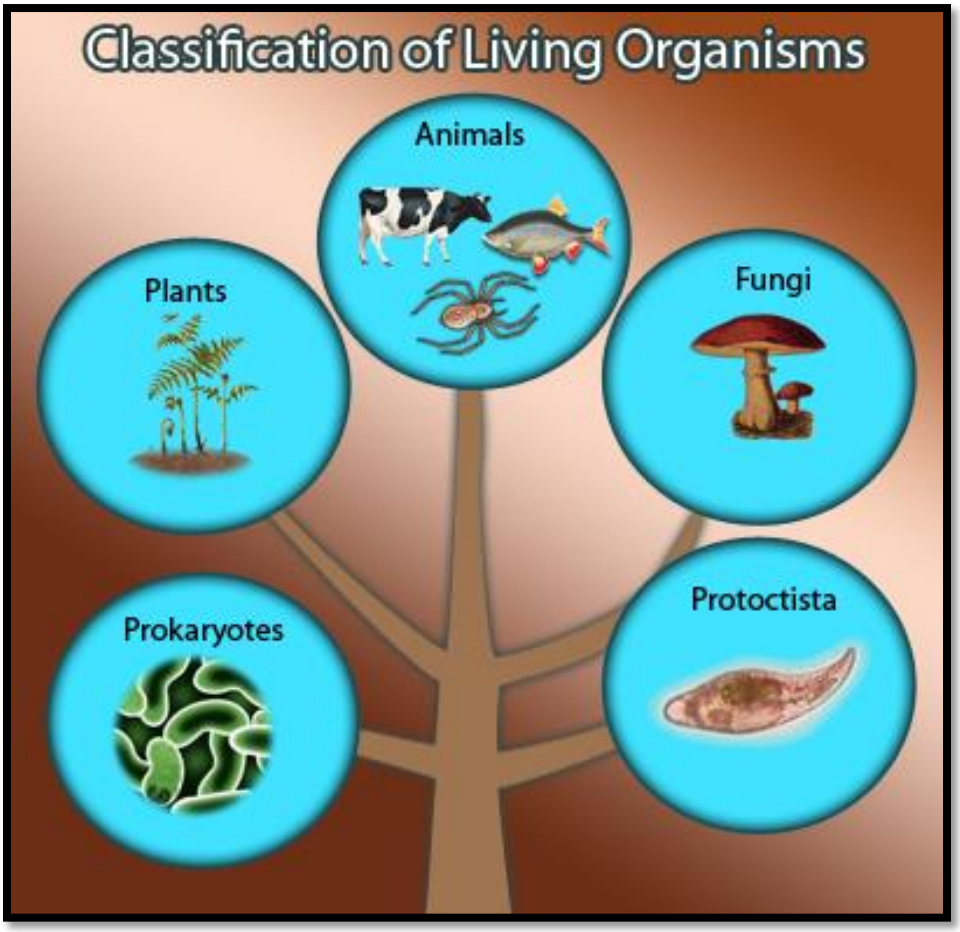
Classification of Living Organisms

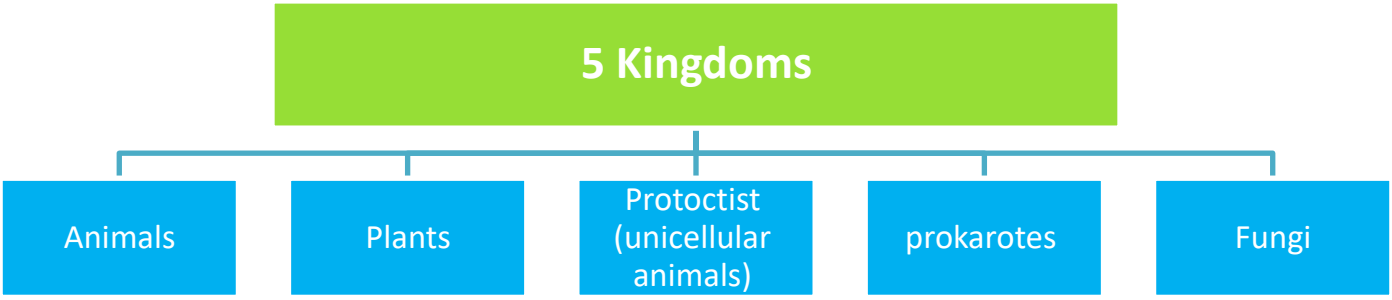


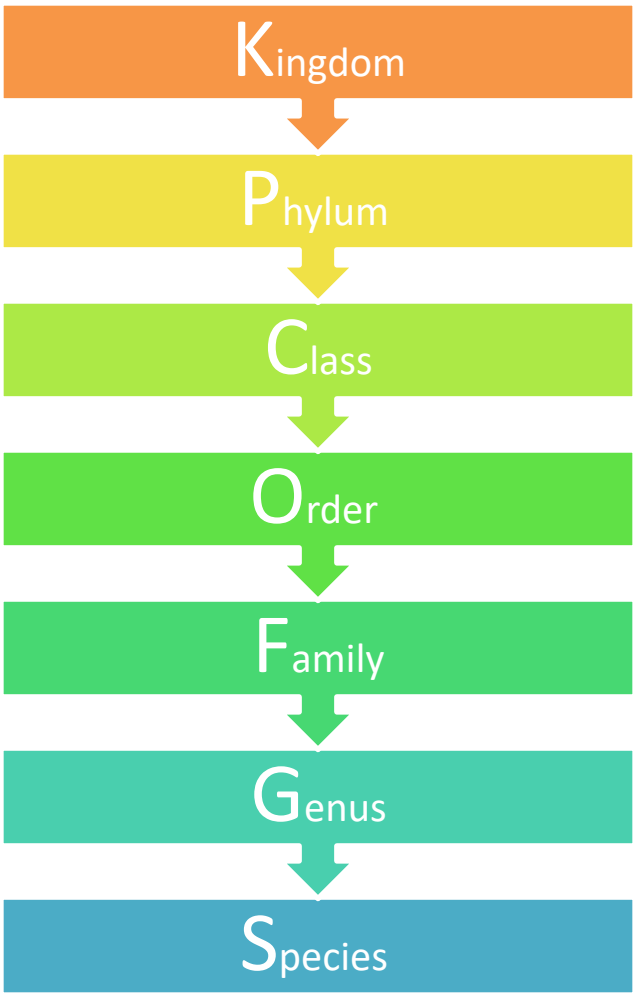
Classification of living things

Nobody knows how many different kinds of species of living organisms there are on earth. About 1.4 million species have been described and named. But many biologists think that this is only about one tenth of all the species of earth! There are plenty of organisms that haven't been discovered yet. There are probably many animals living in the deep oceans which have never been seen by humans.
So to make it easier to study these organisms biologists have sorted them into groups this sorting is called "Classification".

- Classification: Separating or sorting living organisms according to their common characteristics and features.
- Taxonomy: is a system for classifying and identifying organisms. This system was developed by the scientist Carolos Linnaeus

- Biologists used to classify living organisms into 2 groups (animals and plants) but it caused problems concerning (Fungi, Bacteria and Algae) which do not seem to fit into either kingdoms.
- Robert Whittaker is the biologist that found the 5 kingdoms scheme which we are going to study in this topic.





King Philip came out from great spaghetti

Species:
Living organisms of the same species are capable of reproducing successfully and producing fertile offspring of the same species.
Organisms of the same species which are almost identical in their anatomy, physiology and behavior. Members of the same species also often look similar to each other.

Genus: a group of organisms with a large number of similarities but whose different species usually are unable to interbreed successfully

- Closely related species are often grouped together into a genus.

A **mule** is the offspring of a male donkey and a female horse. Horses and donkeys are different species→ mules are infertile

Binomial nomenclature:

Any living organism must be named in such a way that the name is recognized all over the world. That's why the scientist Linnaeus constructed a new system that recognizes organisms by scientific names that are known all over the world despite of all the language barriers. In the past, the most educated people could read and write Latin, so this was the language he chose.

- Each organism has a Latin name made up of two names that's why it was called binomial (meaning two names). The first name is the genus (generic name) and the second name is the species (specific name).

- **Binomial system: An internationally agreed system in which the scientific name of an organism is made up of two parts showing the genus and species**

- There is a specific way for writing the scientific names:

First, the Genus is written, the first letter must be capitalized.
Second, the species name is written, the first letter must be written using small letters.
Both the generic name and the species name must be either underlined or written in italics.

For example:
Genus: Homo
Species: sapiens
Is written as
Homo sapiens or *Homo sapiens*

***Homo sapiens* is the scientific name for humans (Homo sapiens means Wise Man)**

- The specific name are usually descriptive :
  hirsutum meaning hairy
  aquatilis meaning that the organism lives in water
  bulbosus meaning that they have bulbs

Methods of classification :

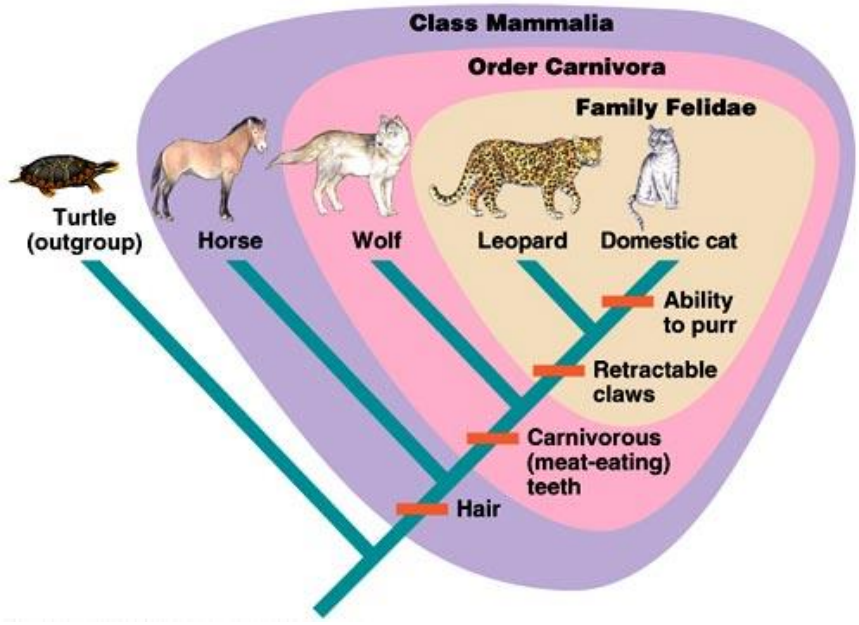
Scientists used the physical features of living organisms to identify how similar they were and therefore decide how to classify them. These features included:

- Morphology: the study of how organisms look like
- Anatomy: the study of the body structure of organisms

This is a good way when organisms share similar features because they evolved from a shared ancestor, but it fails when organisms share features that are adaptations to particular habitats.

Cladistics: is a method of analyzing the evolutionary relationships between groups to construct their family tree. In a family tree we trace back the organism's ancestry. The principle behind it is that organisms should be classified according to their evolutionary relationships.

Classification aims to reflect evolutionary relationships



Analysis and comparison of DNA or RNA can be used as a more accurate method for classifying living organisms and studying relationships between them.
Organisms which share a more recent ancestor (are more closely related); have base sequences in DNA and amino acid sequences in proteins that are more similar than those that share only a distant ancestor.

- The cells of all living organisms contain:
  Cytoplasm, cell membrane, ribosomes and enzymes for respiration

Animal Kingdom

Animal Kingdom is divided into:	
Vertebrates Phylum Chordates: organisms that have a backbone	Invertebrates: organisms that lack a backbone

Characteristics of vertebrates

- All vertebrates have a vertebral column which is a chain of bones called vertebrae. Inside the vertebral column there is a spinal cord that runs along almost all its length.
- They have a skull that encloses and protects the brain.
- There is a pair of jaws in the skull (upper and lower), most of the times they contain teeth.
- All vertebrates have a post-anal tail.

