CORAL CAY CONSERVATION & JFA EDUCATIONAL AIDS

UPPER PRIMARY SCHOOL WORKBOOK

WORKING SCIENTIFICALLY
AND
LIVING THINGS

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Contents

WORKING SCIENTIFICALLY

Working scientifically involves following certain scientific methods, but also requires imagination, and creativity.

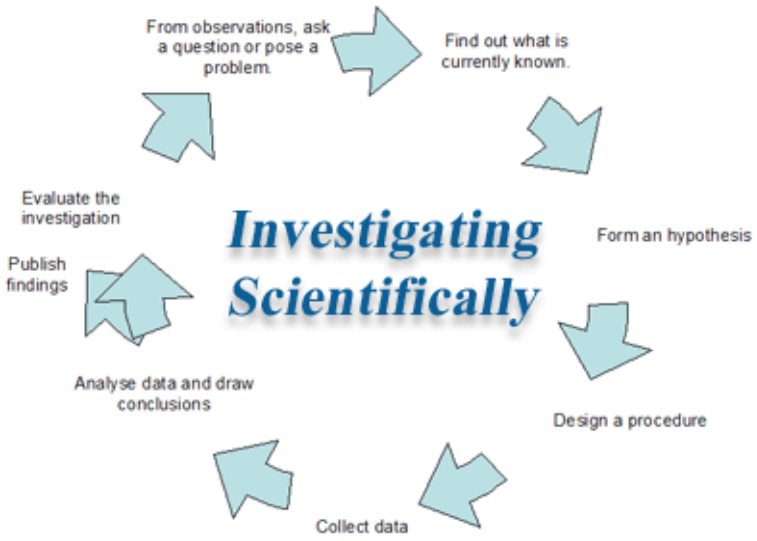
Working scientifically is used to investigate new ideas, or acquiring new knowledge or correcting and integrating previous knowledge. To be termed scientific, a method of inquiry must be based on gathering observable and measurable evidence subject to specific principles of reasoning. A scientific method consists of the collection of data through observation and experimentation, and the formulation and testing of hypotheses.

What is a hypothesis?

A hypothesis is a tentative explanation for an observation, phenomenon, or scientific problem that can be tested by further investigation. Any investigation is motivated by a question.

Although procedures vary from one field of inquiry to another, there are features which distinguish scientific inquiry from other methodologies of knowledge. Scientific researchers propose hypotheses as explanations of phenomena, and design experimental studies to test these hypotheses. These steps must be repeatable in order to dependably predict any future results. For example the following steps can be used:

- Define the question
- Gather information and resources (observe)
- Form a hypothesis
- Perform an experiment and collect data
- Analyse the data
- Interpret data and draw conclusion that serve as a starting point for a new hypothesis
- Retest (sometimes done by other scientists)



To break this down further we can look at the Five Steps of Investigation:

The Five Steps of Investigation

First

Write a short statement that makes clear what the problem is that you have to solve. Also write a research question or hypothesis, and then a prediction. Give a reason for your prediction.

Second

Write a plan which says what you intend doing. Say what you will do to make any tests fair. Explain what measurements are to be made and how they will be made. Draw a diagram to show how the equipment will be used to conduct your tests.

Third

Carry out your investigation and record all your observations and measurements. If you found that you needed to change your plan, write down what changes were made and why they were necessary. Present your data in a way that helps show the patterns or trends in your results.

Fourth

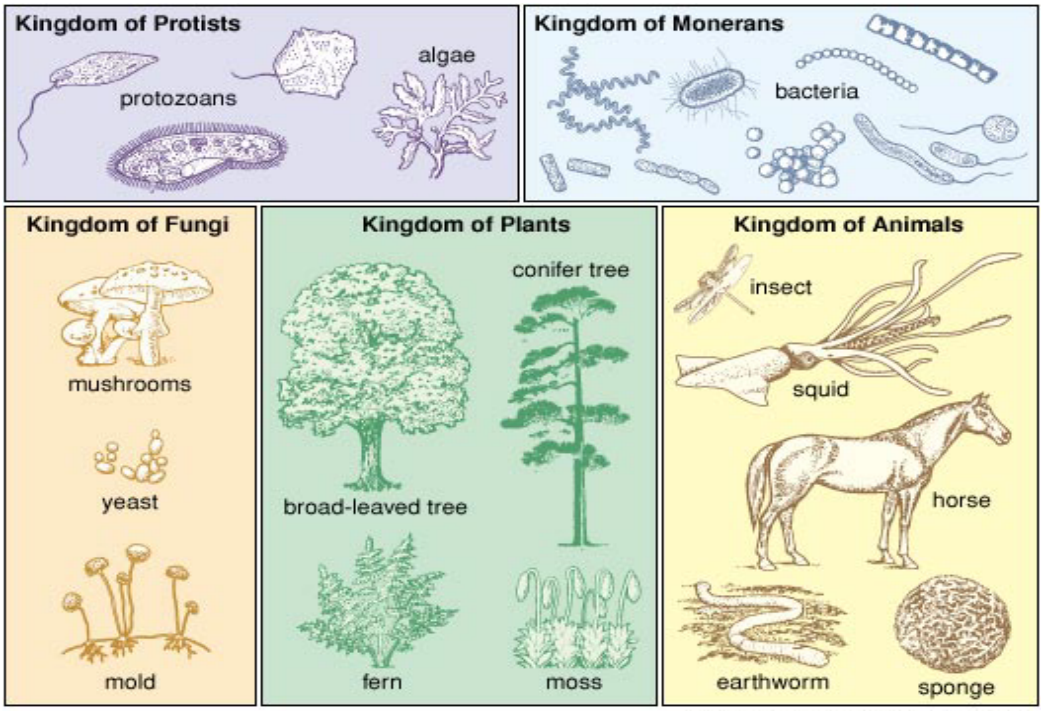
Write a couple of paragraphs in response to these questions: What patterns or trends were present in the results? How do you explain the patterns? What did your results show you about the question or hypothesis that you were investigating?

Fifth

Write a paragraph that evaluates your investigation. Were your findings what you expected? To what extent did you reduce the errors associated with measurements, controlling variables and sampling?

KINGDOMS OF LIVING THINGS

The five-kingdom classification scheme is in general use today.



The kingdom **Monera** includes the bacteria. These one-celled organisms are prokaryotic. Prokaryotic organisms have neither nucleus nor organelles in their cytoplasm.

The second kingdom, **Protista**, includes the protozoa, the one-celled algae. The cells of these organisms are eukaryotic. They are unicellular, and they may be autotrophic or heterotrophic. Eukaryotic organisms have a nucleus and organelles in their cytoplasm, possess multiple chromosomes, and have large ribosomes.

The third kingdom, **Fungi**, includes the yeasts, molds, mushrooms, and other similar organisms. The cells of this kingdom are eukaryotic and heterotrophic. Some fungal species are unicellular, whereas other species form long chains of cells. Food is taken in by the absorption of small molecules from the external environment.

The fourth kingdom is **Plantae**. Classified here are the mosses, ferns, and seed-producing plants. All plant cells are eukaryotic and autotrophic. The organisms synthesize their own foods by photosynthesis. All the organisms are multicellular.

The final kingdom, **Animalia**, includes animals. Animals without backbones (invertebrates) and with backbones (vertebrates) are included here. The cells are eukaryotic; the organisms are heterotrophic. All animals are multicellular, and none have cell walls. In the kingdom Animalia, biologists classify such organisms as sponges, hydras, worms, insects, starfish, reptiles, amphibians, birds, and mammals.

THE CHARACTERISTICS OF LIVING THINGS

There are seven life processes that tell us that things are alive or are living

- **Respiration**
- **Nutrition**
- **Movement**
- **Excretion**
- **Growth**
- **Sensitivity**
- **Reproduction**

Each of these is described below.

Respiration

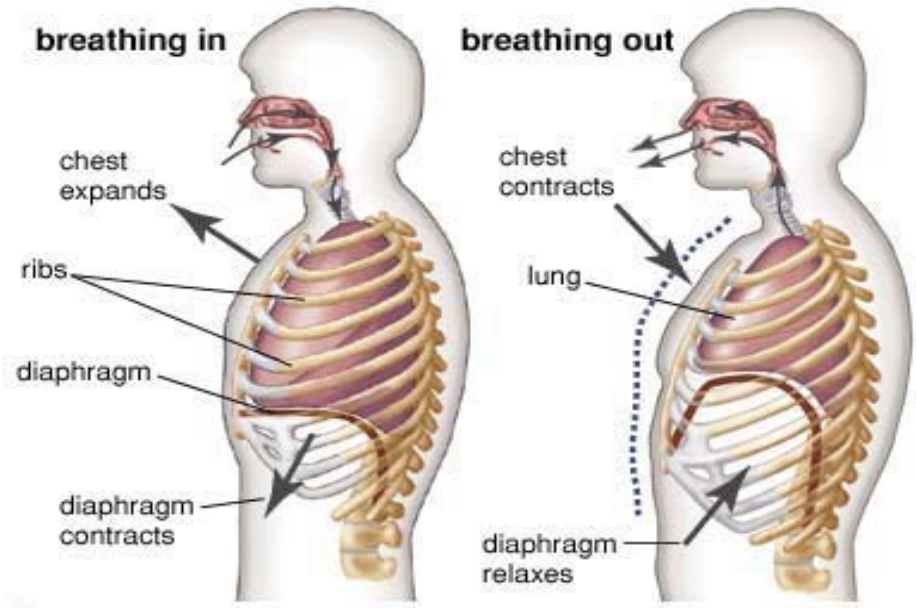
All living things need oxygen to stay alive. They use oxygen to turn food into energy. Respiration is therefore a chemical reaction. It occurs in every cell in your body.

To obtain oxygen from the air, animals and plants exchange gases between themselves and their surroundings. Some obtain oxygen by breathing through lungs. Mammals, such as dogs, cats, and ourselves, obtain oxygen this way. Some animals, such as fish, which live under water, obtain oxygen using gills. Green plants exchange gases with their surroundings through holes in the under-surface of their leaves. These holes are called stomata.

