technique allowing the physician to have the surgical patient's own Blood collected, cleaned and transfused back during and after surgery. The risk of infection or alloimmunization is completely eliminated. In addition, autotransfused Blood carries a higher level of oxygen because it has a higher density of clean red Blood cells.
Homologous Blood Product – Blood product obtained from a donor other than the patient. The Blood is treated, refrigerated in units of approximately 500mls for future use.
Intraoperative – Occurrences during a surgical procedure.
Perfusion – The injection of fluid into a Blood vessel in order to reach an organ or tissues, usually to supply nutrients and oxygen, or most often the re-infusing of the filtered or processed Blood of a patient during surgery.

What is Autologous Blood transfusion?

Autologous Blood transfusion allows you to donate Blood for your own use. After collection, your Blood must be clearly marked with your name and reserved for your use only. You must carefully monitor the documentation.

Who is qualified to be an Autologous Blood donor?

Those who are not anaemic (starting Haemoglobin must be at least 11 grams, slightly lower than required of a regular Blood donor, i.e., 12 grams).

Those who have no medical condition that could cause problems during or after the Blood donation process.
Children weighing over 65 pounds (30 kilograms).
Those who are having planned surgery that routinely requires a Blood transfusion (except in cases where long term storage is desired).
Those who have veins large enough for the procedure.

What is the cost to me?

The cost of Autologous Blood collection, testing, storage and distribution to the final point of use is great. Since this 'self storage' is discouraged by the 'Blood establishment,' there is no real assistance given by those best suited to help. You must look into every aspect of this process before you commit to the long term arrangements. Sometimes there is insurance assistance, but this is rare. Remember, as you consider the expense of paying for the storage of your own blood, in times of emergency, you may still require Blood from random donors. The medical facility treating you may not be able to obtain and prepare your stored Blood in time of need.

What if more Blood is required?

Should you require additional blood, then Blood specified by you will be used, and failing the adequacy of that, you, in an urgent situation, will be transfused with Blood Bank common Blood supply blood.

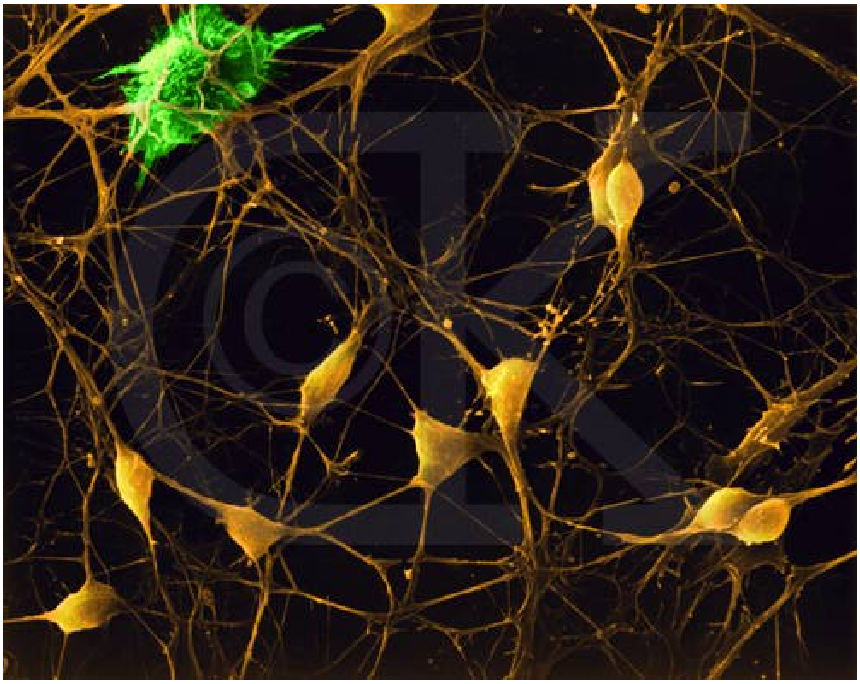
What are the benefits of Autologous Blood transfusion?

Availability..... in contrast with donor blood, the patient's type of Blood is instantly available and requires no cross matching.
Safety..... no risk of transfusion reactions due to incompatibility.
Purity..... no risk of transmitted disease, such as, among others, HIV/AIDS, Hepatitis B & C, HTLV 1&2, & Syphilis.
Acceptance..... sometimes Blood donation is the source of fear or taboo, in others the infusion of Blood is prohibited by religion. Often autologous Blood transfusion may overcome some of these objections.

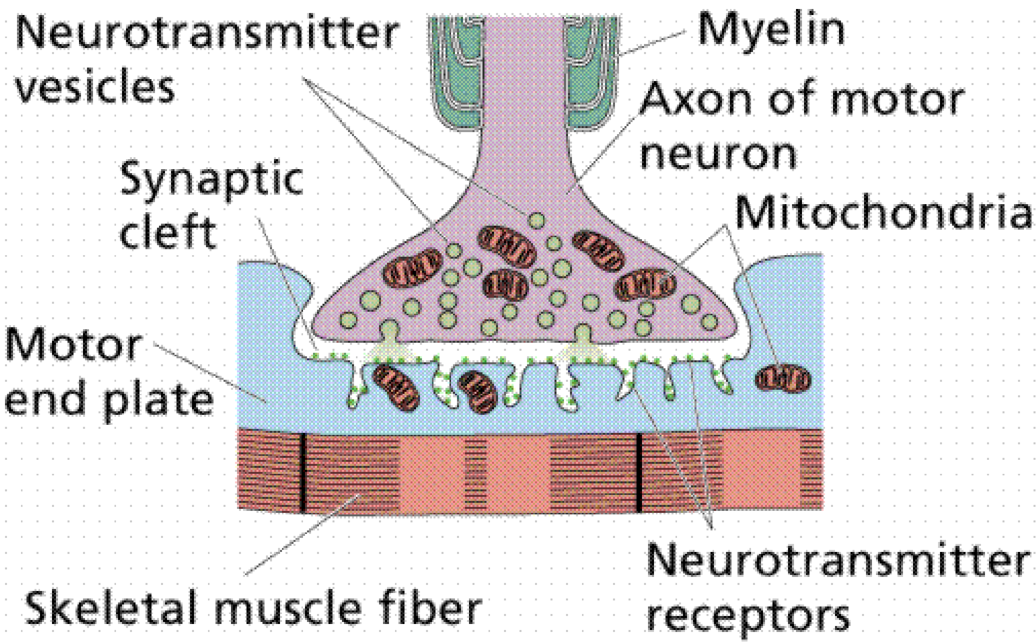
What are the most common possible side effects to donating blood?

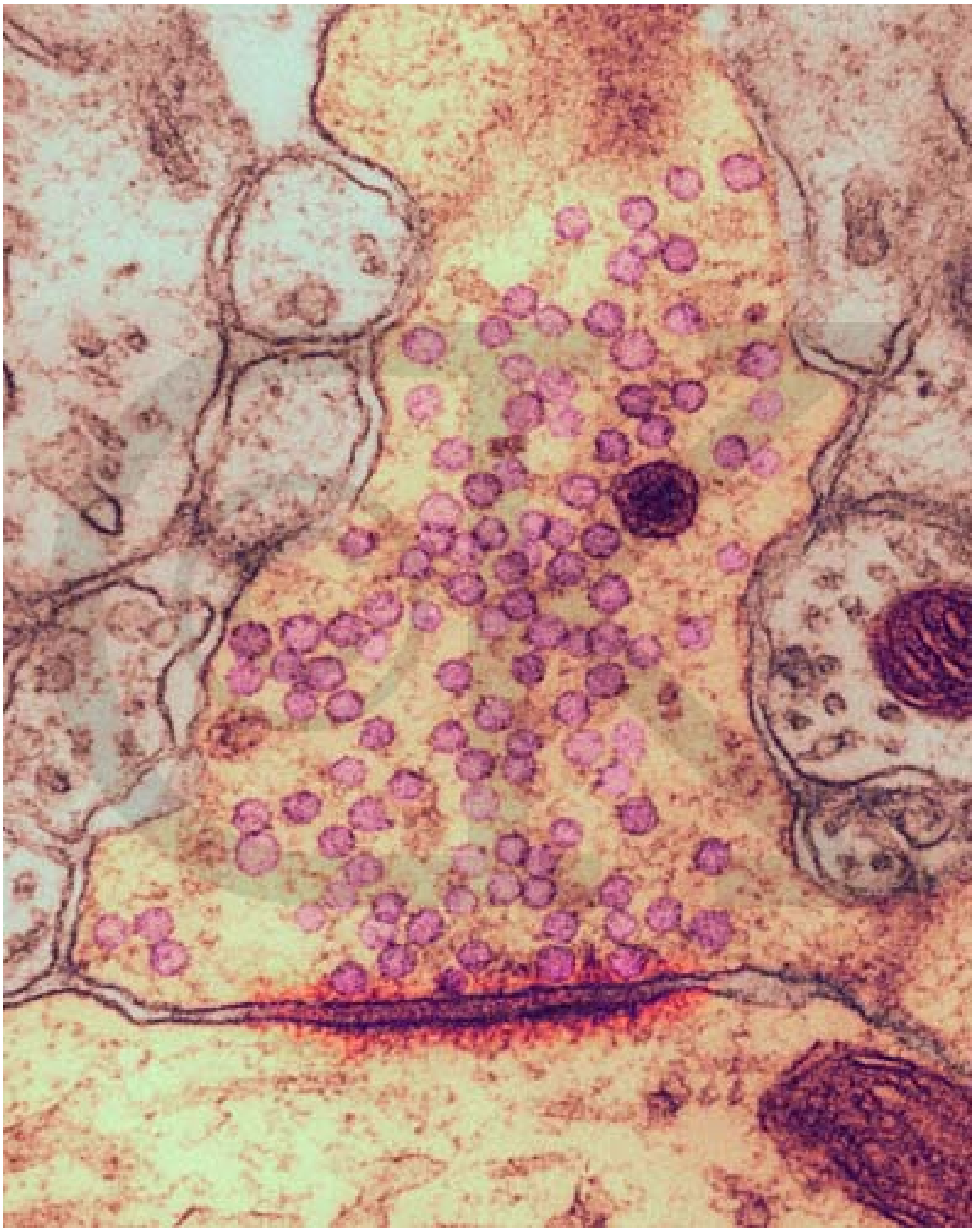
Occasionally some people feel light headed or dizzy during or after the donation; fainting can occur.
Sometimes a bruise may appear around the place where the needle was inserted and the area may be sore to touch for some time.
You may feel fatigued for some time. If this condition persists, contact the Blood transfusion supervisor or the attending physician.

If you have not previously donated blood, it is advisable to have a responsible adult accompany you to the Blood donor centre.

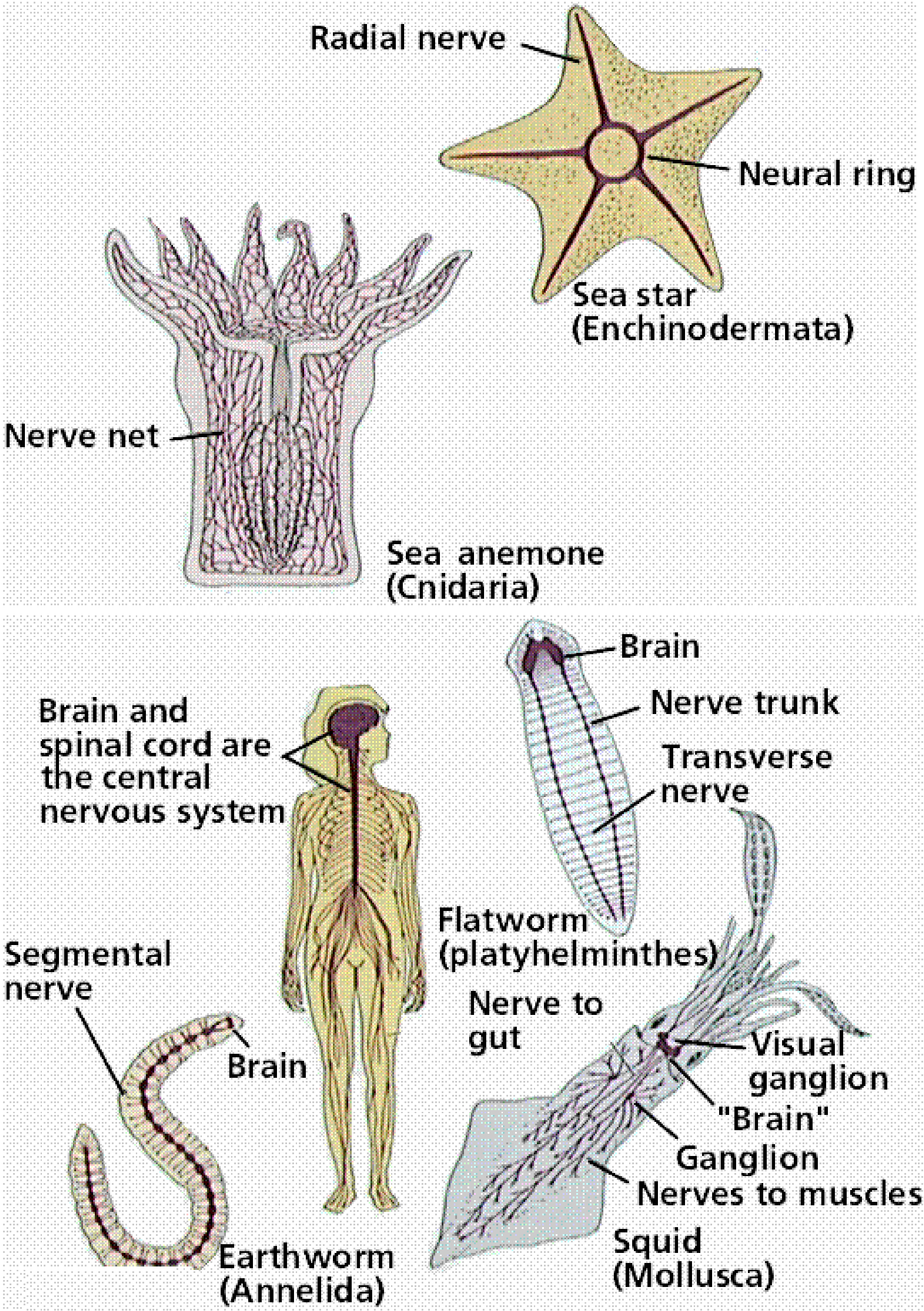


1. At rest the outside of the membrane is more positive than the inside.
2. Sodium moves inside the cell causing an action potential, the influx of positive sodium ions makes the inside of the membrane more positive than the outside.
3. Potassium ions flow out of the cell, restoring the resting potential net charges.
4. Sodium ions are pumped out of the cell and potassium ions are pumped into the cell, restoring the original distribution of ions.

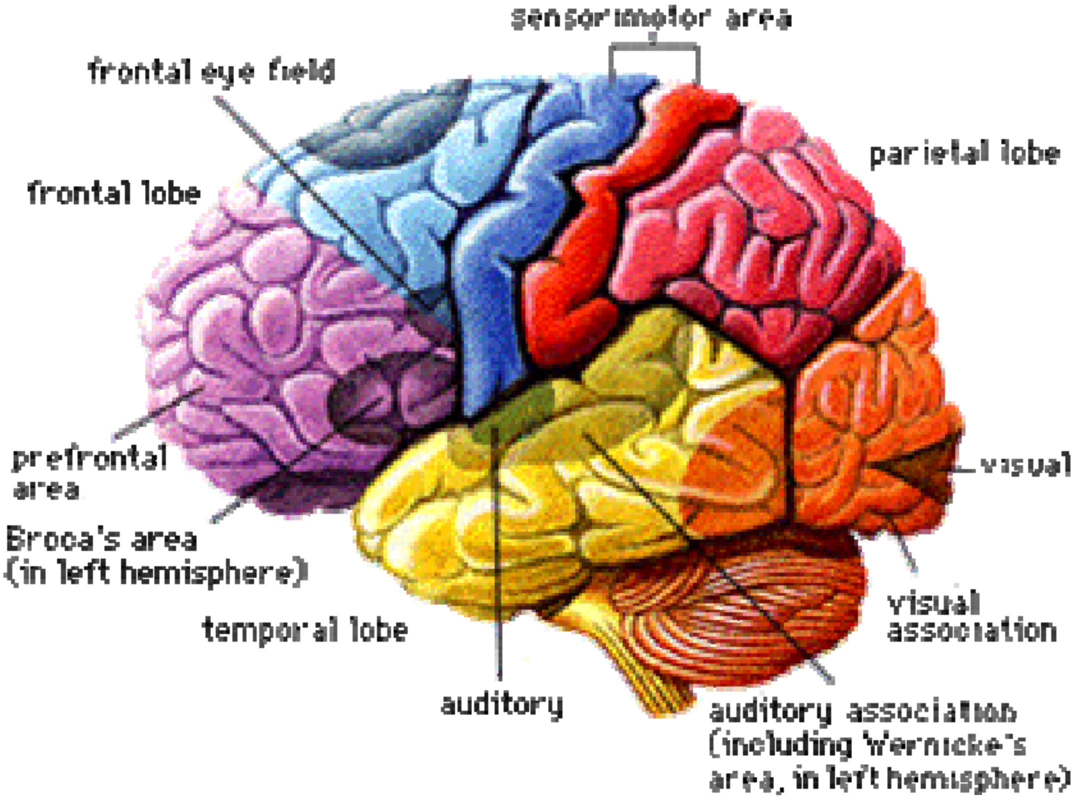


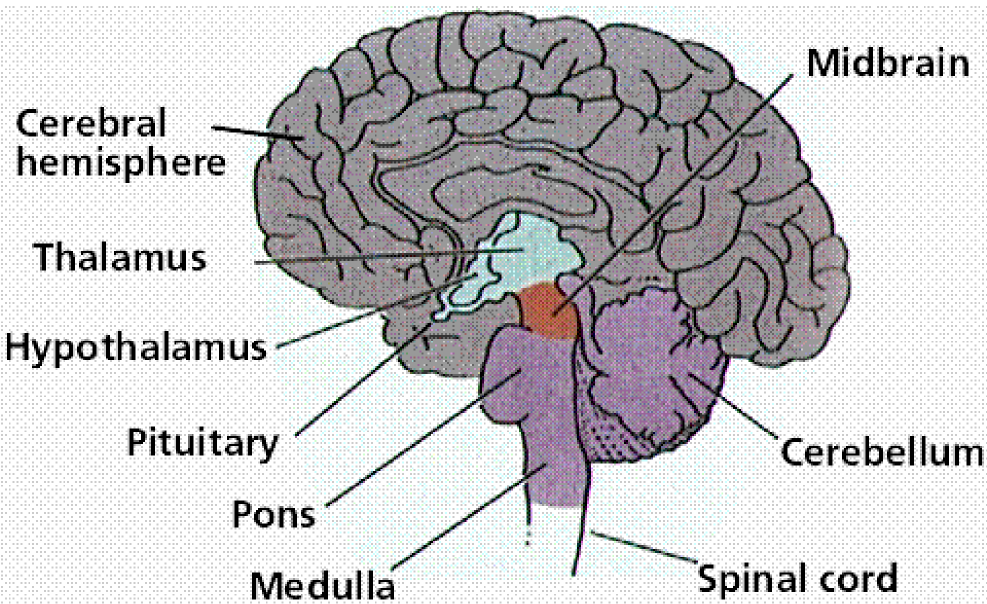


1. Receive sensory input from internal and external environments.
2. Integrate the input.
3. Respond to stimuli.

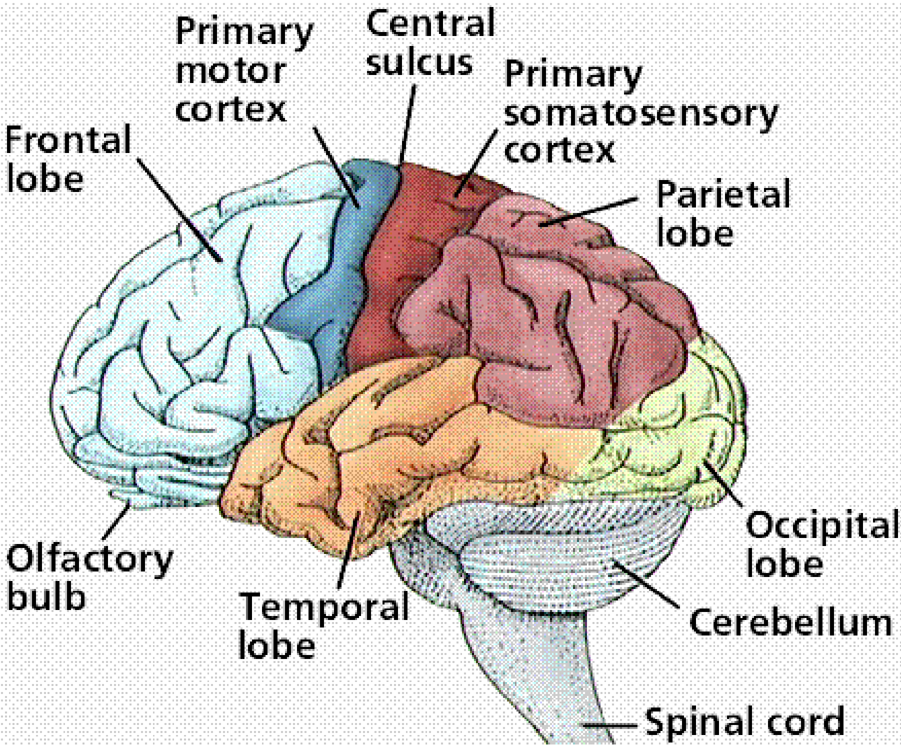


1. Sensory (afferent) pathways that provide input from the body into the CNS.
2. Motor (efferent) pathways that carry signals to muscles and glands (effectors).