Vertebrates can be classified according to their body temperature into:

Homoeothermic animals : Endotherms

Warm-blooded animals, ex. humans/birds. Their body temperature is constant (does not depend on the temperature of the surrounding).

Poikilothermic animals : Ectotherms

Cold blooded animals, ex. fish/reptiles. Their body temperature changes according to the temperature of the surrounding environment (not constant / variable).

Adaptations:

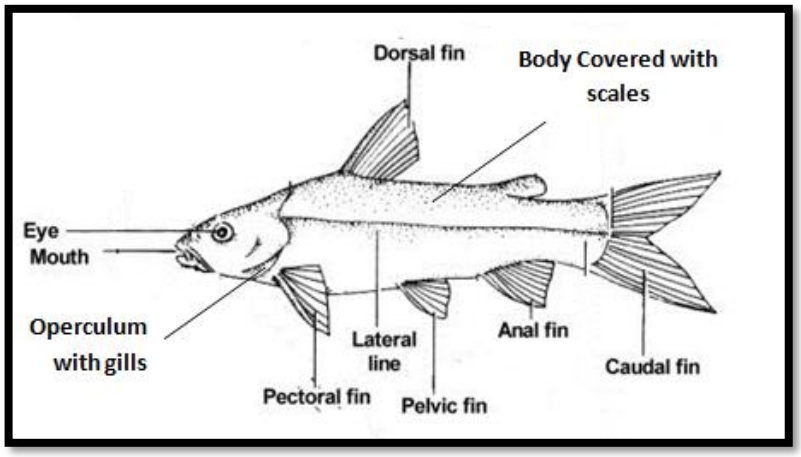
Lizards and snakes stay in the sun in the early morning and seek shelter around noun.

Phylum Chordates

Class : Fish	Class: Amphibians	Class: Reptiles	Class: Birds	Class: Mammals

Class: Bony Fish

External features:



1. Stream-lined shape, which is important to decrease water resistance during swimming.

2. The body is covered with over-lapping scales that give a smooth surface to reduce friction.

3. They have fins (to control direction of movement and balance) :
   - Dorsal fins
   - Anal fins
   - Caudal fins (tail)
   - Pectoral fin.

4. The tail is bilateral (on each side) which helps during forward movement.

5. They have filamentous gills (for breathing). Gills are protected by a bone plate called **operculum.**

6. They have a pair of eyes with no eyelids.

4. They have lateral lines (sense organs) on each side of the body which sense vibrations of nearby fish prey.
5. They have a swim bladder, which allows them to float.
6. They reproduce sexually, fertilization occurs externally (outside the female body); sperms are shed on the eggs.
7. Fertilized egg (jelly like) has no hard covering because it is found in water, so there will be no risk of dehydration.

Class: Amphibians

* Amphibians have a double life; they spend part of their lives in water (in the beginning of their life cycle) and the other part on land (when they become adults) ex: frog, toad, salamander, newts.

Frogs

Salamanders

Toads

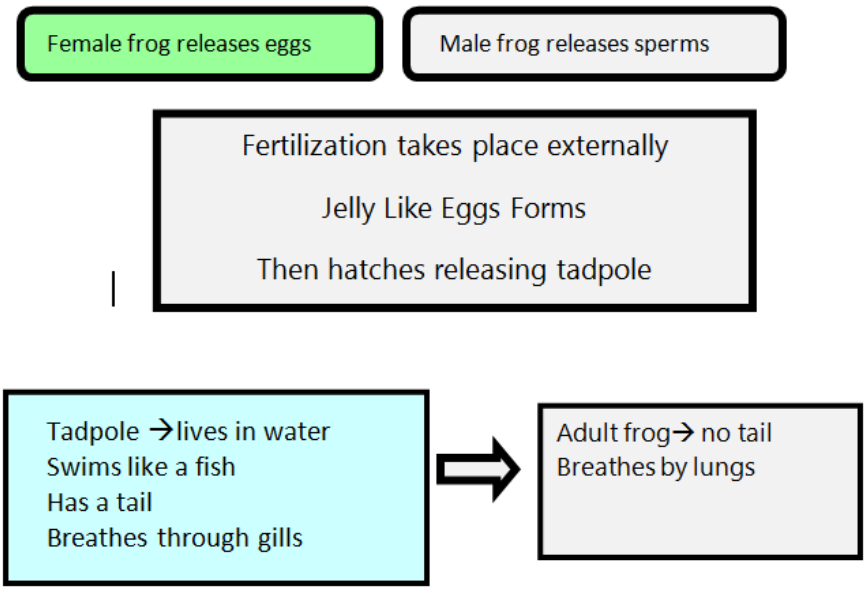
Newts

* Most toads, frogs and newts spend much time on land in moist conditions, and then return to water only to lay eggs.
* Amphibians are poikilothermic (cold –blooded) vertebrates.

External Features:

1. They have a smooth moist skin, with no scales; amphibians breathe through their lungs when they are on land, however when they get in water, the uptake of oxygen takes place by gaseous exchange through the skin that's why the skin has a good supply of blood capillaries for exchange of oxygen and carbon dioxide.

2. They have lungs, no ribs and no diaphragm.
3. They have 4 limbs: 2 fore limbs + 2 hind limbs
4. In frogs and toads, the hind limbs are taller, and they have webbed feet (skin between toes) the skin will make it easier and offer a larger surface area to thrust against the water during swimming.
5. Newts don't use their limbs; they swim like fish (using their tail).
6. Newts and salamanders differ from frogs and toads in having a tail.
7. Amphibians have ears; unlike fish (visible eardrum).
8. They have nostrils for breathing.



Notes:

- A toad's skin is drier than the frog; it has glands that secrete an unpleasant tasting chemical that discourages the predators.

- Fish and amphibians have external fertilization because they live in water (sperms can swim towards the egg).

- Camouflage or blending in:
The animal kingdom is a wild place; animals have to be clever in order to survive. Animals have the ability to mimic plants or any element in the environment e.g. rocks, branches of trees, in order to hide from their predators or hunt their prey.

Class Reptiles:

* Examples: Crocodile (in water), alligators (on land), snake, lizard, turtle (in water), tortoise (on lands).

External features:

1. They have a dry scaly skin to avoid dehydration, because they live on land.

2. They have four limbs for locomotion each limb contains 5 toes except the snake (no limbs).

3. They have ears, but the eardrum is inside the head, it cannot be seen, unlike amphibians.

4. Internal fertilization; they reproduce sexually, fertilization occurs internally. The eggs are fertilized by the male placing sperms inside the body of the female. External fertilization here is impossible because:
    a. there is no water for the sperms to swim in
    b. the sperms would dry up when exposed to air

*In reptiles & birds the eggs are prevented from drying up by having a shell, so sperms have to get to the egg before the shell is formed.
After fertilization the female lays hard-shelled eggs that are protected from predators and dehydration. In some species the female keeps the egg inside the body until they are ready to hatch.

❖ Reptiles are poilkilothermic vertebrates but they can regulate their body temperature by sitting in the sun until their bodies warm up.

Class Birds:

External Features:

1) The body is covered with feathers, except for hind limbs and toes, which are covered with scales.

Types of feathers:

Flight feathers (for flying):

- Long
- The barbs are joined together with no space in between to thrust through air and fly easily.
- Long quill

Down feathers:

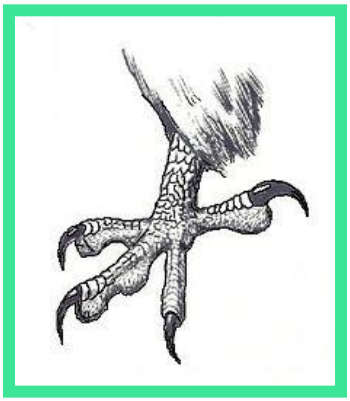
- Small in size
- Barbs are away from each other (not joined – have space)
- Short quills

Functions of down feathers:

- keep their body temperature constant since warm air can be trapped between spaces (they work as insulators)

*Young birds have mainly down feathers, because they can't fly.

2) The body of birds is stream-lined (to minimize air resistance during flying).

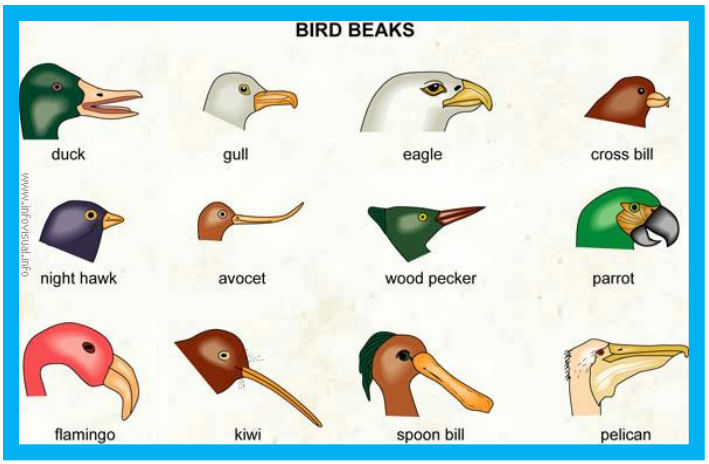


3) They have 4 limbs:

- The forelimbs are modified into wings that are supported by strong muscles for flying.

- The hind limbs are covered with scales and carry claws for catching food.

4) Their upper and lower jaws extend to form the beak which is used for eating (different birds have different shapes of beaks because they feed on different types of food)



5) They have ears, their eardrums are found deep inside the head.

6) They reproduce sexually, fertilization occurs internally:
- The female then lays hard shelled eggs to prevent dehydration and protect eggs from predators.
7) Bones are modified to be strong but light
8) A constant body temperature that is often much higher than that of the surrounding air.

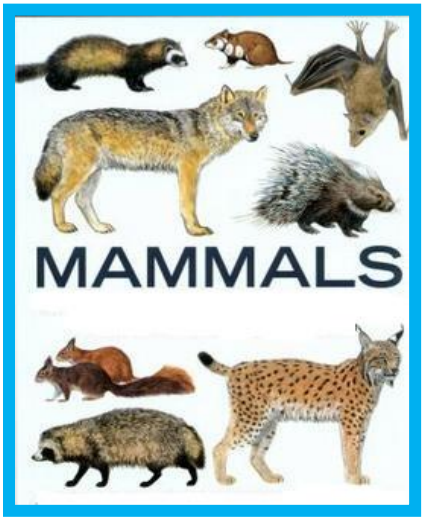
Class Mammals

* They are homoeothermic vertebrates (warm –blooded).

*** External features:**

1) Their bodies are covered with hair, wool or fur.

2) They have 4 limbs used for walking and running except for bats which use their forelimbs for flying (whales use their limbs for swimming).



3) They have ear pinna, and the eardrums are found deep inside the head. The middle ear of mammals consists of three bones.

4) Most mammals have vibrissae (whiskers) near the mouth.

5) They have mammary glands to feed their young (produce milk for breast feeding).

6) They have 4 types of teeth: a. Incisors b. canine c. premolars d. molars.

7) They have lungs with ribs and diaphragm.

8) Parental care.