So what is respiration?
During normal human respiration, glucose (a type of sugar that you get from food) reacts with oxygen to produce energy. The energy is needed for growth, repair and movement. Water and carbon dioxide are bi-products of respiration - they need to be excreted.

So why do people get respiration confused with breathing?
Well, respiration usually requires oxygen, and animals get their oxygen by breathing.

All vertebrate animals that live on land have lungs. When we breathe in, the muscle below the rib cage (called the diaphragm) is pulled down, and air gets sucked into the rib cage, filling the lungs. Blood cells circulating through tiny blood vessels near the lungs pick up oxygen and carry it around the body to the sites of respiration. Air is then forced out of the lungs as the diaphragm bows upwards.



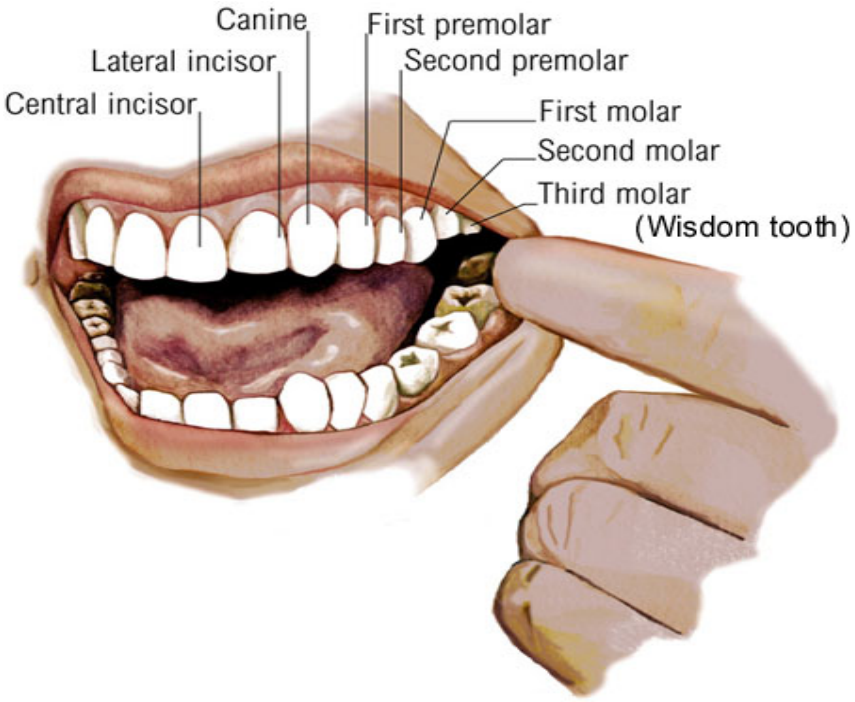
Some animals don't have lungs - fish are the obvious examples. Most fish use gills to breathe. Gills are structures that allow water to pass through very fine channels. Next to these channels are blood vessels, with very thin walls that let the oxygen move from the water into the blood. The oxygen leaves the water, and goes into the blood. From there, it is carried all around the body of the fish.

Nutrition

All living organisms need to take substances from their environment to obtain energy, to grow and to stay healthy.

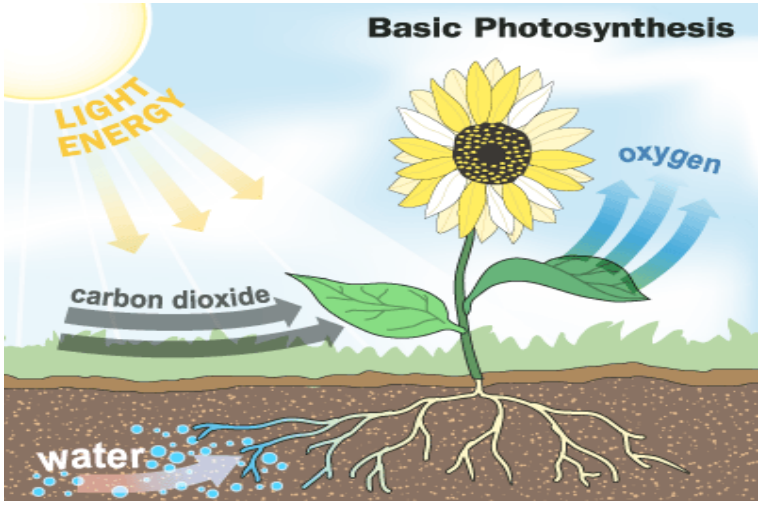
Animals do not make their own food. They feed on other animals and on plants. All animals, including humans, eat to live. They take in food at their mouths, break it down with their teeth, and swallowed down into the stomach. All the nutritious bits of the food are absorbed into the body through the intestine, and the rest comes out the other end!

Chewing is very important - it starts the process that breaks down our food. Most mammals have teeth to chew their food. Their teeth are adapted to their diets, but they usually have some combination of the three types of teeth that are found in human mouths: incisors, canines and molars. The different teeth of humans are shown in the diagram below. How many of each type of teeth do you have?



Humans are omnivores. They eat a bit of everything (meat and plants), and have all three types of teeth to chew their food. But lots of animals are not omnivores. Some animals eat meat and only meat - they are called carnivores. Carnivores have well developed canine teeth - for tearing and slicing meat. Other animals eat only plants - they are called herbivores. Herbivores often have well developed molars or incisors for grinding and cutting plant food.

Most green plants make their own food. They make their food from the simple raw materials carbon dioxide and water. The green colour (chlorophyll) in the leaves together with sunlight allows carbon dioxide and water to be combined to form sugars. This process is called photosynthesis.

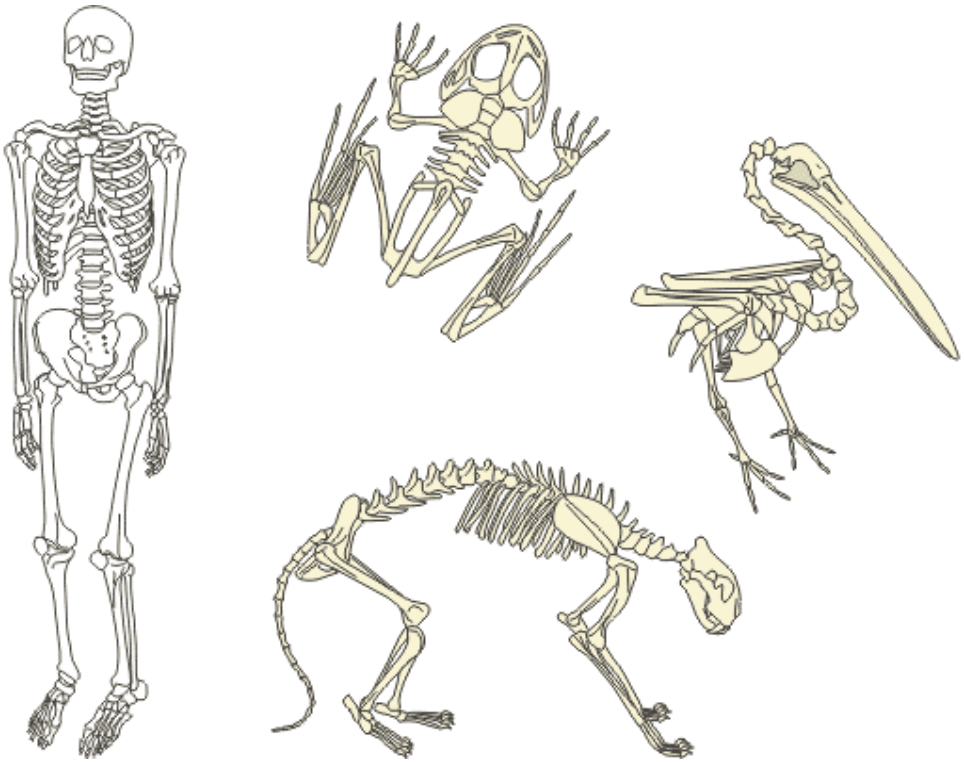


Movement

All living organisms show movement of one kind or another. All living organisms have internal movement, which means that they have the ability of moving substances from one part of their body to another. Some living organisms show external movement as well - they can move from place to place by walking, flying or swimming.

It's a simple fact, most animals move. Humans (like you) can move because your body is supported by an internal skeleton.

Some examples of skeletons are shown below:



So, what does your skeleton do?

The bones in your skeleton act as anchors for all your muscles. Muscles work to pull your bones in different directions. Take the muscles in your arm. Like most muscles they work in pairs - as one expands (gets bigger) the other contracts (gets smaller) allowing you to move your arm around the elbow joint. Your skeleton also provides you with support and protection.

Not all animals walk and run around as humans do - their skeletons have adapted to different forms of movement. Fish swim, their long flexible backs and strong fins allow them to glide through water easily. Frogs hop, their strong back legs and large feet help them jump. Birds fly, their 'arms' have turned into wings.

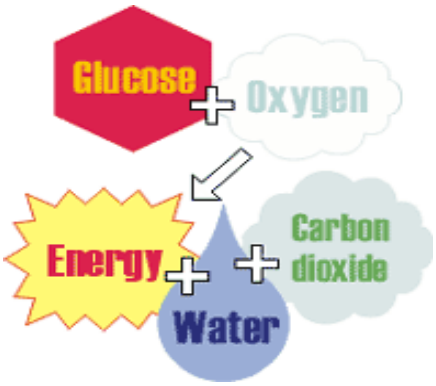
Some animals, like insects and crabs, have a completely different type of skeleton from ours - their skeletons are external (on the outside of their bodies). They are called invertebrates because they do not have a backbone made up of vertebrae. Some other invertebrates, like jellyfish, have no skeleton at all.

Excretion

Excretion is the removal of waste from the body. If this waste was allowed to remain in the body it could be poisonous. Humans produce a liquid waste called urine. We also excrete waste when we breathe out. All living things need to remove waste from their bodies.

Excretion cleans up after respiration. Respiration is a chemical reaction that takes glucose (sugar) and oxygen to produce energy. But it also produces water and carbon dioxide as bi-products.

Excretion gets rid of carbon dioxide, water, and other, possibly harmful, substances from your body.