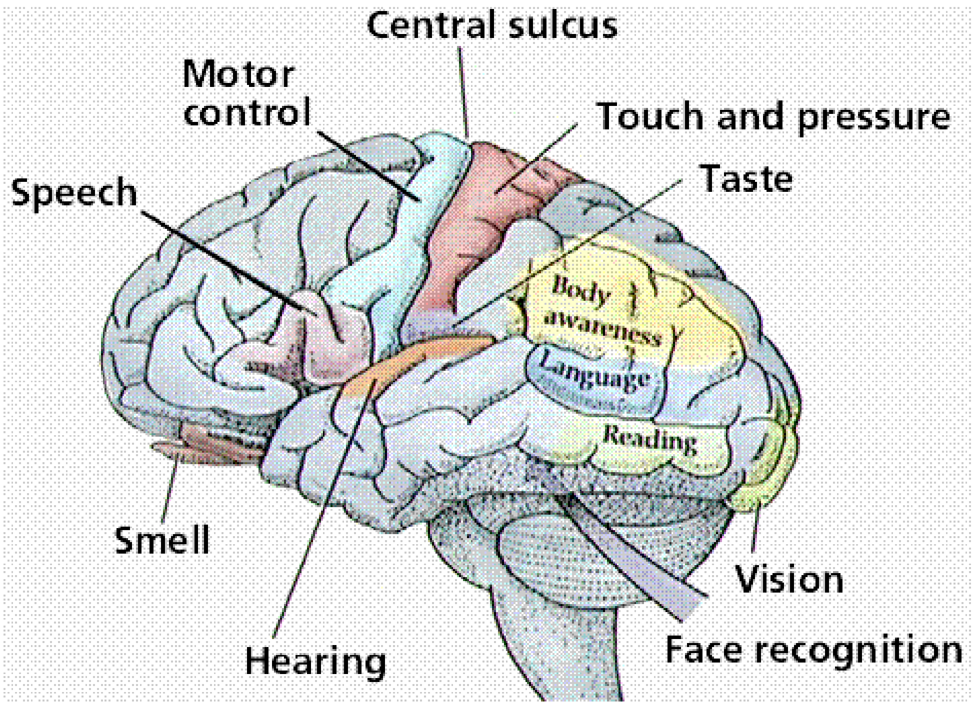




1. Increase in brain size relative to body size.
2. Subdivision and increasing specialization of the forebrain, midbrain, and hindbrain.
3. Growth in relative size of the forebrain, especially the cerebrum, which is associated with increasingly complex behaviour in mammals.



1. Motor activity and integration of muscle activity.
2. Speech.
3. Thought processes.



- Sensory receptors are classified according to the type of energy they can detect and respond to.
- Mechanoreceptors: hearing and balance, stretching.
- Photoreceptors: light.
- Chemoreceptors: smell and taste mainly, as well as internal sensors in the digestive and circulatory systems.
- Thermoreceptors: changes in temperature.
- Electroreceptors: detect electrical currents in the surrounding environment.

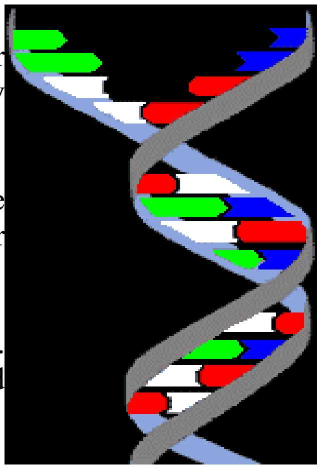
1. The first and, arguably, most important barrier is the **skin**. The skin cannot be penetrated by most organisms unless it already has an opening, such as a nick, scratch, or cut.
2. Mechanically, pathogens are expelled from the lungs by ciliary action as the tiny hairs move in an upward motion; coughing and sneezing abruptly eject both living and nonliving things from the respiratory system; the flushing action of tears, saliva, and urine also force out pathogens, as does the sloughing off of skin.
3. Sticky mucus in respiratory and gastrointestinal tracts traps many microorganisms.
4. Acid pH (< 7.0) of skin secretions inhibits bacterial growth. Hair follicles secrete sebum that contains lactic acid and fatty acids both of which inhibit the growth of some pathogenic bacteria and fungi. Areas of the skin not covered with hair, such as the palms and soles of the feet, are most susceptible to fungal infections. Think athlete's foot.
5. Saliva, tears, nasal secretions, and perspiration contain **lysozyme**, an enzyme that destroys Gram positive bacterial cell walls causing cell lysis. Vaginal secretions are also slightly acidic (after the onset of menses). Spermine and zinc in semen destroy some pathogens. Lactoperoxidase is a powerful enzyme found in mother's milk.
6. The stomach is a formidable obstacle insofar as its mucosa secrete hydrochloric acid ($0.9 < pH < 3.0$, very acidic) and protein-digesting enzymes that kill many pathogens. The stomach can even destroy drugs and other chemicals.

   a. a shorter lag time,
   b. more rapid buildup,
   c. a higher overall level of response,
   d. a more specific or better "fit" to the invading antigen,
   e. utilizes IgG instead of the large multipurpose antibody IgM.

- Active natural (contact with infection): develops slowly, is long term, and antigen specific.
- Active artificial (immunization): develops slowly, lasts for several years, and is specific to the antigen for which the immunization was given.
- Passive natural (transplacental = mother to child): develops immediately, is temporary, and affects all antigens to which the mother has immunity.
- Passive artificial (injection of gamma globulin): develops immediately, is temporary, and affects all antigens to which the donor has immunity.

DNA stands for **DeoxyriboNucleic Acid**. It is the genetic material of a cell. The chromosomes inside the nucleus (control centre) of the cell are made of DNA. Lots and lots of DNA. It is very fine and tightly coiled but there may be as much as a metre in a single cell.

How can a chemical contain information? Looking at the DNA shape from the outside, DNA appears to be pretty boring. It just goes on and on... Until the structure was figured out, many scientists thought DNA was too simple and could not be the Instruction Manual for the body.

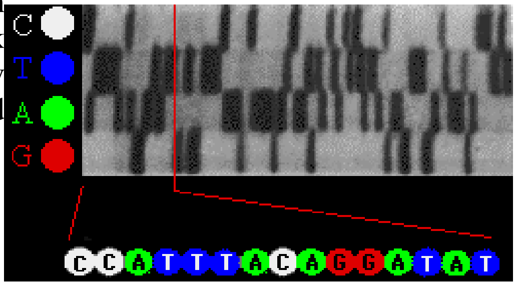


If you could pull apart the double helix, you would see the exposed ends of four different chemicals waving in the air. Those four chemicals, called **bases** carry the information used to make a body and to keep it running.

Scientists named each of the four bases with a letter, G, A, T or C. All of the letters in one cell make up the human **genome**, a complete set of instructions for making a person.

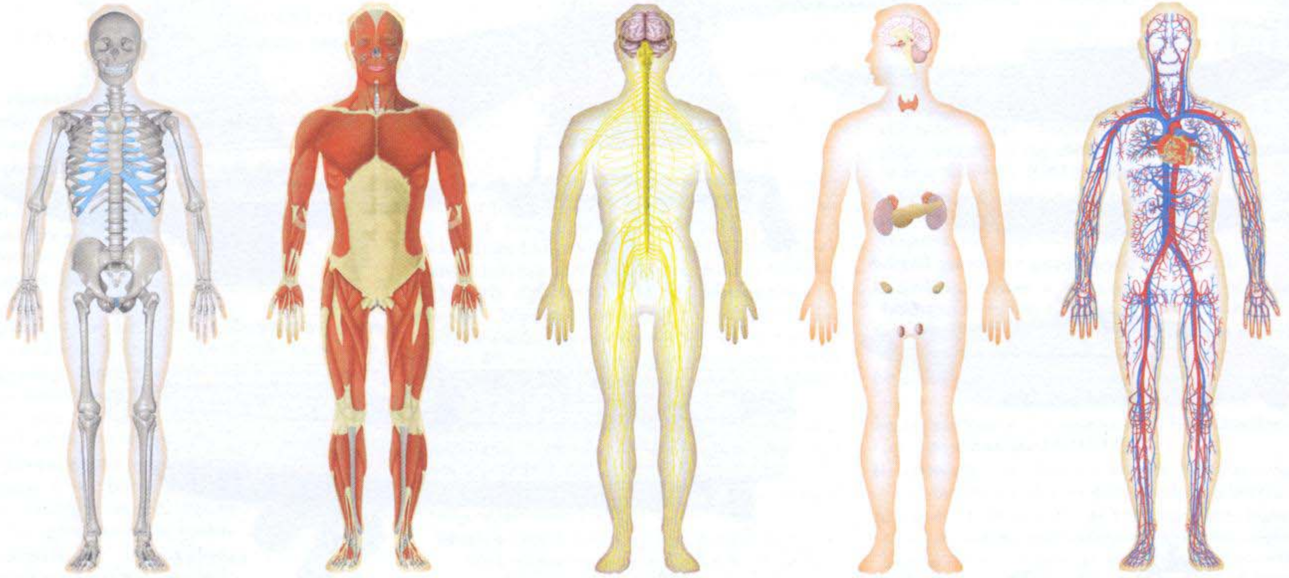
In a complete helix, the A's always line up with the T's and the G's with the C's. In the picture, the white and red bases always hook up together and blue and green are always together.

Here you can see how the bases of a helix become a DNA sequence. Scientists figure out the order of bases in a piece of DNA from an X-ray film like this. This is called sequencing. Each dark band on the X-ray ladder matches a coloured base. Each row of bands corresponds to one of the four bases. You can read the sequence from left to right, in order.



"Peace And Spirit Creating Alternative Solutions"

SYSTEMS OF THE HUMAN BODY



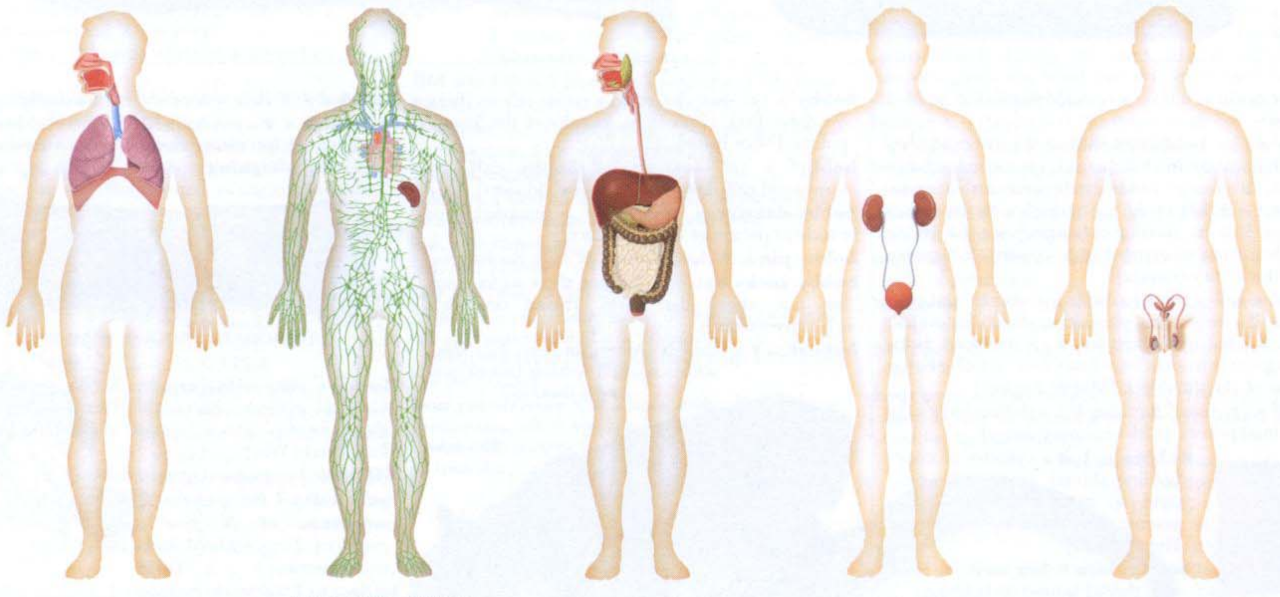
SKELETON
▷ SKELETON

MUSCULAR SYSTEM
▷ MUSCULATURE

NERVOUS SYSTEM
▷ AUTONOMIC NERVOUS SYSTEM, NERVOUS SYSTEM, PERIPHERAL NERVOUS SYSTEM

ENDOCRINE SYSTEM
▷ ENDOCRINE

CARDIOVASCULAR SYSTEM
▷ CARDIOVASCULAR



RESPIRATORY SYSTEM
▷ RESPIRATION

LYMPHATIC SYSTEM
▷ LYMPHATIC SYSTEM

DIGESTIVE SYSTEM
▷ DIGESTION

URINARY SYSTEM
▷ URINARY SYSTEM

REPRODUCTIVE ORGANS
▷ REPRODUCTIVE ORGANS

YOUR BODY'S SYSTEMS:

Circulatory System

The circulatory system is the body's transport system. It is made up of a group of organs that transport blood throughout the body. The heart pumps the blood and the **arteries** and **veins** transport it. Oxygen-rich blood leaves the left side of the heart and enters the biggest artery, called the **aorta**. The aorta branches into smaller arteries, which then branch into even smaller vessels that travel all over the body. When blood enters the smallest blood vessels, which are called **capillaries**, and are found in body tissue, it gives nutrients and oxygen to the cells and takes in carbon dioxide, water, and waste. The blood, which no longer contains oxygen and nutrients, then goes back to the heart through veins. Veins carry waste products away from cells and bring blood back to the heart, which pumps it to the lungs to pick up oxygen and eliminate waste carbon dioxide.

Digestive System

The digestive system is made up of organs that break down food into protein, vitamins, minerals, carbohydrates, and fats, which the body needs for energy, growth, and repair. After food is chewed and swallowed, it goes down the esophagus and enters the stomach, where it is further broken down by powerful stomach acids. From the stomach the food travels into the small intestine. This is where your food is broken down into nutrients that can enter the bloodstream through tiny hair-like projections. The excess food that the body doesn't need or can't digest is turned into waste and is eliminated from the body.

Endocrine System

The endocrine system is made up of a group of glands that produce the body's long-distance messengers, or hormones. **Hormones** are chemicals that control body functions, such as metabolism, growth, and sexual development. The **glands**, which include the pituitary gland, thyroid gland, parathyroid glands, adrenal glands, thymus gland, pineal body, pancreas, ovaries, and testes, release hormones directly into the bloodstream, which transports the hormones to organs and tissues throughout the body.

Immune System

The immune system is our body's defence system against infections and diseases. Organs, tissues, cells, and cell products work together to respond to dangerous organisms (like viruses or bacteria) and substances that may enter the body from the environment. There are three types of response systems in the immune system: the anatomic response, the inflammatory response, and the immune response.

Lymphatic System

The lymphatic system is also a defence system for the body. It filters out organisms that cause disease, produces white blood cells, and generates disease-fighting antibodies. It also distributes fluids and nutrients in the body and drains excess fluids and protein so that tissues do not swell. The lymphatic system is made up of a network of vessels that help circulate body fluids. These vessels carry excess fluid away from the spaces between tissues and organs and return it to the bloodstream.

Muscular System

The muscular system is made up of tissues that work with the skeletal system to control movement of the body. Some muscles—like the ones in your arms and legs—are voluntary, meaning that you decide when to move them. Other muscles, like the ones in your stomach, heart, intestines and other organs, are involuntary. This means that they are controlled automatically by the nervous system and hormones—you often don't even realize they're at work.

The body is made up of three types of muscle tissue: skeletal, smooth and cardiac. Each of these has the ability to contract and expand, which allows the body to move and function. .

Nervous System

The nervous system is made up of the brain, the spinal cord, and nerves. One of the most important systems in your body, the nervous system is your body's control system. It sends, receives, and processes nerve impulses throughout the body. These nerve impulses tell your muscles and organs what to do and how to respond to the environment. There are three parts of your nervous system that work together: the central nervous system, the peripheral nervous system, and the autonomic nervous system.

Reproductive System

The reproductive system allows humans to produce children. Sperm from the male fertilizes the female's egg, or ovum, in the fallopian tube. The fertilized egg travels from the fallopian tube to the uterus, where the foetus develops over a period of nine months.

Respiratory System

The respiratory system brings air into the body and removes carbon dioxide. It includes the nose, trachea, and lungs. When you breathe in, air enters your nose or mouth and goes down a long tube called the trachea. The trachea branches into two bronchial tubes, or primary bronchi, which go to the lungs. The primary bronchi branch off into even smaller bronchial tubes, or bronchioles. The bronchioles end in the alveoli, or air sacs. Oxygen follows this path and passes through the walls of the air sacs and blood vessels and enters the blood stream. At the same time, carbon dioxide passes into the lungs and is exhaled.

Skeletal System

The skeletal system is made up of bones, ligaments and tendons. It shapes the body and protects organs. The skeletal system works with the muscular system to help the body move. **Marrow**, which is soft, fatty tissue that produces red blood cells, many white blood cells, and other immune system cells, is found inside bones.

Urinary System

The urinary system eliminates waste from the body, in the form of urine. The kidneys remove waste from the blood. The waste combines with water to form urine. From the kidneys, urine travels down two thin tubes called ureters to the bladder. When the bladder is full, urine is discharged through the urethra.

How Nerve Cells Communicate

Some of the body's systems are directly connected to the heart, while others are not. Of course, the heart is like the president of the organization. Even if it is not directly involved in the system, it still plays a part. Obviously, if the heart isn't working, nothing else is working either. The heart actively participates in the circulatory system, while it just keeps an eye on the respiratory and excretory systems.