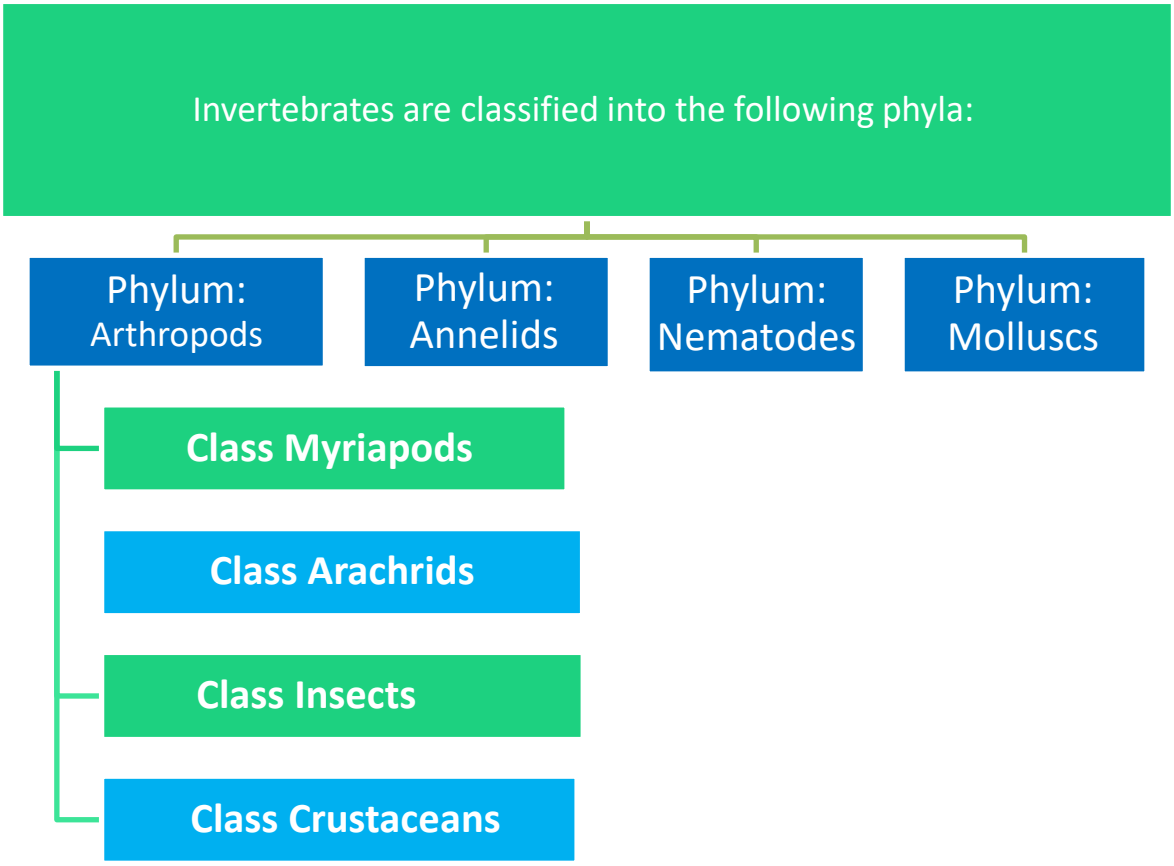
9) They reproduce sexually, fertilization occurs internally, and give birth to fully developed young instead of laying eggs. The fertilized eggs undergo a period of development in the uterus of females.

10) They have sweat glands which secrete sweat.

Invertebrates:

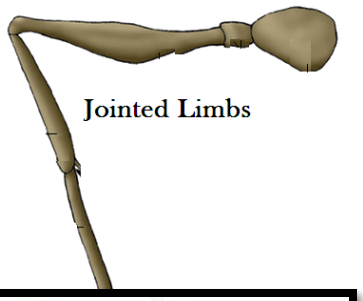
Invertebrates are animals that don't have a vertebral column (backbone).

Invertebrates account for almost 90% of all living things.



Phylum Arthropods:

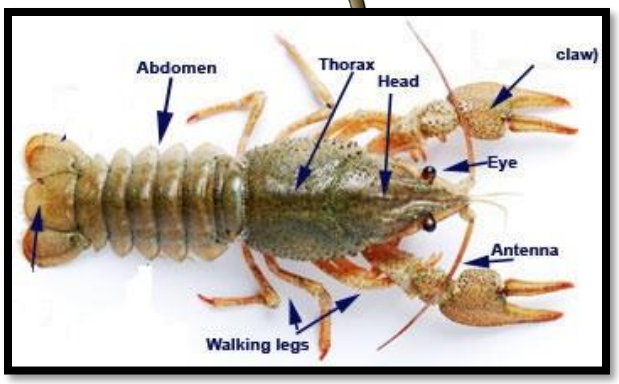
Arthropods means jointed limbs.



*** Common external features:**

1- They have jointed limbs.

2- The body is segmented (divided into segments). In most arthropods a number of segments are joined together and therefore the body becomes divided into 3 district parts (head, thorax, and abdomen).



3-Their body is covered with hard, rigid and firm cover called exoskeleton or cuticle.

* The cuticle is hard substance made up of chitin (a carbohydrate).

Importance of exoskeleton:

a- Protects, supports and gives shape.

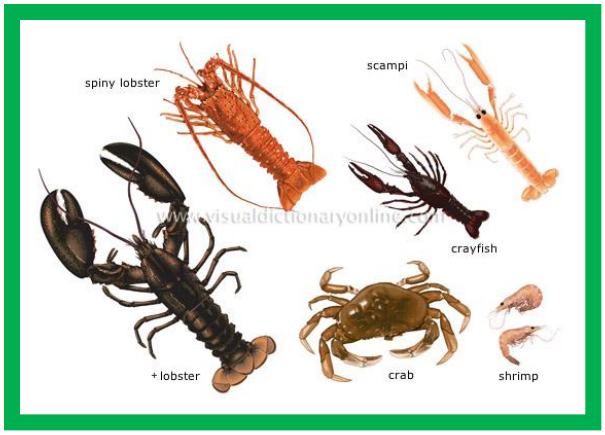
b- Prevents dehydration (water loss)

c- Muscles are attached to cuticle to allow their movement.

4- They have sense organs to detect stimuli such as eyes and antennae.

5-They reproduce sexually internal fertilization, the female then lays eggs.

Class Crustaceans:



***Example: Crabs, lobsters, shrimps, wood lice, water lice.**

External features:

1- Their body is divided into 2 parts:

a. Head and thorax are joined together to form a part called **Cephalothorax.**

b. Abdomen.

2- limbs:

- In the head region: the limbs are modified to form antennae or specialized mouth parts for feeding.
- In the thoracic region: limbs are called walking limbs.
- In the abdominal region: limbs are used as swimming appendages.
  - In the second segment, the pair of limbs is modified to form claws or pincer.

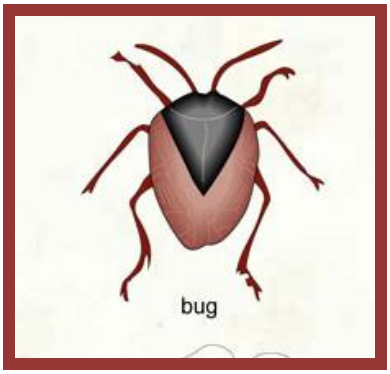
3- They have 2 pairs of antennae which are sensitive to touch and chemicals.

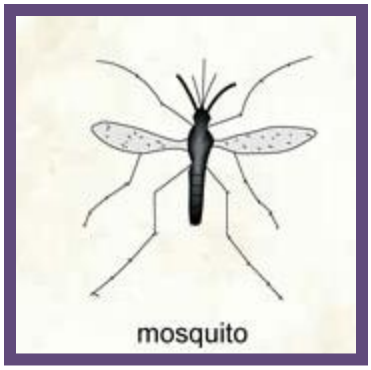
4- They have a pair of compound eyes which are made up of tens or hundreds of separate lenses → very sensitive to movements

5- They have specialized mouth parts for feeding.

Class Insects:

*** Examples: bees, ants, butterfly, mosquitoes.**





External Features:

1) Their body is divided into 3 parts (head, thorax, and abdomen).
2) They have 3 pairs of limbs attached to the thoracic region (no limbs in the abdominal region)
3) They have 1 pair of antennae which detect vibrations

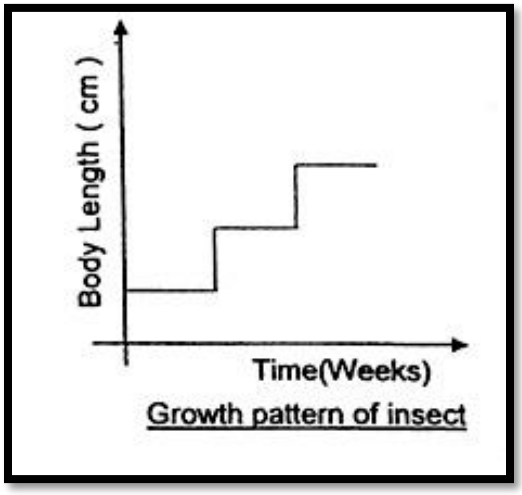
4) Some of them have 2 pairs of wings like butterflies. Some have 1 pair of wings like mosquitoes. Others are wingless (no wings) like ants.

5) They have one pair of compound eyes

6) They have specialized mouth parts for feeding.

Note: during the growth of insects, the exoskeleton covering the insects' body is shed; this is because the exoskeleton is hard and resists expansion in size.

* To do this, the old exoskeleton is shed and the insect emerges with a new soft exoskeleton before it hardens at a larger size.



Class Arachnids:

Examples: spiders, scorpions, mites, ticks

*External Features:

1) Their body is divided into 2 parts:
   a. Cephalothorax
   b. Abdomen
2) They don't have antennae.
3) They have 4 pairs of jointed limbs attached to the thoracic region (no limbs on the abdomen).

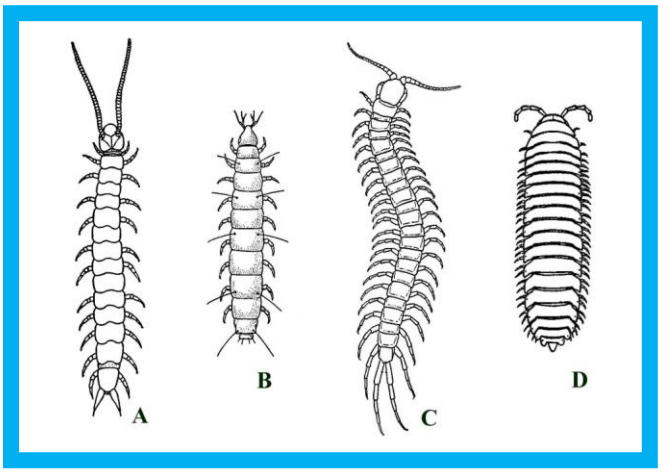
4- They have many pairs of simple eyes.

5- They have specialized mouth parts called chelicerae which pierce the prey and paralyze it with a poison secreted from a gland at the base.

6-They have a pair of pedipalps that are used during breeding (reproduction).

Class Myriapods :

They are divided into 2 groups:



- Centipedes ---- 100 legs-→ Carnivorous
- Millipedes ----- 1000 legs→ Herbivorous

External Features:

1) They have a segmented body that is not clearly divided into head, thorax and abdomen.