Your lungs excrete carbon dioxide as you breathe out, your kidneys filter out other poisons to produce urine, removing nitrogen waste from your body, and your skin sheds excess salt through sweat. The main organs which remove nitrogen waste from the body are the kidneys.

Growth

When living things feed they gain energy. Some of this energy is used in growth. Living things become larger and more complicated as they grow.

So how do we grow?

Like other mammals, humans grow at a fairly steady pace until they reach adulthood. Every day as they get older their bodies are changing. Their skeleton grows with them, each bone getting bigger over time.

But this steady, constant growth does not happen in all animals. Arthropods - insects, spiders, crabs and other animals with external skeletons - grow in a very different way. The problem with having a hard outer skeleton means that you will grow out of

it - just like you grow out of clothes. To get any bigger, animals like crabs and spiders have to shed their skeleton and grow a new one!

Growth requires an organism to take in material from the environment and organize the material into its own structures. During growth, a living organism transforms material that is unlike itself into materials that are like it. A person, for example, digests a meal of meat and vegetables and transforms the chemical material into more of himself or herself. A nonliving organism does not display this characteristic

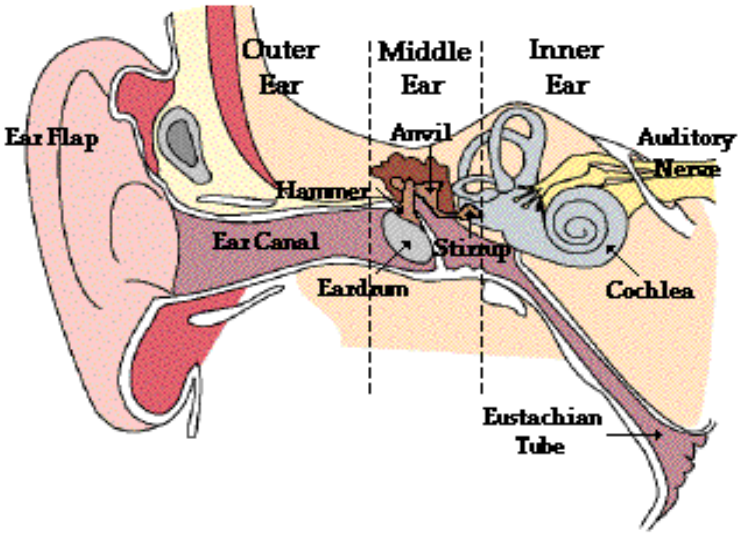
Sensitivity

Living things react to changes around them. We react to touch, light, heat, cold and sound, as do other living things.

Your senses let you know what is going on in the world around you. Humans have five senses: ***hearing, sight, smell, touch and taste***. They are controlled by five sense organs: ***the ears, eyes, nose, skin and tongue***.

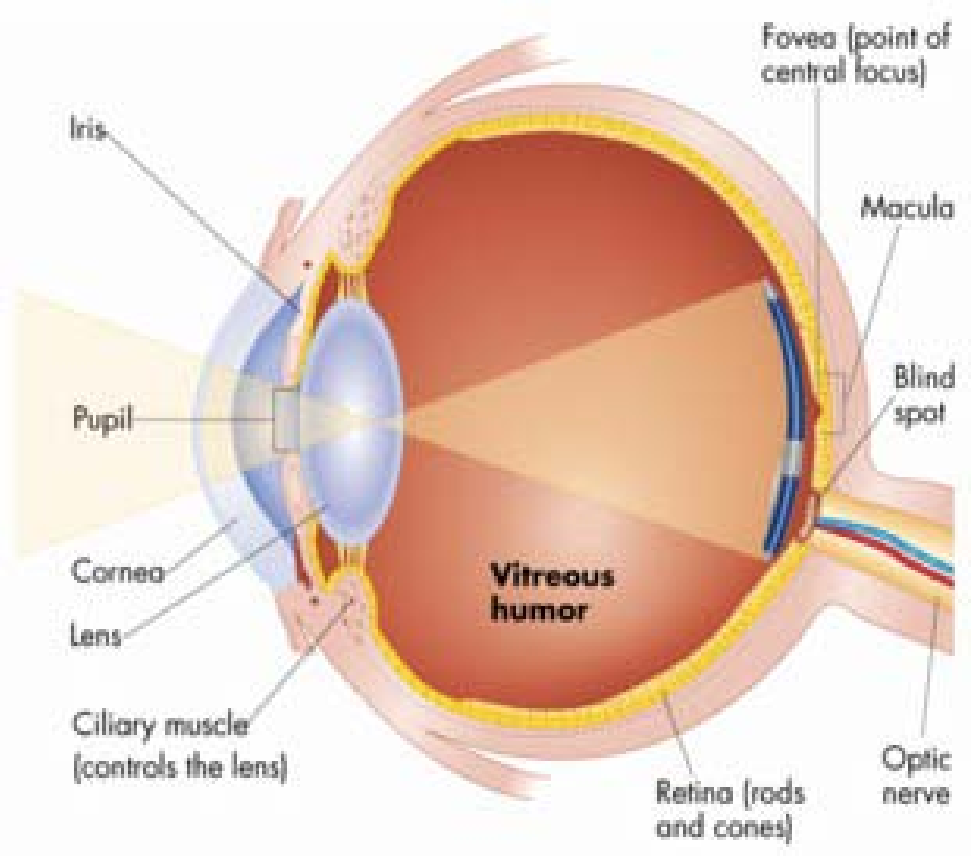
Human senses - hearing

- Ears pick up sounds waves - they convert vibrations in the air to electrical impulses that pass to the brain. The brain processes these impulses and we 'hear' sound.
- The ear contains the smallest bone in human body - the stapes.
- Loudness is measured in decibels, the louder the sound, the more decibels.
- As we get older we lose our ability to hear high pitched (squeaky) sounds.



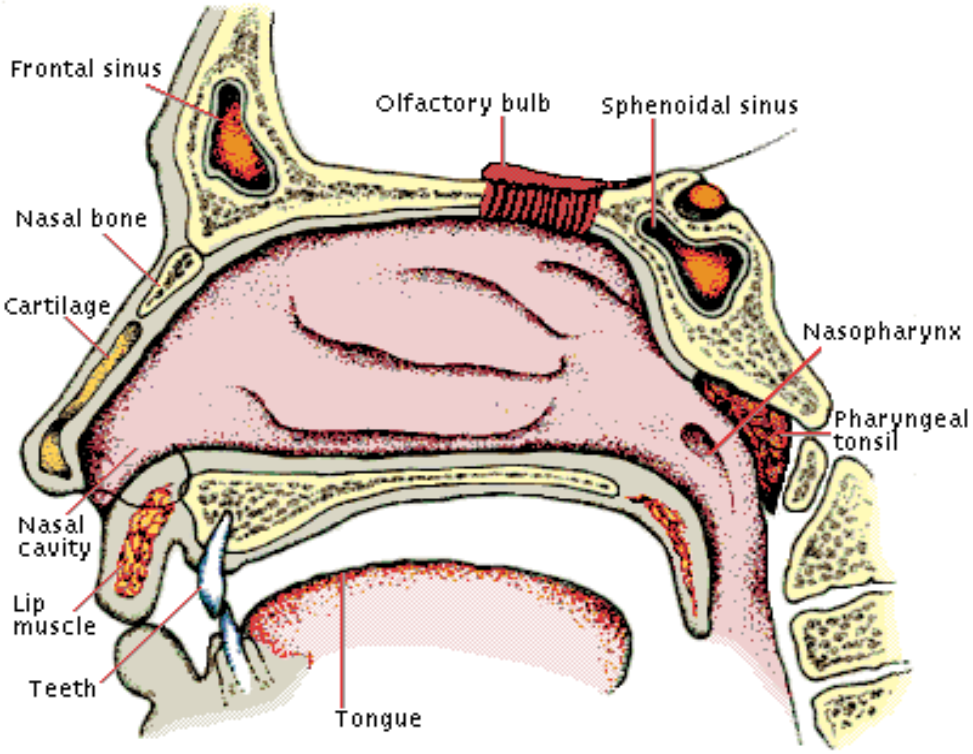
Human senses - sight

- Eyesight is probably our most important sense.
- Eyes pick up light waves - light waves pass through the eyeball, and are focused on the retina at the back of the eye. The retina passes a nerve impulse to the brain. The brain processes these impulses and we 'see' what is in front of us.
- Humans cannot see all types of light. The ultraviolet light that is invisible to us can be seen by bees and other animals.
- The coloured part of the eye is called the iris - what colour are your eyes?