Your body does the same thing every day. Hidden throughout your body are dangerous poisons that must be removed in order for it to survive. The process of excretion involves finding and removing waste materials produced by the body.

The primary organs of excretion are the lungs, kidneys, and skin. Waste gases are carried by blood travelling through the veins to the lungs where respiration takes place. Dead cells and sweat are removed from the body through the skin which is part of the integumentary system.

Liquid waste is removed from the body through the kidneys. Located beside the spine in your back within your ribcage, the kidneys are small (about 10 centimetres long) reddish-brown organs that are shaped like beans.

During circulation, blood passes through the kidneys in order to deposit used and unwanted water, minerals, and a nitrogen-rich molecule called urea. The kidneys filter the wastes from the blood, forming a liquid called urine. The kidneys funnel the urine into the bladder along two separate tubes called ureters. The bladder stores the urine until muscular contractions force the urine out of the body through the urethra. Each day, your kidneys produce about 1.5 litres of urine. All of it needs to be removed from your system. This occurs through urination.

If your kidneys are diseased and not working properly, the buildup of waste in your system will eventually lead to death. Some kidney diseases can be treated with medication. Severe kidney diseases require more intense treatment. One treatment is called dialysis. The patient's blood is pumped through a dialysis machine which filters the waste from the blood and returns the clean blood. A dialysis patient has to spend nearly sixty hours each week attached to the machine.

The most radical treatment for kidney disease is a kidney transplant. Healthy people can live comfortably with only one kidney. Therefore, their other kidney can be donated to a person with kidney disease. The donor and patient must have very similar genetic structures in order for the patient to accept the new kidney without complications. The patient also receives anti-rejection drugs. During a kidney transplant operation, the healthy kidney is placed in the abdomen of the patient and attached to the blood vessels and bladder. The patient's original kidneys are not removed.

Respiration is achieved through the mouth, nose, trachea, lungs, and diaphragm. Oxygen enters the respiratory system through the mouth and the nose. The oxygen then passes through the larynx (where speech sounds are produced) and the trachea which is a tube that enters the chest cavity. In the chest cavity, the trachea splits into two smaller tubes called the bronchi. Each bronchus then divides again forming the bronchial tubes. The bronchial tubes lead directly into the lungs where they divide into many smaller tubes which connect to tiny sacs called alveoli. The average adult's lungs contain about 600 million of these spongy, air-filled sacs that are surrounded by capillaries. The inhaled oxygen passes into the alveoli and then diffuses through the capillaries into the arterial blood. Meanwhile, the waste-rich blood from the veins releases its carbon dioxide into the alveoli. The carbon dioxide follows the same path out of the lungs when you exhale.

The diaphragm's job is to help pump the carbon dioxide out of the lungs and pull the oxygen into the lungs. The diaphragm is a sheet of muscles that lies across the bottom of the chest cavity. As the diaphragm contracts and relaxes, breathing takes place. When the diaphragm contracts, oxygen is pulled into the lungs. When the diaphragm relaxes, carbon dioxide is pumped out of the lungs.

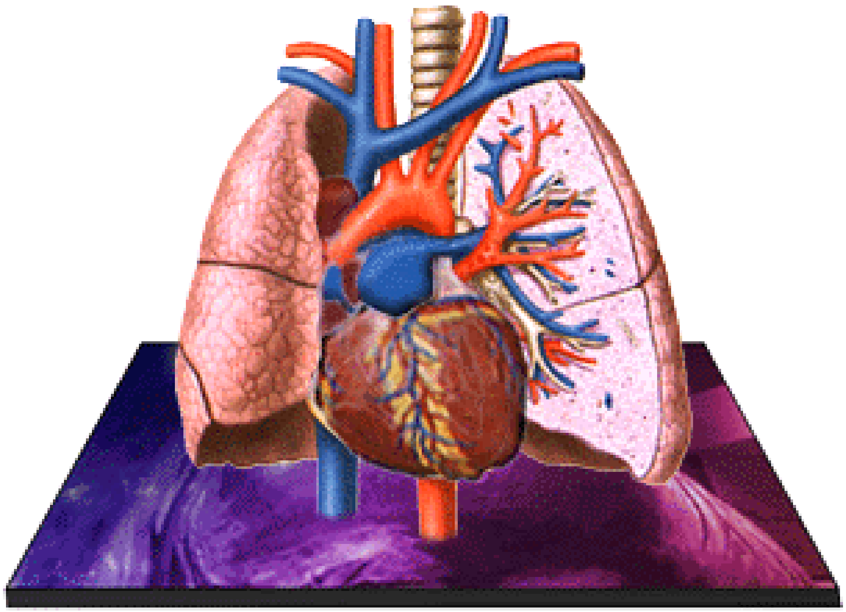
The skin protects the body and also provides for the removal of dead cells and sweat, which contains waste products. Hair, fingernails and toenails are actually accumulations of dead epidermal cells. As more cells die and need to be removed, the hair and nails grow.

The body's circulatory system really has three distinct parts: pulmonary circulation, coronary circulation, and systemic circulation. Or, the lungs (pulmonary), the heart (coronary), and the rest of the system (systemic). Each part must be working independently in order for them to all work together.

There are three varieties of blood vessels: arteries, veins, and capillaries. During blood circulation, the arteries carry blood away from the heart. The capillaries connect the arteries to veins. Finally, the veins carry the blood back to the heart.

If you took all of the blood vessels out of an average child, and laid them out in one line, the line would be over 60,000 miles long (100,000 kilometres long)! An adult's vessels would be closer to 100,000 miles long (160,000 kilometres)!

Besides circulating blood, the blood vessels provide two important means of measuring vital health statistics: pulse and blood pressure. We measure heart rate, or pulse, by touching an artery. The rhythmic contraction of the artery keeps pace with the beat of the heart. Since an artery is near the surface of the skin, while the heart is deeply protected, we can easily touch the artery and get an accurate measure of the heart's pulse.



When we measure blood pressure, we use the blood flowing through the arteries because it has a higher pressure than the blood in the veins. Your blood pressure is measured using two numbers. The first number, which is higher, is taken when the heart beats during the systole phase. The second number is taken when the heart relaxes during the diastole phase. Those two numbers stand for millimetres. A column of mercury rises and falls with the beat of the heart. The height of the column is measured in millimetres. Normal blood pressure ranges from 110 to 150 millimetres (as the heart beats) over 60 to 80 millimetres (as the heart relaxes). It is normal for your blood pressure to increase when you are exercising and to decrease when you are sleeping. If your blood pressure stays too high or too low, however, you may be at risk of heart disease.

It's All in the Lungs

The veins bring waste-rich blood back to the heart, entering the right atrium throughout two large veins called vena cavae. The right atrium fills with the waste-rich blood and then contracts, pushing the blood through a one-way valve into the right ventricle. The right ventricle fills and then contracts, pushing the blood into the pulmonary artery which leads to the lungs. In the lung capillaries, the exchange of carbon dioxide and oxygen takes place. The fresh, oxygen-rich blood enters the pulmonary veins and then returns to the heart, re-entering through the left atrium. The oxygen-rich blood then passes through a one-way valve into the left ventricle where it will exit the heart through the main artery, called the aorta. The left ventricle's contraction forces the blood into the aorta and the blood begins its journey throughout the body.

The one-way valves are important for preventing any backward flow of blood. The circulatory system is a network of one-way streets. If blood started flowing the wrong way, the blood gases (oxygen and carbon dioxide) might mix, causing a serious threat to your body.

You can use a stethoscope to hear pulmonary circulation. The two sounds you hear, "lub" and "dub," are the ventricles contracting and the valves closing.

Arteries are tough on the outside and smooth on the inside. An artery actually has three layers: an outer layer of tissue, a muscular middle, and an inner layer of epithelial cells. The muscle in the middle is elastic and very strong. The inner layer is very smooth so that the blood can flow easily with no obstacles in its path.

The muscular wall of the artery helps the heart pump the blood. When the heart beats, the artery expands as it fills with blood. When the heart relaxes, the artery contracts, exerting a force that is strong enough to push the blood along. This rhythm between the heart and the artery results in an efficient circulation system.

You can actually feel your artery expand and contract. Since the artery keeps pace with the heart, we can measure heart rate by counting the contractions of the artery. That's how we take our pulse.

The arteries deliver the oxygen-rich blood to the capillaries where the actual exchange of oxygen and carbon dioxide occurs. The capillaries then deliver the waste-rich blood to the veins for transport back to the lungs and heart.

Veins receive blood from the capillaries after the exchange of oxygen and carbon dioxide has taken place. Therefore, the veins transport waste-rich blood back to the lungs and heart. It is important that the waste-rich blood keeps moving in the proper direction and not be allowed to flow backward. This is accomplished by valves that are located inside the veins. The valves are like gates that only allow traffic to move in one direction.

The vein valves are necessary to keep blood flowing toward the heart, but they are also necessary to allow blood to flow against the force of gravity. For example, blood that is returning to the heart from the foot has to be able to flow up the leg. Generally, the force of gravity would discourage that from happening. The vein valves, however, provide footholds for the blood as it climbs its way up.

Blood that flows up to the brain faces the same problem. If the blood is having a hard time climbing up, you will feel light-headed and possibly even faint. Fainting is your brain's natural request for more oxygen-rich blood. When you faint, your head comes down to the same level as your heart, making it easy for the blood to quickly reach the brain.

Because it lacks oxygen, the waste-rich blood that flows through the veins has a deep red colour, almost like maroon. Because the walls of the veins are rather thin, the waste-rich blood is visible through the skin on some parts of the body. Look at your wrist, or hands, or ankles. You can probably see your veins carrying your blood back to your heart. Your skin refracts light, though, so that deep red colour actually appears a little blue from outside the skin.

Arteries and veins run parallel throughout the body with a web-like network of capillaries, embedded in tissue, connecting them. The arteries pass their oxygen-rich blood to the capillaries which allow the exchange of gases within the tissue. The capillaries then pass their waste-rich blood to the veins for transport back to the heart. Capillaries are also involved in the body's release of excess heat. During exercise, for example, your body and blood temperature rises. To help release this excess heat, the blood delivers the heat to the capillaries which then rapidly release it to the tissue. The result is that your skin takes on a flushed, red appearance. If you hold your hand, for example, under hot water, your hand will quickly turn red for the same reason. Your arm, however, is not likely to change colour because it is not actually feeling an increase in temperature.

Blood is the fluid of life, transporting oxygen from the lungs to body tissue and carbon dioxide from body tissue to the lungs. Blood is the fluid of growth, transporting nourishment from digestion and hormones from glands throughout the body. Blood is the fluid of health, transporting disease fighting substances to the tissue and waste to the kidneys.

Because it contains living cells, blood is alive. Red blood cells and white blood cells are responsible for nourishing and cleansing the body. Since the cells are alive, they too need nourishment. Vitamins and Minerals keep the blood healthy. The blood cells have a definite life cycle, just as all living organisms do.

Approximately 55 percent of blood is plasma, a straw-coloured clear liquid. The liquid plasma carries the solid cells and the platelets which help blood clot. Without blood platelets, you would bleed to death.

When the human body loses a little bit of blood through a minor wound, the platelets cause the blood to clot so that the bleeding stops. Because new blood is always being made inside of your bones, the body can replace the lost blood. When the human body loses a lot of blood through a major wound, that blood has to be replaced through a blood transfusion from other people.

But everybody's blood is not the same. There are four different blood types. Plus, your blood has Rh factors which make it even more unique. Blood received through a transfusion must match your own. Patients who are scheduled to have major surgery make autologous blood donations (donations of their own blood) so that they have a perfect match.

Red blood cells are red only because they contain a protein chemical called hemoglobin which is bright red in color. Hemoglobin contains the element Iron, making it an excellent vehicle for transporting oxygen and carbon dioxide. As blood passes through the lungs, oxygen molecules attach to the hemoglobin. As the blood passes through the body's tissue, the hemoglobin releases the oxygen to the cells. The empty hemoglobin molecules then bond with the tissue's carbon dioxide or other waste gases, transporting it away.

Over time, the red blood cells get worn out and eventually die. The average life cycle of a red blood cell is 120 days. Your bones are continually producing new blood cells, replenishing your supply. The blood itself, however, is re-circulated throughout your body, not being remade all of the time.

Since the human body is continually making more blood, it is safe for healthy adults to donate blood. The blood is then stored for use in emergency situations. Initially after giving blood, the donor may feel some momentary lightheadedness due to the loss of oxygen-rich red blood cells and blood sugar. The body quickly stabilizes itself.

The white blood cells have a rather short life cycle, living from a few days to a few weeks. A drop of blood can contain anywhere from 7,000 to 25,000 white blood cells at a time. If an invading infection fights back and persists, that number will significantly increase.

A consistently high number of white blood cells is a symptom of Leukaemia, a cancer of the blood. A Leukaemia patient may have as many as 50,000 white blood cells in a single drop of blood.

It might seem like plasma is less important than the blood cells it carries. But that would be like saying that the stream is less important than the fish that swims in it. You can't have one without the other.

Besides water, plasma also contains dissolved salts and minerals like calcium, sodium, magnesium, and potassium. Microbe-fighting antibodies travel to the battlefields of disease by hitching a ride in the plasma.

Without plasma, the life-giving blood cells would be left floundering without transportation. Never underestimate the importance of plasma.

Platelets are irregularly-shaped, colourless bodies that are present in blood. Their sticky surface lets them, along with other substances, form clots to stop bleeding.

When bleeding from a wound suddenly occurs, the platelets gather at the wound and attempt to block the blood flow. The mineral calcium, vitamin K, and a protein called fibrinogen help the platelets form a clot.

A clot begins to form when the blood is exposed to air. The platelets sense the presence of air and begin to break apart. They react with the fibrinogen to begin forming fibrin, which resembles tiny threads. The fibrin threads then begin to form a web-like mesh that traps the blood cells within it. This mesh of blood cells hardens as it dries, forming a clot, or "scab."

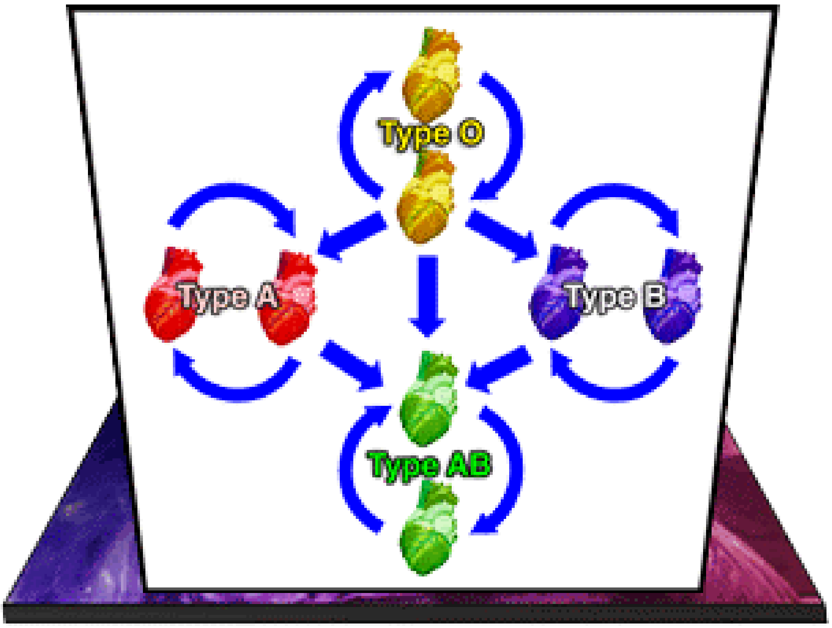
Calcium and vitamin K must be present in blood to support the formation of clots. If your blood is lacking these nutrients, it will take longer than normal for your blood to clot. If these nutrients are missing, you could bleed to death. A healthy diet provides most people with enough vitamins and minerals, but vitamin supplements are sometimes needed.

A scab is an external blood clot that we can easily see, but there are also internal blood clots. A bruise, or black-and-blue mark, is the result of a blood clot. Both scabs and bruises are clots that lead to healing. Some clots can be extremely dangerous. A blood clot that forms inside of a blood vessel can be deadly because it blocks the flow of blood, cutting off the supply of oxygen. A stroke is the result of a clot in an artery of the brain. Without a steady supply of oxygen, the brain cannot function normally. If the oxygen flow is broken, paralysis, brain damage, loss of sensory perceptions, or even death may occur.

Feeling Healing with Divine Love is the key!

What's Your Type?

Landsteiner observed two distinct chemical molecules present on the surface of the red blood cells. He labelled one molecule "A" and the other molecule "B." If the red blood cell had only "A" molecules on it, that blood was called type A. If the red blood cell had only "B" molecules on it, that blood was called type B. If the red blood cell had a mixture of both molecules, that blood was called type AB. If the red blood cell had neither molecule, that blood was called type O.



If two different blood types are mixed together, the blood cells may begin to clump together in the blood vessels, causing a potentially fatal situation. Therefore, it is important that blood types be matched before blood transfusions take place. In an emergency, type O blood can be given because it is most likely to be accepted by all blood types. However, there is still a risk involved.

A person with type A blood can donate blood to a person with type A or type AB. A person with type B blood can donate blood to a person with type B or type AB. A person with type AB blood can donate blood to a person with type AB only. A person with type O blood can donate to anyone.

A person with type A blood can receive blood from a person with type A or type O. A person with type B blood can receive blood from a person with type B or type O. A person with type AB blood can receive blood from anyone. A person with type O blood can receive blood from a person with type O.

Because of these patterns, a person with type O blood is said to be a universal donor. A person with type AB blood is said to be a universal receiver. In general, however, it is still best to mix blood of matching types and Rh factors.

If your blood does contain the protein, your blood is said to be Rh positive (Rh+). If your blood does not contain the protein, your blood is said to be Rh negative (Rh-).

This Rh factor is connected to your blood type. For example, your blood may be AB+ which means that you have type AB blood with a positive Rh factor. Or, you might have O- blood which means that you have type O blood with a negative Rh factor.

It is particularly important for expectant mothers to know their blood's Rh factor. Occasionally, a baby will inherit an Rh positive blood type from its father while the mother has an Rh negative blood type. The baby's life could be in great danger if the mother's Rh negative blood attacks the baby's Rh positive blood. If this happens, an exchange transfusion may save the baby's life. The baby's blood can be exchanged for new blood that matches the mother's.

AUTOLOGOUS BLOOD DONATION BASICS: **BLOODBOOK.COM**

http://www.bloodbook.com/autolog-1.html

Autologous Blood transfusion is the collection and re-infusion of the patient's own Blood or Blood components. Recommended by the American Medical Association's Council on Scientific Affairs, and described as the safest Blood product by Blood banks themselves, it clearly should be the transfusion therapy of choice. The alternative, allogeneic Blood, on the other hand, is collected from a Blood donor other than the patient, and transfused into that patient.

Although not completely risk free, autologous Blood is the safest form of Blood transfusion. Exclusive use of a patient's own Blood eliminates reactions due to donor recipient incompatibility and precludes exposure to transfusion transmitted infection. There is a vast body of knowledge on human blood. There are literally hundreds of areas of Blood research with large sums of money invested. Even so, every year, there are discoveries rendering the standard conventions unusable, or even dangerous. Many of the antibodies in donated blood, which develop when people are exposed to diseases, may be undetectable despite intensive testing, and these can cause transfusion reactions in patients receiving the blood. While Blood bank tests greatly reduce the risks of acquiring certain infectious diseases, these risks can not be eliminated entirely. Your own blood is the safest blood for you.

This year, the United States will be short more than 250,000 of the one-pint units of Blood that Americans will need. About that same amount of Blood is imported from abroad each year to fill Americans' needs. This estimate is from the non-profit National Blood Data Resource Center in Bethesda, Maryland. Imported blood..... hmmm! Other credible estimates indicate imports of up to 20% of the total supply.