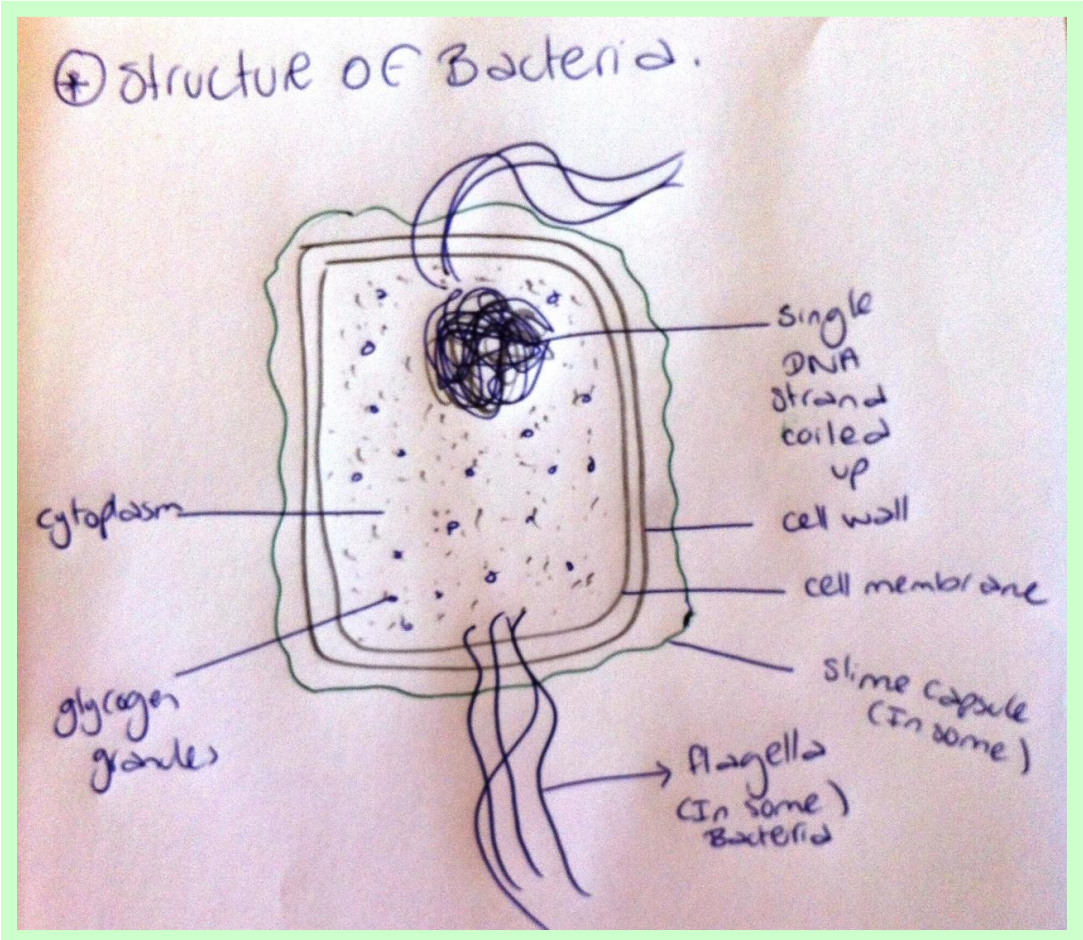
-The first segment is the head.
-The following 4 segments following the head is the thorax

2) Each segment carries a pair of jointed limbs. In millipedes, each 2 segments fuse together (every segment appears to have 2 pairs of limbs).
3) They have a pair of antennae.
4) They have one pair of simple eyes.
5) They have specialized mouth parts.

Summary:

Class	Crustaceans	Insects	Arachnids	Myriapods
Number of segments	The body is divided into 2 segments Cephalothorax and abdomen	The body is divided into 3 segments: Head , thorax and abdomen	The body is divided into two segments : Cephalothorax and abdomen	MANY SEGMENTS!
Number of jointed limbs	Each segment carries a pair of jointed limbs	3 pairs of jointed limbs	4 pairs of jointed limbs ATTACHED TO THORAX	MANY LEGS!
Extra features	Claws \ pincers	Usually one or 2 pairs of wings	Pedipalps and Specialized mouth parts called chelicera	Every segment carries a pair of jointed limbs in centipedes Each segment carried 2 pair of jointed limbs in millipedes

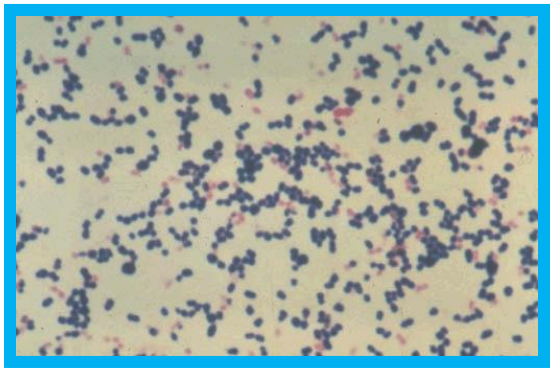
The Kingdom of Prokaryotes



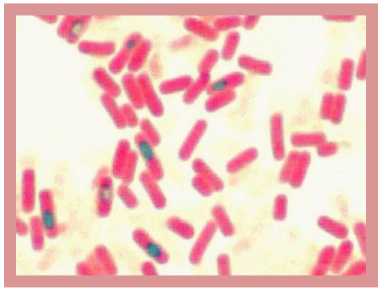
- Are very small organisms consisting of a single cell (unicellular)
- Rarely more than 0.01 mm in length.
- Cannot be seen by naked eye i.e. we need to use a microscope in order to see bacterial cells, they are much smaller than animal and plant cells

Bacteria have several shapes:

1- Spherical (cocci) singular coccus



2- Rod-shaped (bacilli) singular bacillus



3- Spiral shaped (spirilli) singular spirillum

Common Features:

1. They have a cell membrane (similar to that of an animal and of a plant cell).

2. They have a cytoplasm which contain granules of glycogen (similar to animal cell cytoplasm) lipids & other food reserves.

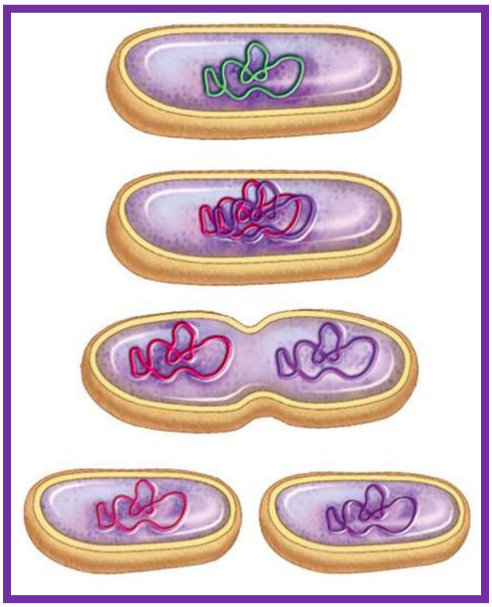
3. They don't have a nucleus (unlike animal and plant cells); instead they have a single strand of DNA coiled up free in the cytoplasm, with no nuclear envelope.
    - That's why they are referred to as **prokaryotes**
    - Other structures present in the cytoplasm include the **plasmids**; these are small circular rings of DNA, carrying some of the bacterial genes (not all bacteria have plasmids).

4. They have a cell wall (differs in composition from plant cell wall) made up of sugars, proteins & lipids

5. Some species have flagella for locomotion.
6. Some species of bacteria have an outermost layer called capsule which protects it from phagocytes (white blood cells).

Reproduction of bacteria

They reproduce asexually by a process called **binary fission**. In this process bacterial cell divides into two → each cell becomes an independent bacterium.



In some cases, binary fission can take place every 20 minutes, so that in a very short time a large colony of thousands & thousands of cells (these are derived from the continuous division of the original bacterial cell) is produced. This is one reason why a small number of bacteria can seriously contaminate our food.

Respiration of Bacteria:

Bacteria which need oxygen for their respiration are called (aerobic bacteria). Those which do not need oxygen for respiration are called (anaerobic bacteria).

Nutrition of bacteria:

Bacteria can be:
1) **Parasites:** causing a variety of animal and plant diseases

2) **Decomposers:** (Saprobes) they release enzymes which digest the food outside the cell. The products of digestion are then absorbed back into the bacteria cell.

3) **Autotroph**s: has chlorophyll pigment e.g. blue – green bacteria.

The Effect of heat on bacteria:

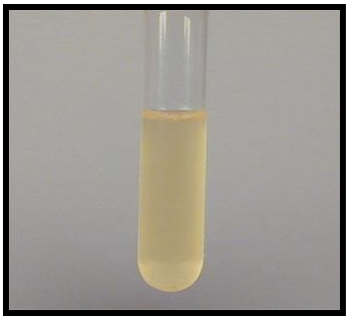
Bacteria, like any other living organisms, are killed by high temperatures. The process of cooking destroys any bacteria in food. However, some bacteria are able to produce spores upon exposure to high temperatures; these spores are **heat resistant spores** and can survive high temperature. When the conditions become favorable again (temp drops) spores transform back into **bacterial cells** that are capable of dividing and reproducing all over again (Method of survival).

Exploring the Bacterial World

As previously described, a bacterial cell is capable of dividing & producing new cells.

What is a bacterial Colony?

It is a group of cells with similar characteristics derived from continuous divisions of a single parent cell.

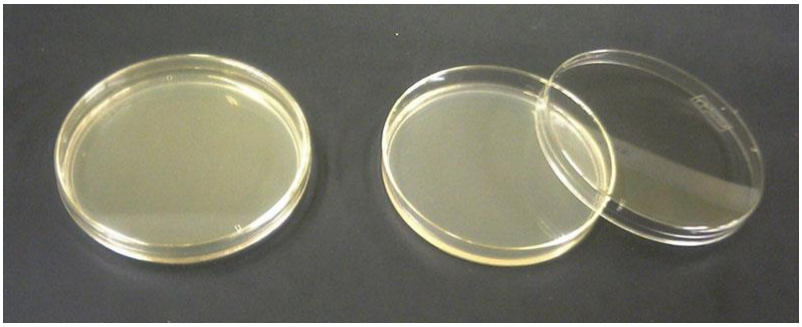


Culture Media: it is a medium that provides essential nutrients that allow bacteria (and fungi) to grow and divide.

Agar: jelly-like substance derived from seaweed. Agar is a substance used for growing bacteria. Agar contains nutrients that enable the bacteria to grow & divide. Normally, agar is readily prepared and placed in plates called Petri dishes; these are used for the purpose of studying bacteria.

How to observe bacterial colonies:

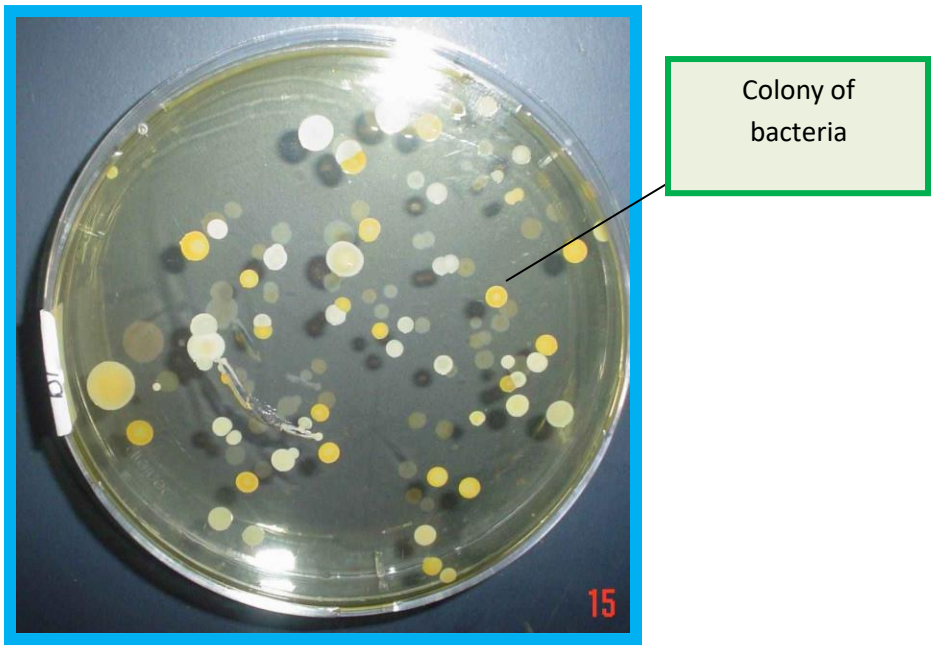
Simply remove the lid of the Petri dish containing the agar and leave it exposed to air for 10 minutes. Air contains many bacteria; some bacterial cells will fall onto the agar in the Petri dish.



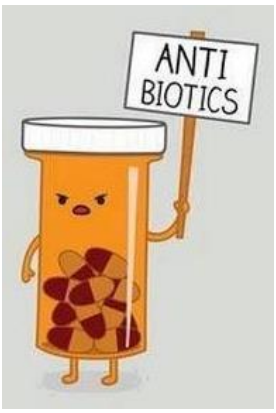
Place the Petri dish in an incubator (to provide suitable conditions for growth) for 24 hours and look for results.

Results:

Bacterial cells from air will start growing and reproducing in the Petri dish forming colonies of bacteria. A single bacterial cell ends up with a bacterial colony.