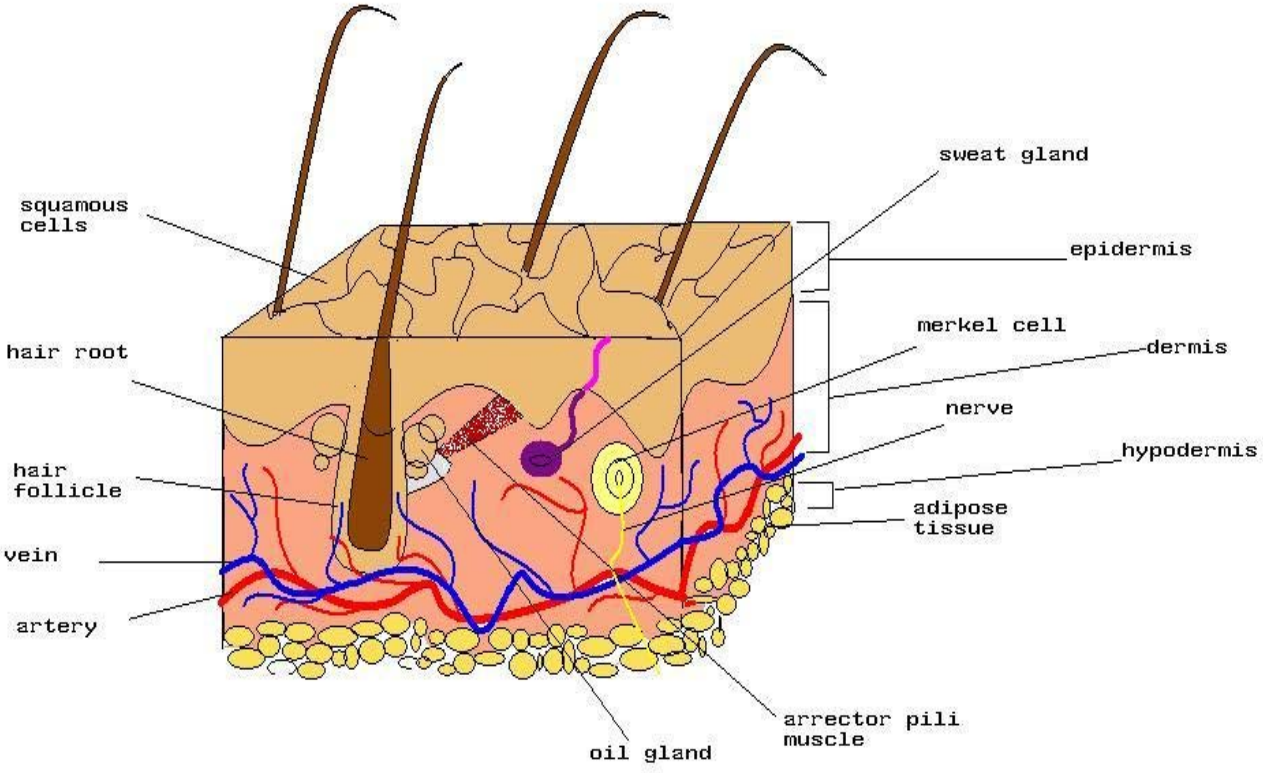
Human senses - smell

- The inside of the nose is covered in tiny hairs that act as smell receptors. They react to different chemicals in the air and send nerve impulses to the brain. The brain processes these impulses and we 'smell' the food in front of us, or anything else around us.
- Humans have a reasonable sense of smell. But other animals, like dogs, depend far more on this sense.
- The parts of the brain that process smell information are also involved in memory. You may have noticed that sometimes, when you smell something, it often brings back memories associated with that object.



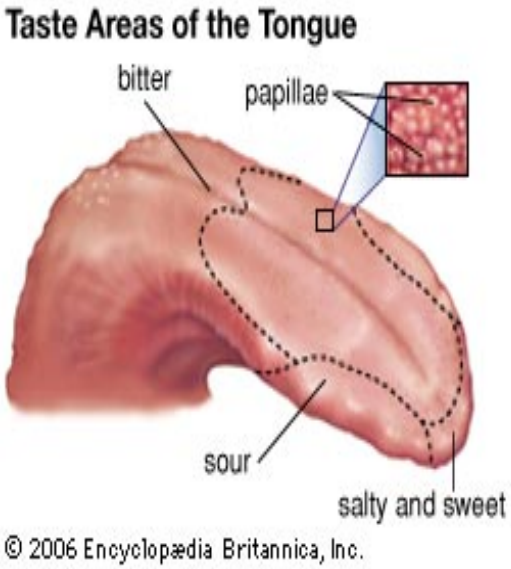
Human senses - touch

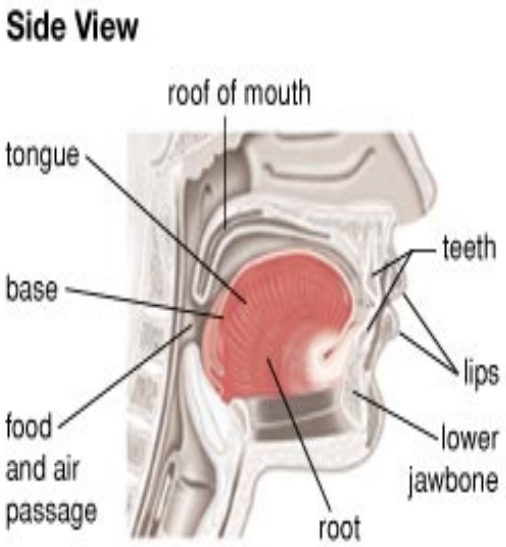
- Skin is covered with different types of receptor cells. Each type of receptor cell picks up a different feeling - pressure, pain, and temperature (hot and cold).
- When the receptor cells are activated they send electrical impulses that pass to the brain. The brain processes these impulses and we 'feel' what is around us.
- Our sense of touch varies on different areas of our bodies. Our fingertips are very sensitive to touch - the skin on our fingertips contains many receptor cells.



Human senses - taste

- There are four basic tastes - salty, sweet, sour, and bitter.
- The human tongue is covered in taste buds which are made up of receptor cells. Each receptor cell responds best to one of the basic tastes.
- As you eat, the receptor cells send nervous impulses to the brain. The brain processes these impulses and we 'taste' what is in our mouths.
- Our sense of taste depends on other senses like smell and sight.
- There are probably about 10,000 taste buds on your tongue.



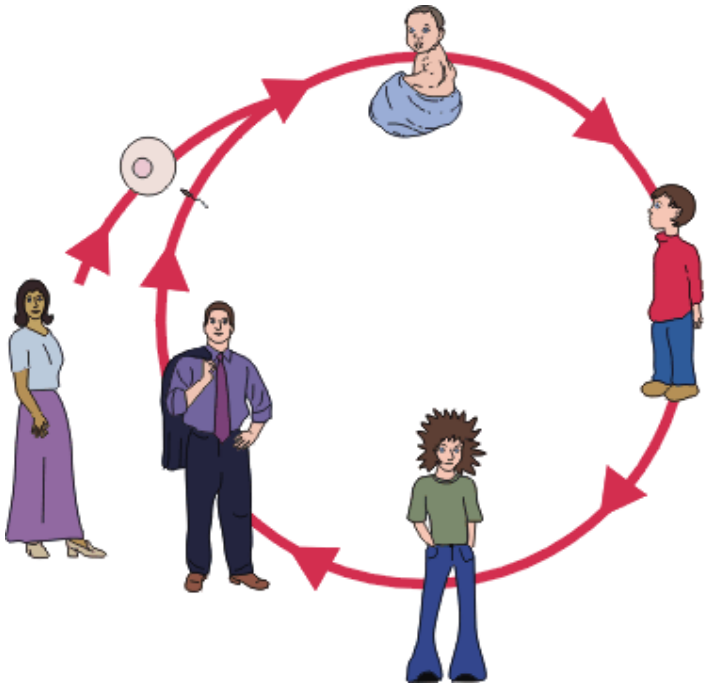


Reproduction

All living things produce young. Humans make babies, cats produce kittens and birds lay eggs. Plants also reproduce. Many make seeds which can germinate and grow into new plants.

All animals reproduce. Human babies develop within their mother for nine months before they are born. They grow into children, adolescents, and eventually, adults.

The human life cycle is pretty simple. Look at the picture below, where do you fit in?

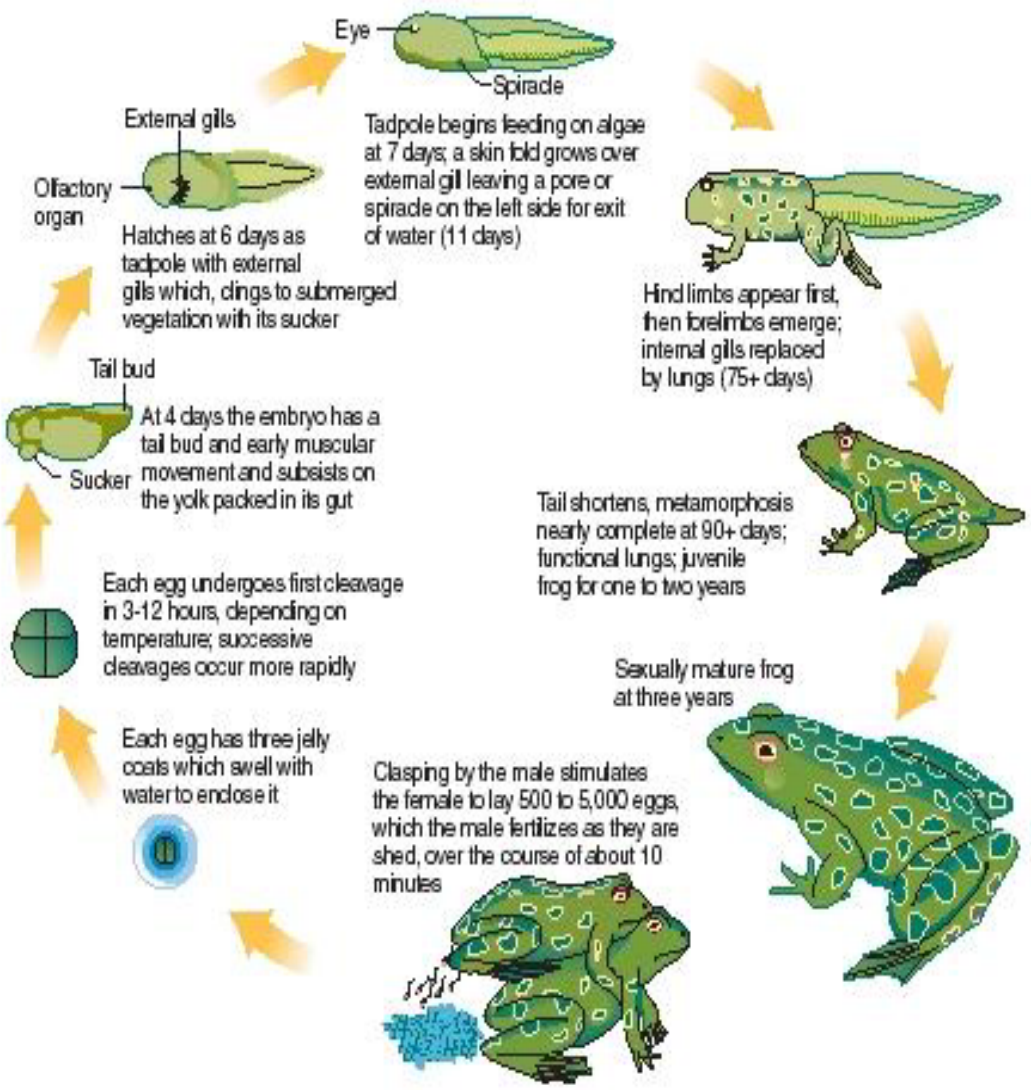


But not all animals reproduce in this way.