Over the last several years, an increased awareness of diseases transmitted by allogeneic Blood has resulted in a dramatic increase in autologous Blood transfusion. Approximately 16 million units are donated annually, and of those, about 643,000 are autologous. This number of autologous donations is growing each year. Clinical research and practice in autologous Blood use have also grown in recent years, providing new insights into the issues involved.

Remember, we are assured that all Blood is safe. To me, 'safe' is a relative term. I know for certain that my Blood is the safest for me when I use it for myself.

TYPES of AUTOLOGOUS BLOOD for TRANSFUSION

Five categories of autologous transfusions are generally recognized:

- **Preoperative autologous Blood** donation, transfusion and storage (PABD): units of Blood are drawn from a patient usually starting (in the short term case) three to five weeks before an elective surgical procedure and stored for transfusion at the time of the surgery.
- **Intraoperative hemodilution**: Blood is collected at the start of surgery and the fluid volume lost is replaced with appropriate IV solutions, and then finally, stored Blood is reinfused after surgery.
- **Intraoperative Blood salvage**: Blood is salvaged from the surgical area during the operation for

reinfusion during or after the surgical procedure.

- **Postoperative Blood salvage**: Blood is collected after the surgical procedure is complete by drainage of the operative area and reinfused.

- **Autologous self stored Blood** (Blood banking): your own Blood is preserved in a frozen state for use by you or your designee at a later time, in case your need of a Blood transfusion arises. The safest Blood you can receive is your own! This process eliminates donor-transmitted diseases. If you have a rare Blood type, or if your Blood contains rare components, this process may mean the difference between life and death (and be covered by insurance). Autologous Blood is always a perfect match. It will be there when you need it..... regardless of a general Blood shortage. Not everything about Blood is known. Your Blood is unique in its composition. In addition to the groups of A, B, O and Rh types, there are as many as 100 or more sub-types. The chances of obtaining a transfusion from an unrelated stranger, where all sub-types match, is estimated to be less than 1 in 100,000. You will not form harmful antibodies or have a transfusion reaction when you receive your own blood.

  Often your own Blood is a very good match for a close relative and members of your family can be cross-matched to pool the total number of units stored (see designated donation).

The propriety of these procedures varies with the clinical situation, and with the size of your purse. They can be used alone or in combination to reduce or eliminate your need for allogeneic (volunteer donor) blood, as you desire.

What are risks of donating and storing Blood for my own use?

Although autologous transfusion is the safest possible option for some patients, it is not completely risk free. Clerical errors and the administration of the wrong unit of Blood could occur with autologous Blood as well as with allogeneic Blood (volunteer donor blood). The label on autologous Blood must be matched to the patient identification band at the time of transfusion as with any other transfusion. There is risk of mishandling, and extreme risk of loss or spoilage during transport. The autologous method has an added risk: because patients who donate their own Blood in the close weeks before surgery often do so with lower Blood counts, they may require a transfusion sooner than someone who did not donate his or her own Blood just before surgery. The ever-present risk of transfusion-related volume overload may also be increased if autologous Blood is indiscriminately transfused.

Other risks of note include, Anaemia and Hypovolemia, which are the most common adverse effects of PABD. The most unusual statistic that we unearthed in the year 2000 was that approximately 1 donor in 16,000, of those making annual autologous donations, is hospitalized as a result of that Blood donation. No specific causes were stated in the statistic. Generally, the indications for transfusion of autologous Blood should not vary greatly from those for allogeneic blood.

What factors increase risk for Autologous donation?

Paediatric Donors – Statistics demonstrate that autologous Blood donation is safe for children from ages seven to18 years. The lower age limit is determined by the ability of the child to safely cooperate and their availability of suitable veins. The maximum amount of Blood that may be safely withdrawn at one sitting is approximately 12% of the donor's Blood volume.

Adult Cardiac Donors – Experience with pre-operative autologous Blood donations in adult cardiac patients suggests that this technique is safe and effective in reducing homologous Blood requirements. A thorough physical examination prior to donation is recommended, and continuous EKG and Blood pressure monitoring during and after donation is prudent. The consensus of objective experts is that isovolemic autologous donation can safely be used in patients scheduled for cardiac surgery, based on the absence of subjective complaints, without objective monitoring. Exceptions are those patients with unstable angina, critical aortic stenosis, and recent myocardial infarction.

How is the donation arranged?

Once you have decided to donate Blood for your own use, your request for autologous donation must be made to a Blood collection centre. The centre will manage scheduling, paperwork, the donation itself and the proper labelling and storage of your blood. Someone there will make an appointment for you and will get the answers to the questions that you will have. This is the time when you must begin the process of taking accurate and complete notes of with whom you spoke, what time and date the conversation took place, exactly what was said and the result of the call.

What does Autologous Blood donation involve?

You will be required to visit the donor centre several times depending on the number of units of Blood to be collected for your purposes, each visit taking about one to two hours. At each visit you will have a small sample of Blood collected from your fingertip to ascertain your haemoglobin level. Other tests may be required. You or your parent or guardian will be required to complete a donor declaration form prior to each donation.

A pre-autologous interview will be conducted at the donor centre prior to your first collection. Here the procedure, donor consent, informed consent, and donor declaration forms, as well as costs and your requirements will be explained. Screening bloods will be collected and the prescription of iron and vitamin tablets will normally be discussed.

What happens to my Blood once it is collected?

Your Blood is labelled and signed by you or your parent/guardian. It is normally then witnessed by the Donor Centre. The unit of Blood is then stored in a designated area for "Long Term Autologous Donation." At the time of your donation samples of Blood will be collected for testing and certification.

Is there something often overlooked that I should remember?

Yes..... keep a written record of every name, every date and every number. Be certain of the accuracy and legibility of every one of your records. You must also have these records available to you at all times. If you do not have your notes with you, they will be of little value! The other paramount rule is to make certain that you always know the final and complete delivered costs.

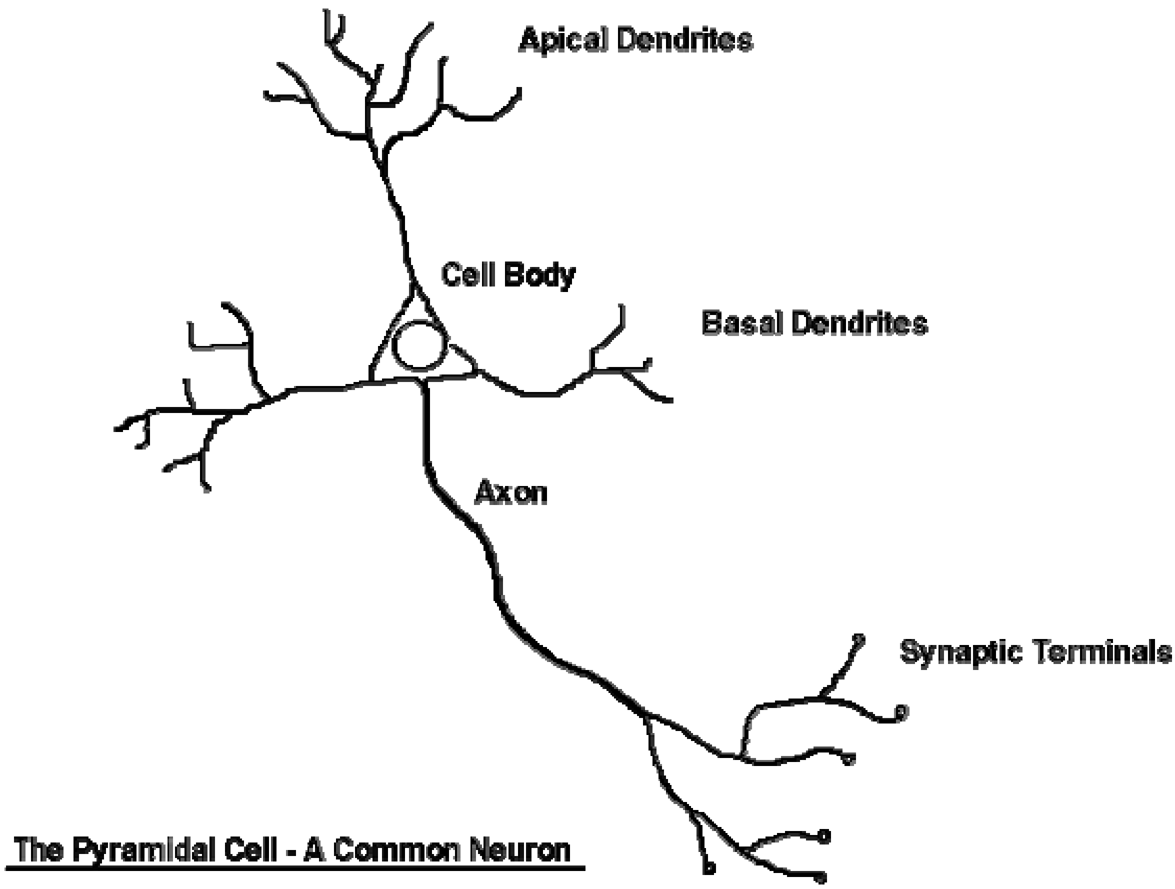
THE NERVOUS SYSTEM:

The Neuron

Nervous tissue is composed of two main cell types: neurons and glial cells. Neurons transmit nerve messages. Glial cells are in direct contact with neurons and often surround them.

Nerve Cells and Astrocyte (SEM x2,250).

The neuron is the functional unit of the nervous system. Humans have about 100 billion neurons in their brain alone! While variable in size and shape, all neurons have three parts. Dendrites receive information from another cell and transmit the message to the cell body. The cell body contains the nucleus, mitochondria and other organelles typical of eukaryotic cells. The axon conducts messages away from the cell body.

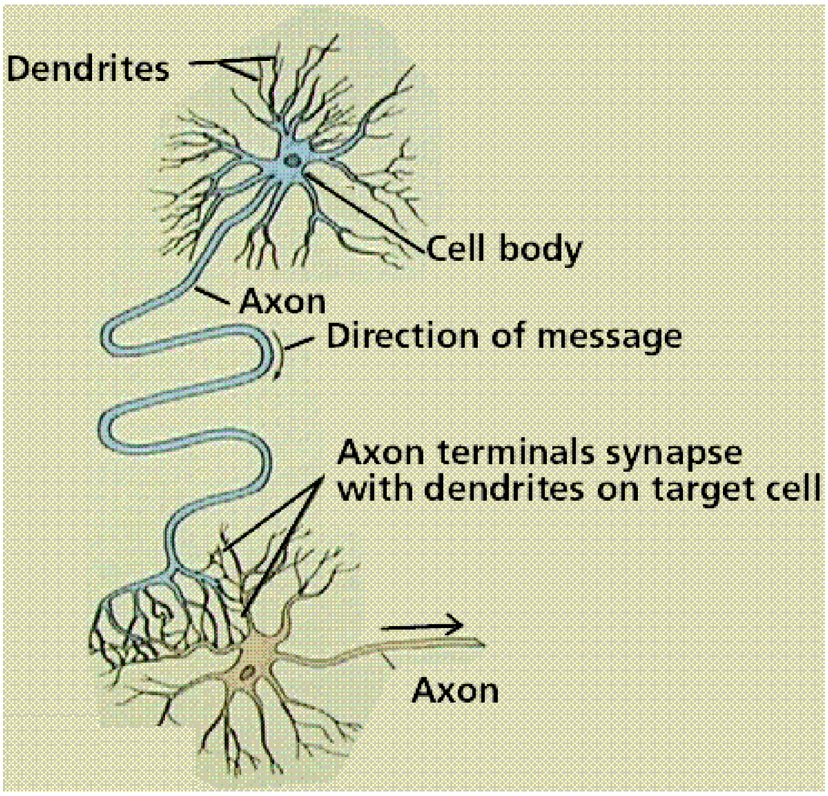


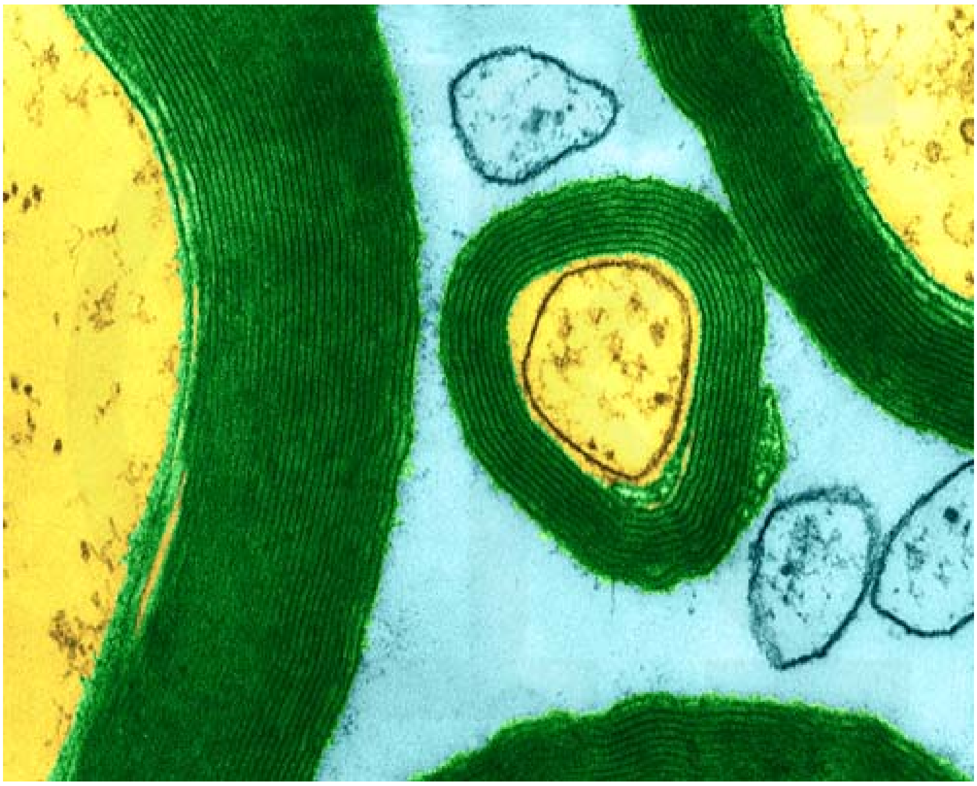
Structure of a typical neuron. The above image is from: http://eleceng.ukc.ac.uk/~sd5/pics/research/big/neuron.gif.

Three types of neurons occur. Sensory neurons typically have a long dendrite and short axon, and carry messages from sensory receptors to the central nervous system. Motor neurons have a long axon and short dendrites and transmit messages from the central nervous system to the muscles (or to glands). Interneurons are found only in the central nervous system where they connect neuron to neuron.

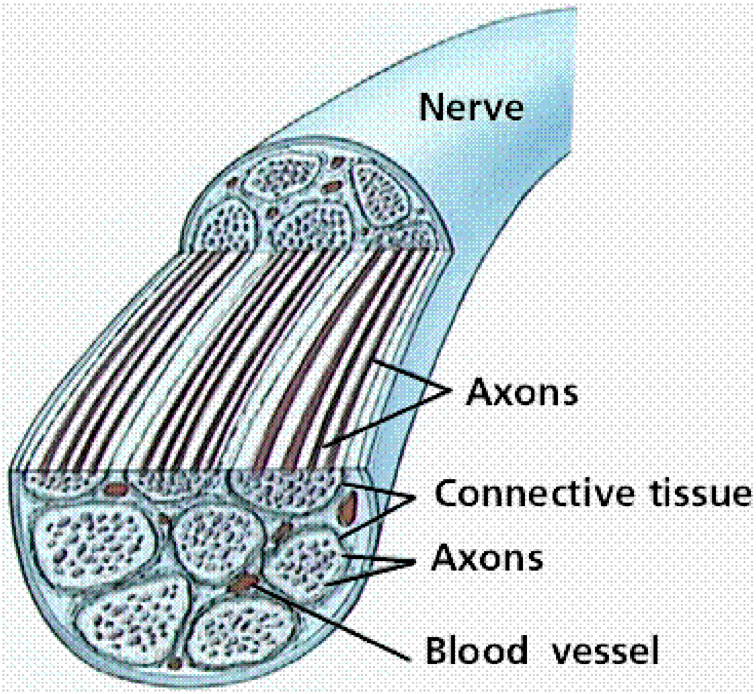
Structure of a neuron and the direction of nerve message transmission. Image from Purves et al., Life: The Science of Biology, 4th Edition, by Sinauer Associates (www.sinauer.com) and WH Freeman (www.whfreeman.com), used with permission.

Some axons are wrapped in a myelin sheath formed from the plasma membranes of specialized glial cells known as Schwann cells. Schwann cells serve as supportive, nutritive, and service facilities for neurons. The gap between Schwann cells is known as the node of Ranvier, and serves as points along the neuron for generating a signal. Signals jumping from node to node travel hundreds of times faster than signals travelling along the surface of the axon. This allows your brain to communicate with your toes in a few thousandths of a second.





Cross section of **myelin sheaths** that surround **axons** (TEM x191,175).

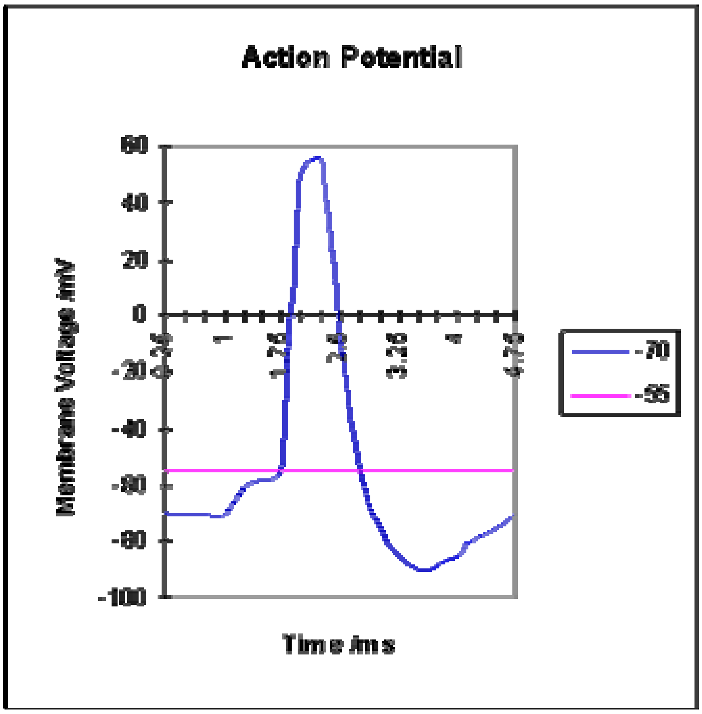


Structure of a nerve bundle.

The Nerve Message

The plasma membrane of neurons, like all other cells, has an unequal distribution of ions and electrical charges between the two sides of the membrane. The outside of the membrane has a positive charge, inside has a negative charge. This charge difference is a resting potential and is measured in millivolts. Passage of ions across the cell membrane passes the electrical charge along the cell. The voltage potential is -65mV (millivolts) of a cell at rest (resting potential). Resting potential results from differences between sodium and potassium positively charged ions and negatively charged ions in the cytoplasm. Sodium ions are more concentrated outside the membrane, while potassium ions are more concentrated inside the membrane. This imbalance is maintained by the active transport of ions to reset the membrane known as the sodium potassium pump. The sodium-potassium pump maintains this unequal concentration by actively transporting ions against their concentration gradients.

Transmission of an action potential. The above image is from:
http://eleceng.ukc.ac.uk/~sd5/pics/research/big/actpot.gif.