Testing Antibiotics:



Penicillin was the first antibiotic to be discovered

What are antibiotics?

Antibiotics are substances used to kill bacterial cells without harming our own cells.

Antibiotics work by targeting specific structures in the bacteria; some cause the bacterial cell membrane to break open and so killing the bacterial cell, while others prevent bacterial cell wall formation and so prevent them from dividing and forming new cells. The advantage of treating bacterial infection with antibiotics is that bacterial cells and human cells have different structures so antibiotics don't affect human cells, hence it is safe to use them.

Antibiotics have no effect on viruses because they are made of proteins and a single strand of DNA or RNA and thus antibiotics have no structural targets to work on.

Viruses:

- have no cell walls
- do not synthesize their own protein
- are only active inside living cells, thus they are protected by the host cell since most antibiotics cannot enter human cells

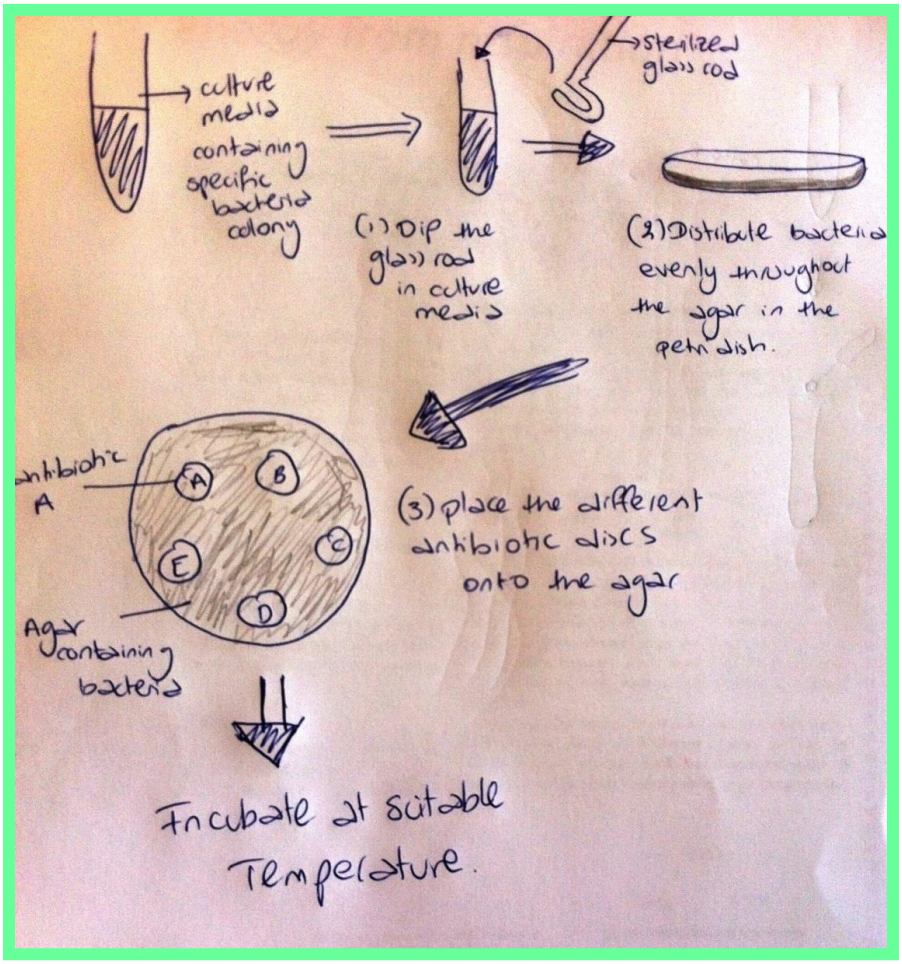
To treat viral infections we use **antivirals**.

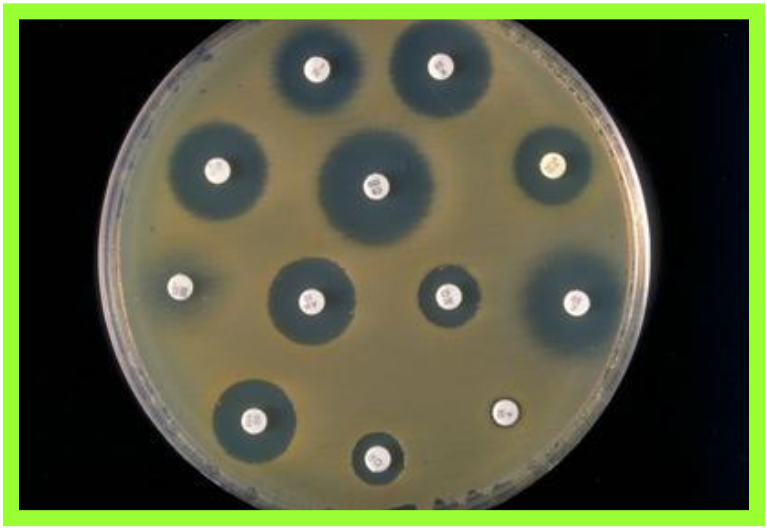
How do we determine the most effective antibiotic against a certain type of bacteria?

*Antibiotic discs can be made by simply cutting small circles of filter paper and soaking it in the desired antibiotic.

*The Antibiotic diffuses into the gel and prevents the growth of bacteria in the region surrounding the antibiotic (clear zone). The antibiotic with the largest clear zone diameter is the most effective one for this kind of bacteria.

The picture shows the appearance on the clear zones around the antibiotics at the end of the experiment.
Greatest diameter → most effective
Smallest diameter →least effective.





Counting bacterial cells:

Using a dropper, apply one drop (1ml) of diluted bacterial culture into a microscopic slide. Add a suitable stain to stain the cells and then count the cells using a cell counter under the microscope.
Then find out the number of cells in the flask by multiplying the number of bacterial cells counted in the drop by the volume of the flask.
For example:
1 ml (drop) → contains 70 cells
250 ml (flask volume)→ X
Cross multiply to find the number of cells in the whole flask then multiply with the dilution factor → Number of cells in the flask

Since this procedure is subject to error (because you might miss counting some cells) you should repeat it more than once to obtain more reliable results.

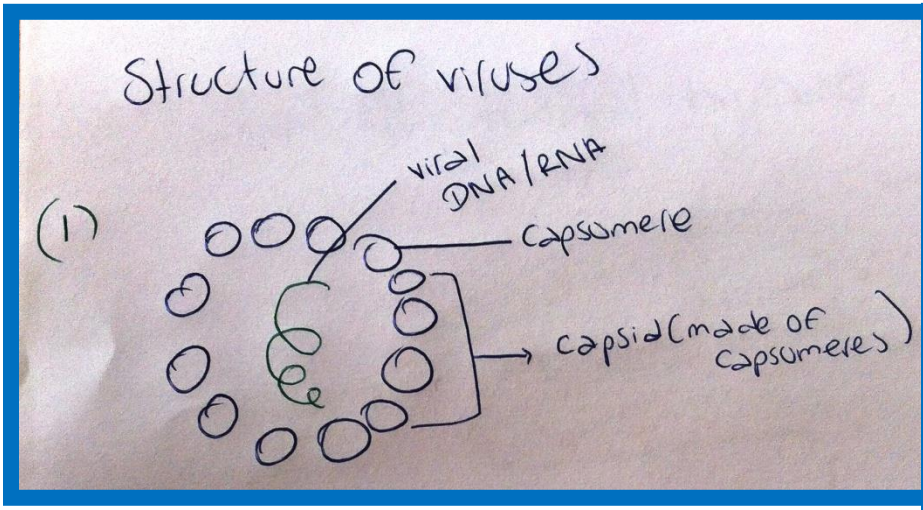
Using Keys:

A dichotomous key is a tool that allows you to determine the name of unknown organisms, such as trees, flowers, mammals, reptiles and fish. The Keys consist of a series of choices that lead you to the correct name of a given organism. "Dichotomous" means "divided into two parts". Therefore, dichotomous keys always give two choices in each step.

<u>Note: Where do you Find DNA in a cell?</u>
* Nucleus
* Chromosome
* Plasmid
* Mitochondria
* Chloroplast

Viruses

These are non-cellular organisms that are usually considered as particles because of their extremely small size.
Viruses are not included in the 5 kingdom scheme because they are non-cellular and lack many characteristics of living things.



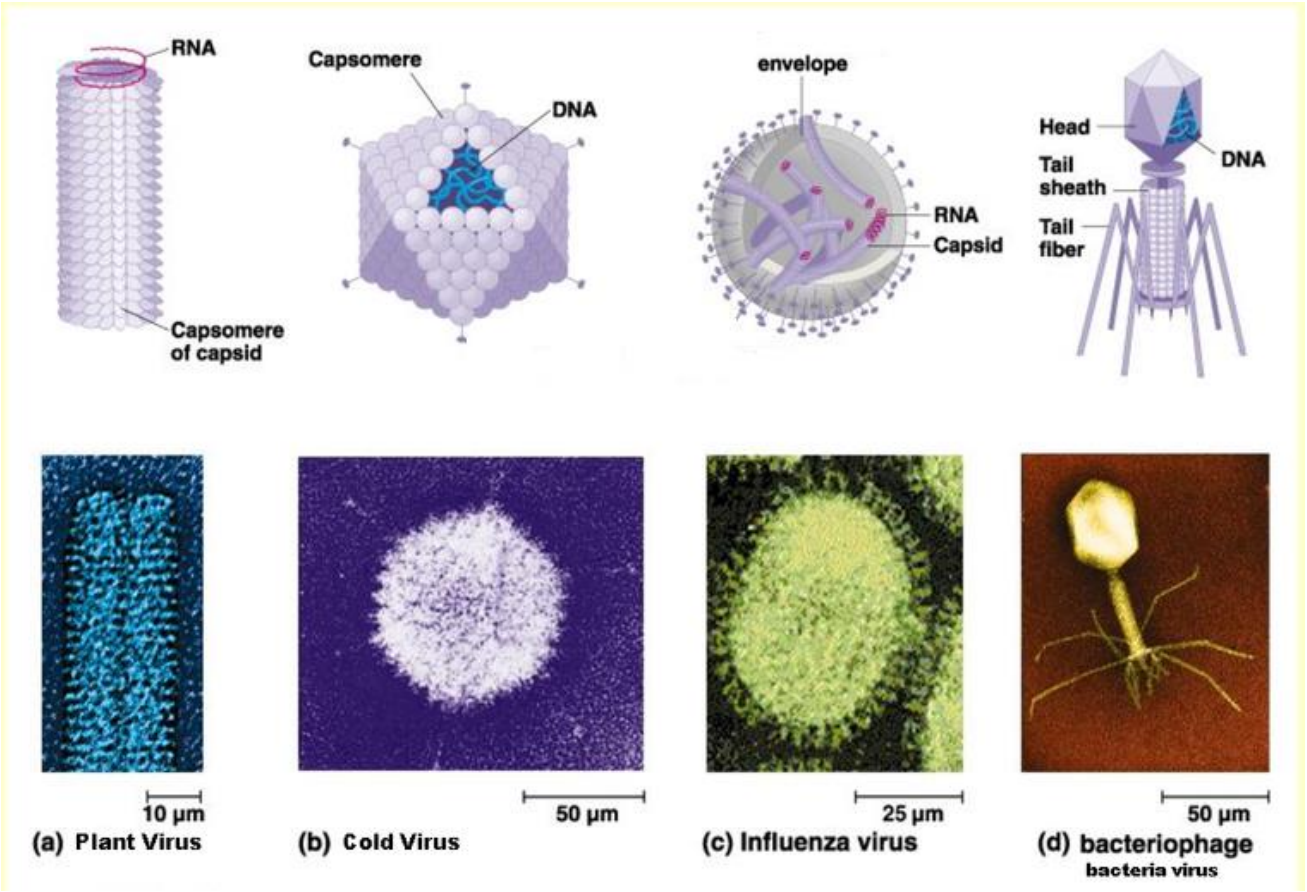
Viruses are made up of a DNA or RNA strand coiled up inside a protein coat called **Capsid**. Capsid is made up of protein units called **Capsomeres**

- Length: 0.1 (micrometer) 10^{-6} m
- Width: 20-30 nm (nanometer) 10^{-9} m

Viruses are about thousand times smaller than bacteria, and bacteria are much smaller than most animal cells. Viruses are so small that cannot be seen with a light microscope, but can be observed with an electron microscope.