Birds lay hard-shelled eggs that hatch and produce helpless chicks. Marsupial mammals, like tree kangaroos give birth to tiny babies that spend a long time in their mother's pouch before they are able to live independently.

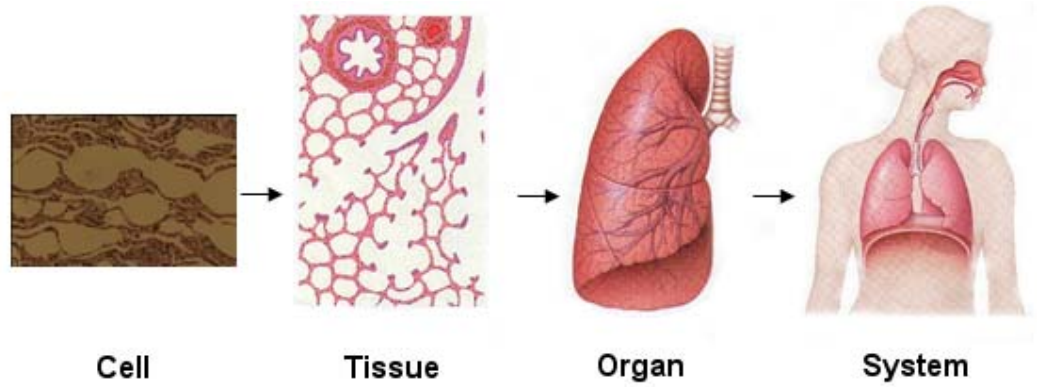
And what about other creatures such as frogs?

Have a look at the frog's life cycle. How does it differ from the human life cycle?



COMPLEX ORGANISMS

Living things have a level of complexity and organization not found in lifeless objects. At its most fundamental level, a living thing is composed of one or more cells. These units, generally too small to be seen with the unaided eye, are organized into tissues. A tissue is a series of cells that accomplish a shared function. Tissues, in turn, form organs, such as the stomach, lung and kidney. A number of organs working together compose an organ system. An organism is a complex series of various organ systems.



Definitions of these are shown described below:

The cell is the structural and functional unit of all known living organisms. It is the smallest unit of an organism that is classified as living, and is often called the building block of life. Some organisms, such as most bacteria, are unicellular (consist of a single cell). Other organisms, such as humans, are multicellular. (Humans have an estimated 100 trillion cells).

Tissues are made up of lots of cells of the same type. (e.g. muscle tissue is made up of many muscle cells) Tissue is a cellular organizational level intermediate between cells and a complete organism. Hence, a tissue is an ensemble of cells, not necessarily identical, but from the same origin, that together carry out a specific function. Organs are then formed by the functional grouping together of multiple tissues.

Organs are different tissues working together to carry out a certain function. An organ can contain different types of tissue (e.g. the heart). An organ is a group of tissues that perform a specific function or group of functions.

The human body has many **systems.** These are when organs work together to do a specific function such as digestion, breathing, circulation. The human body uses many systems that work side by side.

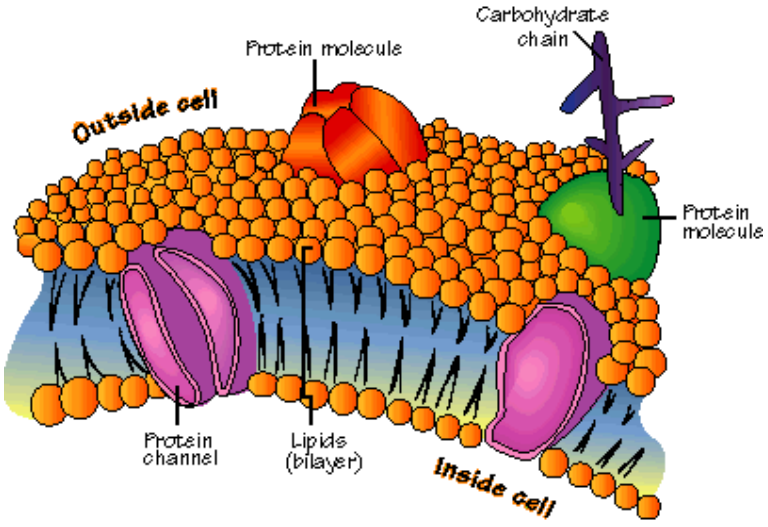
CELLS

Each cell is at least somewhat self-contained and self-maintaining: it can take in nutrients, convert these nutrients into energy, carry out specialized functions, and reproduce as necessary. Each cell stores its own set of instructions for carrying out each of these activities.

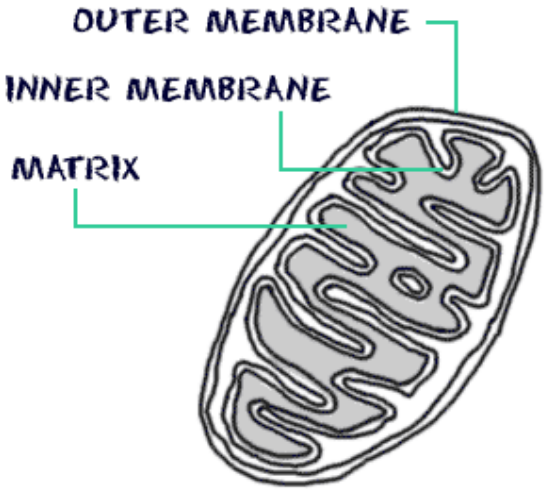
There are over 100 different kinds of cells in the vertebrate animals. Together they make up tissues and the tissues make up organs, like lungs, skin, bladder, etc. Groups of organs make up the different kinds of systems in a body: digestive, excretory, and respiratory.

Cells contain different organelles within the individual cell. These all have a function that and work together to allow the cell to function as a whole.

- Cell Wall - This is the rigid wall that surrounds another membrane and keeps all the organelles inside the cell. This is specific to the plant cell. There are a variety of functions including protecting the cell, and regulating the life cycle of the plant organism.
- The cell membrane packages up the cell and all its organelles. Water, energy, and nutrients enter the cell, and waste material leaves the cell through the cell membrane.

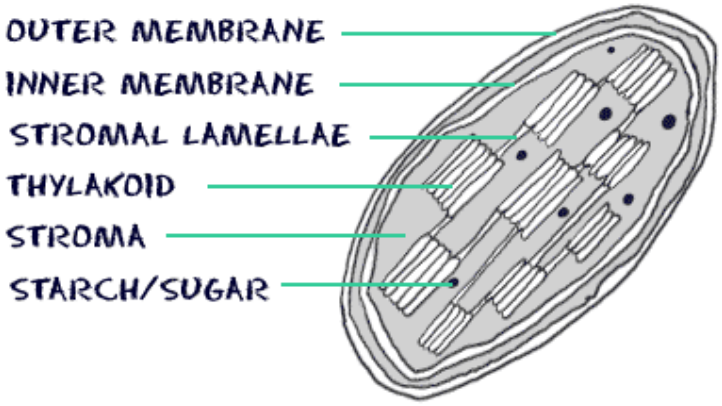


- Mitochondria - The mitochondria are sometimes considered the powerhouse of the cell. This organelle belongs to both plant and animal cells. The mitochondria are large organelles that produce energy. The structure of mitochondria is shown below:



- Vacuole - This organelle is present in both cells. In plants it is a large part of the cell that stores compounds, helps in plant growth and also helps give the plant structure. In animals it stores anything the cell might need for later use.
- Golgi apparatus - This is comprised of small sacs surrounded by membranes, and it is related to the endoplasmic reticulum. The golgi body (or the golgi apparatus) makes some of the chemicals produced within the cell. It also collects and packages chemicals for transport to different parts of the cell.
- Cytoplasm - This is the jelly-like substance inside the cell that contains all the other organelles. The cytoplasm of a cell is not really an organelle - it is the fluid the organelles are bathed in. It contains proteins, sugars and other substances that help the cell function properly.
- Nucleus - It is often the largest organelle in the cell. The nucleus controls cell activity. It also contains the cell's chromosomes. The chromosomes are made up of the genetic information (the DNA) that makes you who you are.
- Endoplasmic Reticulum (ER) - Endoplasmic reticulum is made up of a network of membranes folded into a series of sheets or tubes. Rough endoplasmic reticulum is covered in ribosomes, giving it a grainy look. Proteins are made here and are packaged up for transport around, or out of, the cell. Smooth endoplasmic reticulum has different functions in different Smooth ER plays a role in calcium sequestration and release.