Changed polarity of the membrane, the action potential, results in propagation of the nerve impulse along the membrane. An action potential is a temporary reversal of the electrical potential along the membrane for a few milliseconds. Sodium gates and potassium gates open in the membrane to allow their respective ions to cross. Sodium and potassium ions reverse positions by passing through membrane protein channel gates that can be opened or closed to control ion passage. Sodium crosses first. At the height of the membrane potential reversal, potassium channels open to allow potassium ions to pass to the outside of the membrane. Potassium crosses second, resulting in changed ionic distributions, which must be reset by the continuously running sodium-potassium pump. Eventually enough potassium ions pass to the outside to restore the membrane charges to those of the original resting potential. The cell begins then to pump the ions back to their original sides of the membrane.

The action potential begins at one spot on the membrane, but spreads to adjacent areas of the membrane, propagating the message along the length of the cell membrane. After passage of the action potential, there is a brief period, the refractory period, during which the membrane cannot be stimulated. This prevents the message from being transmitted backward along the membrane.

Steps in an Action Potential

Synapses

The junction between a nerve cell and another cell is called a synapse. Messages travel within the neuron as an electrical action potential. The space between two cells is known as the synaptic cleft. To cross the synaptic cleft requires the actions of neurotransmitters. Neurotransmitters are stored in small synaptic vesicles clustered at the tip of the axon.

Arrival of the action potential causes some of the vesicles to move to the end of the axon and discharge their contents into the synaptic cleft. Released neurotransmitters diffuse across the cleft, and bind to receptors on the other cell's membrane, causing ion channels on that cell to open. Some neurotransmitters cause an action potential, others are inhibitory.

Neurotransmitters tend to be small molecules, some are even hormones. The time for neurotransmitter action is between 0.5 and 1 millisecond. Neurotransmitters are either destroyed by specific enzymes in the synaptic cleft, diffuse out of the cleft, or are reabsorbed by the cell. More than 30 organic molecules are thought to act as neurotransmitters. The neurotransmitters cross the cleft, binding to receptor molecules on the next cell, prompting transmission of the message along that cell's membrane. Acetylcholine is an example of a neurotransmitter, as is norepinephrine, although each acts in different responses. Once in the cleft, neurotransmitters are active for only a short time. Enzymes in the cleft inactivate the neurotransmitters. Inactivated neurotransmitters are taken back into the axon and recycled.

Diseases that affect the function of signal transmission can have serious consequences. Parkinson's disease has a deficiency of the neurotransmitter dopamine. Progressive death of brain cells increases this deficit, causing tremors, rigidity and unstable posture. L-dopa is a chemical related to dopamine that eases some of the symptoms (by acting as a substitute neurotransmitter) but cannot reverse the progression of the disease.

The bacterium *Clostridium tetani* produces a toxin that prevents the release of GABA. GABA is important in control of skeletal muscles. Without this control chemical, regulation of muscle contraction is lost; it can be fatal when it effects the muscles used in breathing.

Clostridium botulinum produces a toxin found in improperly canned foods. This toxin causes the progressive relaxation of muscles, and can be fatal. A wide range of drugs also operate in the synapses: cocaine, LSD, caffeine, and insecticides.

Nervous Systems

Multicellular animals must monitor and maintain a constant internal environment as well as monitor and respond to an external environment. In many animals, these two functions are coordinated by two integrated and coordinated organ systems: the nervous system and the endocrine system.

Three basic functions are performed by nervous systems:

Sensory Input

Receptors are parts of the nervous system that sense changes in the internal or external environments. Sensory input can be in many forms, including pressure, taste, sound, light, blood pH, or hormone levels that are converted to a signal and sent to the brain or spinal cord.

Integration and Output

In the sensory centres of the brain or in the spinal cord, the barrage of input is integrated and a response is generated. The response, a motor output, is a signal transmitted to organs than can convert the signal into some form of action, such as movement, changes in heart rate, release of hormones, etc.

Endocrine Systems

Some animals have a second control system, the endocrine system. The nervous system coordinates rapid responses to external stimuli. The endocrine system controls slower, longer lasting responses to internal stimuli. Activity of both systems is integrated.

Divisions of the Nervous System

The nervous system monitors and controls almost every organ system through a series of positive and negative feedback loops. The Central Nervous System (CNS) includes the brain and spinal cord. The Peripheral Nervous System (PNS) connects the CNS to other parts of the body, and is composed of nerves (bundles of neurons).

Not all animals have highly specialized nervous systems. Those with simple systems tend to be either small and very mobile or large and immobile. Large, mobile animals have highly developed nervous systems: the evolution of nervous systems must have been an important adaptation in the evolution of body size and mobility.

Coelenterates, cnidarians, and echinoderms have their neurons organized into a nerve net. These creatures have radial symmetry and lack a head. Although lacking a brain or either nervous system (CNS or PNS) nerve nets are capable of some complex behaviour.

Nervous systems in radially symmetrical animals.

Bilaterally symmetrical animals have a body plan that includes a defined head and a tail region. Development of bilateral symmetry is associated with cephalisation, the development of a head with the accumulation of sensory organs at the front end of the organism. Flatworms have neurons associated into clusters known as ganglia, which in turn form a small brain. Vertebrates have a spinal cord in addition to a more developed brain.

Some nervous systems in bilaterally symmetrical animals.

Chordates have a dorsal rather than ventral nervous system. Several evolutionary trends occur in chordates: spinal cord, continuation of cephalization in the form of larger and more complex brains, and development of a more elaborate nervous system. The vertebrate nervous system is divided into a number of parts. The central nervous system includes the brain and spinal cord. The peripheral nervous system consists of all body nerves. Motor neuron pathways are of two types: somatic (skeletal) and autonomic (smooth muscle, cardiac muscle, and glands). The autonomic system is subdivided into the sympathetic and parasympathetic systems.

Peripheral Nervous System

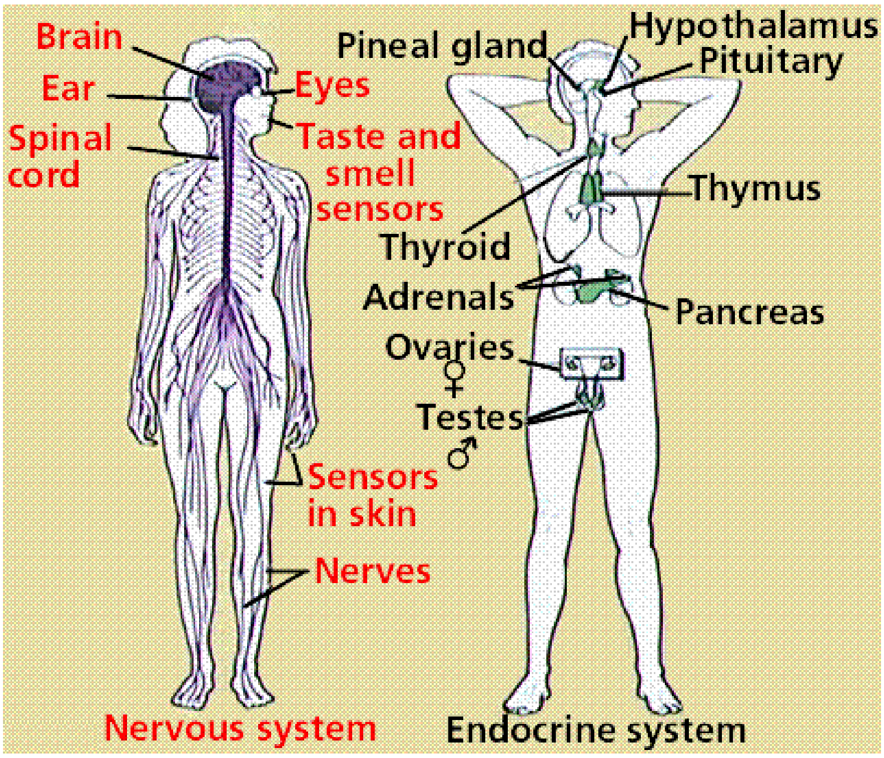
The Peripheral Nervous System (PNS) contains only nerves and connects the brain and spinal cord (CNS) to the rest of the body. The axons and dendrites are surrounded by a white myelin sheath. Cell bodies are in the central nervous system (CNS) or ganglia. Ganglia are collections of nerve cell bodies. Cranial nerves in the PNS take impulses to and from the brain (CNS). Spinal nerves take impulses to and away from the spinal cord. There are two major subdivisions of the PNS motor pathways: the somatic and the autonomic.

Two main components of the PNS:

Most sensory input carried in the PNS remains below the level of conscious awareness. Input that does reach the conscious level contributes to perception of our external environment.

Somatic Nervous System

The Somatic Nervous System (SNS) includes all nerves controlling the muscular system and external sensory receptors. External sense organs (including skin) are receptors. Muscle fibres and gland cells are effectors. The reflex arc is an automatic, involuntary reaction to a stimulus. When the doctor taps your knee with the rubber hammer, she/he is testing your reflex (or knee-jerk). The reaction to the stimulus is involuntary, with the CNS being informed but not consciously controlling the response. Examples of reflex arcs include balance, the blinking reflex, and the stretch reflex.



Sensory input from the PNS is processed by the CNS and responses are sent by the PNS from the CNS to the organs of the body.

Motor neurons of the somatic system are distinct from those of the autonomic system. Inhibitory signals, cannot be sent through the motor neurons of the somatic system.

Autonomic Nervous System

The Autonomic Nervous System is that part of PNS consisting of motor neurons that control internal organs. It has two subsystems. The autonomic system controls muscles in the heart, the smooth muscle in internal organs such as the intestine, bladder, and uterus. The Sympathetic Nervous System is involved in the fight or flight response. The Parasympathetic Nervous System is involved in relaxation. Each of these subsystems operates in the reverse of the other (antagonism). Both systems innervate the same organs and act in opposition to maintain homeostasis. For example: when you are scared the sympathetic system causes your heart to beat faster; the parasympathetic system reverses this effect.

Motor neurons in this system do not reach their targets directly (as do those in the somatic system) but rather connect to a secondary motor neuron which in turn innervates the target organ.

Central Nervous System

The Central Nervous System (CNS) is composed of the brain and spinal cord. The CNS is surrounded by bone-skull and vertebrae. Fluid and tissue also insulate the brain and spinal cord.

Areas of the brain.

The brain is composed of three parts: the cerebrum (seat of consciousness), the cerebellum, and the medulla oblongata (these latter two are "part of the unconscious brain").

The medulla oblongata is closest to the spinal cord, and is involved with the regulation of heartbeat, breathing, vasoconstriction (blood pressure), and reflex centres for vomiting, coughing, sneezing, swallowing, and hiccuping. The hypothalamus regulates homeostasis. It has regulatory areas for thirst, hunger, body temperature, water balance, and blood pressure, and links the Nervous System to the Endocrine System. The midbrain and pons are also part of the unconscious brain. The thalamus serves as a central relay point for incoming nervous messages.

The cerebellum is the second largest part of the brain, after the cerebrum. It functions for muscle coordination and maintains normal muscle tone and posture. The cerebellum coordinates balance.

The conscious brain includes the cerebral hemispheres, which are separated by the *corpus callosum*. In reptiles, birds, and mammals, the cerebrum coordinates sensory data and motor functions. The cerebrum governs intelligence and reasoning, learning and memory. While the cause of memory is not yet definitely known, studies on slugs indicate learning is accompanied by a synapse decrease. Within the cell, learning involves change in gene regulation and increased ability to secrete transmitters.

The Brain

During embryonic development, the brain first forms as a tube, the anterior end of which enlarges into three hollow swellings that form the brain, and the posterior of which develops into the spinal cord. Some parts of the brain have changed little during vertebrate evolutionary history.

Parts of the brain as seen from the middle of the brain.

Vertebrate evolutionary trends include

The Brain Stem and Midbrain

The brain stem is the smallest and from an evolutionary viewpoint, the oldest and most primitive part of the brain. The brain stem is continuous with the spinal cord, and is composed of the parts of the hindbrain and midbrain. The medulla oblongata and pons control heart rate, constriction of blood vessels, digestion and respiration.

The midbrain consists of connections between the hindbrain and forebrain. Mammals use this part of the brain only for eye reflexes.

The Cerebellum

The cerebellum is the third part of the hindbrain, but it is not considered part of the brain stem. Functions of the cerebellum include fine motor coordination and body movement, posture, and balance. This region of the brain is enlarged in birds and controls muscle action needed for flight.

The Forebrain

The forebrain consists of the diencephalon and cerebrum. The thalamus and hypothalamus are the parts of the diencephalon. The thalamus acts as a switching centre for nerve messages. The hypothalamus is a major homeostatic centre having both nervous and endocrine functions.

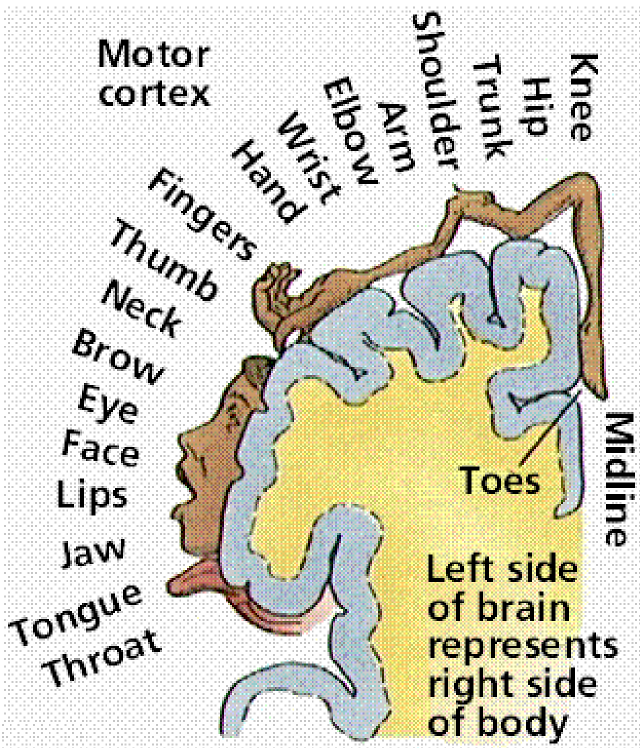
The cerebrum, the largest part of the human brain, is divided into left and right hemispheres connected to each other by the corpus callosum. The hemispheres are covered by a thin layer of gray matter known as the cerebral cortex, the most recently evolved region of the vertebrate brain. Fish have no cerebral cortex, amphibians and reptiles have only rudiments of this area.

The cortex in each hemisphere of the cerebrum is between 1 and 4 mm thick . Folds divide the cortex into four lobes: occipital, temporal, parietal, and frontal. No region of the brain functions alone, although major functions of various parts of the lobes have been determined.

The major brain areas and lobes.

The occipital lobe (back of the head) receives and processes visual information. The temporal lobe receives auditory signals, processing language and the meaning of words. The parietal lobe is associated with the sensory cortex and processes information about touch, taste, pressure, pain, and heat and cold. The frontal lobe conducts three functions:

Functional areas of the brain.



Most people who have been studied have their language and speech areas on the left hemisphere of their brain. Language comprehension is found in Wernicke's area. Speaking ability is in Broca's area. Damage to Broca's area causes speech impairment but not impairment of language comprehension. Lesions in Wernicke's area impairs ability to comprehend written and spoken words but not speech. The remaining parts of the cortex are associated with higher thought processes, planning, memory, personality and other human activities.

Parts of the cerebral cortex and the relative areas that are devoted to controlling various body regions.

The Spinal Cord

The spinal cord runs along the dorsal side of the body and links the brain to the rest of the body. Vertebrates have their spinal cords encased in a series of (usually) bony vertebrae that comprise the vertebral column.

The gray matter of the spinal cord consists mostly of cell bodies and dendrites. The surrounding white matter is made up of bundles of interneuronal axons (tracts). Some tracts are ascending (carrying messages to the brain), others are descending (carrying messages from the brain). The spinal cord is also involved in reflexes that do not immediately involve the brain.

The Brain and Drugs

Some neurotransmitters are excitory, such as acetylcholine, norepinephrine, serotonin, and dopamine. Some are associated with relaxation, such as dopamine and serotonin. Dopamine release seems related to sensations of pleasure. Endorphins are natural opioids that produce elation and reduction of pain, as do artificial chemicals such as opium and heroin. Neurological diseases, for example **Parkinson's disease** and Huntington's disease, are due to imbalances of neurotransmitters. Parkinson's is due to a dopamine deficiency. Huntington's disease is thought to be cause by malfunctioning of an inhibitory neurotransmitter. **Alzheimer's disease** is associated with protein plaques in the brain.

Drugs are stimulants or depressants that block or enhance certain neurotransmitters. Dopamine is thought involved with all forms of pleasure. Cocaine interferes with uptake of dopamine from the synaptic cleft. Alcohol causes a euphoric "high" followed by a depression.

Marijuana, material from the Indian hemp plant (*Cannabis sativa*), has a potent chemical THC (tetrahydracannibinol) that in low, concentrations causes a euphoric high (if inhaled, the most common form of action is smoke inhalation). High dosages may cause severe effects such as hallucinations, anxiety, depression, and psychotic symptoms.

Cocaine is derives from the plant *Erthoxylon coca*. Inhaled, smoked or injected. Cocaine users report a "rush" of euphoria following use. Following the rush is a short (5-30 minute) period of arousal followed by a depression. Repeated cycle of use terminate in a "crash" when the cocaine is gone. Prolonged used causes production of less dopamine, causing the user to need more of the drug.

Heroin is a derivative of morphine, which in turn is obtained from opium, the milky secretions obtained from the opium poppy, *Papaver somniferum*. Heroin is usually injected intravenously, although snorting and smoking serve as alternative delivery methods. Heroin binds to ophioid receptors in the brain, where the natural chemical endorphins are involved in the cessation pain. Heroin is physically addictive, and prolonged use causes less endorphin production. Once this happens, the euphoria is no longer felt, only dependence and delay of withdrawal symptoms.

Senses

Input to the nervous system is in the form of our five senses: **pain, vision, taste, smell, and hearing**. Vision, taste, smell, and hearing input are the special senses. Pain, temperature, and pressure are known as somatic senses. Sensory input begins with sensors that react to stimuli in the form of energy that is transmitted into an action potential and sent to the CNS.

Sensory Receptors

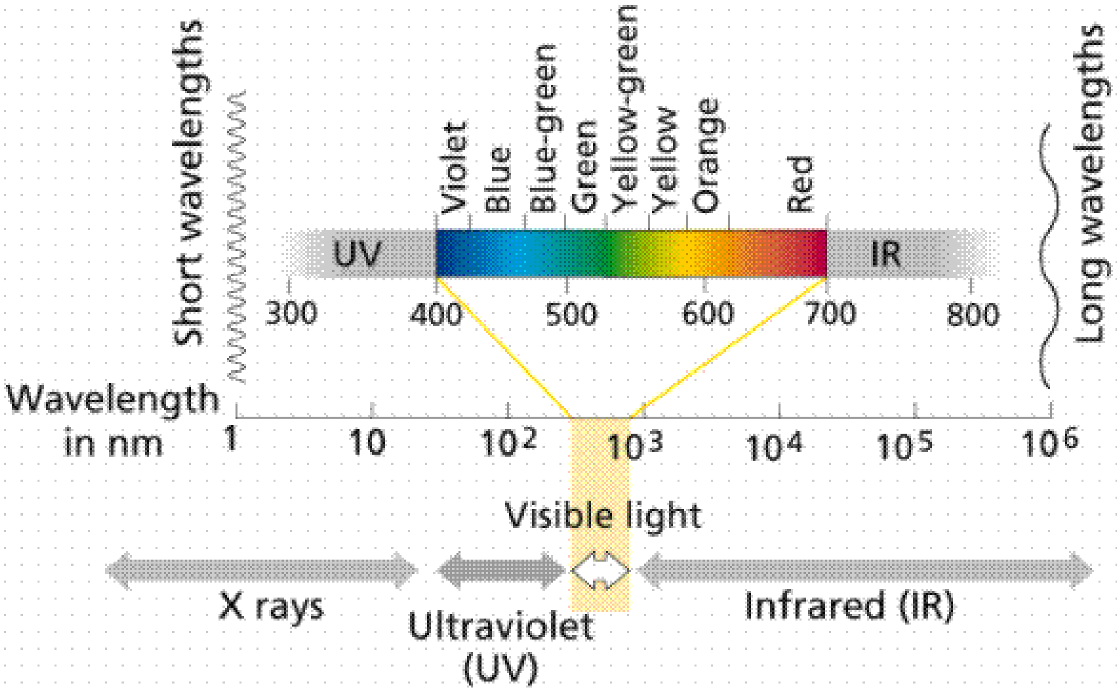
Mechanoreceptors vary greatly in the specific type of stimulus and duration of stimulus/action potentials. The most adaptable vertebrate mechanoreceptor is the hair cell. Hair cells are present in the lateral line of fish. In humans and mammals hair cells are involved with detection of sound and gravity and providing balance.