Viruses can infect vertebrates, insects, fungi and bacteria.
Viruses that infect bacterial cells are called Bacteriophages.

The protein capsid of viruses can have different shapes:



General Features of viruses:

- All viruses are parasites that kill host cells as they reproduce inside them using the cell's energy & materials.
- They have a single strand of DNA or RNA coiled up.
- They have no nucleus, no cytoplasm, no cell membrane → Viruses are too small to contain organelles.
- Viruses are not active outside the host cell. They cannot reproduce, respire, move or excrete outside the host cell even if they were cultured in a lab with all the nutrients provided.

* Multiplication of viruses:

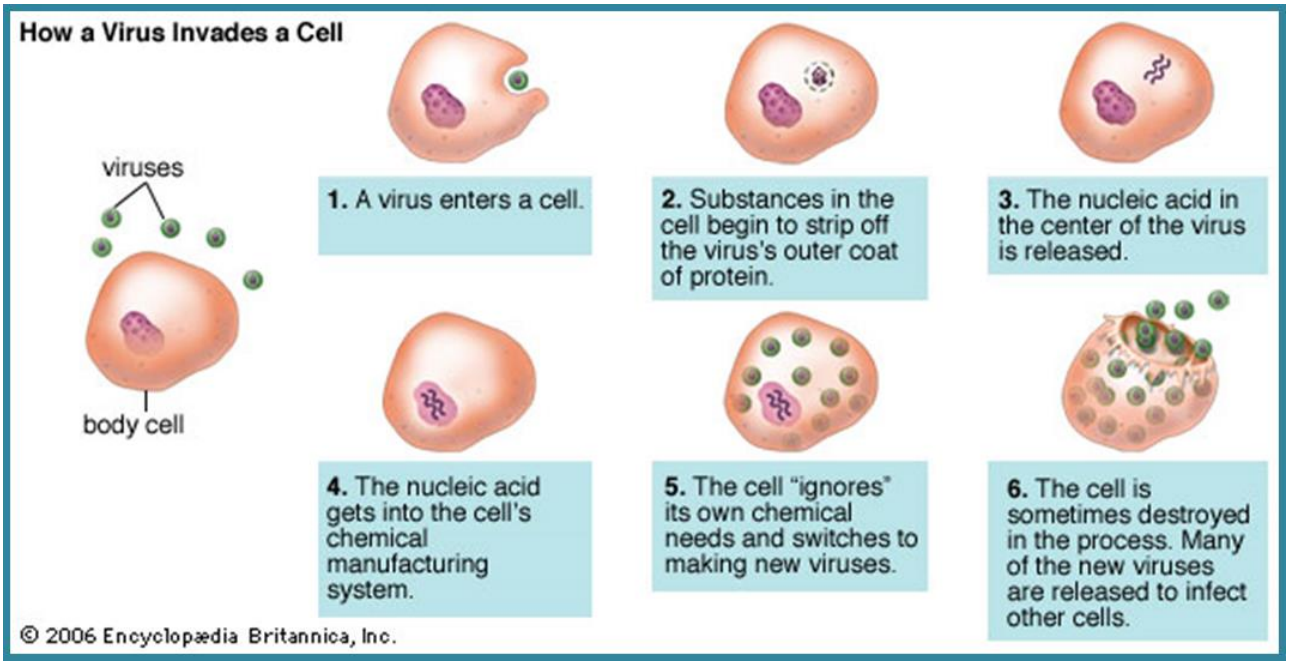
Viruses are found everywhere around us. They get into our bodies through mouth, nose, or even a cut in the skin. Once inside the body, a virus can recognize the proper host cell through special proteins found on the surface of the virus. That's why an influenza virus infects the cells of the respiratory tract while an HIV (the causative agent of AIDS) recognizes the cells of your immune system.

When a virus infects a cell, it usually has two goals:

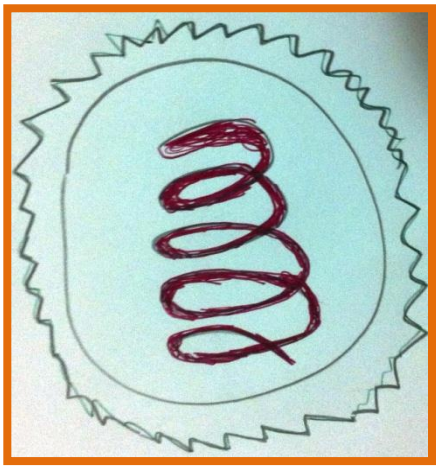
A. Replication of genetic material (DNA /RNA)
B. Production of capsid proteins and eventually forming new viral units.

Stages of viral Replication:

1. The viruses attach to the host cell membrane.
2. The virus enters the cell, the protein coat breaks down exposing the strand of DNA or RNA.
3. The DNA/RNA replicate forming many copies of DNA/RNA.
4. New protein coat will be produced by the host cell ordered by the viral DNA or RNA.

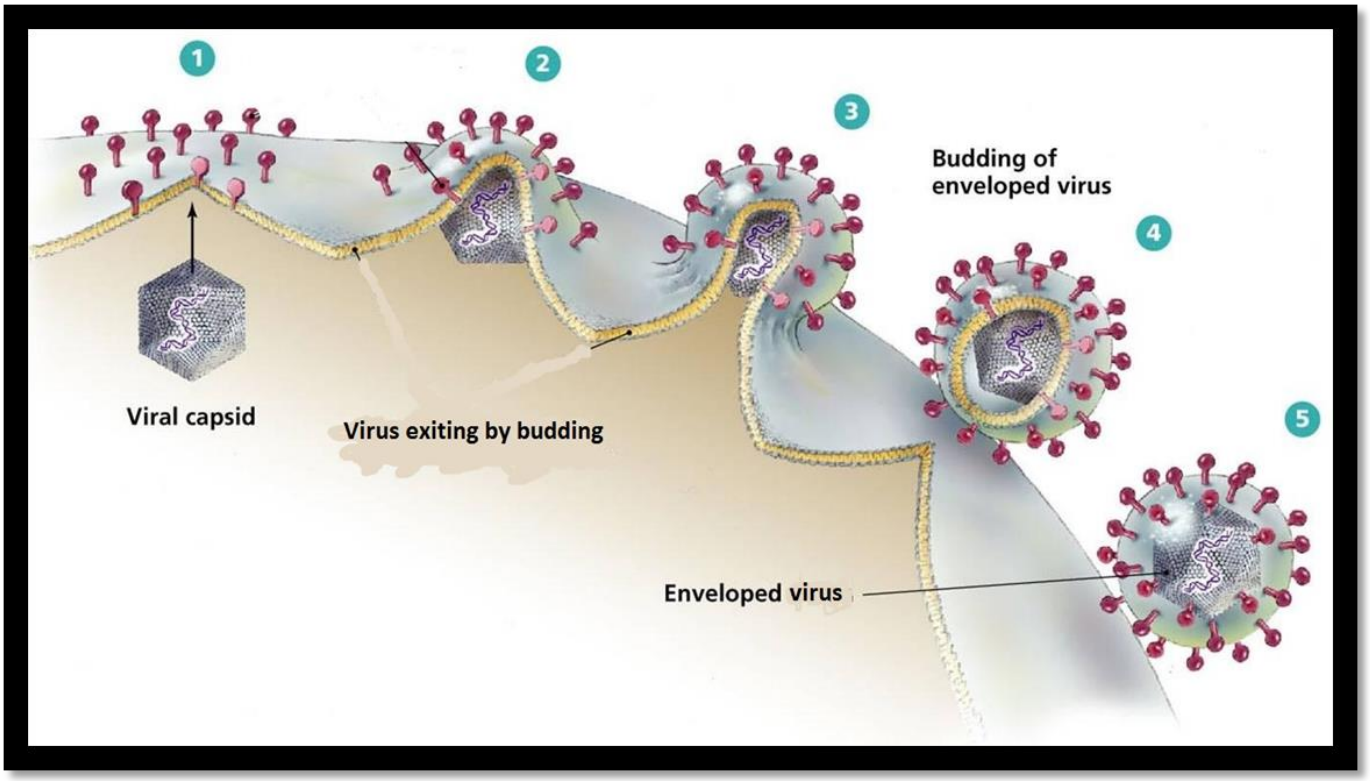


5. The DNA/RNA strands become packaged within the newly produced protein coats.
6. The new viruses then leave the cell either by bursting it open or by budding.



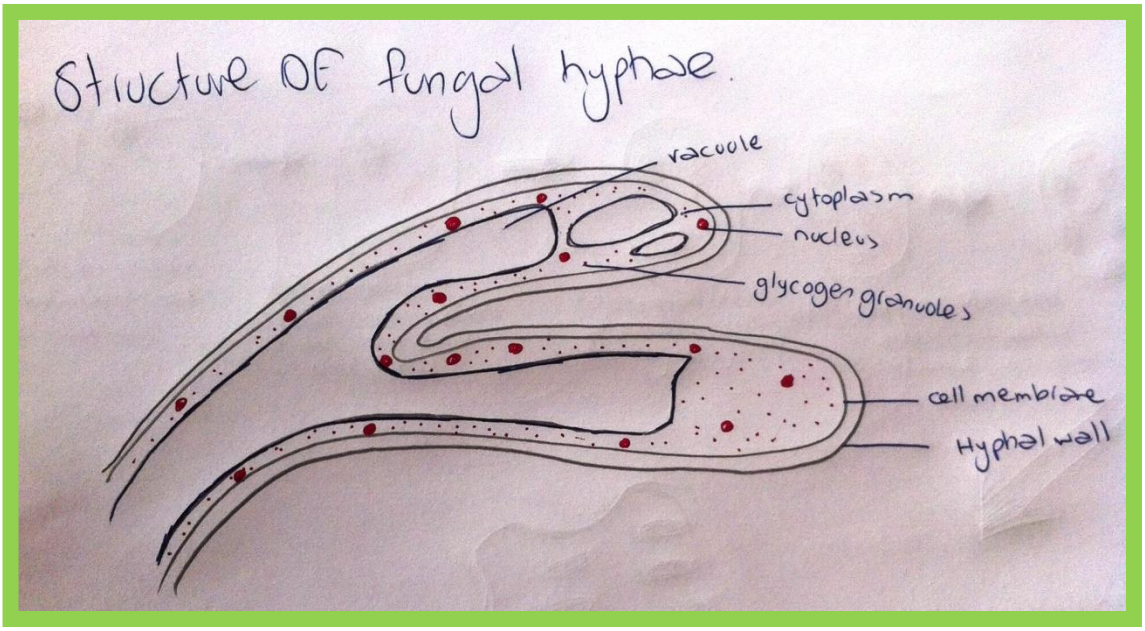
Note:
Some viruses exit the cell by budding (without bursting the cell) these viruses may acquire an envelope derived from the membrane of the host cell they infect. The figure on the right shows the structure of an **enveloped virus**.

* When a virus infects a cell it completely blocks the synthesis of the host cell proteins.
* Keep in Mind that viruses cannot be treated by antibiotics for the reasons mentioned earlier.