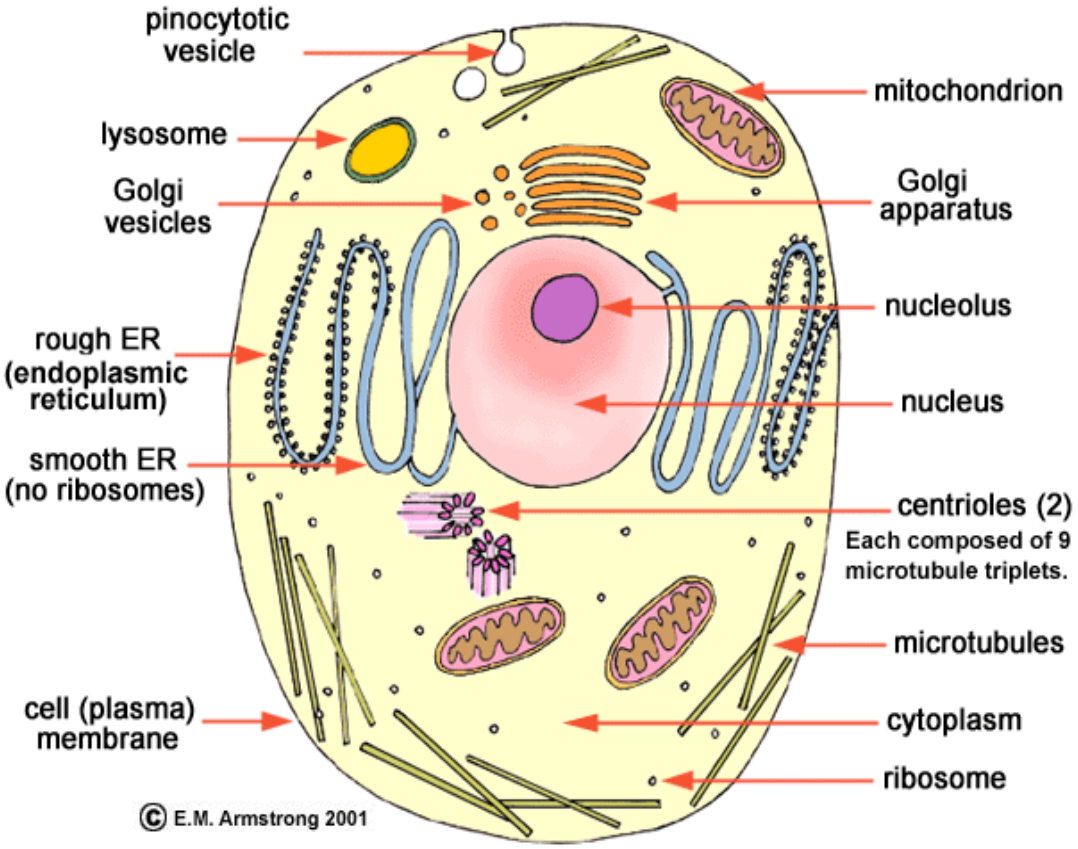
- Chloroplast - These organelles are specific to plant cells. These specialized organelles carry out the process of photosynthesis, which is converting light energy into chemical energy. This energy is the food for the plant.



- Lysosomes - These are sacs that contain digestive enzymes. The function of these is to breakdown old or unneeded parts of the cell for possible reuse. Lysosomes contain enzymes that break down cell material (if these enzymes were not contained within lysosomes, they would eat away the cell). When organelles have 'died' they are surrounded by the lysosome and broken down by the enzymes.
- Ribosomes - There are thousands of ribosomes inside a cell. They are found in the cytoplasm, in mitochondria and they make endoplasmic reticulum rough. Ribosomes make proteins. This is where proteins are produced. Ribosomes can be found either floating freely or bound to a membrane (the rough endoplasmatic reticulum

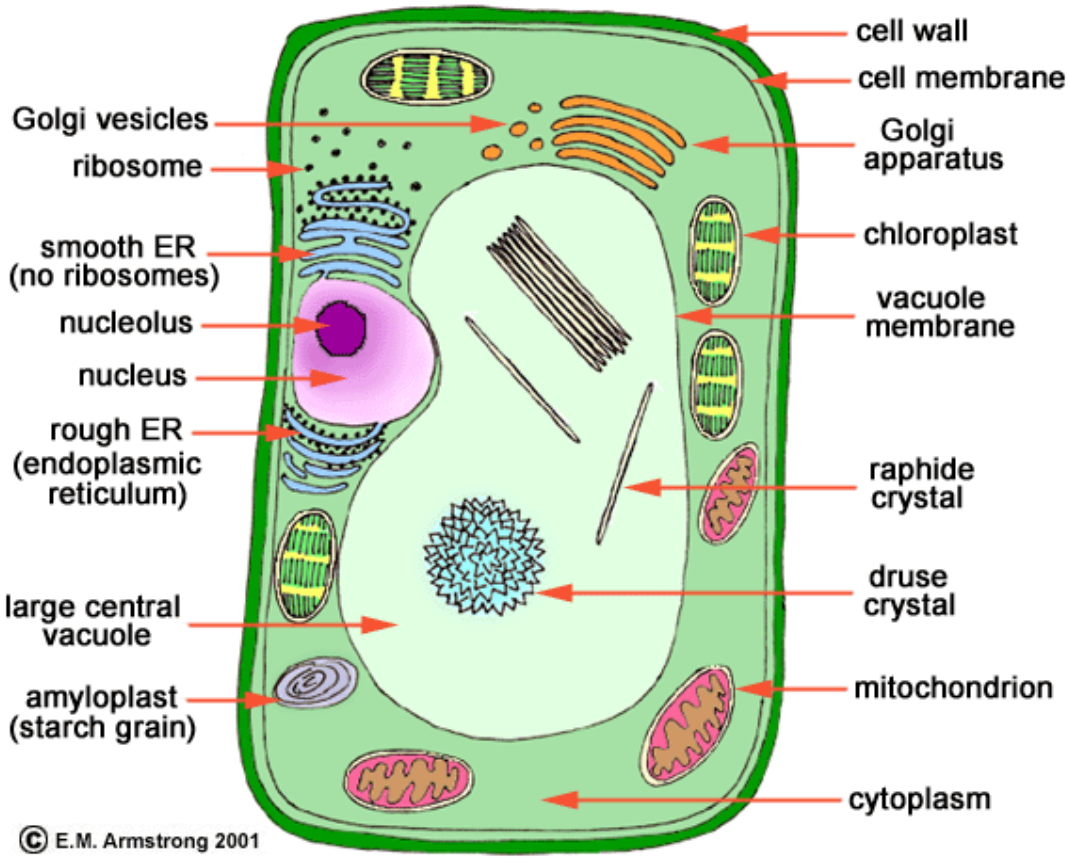
ANIMAL CELL

The diagram below shows where all the organelles are found in a typical animal cell.



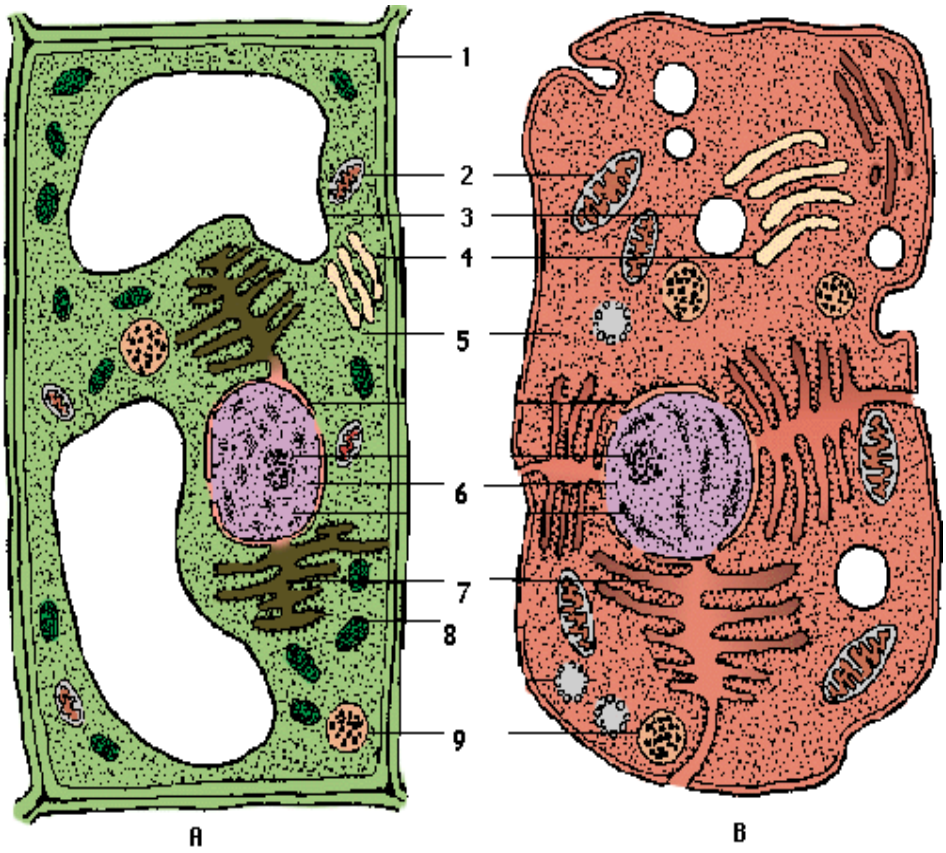
PLANT CELLS

The diagram below shows where all the organelles are found in a typical plant cell.



ANIMAL VS PANT CELL: WHAT IS THE DIFFERENCE?

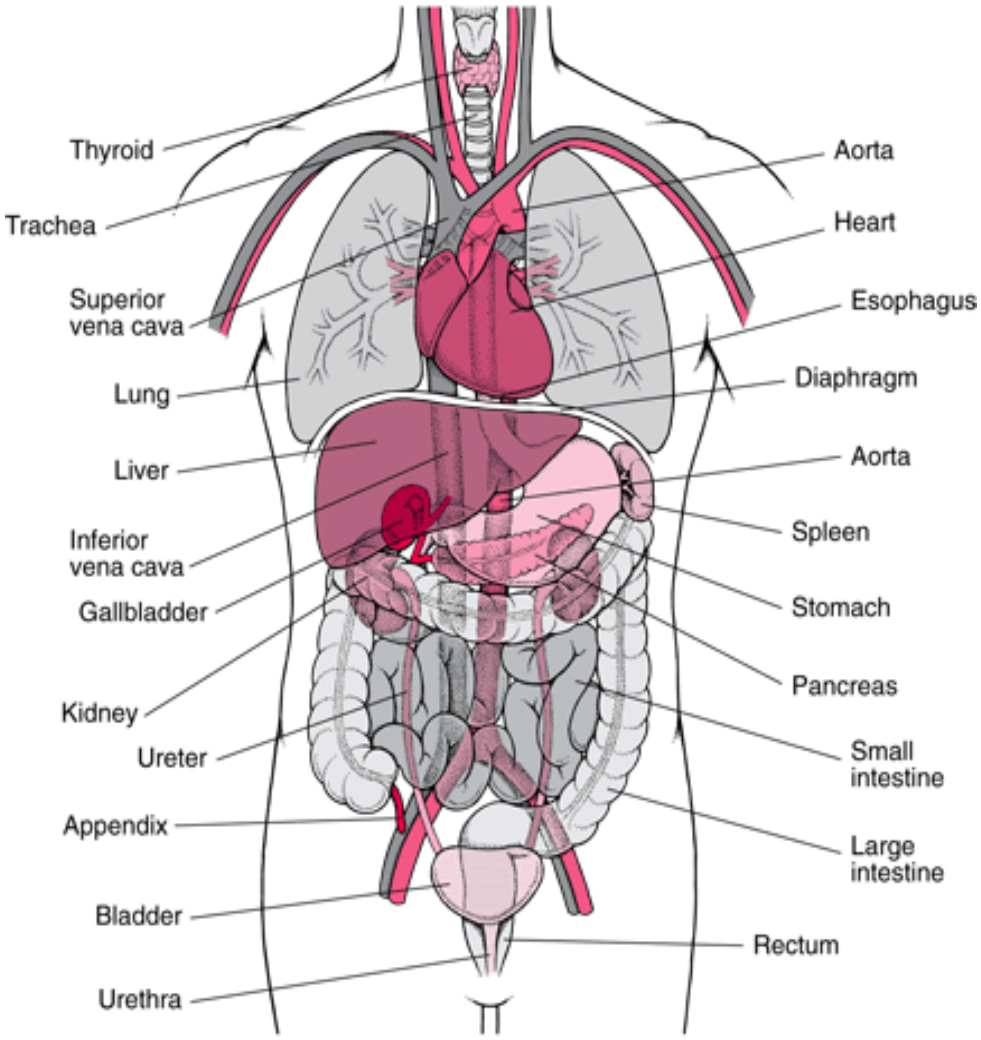
Below are two diagrams of cells – one is an animal cell the other is a plant cell. Can you see what the main differences they have?