Hearing

Hearing involves the actions of the external ear, eardrum, ossicles, and cochlea. In hearing, sound waves in air are converted into vibrations of a liquid then into movement of hair cells in the cochlea. Finally they are converted into action potentials in a sensory dendrite connected to the auditory nerve. Very loud sounds can cause violent vibrations in the membrane under hair cells, causing a shearing or permanent distortion to the cells, resulting in permanent hearing loss.

Orientation and Gravity

Orientation and gravity are detected at the semicircular canals. Hair cells along three planes respond to shifts of liquid within the cochlea, providing a three-dimensional sense of equilibrium. Calcium carbonate crystals can shift in response to gravity, providing sensory information about gravity and acceleration.



The electromagnetic spectrum.

Photoreceptors Detect Vision and Light Sensitivity

The human eye can detect light in the 400-700 nanometer (nm) range, a small portion of the electromagnetic spectrum, the visible light spectrum. Light with wavelengths shorter than 400 nm is termed ultraviolet (UV) light. Light with wavelengths longer than 700 nm is termed infrared (IR) light.

Eye

In the eye, two types of photoreceptor cells are clustered on the retina, or back portion of the eye. These receptors, rods and cones, apparently evolved from hair cells. Rods detect differences in light intensity; cones detect colour. Rods are more common in a circular zone near the edge of the eye. Cones occur in the centre (or fovea centralis) of the retina.

Light reaching a photoreceptor causes the breakdown of the chemical rhodopsin, which in turn causes a membrane potential that is transmitted to an action potential. The action potential transfers to synapsed neurons that connect to the optic nerve. The optic nerve connects to the occipital lobe of the brain.

Humans have three types of cones, each sensitive to a different colour of light: red, blue and green. Opsins are chemicals that bind to cone cells and make those cells sensitive to light of a particular wavelength (or colour). Humans have three different form of opsins coded for by three genes on the X chromosome. Defects in one or more of these opsin genes can cause colour blindness, usually in males.

<u>IMMUNE SYSTEM</u>:

http://uhaweb.hartford.edu/BUGL/immune.htm

Introduction

The human immune system is a truly amazing constellation of responses to attacks from outside the body. It has many facets, a number of which can change to optimize the response to these unwanted intrusions. The system is remarkably effective, most of the time. This note will give you a brief outline of some of the processes involved.

An **antigen** is any substance that elicits an immune response, from a virus to a sliver.

The immune system has a series of dual natures, the most important of which is self/non-self recognition. The others are: general/specific, natural/adaptive = innate/acquired, cell-mediated/humoral, active/passive, primary/secondary. Parts of the immune system are **antigen-specific** (they recognize and act against particular antigens), **systemic** (not confined to the initial infection site, but work throughout the body), and have **memory** (recognize and mount an even stronger attack to the same antigen the next time).

Self/non-self recognition is achieved by having every cell display a marker based on the major histocompatibility complex (MHC). Any cell not displaying this marker is treated as non-self and attacked. The process is so effective that undigested proteins are treated as antigens.

Sometimes the process breaks down and the immune system attacks self-cells. This is the case of **autoimmune diseases** like multiple sclerosis, systemic lupus erythematosus, and some forms of arthritis and diabetes. There are cases where the immune response to innocuous substances is inappropriate. This is the case of allergies and the simple substance that elicits the response is called an **allergen**.

Fluid Systems of the Body

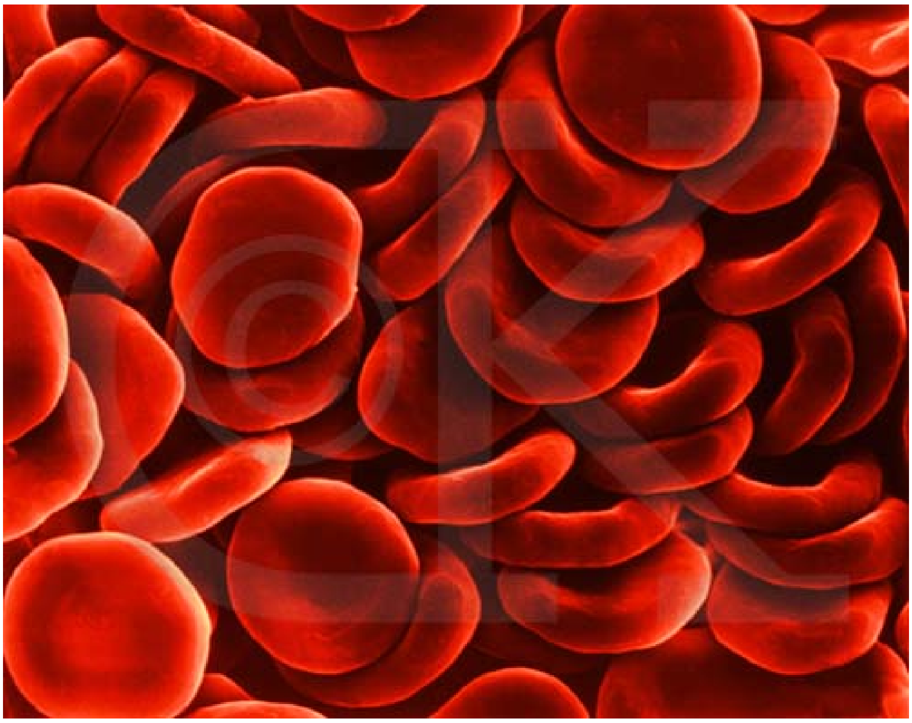
There are two main fluid systems in the body: blood and lymph. The blood and lymph systems are intertwined throughout the body and they are responsible for transporting the agents of the immune system.

The Blood System

The 5 litres of blood of a 70 kg (154 lb) person constitute about 7% of the body's total weight. The blood flows from the heart into arteries, then to capillaries, and returns to the heart through veins.

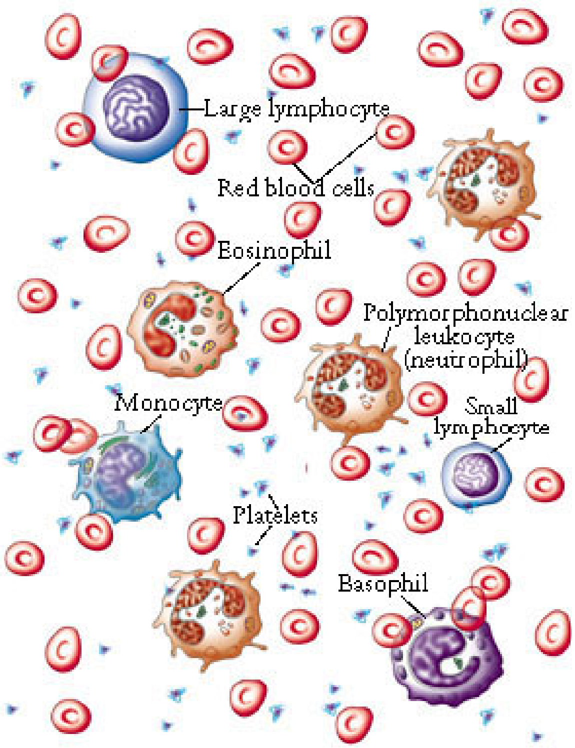
Blood is composed of 52–62% liquid plasma and 38–48% cells. The plasma is mostly water (91.5%) and acts as a solvent for transporting other materials (7% protein [consisting of albumins (54%), globulins (38%), fibrinogen (7%), and assorted other stuff (1%)] and 1.5% other stuff). Blood is slightly alkaline (pH = 7.40 □ .05) and a tad heavier than water (density = 1.057 □ .009).

All blood cells are manufactured by stem cells, which live mainly in the bone marrow, via a process called **hematopoiesis**. The stem cells produce hemocytoblasts that differentiate into the precursors for all the different types of blood cells. Hemocytoblasts mature into three types of blood cells: **erythrocytes** (red blood cells or RBCs), **leukocytes** (white blood cells or WBCs), and **thrombocytes** (platelets).



The leukocytes are further subdivided into **granulocytes** (containing large granules in the cytoplasm) and **agranulocytes** (without granules). The granulocytes consist of neutrophils (55–70%), eosinophils (1–3%), and basophils (0.5–1.0%). The agranulocytes are **lymphocytes** (consisting of B cells and T cells) and **monocytes**. Lymphocytes circulate in the blood and lymph systems, and make their home in the lymphoid organs.

All of the major cells in the blood system are illustrated here.



There are 5000–10,000 WBCs per mm^3 and they live 5-9 days. About 2,400,000 RBCs are produced each second and each lives for about 120 days (They migrate to the spleen to die. Once there, that organ scavenges usable proteins from their carcasses). A healthy male has about 5 million RBCs per mm^3, whereas females have a bit fewer than 5 million.

Normal Adult Blood Cell Counts			
Red Blood Cells		$5.0*10^6/mm^3$	
Platelets		$2.5*10^5/mm^3$	
Leukocytes		$7.3*10^3/mm^3$	
	Neutrophil		50-70%
	Lymphocyte		20-40%
	Monocyte		1-6%
	Eosinophil		1-3%
	Basophil		<1%

The goo on RBCs is responsible for the usual ABO blood grouping, among other things. The grouping is characterized by the presence or absence of A and/or B antigens on the surface of the RBCs. Blood type AB means both antigens are present and type O means both antigens are absent. Type A blood has A antigens and type B blood has B antigens.

Some of the blood, but not red blood cells (RBCs), is pushed through the capillaries into the interstitial fluid.

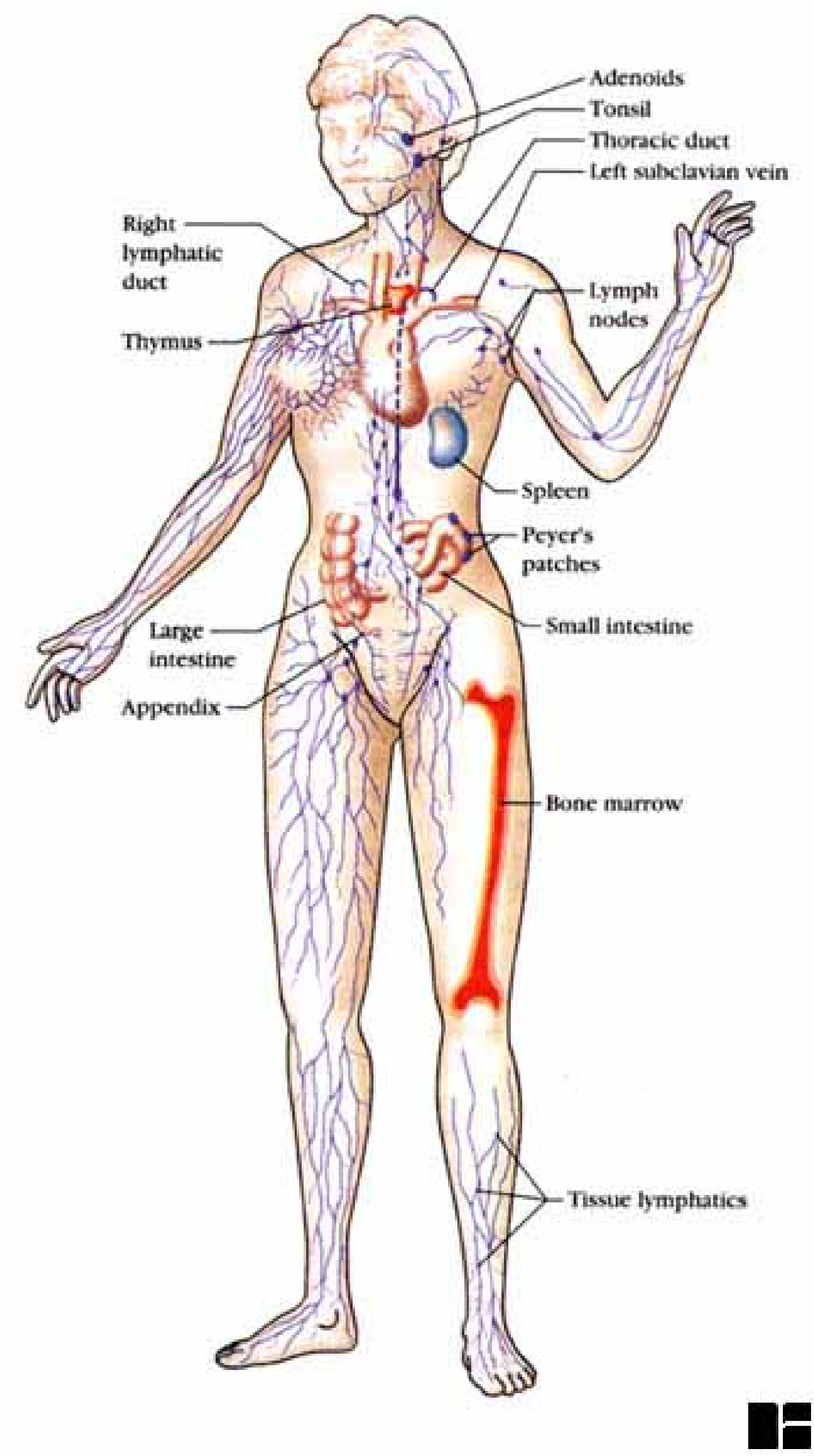
The Lymph System

Lymph is an alkaline (pH > 7.0) fluid that is usually clear, transparent, and colourless. It flows in the lymphatic vessels and bathes tissues and organs in its protective covering. There are no RBCs in lymph and it has a lower protein content than blood. Like blood, it is slightly heavier than water (density = 1.019 $\pm$ .003).

The lymph flows from the interstitial fluid through lymphatic vessels up to either the thoracic duct or right lymph duct, which terminate in the subclavian veins, where lymph is mixed into the blood. (The right lymph duct drains the right sides of the thorax, neck, and head, whereas the thoracic duct drains the rest of the body.) Lymph carries lipids and lipid-soluble vitamins absorbed from the gastrointestinal (GI) tract. Since there is no active pump in the lymph system, there is no back-pressure produced. The lymphatic vessels, like veins, have one-way valves that prevent backflow. Additionally, along these vessels there are small bean-shaped **lymph nodes** that serve as filters of the lymphatic fluid. It is in the lymph nodes where antigen is usually presented to the immune system.

The human **lymphoid system** has the following:

- **Primary organs**: bone marrow (in the hollow centre of bones) and the thymus gland (located behind the breastbone above the heart), and
- **Secondary organs** at or near possible portals of entry for pathogens: adenoids, tonsils, spleen (located at the upper left of the abdomen), lymph nodes (along the lymphatic vessels with concentrations in the neck, armpits, abdomen, and groin), Peyer's patches (within the intestines), and the appendix.



Innate Immunity

The innate immunity system is what we are born with and it is nonspecific; all antigens are attacked pretty much equally. It is genetically based and we pass it on to our offspring.

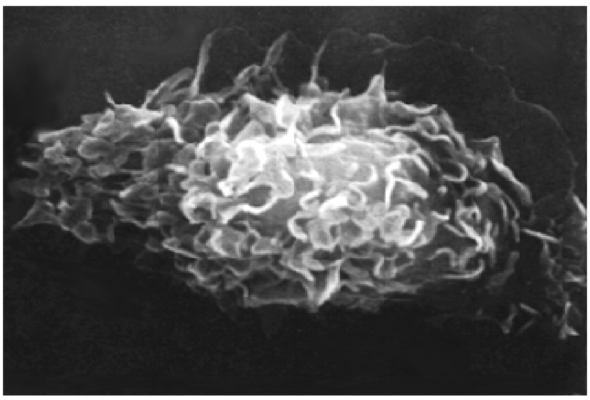
Surface Barriers or Mucosal Immunity

Normal flora are the microbes, mostly bacteria, that live in and on the body with, usually, no harmful effects to us. We have about 10^{13} cells in our bodies and 10^{14} bacteria, most of which live in the large intestine. There are 10^3–10^4 microbes per cm^2 on the skin (*Staphylococcus aureus*, *Staph. epidermidis*, diphtheroids, streptococci, *Candida*, etc.). Various bacteria live in the nose and mouth. Lactobacilli live in the stomach and small intestine. The upper intestine has about 10^4 bacteria per gram; the large bowel has 10^{11} per gram, of which 95–99% are anaerobes (An **anaerobe** is a microorganism that can live without oxygen, while an **aerobe** requires oxygen.) or bacteroides. The urogenitary tract is lightly colonized by various bacteria and diphtheroids. After puberty, the vagina is colonized by *Lactobacillus aerophilus* that ferment glycogen to maintain an acid pH.

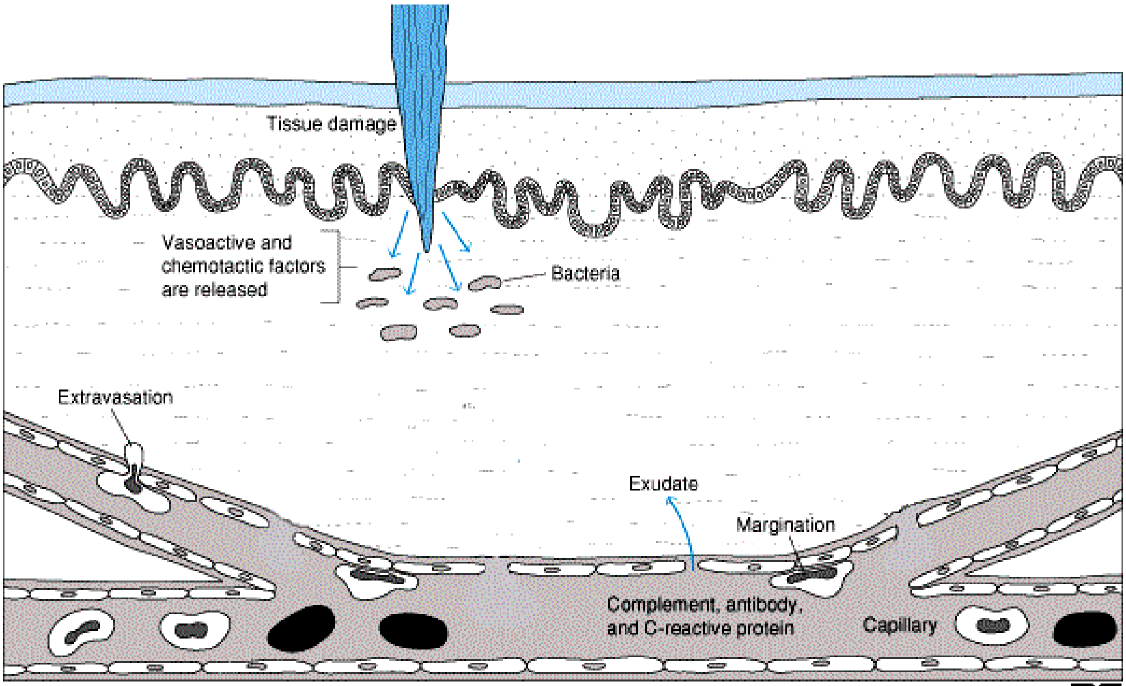
Normal flora fill almost all of the available ecological niches in the body and produce bacteriocidins, defensins, cationic proteins, and lactoferrin all of which work to destroy other bacteria that compete for their niche in the body.