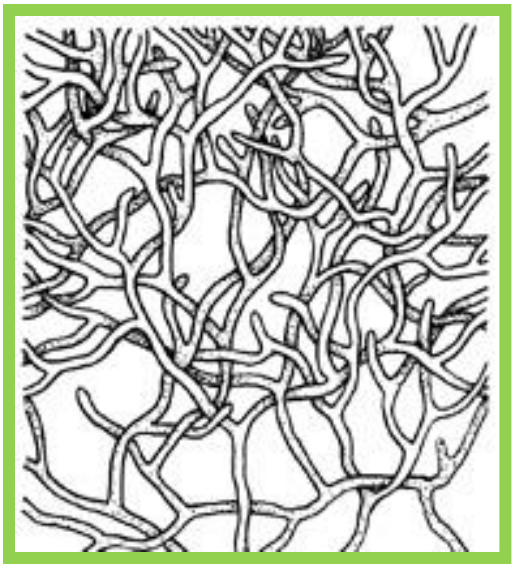


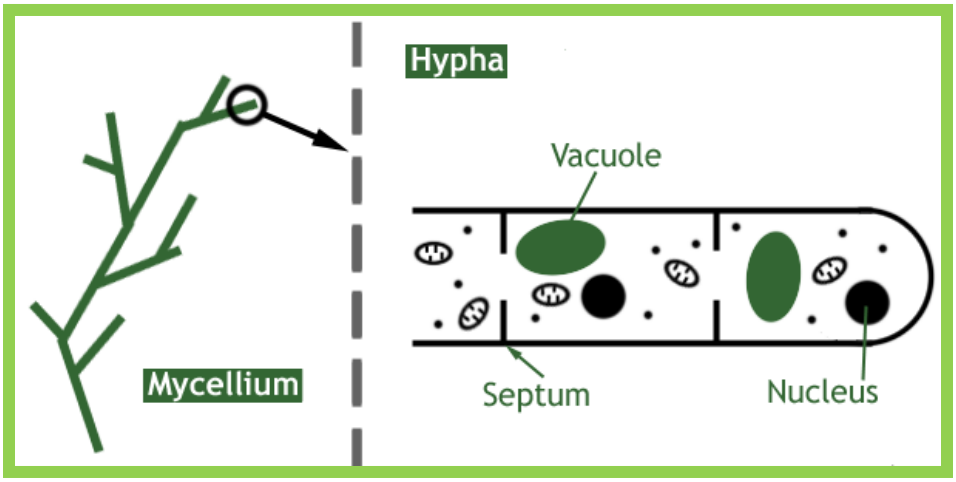
The Kingdom of Fungi

Fungi are multicellular organisms except for yeast, which is **unicellular** (made up of a single cell). Fungi consist of multicellular filaments (threads) called **hyphae.**

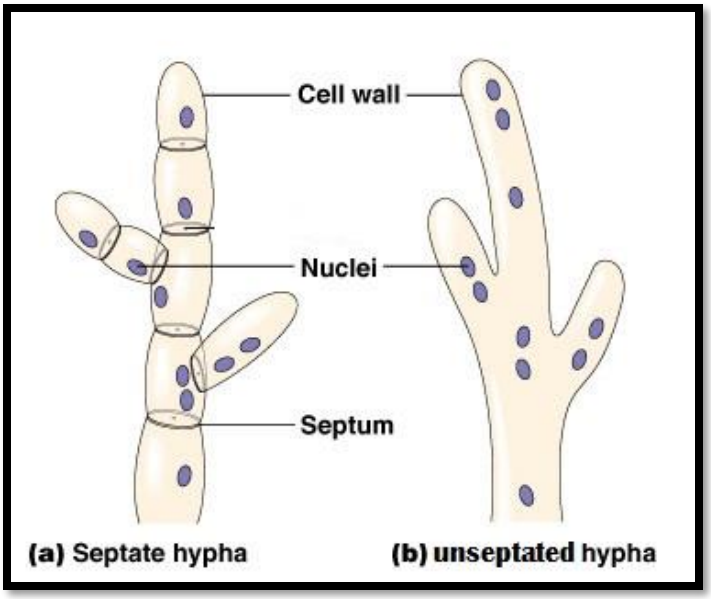


A network of Hyphae is called mycelium.





Some species have partitions called septa (singular: septum) that divide the hyphae (singular hypha) into cell-like segments.



*** Similar to animal cells in having glycogens granules as energy stores.**

*** Similar to plant cells in having large vacuoles.**

Features:

- They have a hyphal wall which is made up primarily of chitin.
- They have a cytoplasm that contains organelles, lipids & glycogen granules (la feature of animal cells). Fungi have no chloroplasts.
- They have large vacuoles (a feature of plant cells).

Nutrition of Fungi:

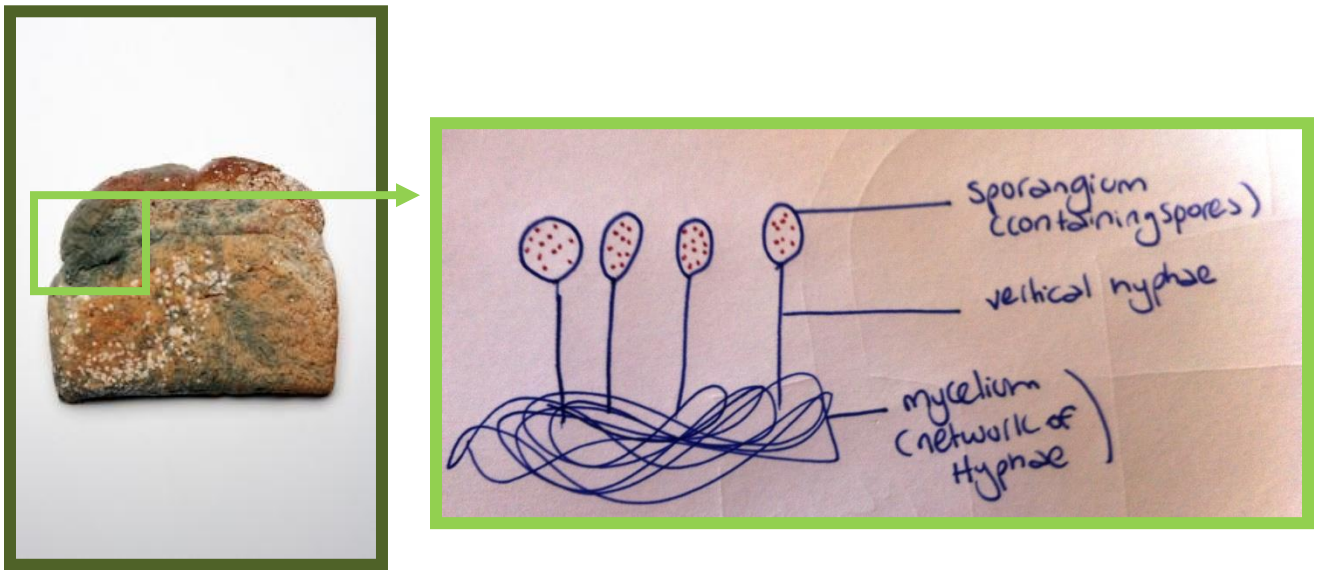
They don't have chloroplasts so they cannot carry out photosynthesis

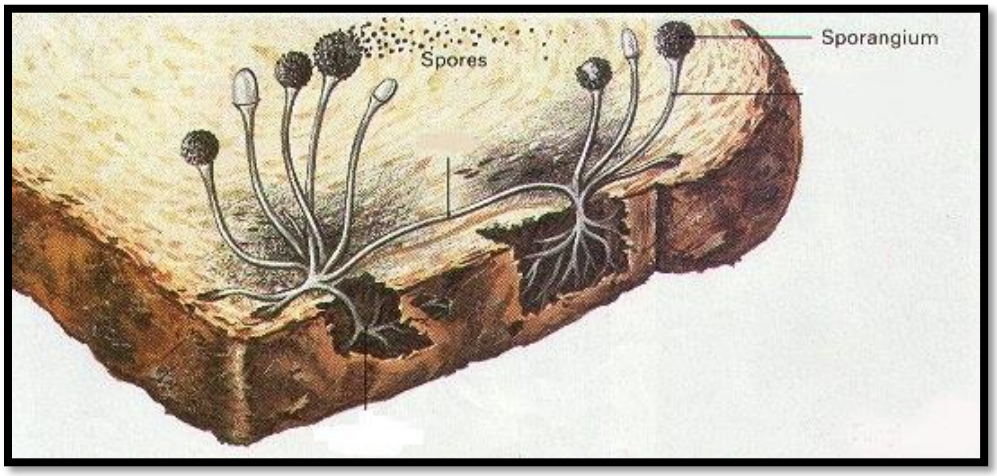
1) Some are parasites of animals and plants
2) Mainly they are saprobes (decomposers)

* Decomposers produce enzymes outside the feeding hyphae that digest organic matter (proteins, carbohydrate) then the digested molecules (amino acids, glucose) are absorbed into the fungus.
5) They reproduce asexually by formation of sexual spores. On the other hand, some fungi are capable of reproducing sexually by forming asexual spores that are kept within a structure called sporangium (plural: sporangia).

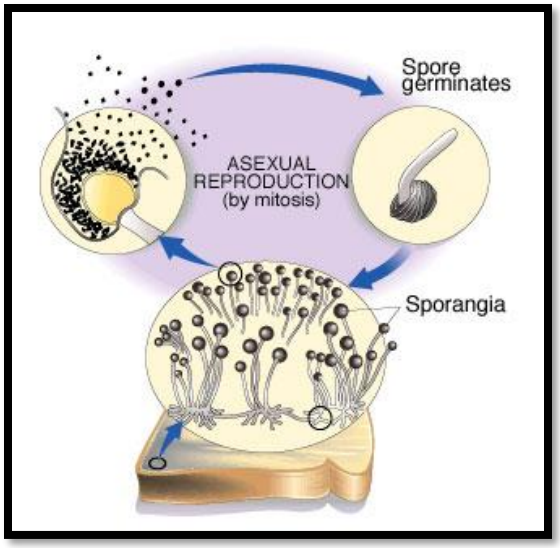
How Fungus spreads to new food sources.

e.g. Bread Mold .



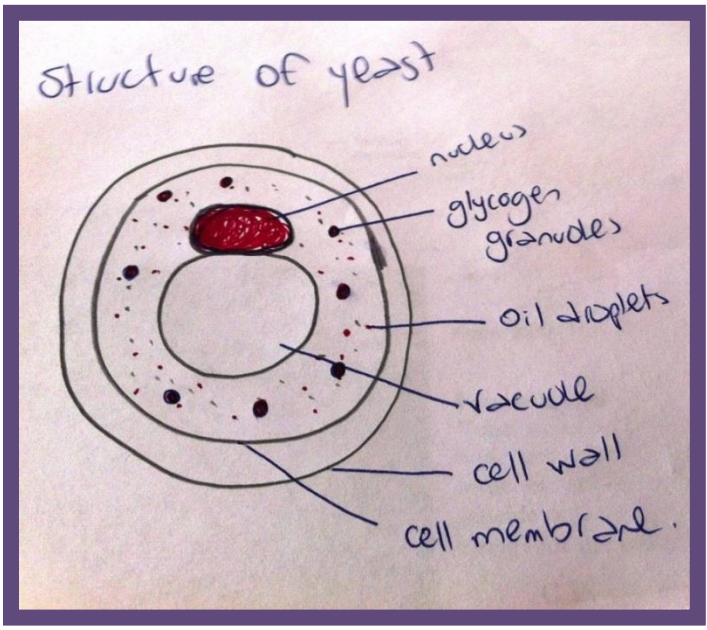


Sporangium contains **asexual spores**. When the sporangium bursts open, the spores are released & are dispersed in air. When a spore lands on suitable organic matter it germinates to produce a mycelium. That's why it is always recommended to remove the infected loaf of bread away from the uninfected ones because the fungus can spread and infect them all easily.



Yeast: The Unicellular Fungus

They consist of spherical, separate cells that can only be seen with the aid of the microscope.



Structure:

They have a cytoplasm that contains a nucleus, vacuole and granules of glycogen and other food reserves, enclosed by a cell membrane and a thin cell wall.

Respiration:

Yeast respires aerobically in the presence of oxygen and anaerobically in the absence of O2.