When you look inside a cell you see many different structures called organelles. Can you name all 9 labelled organelles in the animal and plant cells?

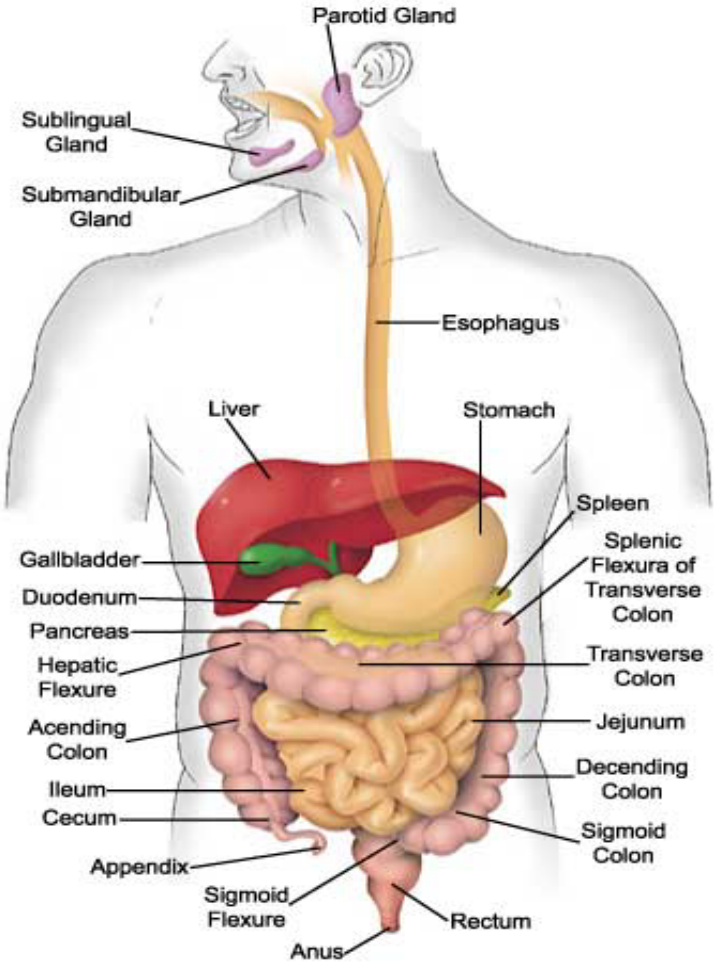
THE INTERNAL ORGANS OF THE HUMAN BODY

Below is a diagram of all the major organs of the human body.



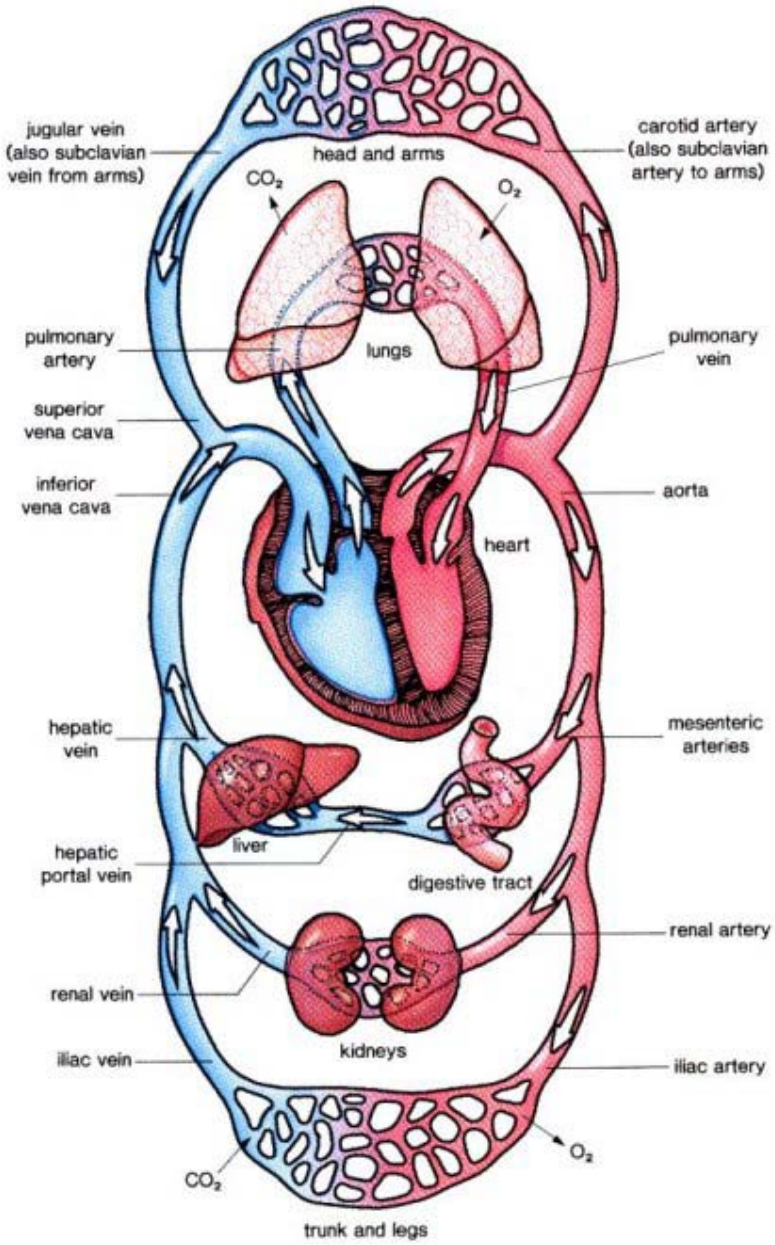
DIGESTIVE SYSTEM

Digestion is the breaking down of chemicals in the body, into a form that can be absorbed. It is also the process by which the body breaks down food into smaller components that can be absorbed by the blood stream. In mammals, preparation for digestion begins with the mouth in which saliva is produced and digestive enzymes are produced in the stomach. Mechanical and chemical digestion begins in the mouth where food is chewed, and mixed with saliva. The stomach continues to break food down mechanically and chemically through the churning of the stomach and mixing with enzymes. Absorption occurs in the stomach and intestine, and the process finishes with defecation.



CIRCULATORY SYSTEM

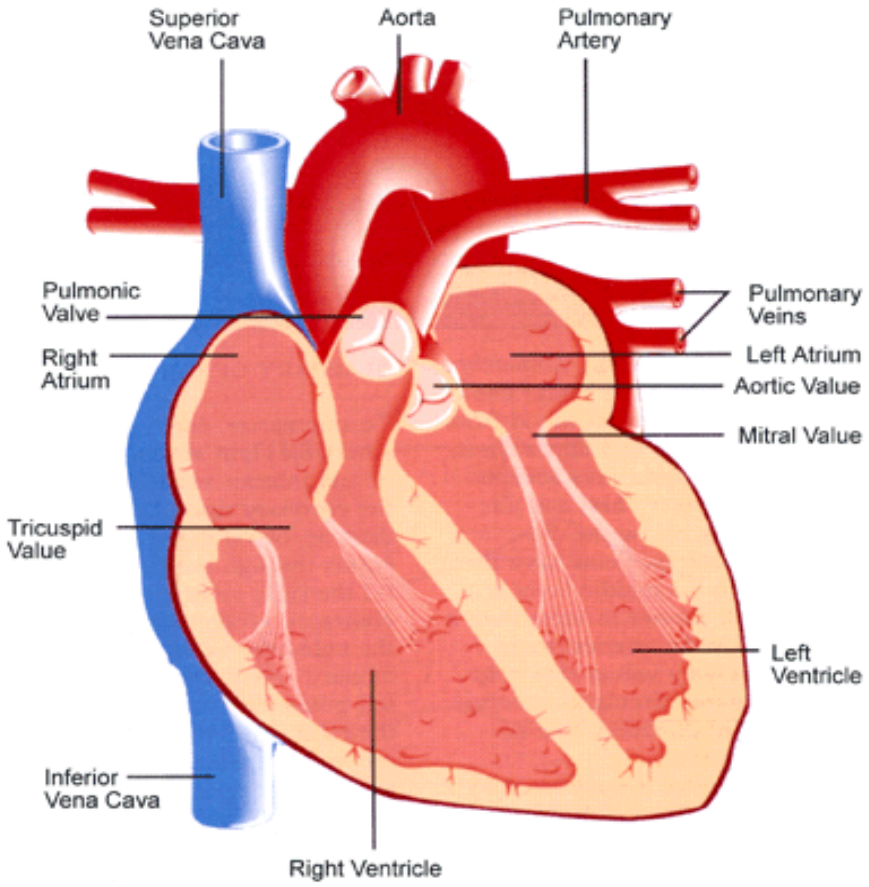
The main components of the human circulatory system are the heart, the blood, and the blood vessels. The circulatory system includes: the pulmonary circulation, a "loop" through the lungs where blood is oxygenated; and the systemic circulation, a "loop" through the rest of the body to provide oxygenated blood. An average adult contains roughly 4.7 to 5.7 liters of blood, which consists of plasma, red blood cells, white blood cells, and platelets. Also, the digestive system works with the circulatory system to provide the nutrients the system needs to keep the heart pumping.