The resident bacteria can become problematic when they invade spaces in which they were not meant to be. As examples: (a) staphylococcus living on the skin can gain entry to the body through small cuts/nicks. (b) Some antibiotics, in particular clindamycin, kill some of the bacteria in our intestinal tract. This causes an overgrowth of *Clostridium difficile*, which results in pseudomembranous colitis, a rather painful condition wherein the inner lining of the intestine cracks and bleeds.

A **phagocyte** is a cell that attracts (by chemotaxis), adheres to, engulfs, and ingests foreign bodies. *Promonocytes* are made in the bone marrow, after which they are released into the blood and called circulating *monocytes*, which eventually mature into **macrophages** (meaning "big eaters", see below).



Some macrophages are concentrated in the lungs, liver (Kupffer cells), lining of the lymph nodes and spleen, brain microglia, kidney mesoangial cells, synovial A cells, and osteoclasts. They are long-lived, depend on mitochondria for energy, and are best at attacking dead cells and pathogens capable of living within cells. Once a macrophage phagocytizes a cell, it places some of its proteins, called epitopes, on its surface—much like a fighter plane displaying its hits. These surface markers serve as an alarm to other immune cells that then infer the form of the invader. All cells that do this are called **antigen presenting cells** (APCs).



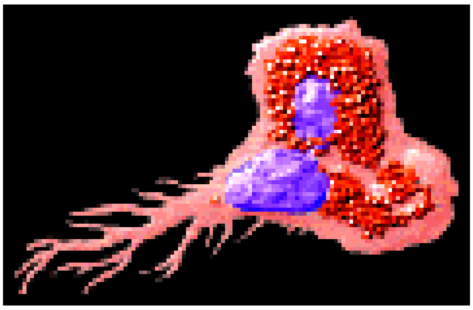
The non-fixed or *wandering macrophages* roam the blood vessels and can even leave them to go to an infection site where they destroy dead tissue and pathogens. Emigration by squeezing through the capillary walls to the tissue is called **diapedesis** or **extravasation**. The presence of histamines at the infection site attract the cells to their source.

Natural killer cells move in the blood and lymph to lyse (cause to burst) cancer cells and virus-infected body cells. They are large granular lymphocytes that attach to the glycoproteins on the surfaces of infected cells and kill them.

Polymorphonuclear **neutrophils**, also called **polys** for short, are phagocytes that have no mitochondria and get their energy from stored glycogen. They are nondividing, short-lived (half-life of 6–8 hours, 1–4 day lifespan), and have a segmented nucleus. [The picture below shows the neutrophil phagocytizing bacteria, in yellow.] They constitute 50–75% of all leukocytes. The neutrophils provide the major defence against pyogenic (pus-forming) bacteria and are the first on the scene to fight infection. They are followed by the wandering macrophages about three to four hours later.

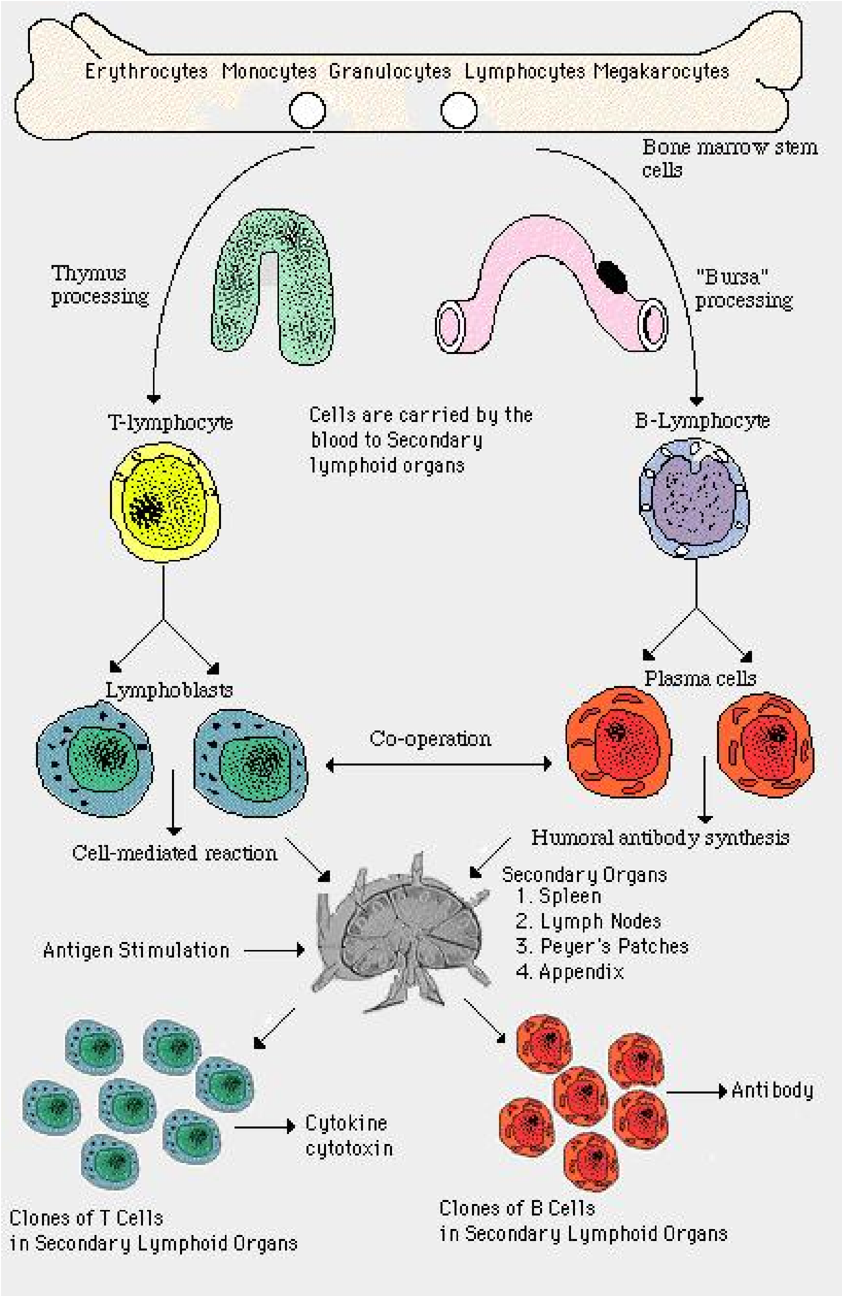
The **complement system** is a major triggered enzyme plasma system. It coats microbes with molecules that make them more susceptible to engulfment by phagocytes. Vascular permeability mediators increase the permeability of the capillaries to allow more plasma and complement fluid to flow to the site of infection. They also encourage polys to adhere to the walls of capillaries (**margination**) from which they can squeeze through in a matter of minutes to arrive at a damaged area. Once phagocytes do their job, they die and their "corpses," pockets of damaged tissue, and fluid form pus.

Eosinophils are attracted to cells coated with complement C3B, where they release major basic protein (MBP), cationic protein, perforins, and oxygen metabolites, all of which work together to burn holes in cells and helminths (worms). About 13% of the WBCs are eosinophils. Their lifespan is about 8–12 days. Neutrophils, eosinophils, and macrophages are all phagocytes.



Dendritic cells are covered with a maze of membranous processes that look like nerve cell dendrites. Most of them are highly efficient antigen presenting cells. There are four basic types: Langerhans cells, interstitial dendritic cells, interdigitating dendritic cells, and circulating dendritic cells. Our major concern will be **Langerhans cells**, which are found in the epidermis and mucous membranes, especially in the anal, vaginal, and oral cavities. These cells make a point of attracting antigen and efficiently presenting it to T helper cells for their activation. [This accounts, in part, for the transmission of HIV via sexual contact.]

Feeling Healing with Divine Love is the key!



Each of the cells in the innate immune system bind to antigen using **pattern-recognition receptors**. These receptors are encoded in the germ line of each person. This immunity is passed from generation to generation. Over the course of human development these receptors for pathogen-associated molecular patterns have evolved via natural selection to be specific to certain characteristics of broad classes of infectious organisms. There are several hundred of these receptors and they recognize patterns of bacterial lipopolysaccharide, peptidoglycan, bacterial DNA, dsRNA, and other substances. Clearly, they are set to target both Gram-negative and Gram-positive bacteria.

Adaptive or Acquired Immunity

Lymphocytes come in two major types: B cells and T cells. The peripheral blood contains 20%–50% of circulating lymphocytes; the rest move in the lymph system. Roughly 80% of them are T cells, 15% B cells and remainder are null or undifferentiated cells. Lymphocytes constitute 20%–40% of the body's WBCs. Their total mass is about the same as that of the brain or liver. (Heavy stuff!)

B cells are produced in the **stem cells** of the bone marrow; they produce antibody and oversee humoral immunity. **T cells** are nonantibody-producing lymphocytes which are also produced in the bone marrow but sensitized in the **thymus** and constitute the basis of cell-mediated immunity. The production of these cells is diagrammed below.

Parts of the immune system are changeable and can adapt to better attack the invading antigen. There are two fundamental adaptive mechanisms: cell-mediated immunity and humoral immunity.

Cell-mediated immunity

Macrophages engulf antigens, process them internally, then display parts of them on their surface together with some of their own proteins. This sensitizes the T cells to recognize these antigens. All cells are coated with various substances. CD stands for **cluster of differentiation** and there are more than one hundred and sixty clusters, each of which is a different chemical molecule that coats the surface. CD8+ is read "CD8 positive". Every T and B cell has about 10^5 = 100,000 molecules on its surface. B cells are coated with CD21, CD35, CD40, and CD45 in addition to other non-CD molecules. T cells have CD2, CD3, CD4, CD28, CD45R, and other non-CD molecules on their surfaces.

The large number of molecules on the surfaces of lymphocytes allows huge variability in the forms of the receptors. They are produced with random configurations on their surfaces. There are some 10^{18} different structurally different receptors. Essentially, an antigen may find a near-perfect fit with a very small number of lymphocytes, perhaps as few as one.

T cells are primed in the thymus, where they undergo two selection processes. The first *positive* selection process weeds out only those T cells with the correct set of receptors that can recognize the MHC molecules responsible for self-recognition. Then a *negative* selection process begins whereby T cells that can recognize MHC molecules complexed with foreign peptides are allowed to pass out of the thymus.

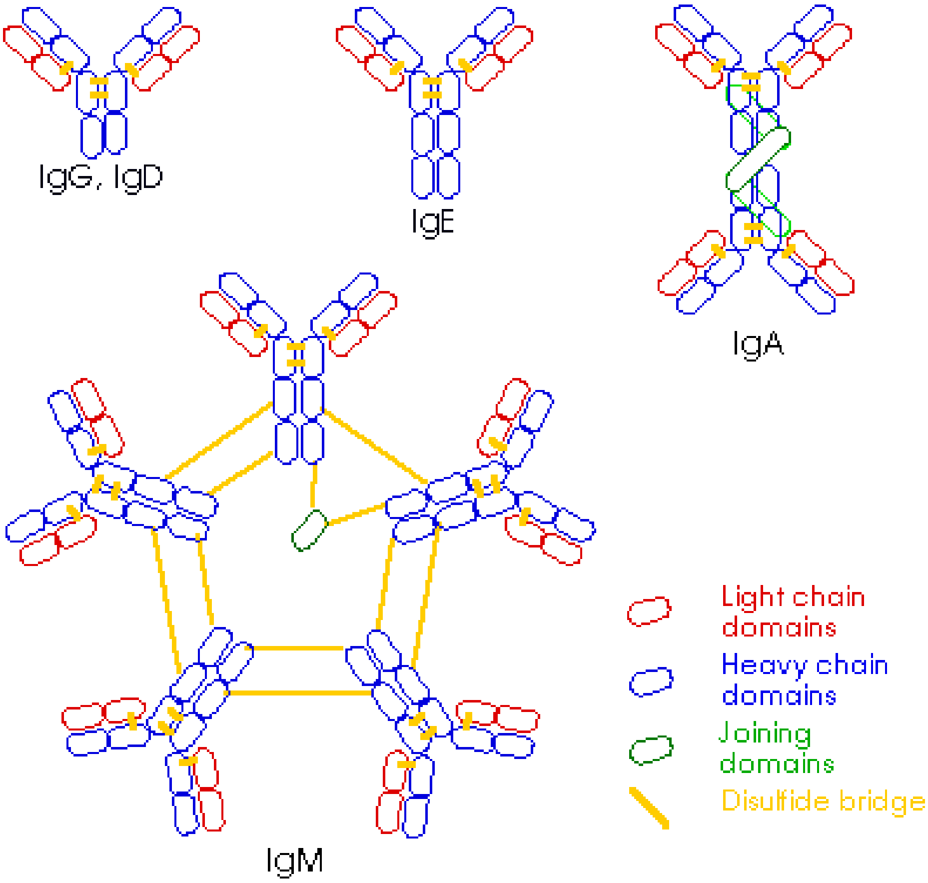
Cytotoxic or **killer T cells** (CD8+) do their work by releasing **lymphotoxins**, which cause cell lysis. **Helper T cells** (CD4+) serve as managers, directing the immune response. They secrete chemicals called **lymphokines** that stimulate cytotoxic T cells and B cells to grow and divide, attract neutrophils, and enhance the ability of macrophages to engulf and destroy microbes. **Suppressor T cells** inhibit the production of cytotoxic T cells once they are unneeded, lest they cause more damage than necessary. **Memory T cells** are programmed to recognize and respond to a pathogen once it has invaded and been repelled.

Humoral immunity

An immunocompetent but as yet immature B-lymphocyte is stimulated to maturity when an antigen binds to its surface receptors and there is a T helper cell nearby (to release a cytokine). This **sensitizes** or **primes** the B cell and it undergoes **clonal selection**, which means it reproduces asexually by mitosis. Most of the family of clones become plasma cells. These cells, after an initial lag, produce highly specific antibodies at a rate of as many as 2000 molecules per second for four to five days. The other B cells become long-lived **memory cells**.

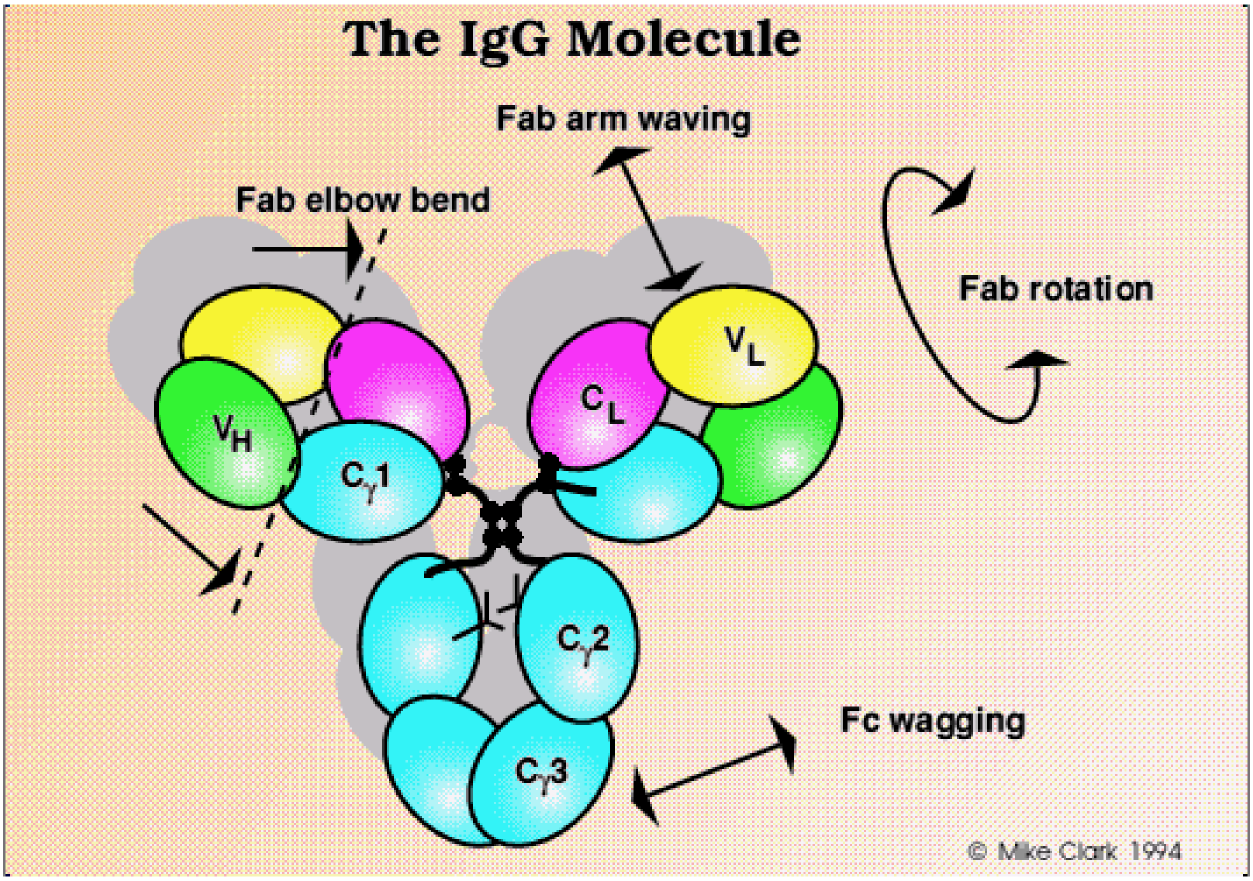
Antibodies, also called **immunoglobulins** or Igs [with molecular weights of 150–900 Md], constitute the *gamma globulin* part of the blood proteins. They are soluble proteins secreted by the plasma offspring (clones) of primed B cells. The antibodies inactivate antigens by, (a) **complement fixation** (proteins attach to antigen surface and cause holes to form, i.e., cell lysis), (b) **neutralization** (binding to specific sites to prevent attachment—this is the same as taking their parking space), (c) **agglutination** (clumping), (d) **precipitation** (forcing insolubility and settling out of solution), and other more arcane methods.

Constituents of gamma globulin are: IgG-76%, IgA-15%, IgM-8%, IgD-1%, and IgE-0.002% (responsible for autoimmune responses, such as allergies and diseases like arthritis, multiple sclerosis, and systemic lupus erythematosus). IgG is the only antibody that can cross the placental barrier to the foetus and it is responsible for the 3 to 6 month immune protection of newborns that is conferred by the mother.



IgM is the dominant antibody produced in primary immune responses, while IgG dominates in secondary immune responses. IgM is physically much larger than the other immunoglobulins.