Anaerobic respiration:

- $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2 + 2ATP$
- Glucose →Ethanol + Carbon dioxide + Energy

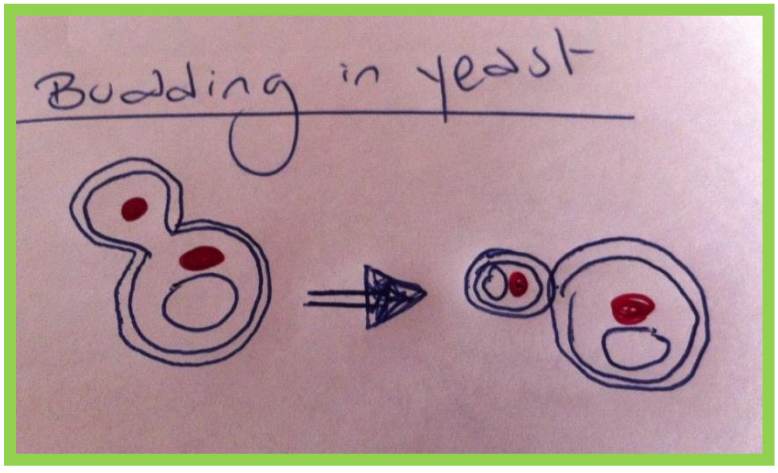
This reaction takes place when wheat flour, sugar & yeast are mixed with water to form dough. In the dough, the yeast respires anaerobically and the CO_2 produced

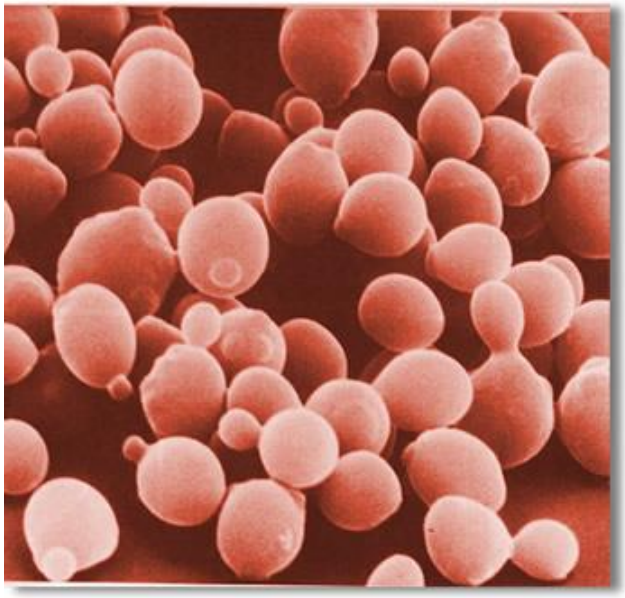
causes the dough to rise (the bubbles within bread) while the alcohol produced evaporates.

And that is the recipe for making bread

Reproduction:

Yeast reproduces by **budding**, which is a form of **asexual reproduction.** An outgrowth from the cell enlarges & is finally cut off as an independent cell.





Comparison between Fungi, bacteria and viruses

Feature	Fungi	Bacteria	Virus
Nucleus	**Present**	**Absent**	**Absent**
Cell membrane	**Present**	**Present**	**Absent (Protein Coat)**
Cell Wall	**Present (Made up of Chitin)**	**Present (made up of proteins sugar & Lipids)**	**Absent**

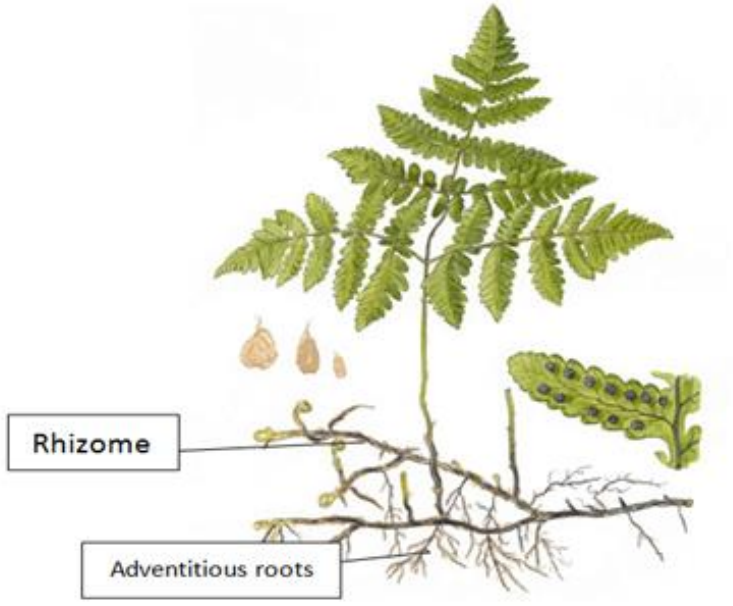
Plant kingdom

Features of the plant kingdom:

- Plants are autotrophic living organisms that can synthesize their own food by the process of photosynthesis.
- All plants contain the light absorbing pigment chlorophyll.
- All plants have a cell wall made up of cellulose.
- The plant kingdom is divided into 4 phyla but we will only consider two:
  1) **Ferns**
  2) **Flowering Plants**

The Phylum of Ferns:

- The stem of ferns is almost entirely found underground, and takes the form of a rhizome.
- The roots which grow from the rhizome are called adventitious roots.



- The stems and leaves of ferns have sieve tubes and vessels that carry water similar to phloem and xylem of flowering plants → that's why they are referred to as vascular plants because they all have vascular bundles.
- Most of fern leaves have an upper and lower epidermis and a layer of mesophyll cells similar to the leaves of flowering plants. Leaves of ferns are called **fronds** have the same appearance of bird feathers.

- They reproduce by spores. Spores are stored in a capsule structure called **sporangium.** Sporangia are formed on the lower side of the leaves. When spores fuse together the zygote gives rise to a new fern plant.

Phylum of Flowering plants
Class Monocotyledons
Class Dicotyledons

- **Monocotyledonous:** The seeds contain only one cotyledon examples: corn, wheat.

- **Dicotyledonous:** The seeds contain 2 cotyledons enclosed within a coat, such as beans (broad beans, french beans)

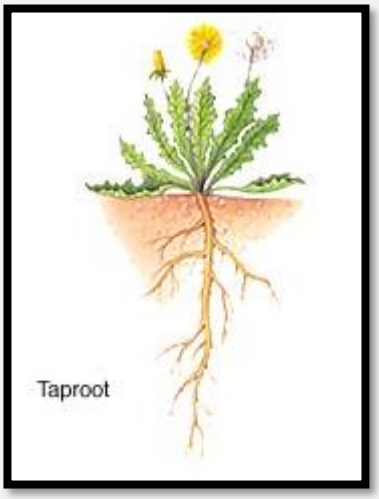
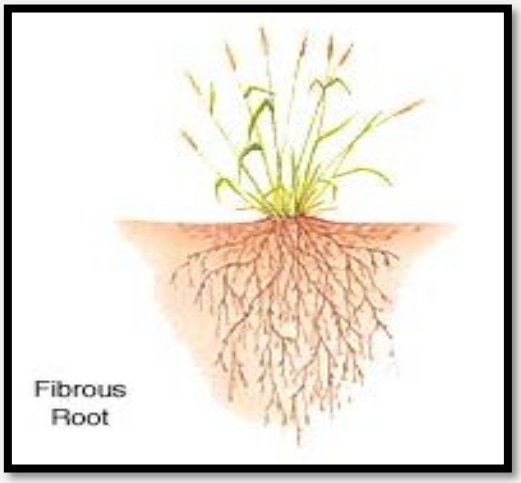
Main Features:

- They have a stem, leaves and roots.

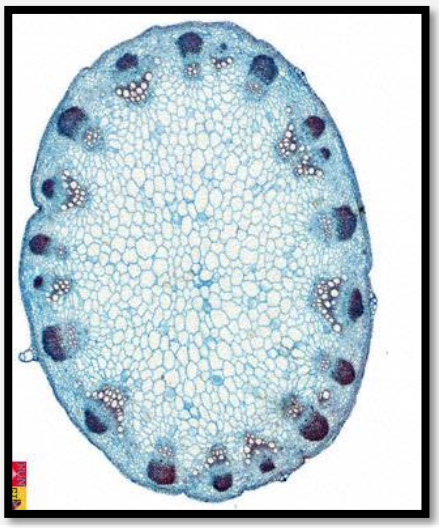
- They contain chloroplasts (chlorophyll) which is a green pigment used during the process of photosynthesis.

- They have a cell wall made up of cellulose.

Comparison between monocots and dicots :

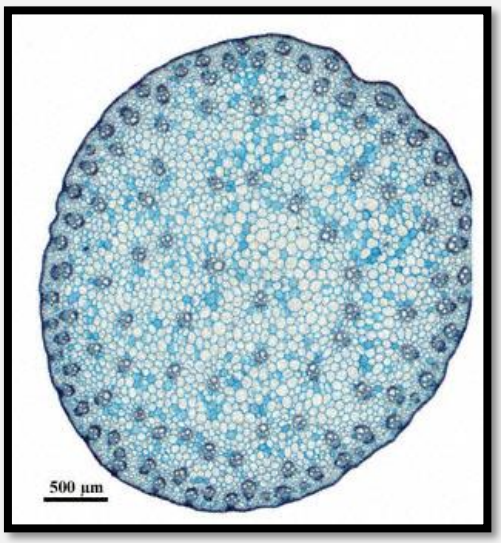
Dicots	Monocots
Two cotyledons (seeds give two leaves)	One cotyledon (seeds give one leaf)
Short and broad leaves	Long and narrow leaves
Veins are branched out of the midrib 	Veins are found a parallel pattern 
Have a petiole (leaf stalk)	No petiole (leaf stalk)
Stomata are mainly found in the **lower epidermis** of the leaf	Stomata (pores in the epidermis of the leaf) are **distributed evenly** on the upper and lower epidermis
Have main root from which lateral roots grow. 	The roots are branched and shallow (no main root) 
The petals (colored parts of the flower) are found in multiples of 4 or 5	The petals are found in multiples of 3

The vascular bundles (made up of xylem and phloem which make the transport system) are arranged in a circular pattern in the stem.



Vascular Bundles of dicots

The vascular bundles of the stem (made up of xylem and phloem which make the transport system) are scattered randomly

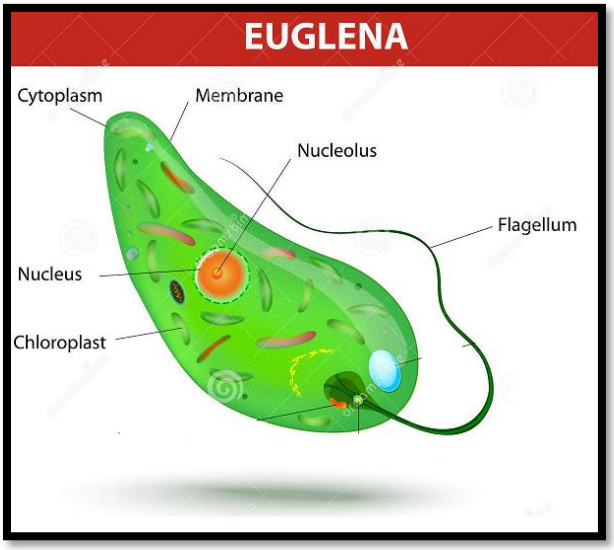


Vascular Bundles of Monocots

Kingdom of Protista

General Features:

- These are single-celled (unicellular) microorganisms
- Their genetic material is enclosed in a nuclear membrane to form a nucleus → eukaryotic cells
- Some have contractile vacuoles involved in maintaining the amount of water in the cell by removing excess water
- They reproduce asexually



Feeding:

Some of them have chloroplasts and can make their food by the process of photosynthesis e.g. *Euglena* (These are called unicellular plants or **protophyta**)

Some can take in and digest food by engulfing like amoeba.

Movement:

1) By pseudopodia → flowing movement of the cytoplasm, like amoeba.

2) By cilia → like paramecium

3) By flagella → like euglena and chlamydomonas