THE HEART

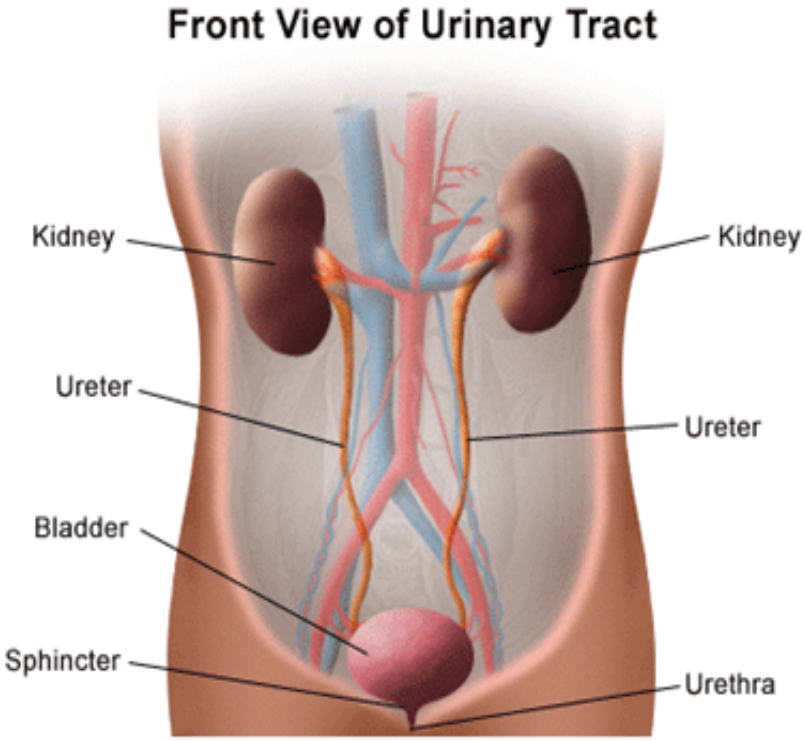
The heart pumps oxygenated blood to the body and deoxygenated blood to the lungs. In the human heart there is one atrium and one ventricle for each circulation, and with both a systemic and a pulmonary circulation there are four chambers in total: left atrium, left ventricle, right atrium and right ventricle. The right Atrium, which is the upper chamber of the right side of the heart, receives blood from the upper body through the Superior Vena Cava, and from the lower body through the Inferior Vena Cava.

The **heart** is a muscular organ in all vertebrates responsible for pumping blood through the blood vessels by repeated, rhythmic contractions.



THE URINARY SYSTEM

The **urinary system** (also called excretory system) is the organ system that produces, stores, and eliminates urine. In humans it includes two kidneys, two ureters, the bladder, and the urethra.



The kidneys are bean-shaped organs, which lie in the abdomen around or just below the ribcage and close to the spine. The organ is about the size of a human fist. The kidneys receive their blood supply of 1.25 L/min (25% of the cardiac output) from the renal arteries which are fed by the abdominal aorta. This is important because the kidneys' main role is to filter water soluble waste products from the blood.

Functionally the kidney performs a number of tasks. In its role in the urinary system it concentrates urine, plays a crucial role in regulating salts and sugars, and maintains the pH of the blood. In addition, they remove urea, a nitrogenous waste product from the metabolism of proteins. Humans produce about 1.5 litres of urine over 24 hours, although this amount may vary according to circumstances.

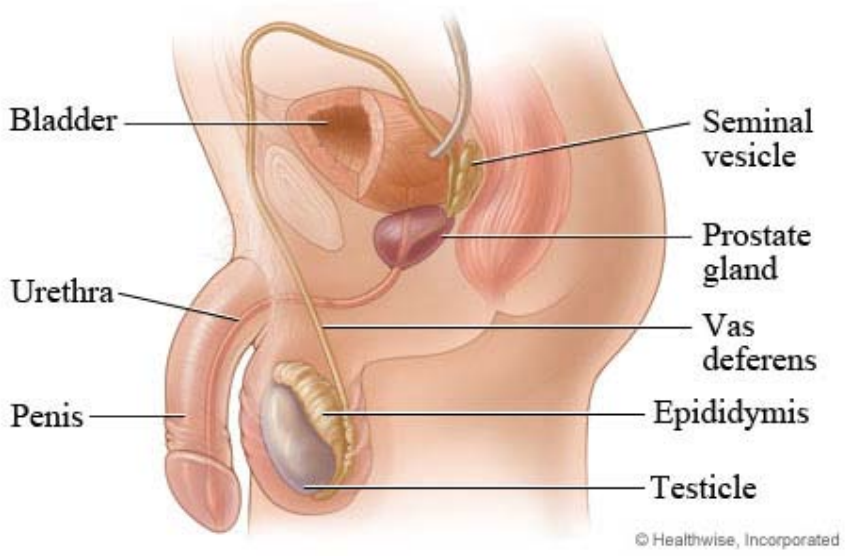
In humans and other related organisms, the urinary bladder is a hollow muscular organ shaped like a balloon, located in the anterior pelvis. The bladder stores urine. The maximum that it can hold is one litre. It swells into a round shape when it is full and gets smaller when empty.

Sphincters (circular muscles) regulate the flow of urine from the bladder. The bladder itself has a muscular layer that, when contracted, increases pressure on the bladder and creates urinary flow. The Urethra is the endpoint of the urinary system is the urethra.

MALE REPRODUCTIVE SYSTEM

The human male reproductive system is a series of organs located outside of the body and around the pelvic region of a male that contribute towards the reproductive process.

The male contributes to reproduction by producing spermatozoa. The spermatozoa then fertilize the egg in the female body and the fertilized egg (zygote) gradually develops into a foetus, which is later born as a child.



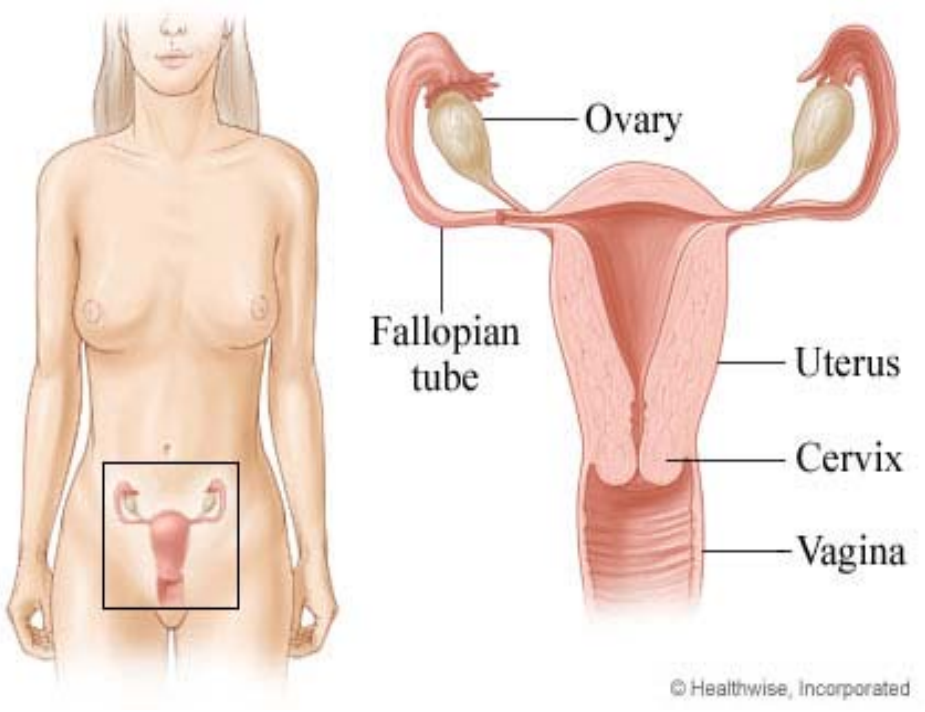
The testes hang outside the abdominal cavity of the male within the scrotum. They begin their development in the abdominal cavity but descend into the scrotal sacs during the last 2 months of foetal development. This is required for the production of sperm because internal body temperatures are too high to produce viable sperm.

penis is the copulatory organ of the males. When the male is sexually aroused, the penis becomes erect and ready for intercourse. A normal human male usually produces several hundred million sperm per day. Sperm are continually produced throughout a male's reproductive life, though production decreases with age.

During ejaculation, sperm leaves the penis in a fluid called seminal fluid. This fluid is produced by 3 types of glands, the seminal vesicles, the prostate gland, and Cowper's glands. Each component of a seminal fluid has a particular function

FEMALE REPRODUCTIVE SYSTEM

The female reproductive system consists of two ovaries, two fallopian tubes, the uterus, and the vagina. Either the left or right ovary normally produces an egg (ovulation) about 11 to 17 days before the woman's next menstrual period, or approximately once a month. The egg is released from the ovary into a fallopian tube and swept into the uterus.



If, in this transit, it meets with sperm, the sperm penetrate and merge with the egg, fertilizing it. The fertilization usually occurs in the oviducts/fallopian tubes, but can happen in the uterus itself. The zygote then implants itself in the wall of the uterus, where it begins the processes of embryogenesis. When developed enough to survive outside the womb, the cervix dilates and contractions of the uterus propel the foetus through the birth canal, which is the vagina.