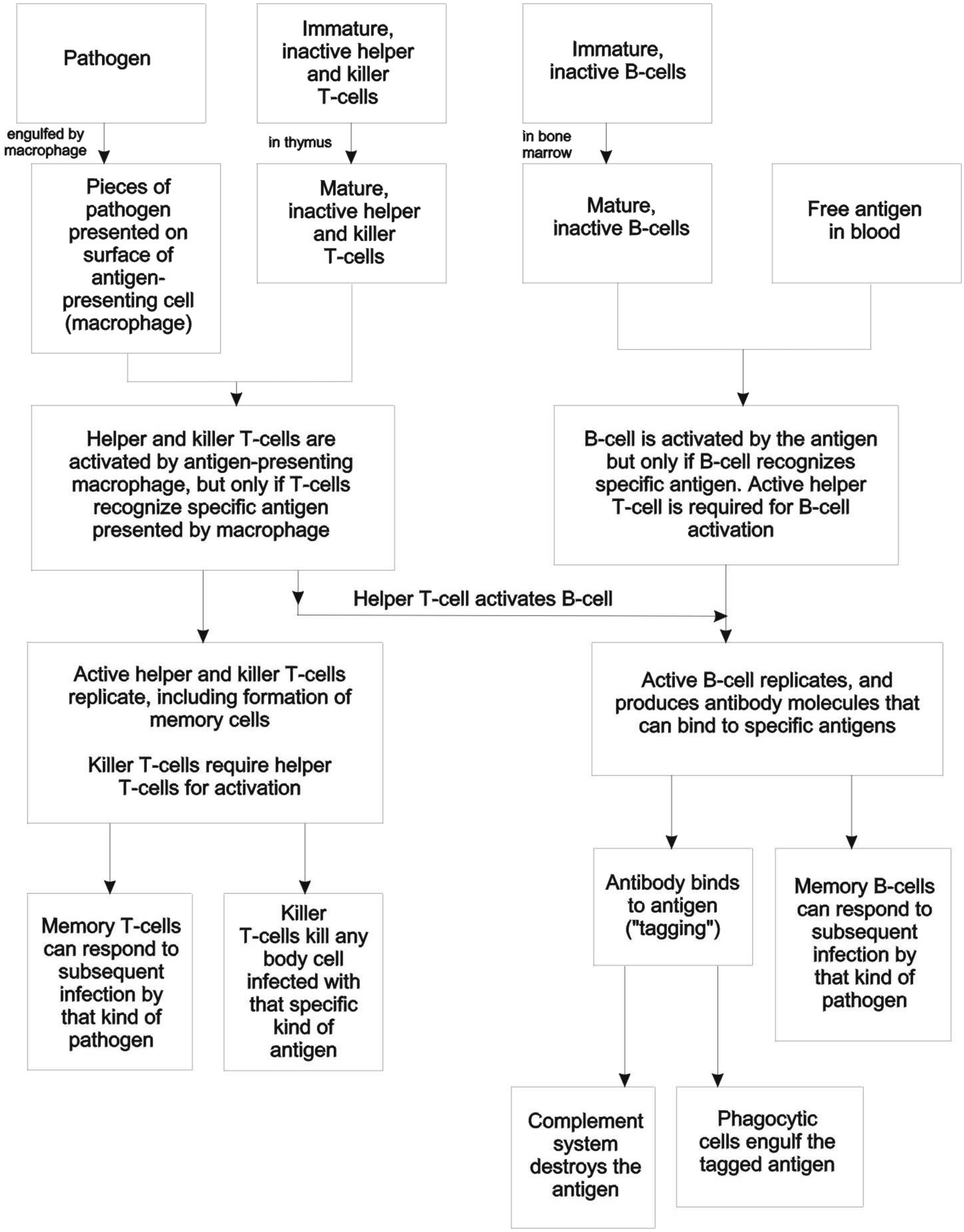
Immortality with the Love.



Notice the many degrees of flexibility of the antibody molecule. This freedom of movement allows it to more easily conform to the nooks and crannies on an antigen. The upper part or Fab (**a**ntigen **b**inding) portion of the antibody molecule (physically and not necessarily chemically) attaches to specific proteins [called epitopes] on the antigen. Thus antibody recognizes the epitope and not the entire antigen. The Fc region is crystallizable and is responsible for effector functions, i.e., the end to which immune cells can attach.

Lest you think that these are the only forms of antibody produced, you should realize that the B cells can produce as many as 10^{14} conformationally different forms.

The process by which T cells and B cells interact with antigens is summarized in the diagram below.


Pathogen
engulfed by macrophage
Pieces of pathogen presented on surface of antigen-presenting cell (macrophage)
Immature, inactive helper and killer T-cells
in thymus
Mature, inactive helper and killer T-cells
Immature, inactive B-cells
in bone marrow
Mature, inactive B-cells
Free antigen in blood
Helper and killer T-cells are activated by antigen-presenting macrophage, but only if T-cells recognize specific antigen presented by macrophage
B-cell is activated by the antigen but only if B-cell recognizes specific antigen. Active helper T-cell is required for B-cell activation
Helper T-cell activates B-cell
Active helper and killer T-cells replicate, including formation of memory cells
Killer T-cells require helper T-cells for activation
Active B-cell replicates, and produces antibody molecules that can bind to specific antigens
Memory T-cells can respond to subsequent infection by that kind of pathogen
Killer T-cells kill any body cell infected with that specific kind of antigen
Antibody binds to antigen ("tagging")
Memory B-cells can respond to subsequent infection by that kind of pathogen
Complement system destroys the antigen
Phagocytic cells engulf the tagged antigen

In the ABO blood typing system, when an A antigen is present (in a person of blood type A), the body produces an anti-B antibody, and similarly for a B antigen. The blood of someone of type AB, has both antigens, hence has *neither* antibody. Thus that person can be transfused with any type of blood, since there is no antibody to attack foreign blood antigens. A person of blood type O has neither antigen but both antibodies and cannot receive AB, A, or B type blood, but they can donate blood for use by anybody. If someone with blood type A received blood of type B, the body's anti-B antibodies would attack the new blood cells and death would be imminent.

All of these of these mechanisms hinge on the attachment of antigen and cell receptors. Since there are many, many receptor shapes available, WBCs seek to optimize the degree of confluence between the two receptors. The number of these "best fit" receptors may be quite small, even as few as a single cell. This attests to the **specificity** of the interaction. Nevertheless, cells can bind to receptors whose fit is less than optimal when required. This is referred to as **cross-reactivity**. Cross-reactivity has its limits. There are many receptors to which virions cannot possibly bind. Very few viruses can bind to skin cells.

The design of immunizing vaccines hinges on the specificity and cross-reactivity of these bonds. The more specific the bond, the more effective and long-lived the vaccine. The smallpox vaccine, which is made from the vaccinia virus that causes cowpox, is a very good match for the smallpox receptors. Hence, that vaccine is 100% effective and provides immunity for about 20 years. Vaccines for cholera have a relatively poor fit so they do not protect against all forms of the disease and protect for less than a year.

The goal of all vaccines is promote a primary immune reaction so that when the organism is again exposed to the antigen, a much stronger secondary immune response will be elicited. Any subsequent immune response to an antigen is called a **secondary response** and it has:

Summary

Immunity can be either **natural** or **artificial**, **innate** or **acquired=adaptive**, and either **active** or **passive**.

Objectives

Know: antigen, overall properties of the immune system, allergen; major fluid systems of the body; hematopoiesis occurs in stem cells of the bone; erythrocytes, leukocytes, and thrombocytes; types of white blood cells; lymphoid system and lymph nodes; mucosal immunity and types of surface barriers to infection; normal flora; phagocytes, macrophages, antigen presenting cells, neutrophils, B cells and T cells are produced in the bone marrow and T cells are primed in the thymus, CD4+ and CD8+ cells, helper cells, memory cells, cytotoxic cells, suppressor cells; priming and clonal selection; antibody and Igs; differences between identifying self and non-self, innate and acquired immunity, primary and secondary immunity, active and passive immunity; specificity and cross-reactivity.

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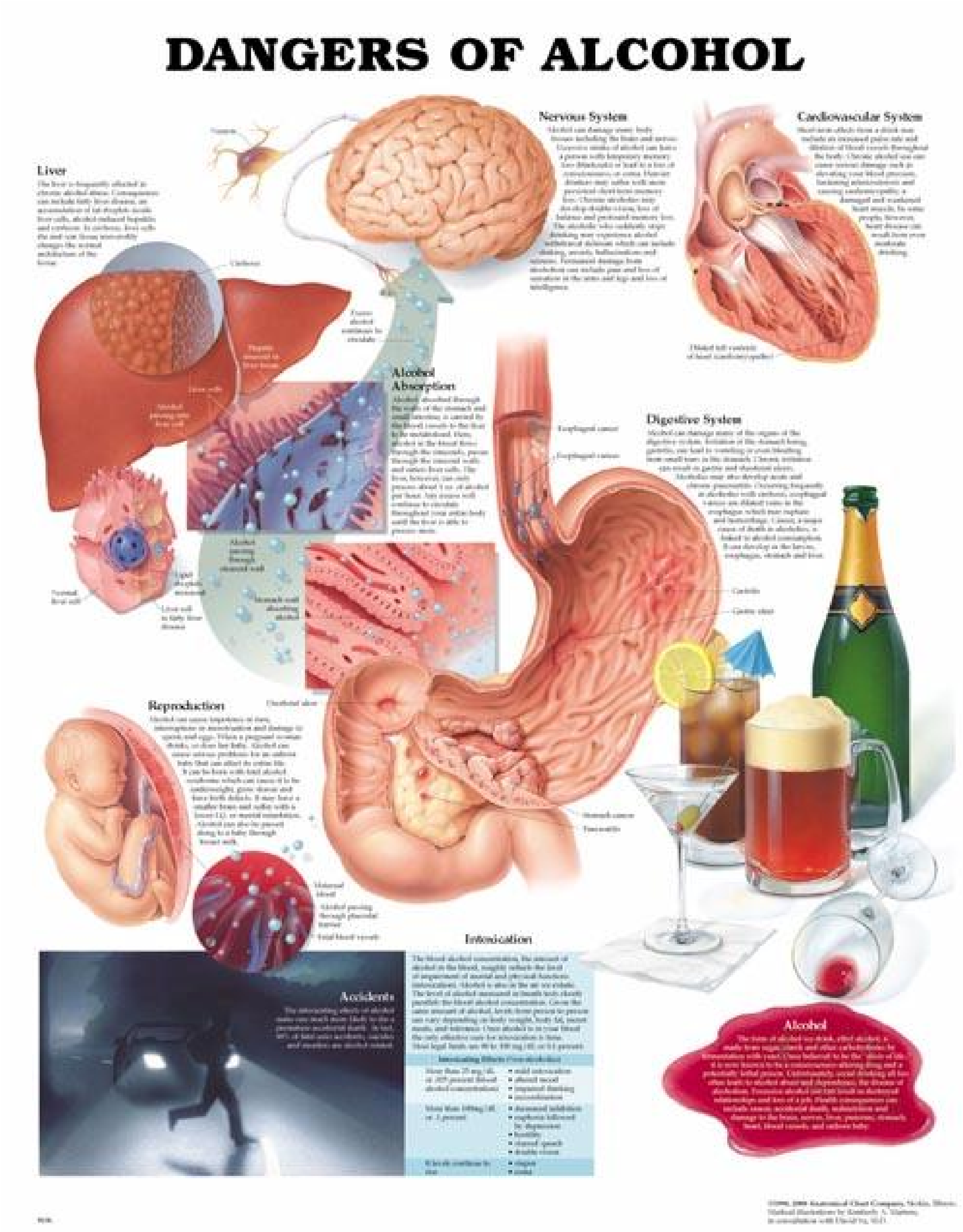

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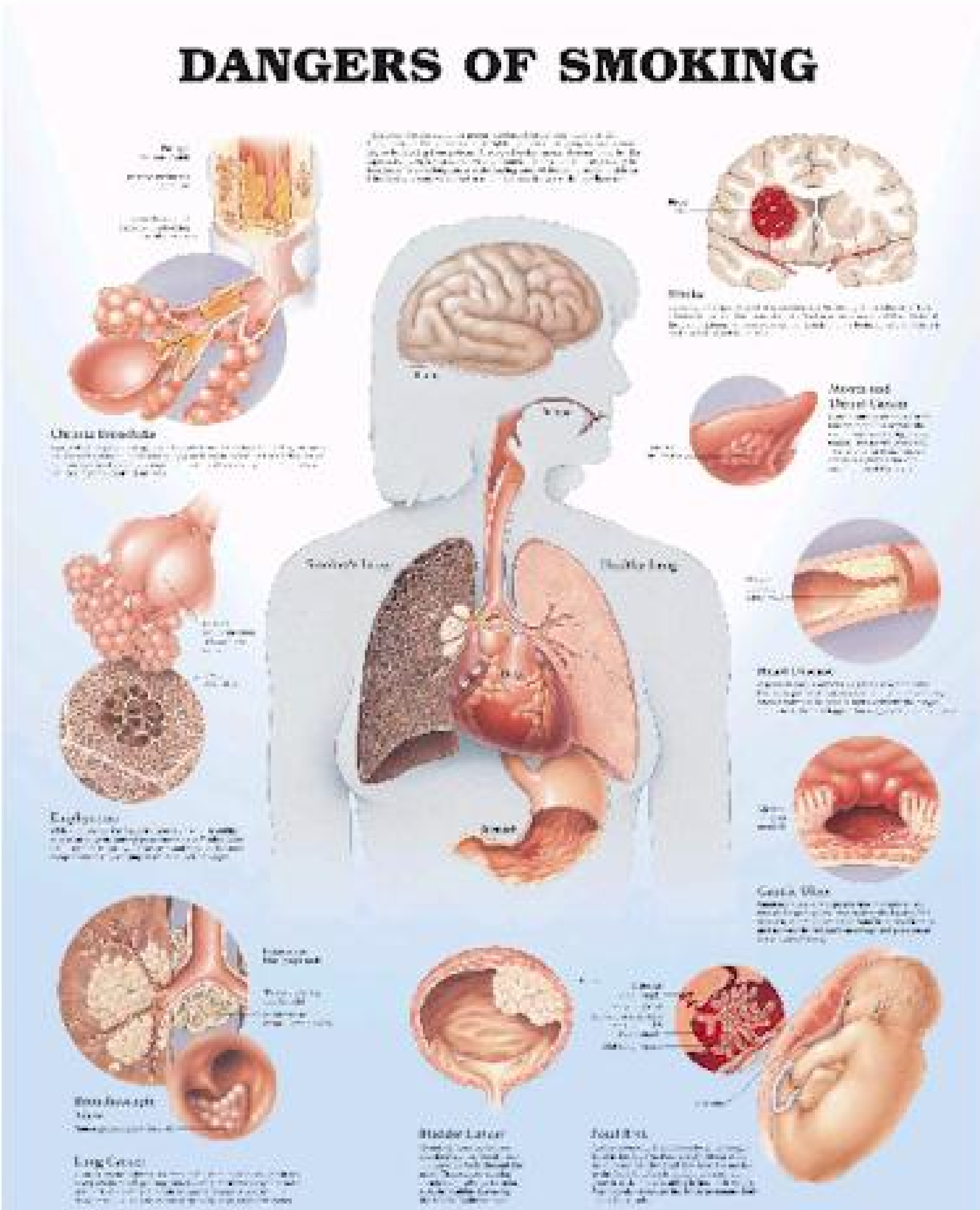
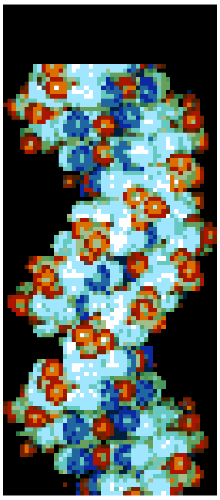
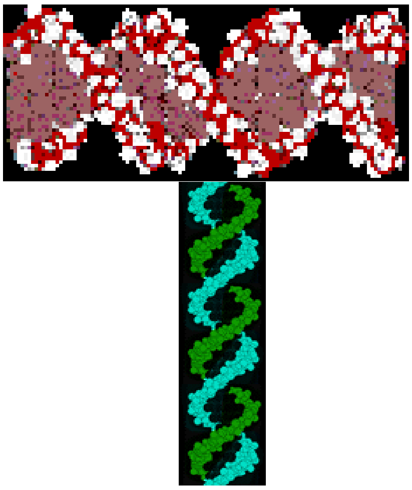
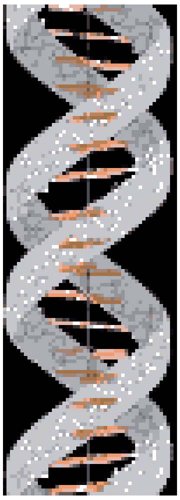


<u>DNA is Information</u>?

DNA is actually an endless march of characters in a 4-letter alphabet, but you don't see that until you open up the helix and look inside....







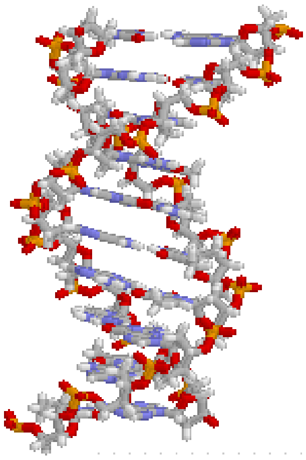
Reading DNA

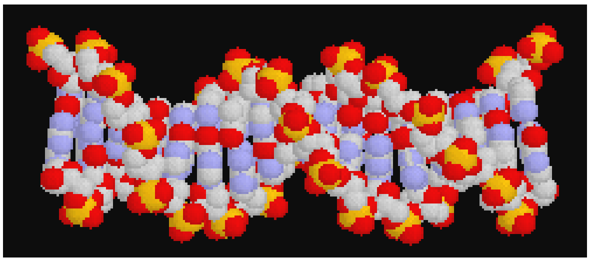
When you write a letter, you put together words using different letters of the alphabet. With twenty-six letters you can say anything you want. It is important that the letters go in the right order. This sentence stops making sense whenthaliekrnviserhflker are in the wrong order.

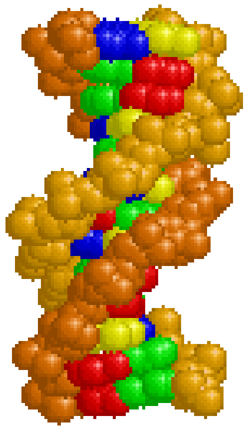
When you make new cells, your body is putting together different letters of the DNA alphabet. Even with just four letters, the DNA alphabet spells out all of the information you need to create new cells and to stay healthy. The order of the DNA bases is called the sequence. Just like the order of the letters in a sentence, the sequence of the bases in DNA can spell all the instructions for your body -- even with only four letters.

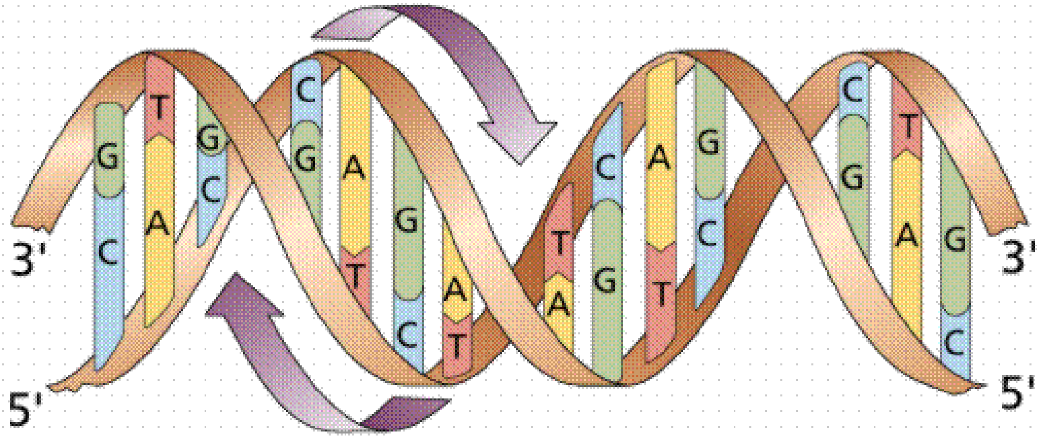
Sequences Matter

Right now, scientists are trying to sequence every base in a human cell. They're trying to create a complete map of the human genome. With this information they hope to cure disease.





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