Unit 2:
Nutrition

Think and answer

a. What is the adult swallow doing in the photograph? Why?

b. Are all the substances that chicks need to keep alive present in foods?

c. What type of nutrition have birds and the rest of animals?

d. What are the droppings that we can see in the nest?

UNIT OBJECTIVES

In this unit you will learn:

- To compare the nutrition process in animals and plants.
- To describe the digestion, breathing, circulation and excretion processes in animals.
- To distinguish different kinds of digestion, breathing, circulation and excretion in animals.
- To identify the nutrition processes in plants.

1. Nutrition function.

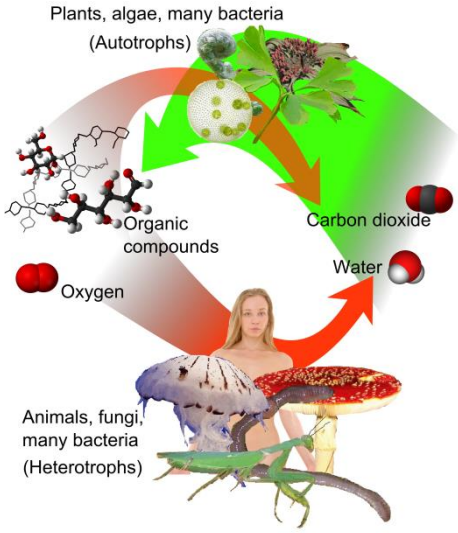
Nutrition is the joint of processes that allows living beings obtain matter and energy from the environment, in order to perform the vital functions and to grow and to replace the damaged or lost parts of their bodies.

Living beings can be classified by the type of nutrition they have into two groups: autotrophs and heterotrophs.

a) Autotrophic nutrition:

Living beings which make their own organic matter from the inorganic matter using any external source of energy are called **autotrophs**. Depending on the type of energy they use, autotrophs can perform:

- **Photosynthesis**. It is a chemical reaction which uses sunlight energy to synthesize organic matter. Plants, algae and some bacteria are photosynthetic organisms.
- **Chemosynthesis**. The energy to synthesize organic matter comes from other chemical reactions which take place inside the own cell. Only some types of bacteria are able to perform it.



b) Heterotrophic nutrition:

Living beings which are not able to make organic matter are called **heterotrophs**. They have to feed on organic matter produced by other living beings. They transform this food to obtain nutrients and energy. Animals, fungi, protozoa and some bacteria are heterotrophs.

According to the source they obtain their food, they can be:

- **Herbivores**. They feed on plants.
- **Carnivores**. They feed on other animals.
- **Omnivores**. They feed on both plants and animals.
- **Saprophytes**. They feed on decaying matter.

READING ACTIVITIES

After reading the text, copy and answer the following questions into your notebook:
Remember: you must make complete sentences.

1.1. Why is nutrition necessary for living beings?

1.2. Classify the following organisms into autotrophs or heterotrophs. What criteria have you followed?

1.3. Indicate the main difference between:

a. Photosynthesis - Chemosynthesis

b. Autotrophs - Heterotrophs

2. Nutrition in animals.

Animals are complex organisms:

- They are **heterotrophs** that is to say that they need obtain the organic matter elaborated by other living beings.
- They are **multicellular** organisms that is to say that their cells are not able to obtain nutrients directly from the environment.

For these reasons, nutrition function in Animals involves several processes:

- Digestion

Animals take organic matter from **foods** through a process called **feeding**. They have to transform these foods and extract from them the useful substances (**nutrients**).
These transformations are made by the **digestive system**.

- Breathing

Animals need **oxygen** (O_2) to carry out **cellular respiration**. This oxygen comes from the air and is obtained by the **respiratory system**. This is also the system that expels the **carbon dioxide** (CO_2) produced during the same process as waste.

- Circulation

It is the transport of nutrients and oxygen to every one of the cells of the organism. It is carried out by the **circulatory system**. This system picks up the waste substances and the carbon dioxide from every cell, too.

- Excretion

It is the expulsion of waste substances produced by the metabolism. It is made by the **excretory system**.

READING ACTIVITIES

After reading the text, copy and answer the following questions into your notebook:

2.1. What is the difference between nutrition and feeding?

2.2. Complete the following chart:

NUTRITION PROCESS	System that carry out it	Substances implicated
Digestion		
Breathing		
Circulation		
Excretion		

2.1. Digestion.

Digestion includes all the processes which break down foods to obtain from them the essential substances for life (**nutrients**) and the transformations that these nutrients suffer to change into simpler substances able to be absorbed by the organism.

a) Stages of the digestive process:

1st) Ingestion

It is the intake of food into the body through the mouth. It is also called **feeding**.

2nd) Digestion

It is the transformation of food into nutrients which the body can absorb.

There are two types of digestion:

- **Intracellular digestion.**
  It takes place inside the cells. It appears in Sponges, the most primitive animals, and in unicellular organisms such as protozoa, too.

- **Extracellular digestion.**
  It takes place outside the cells, within the digestive tube. It is characteristic of the rest of animals. The transformation of food is both mechanical and chemical.

  - **Mechanical digestion** includes chewing and crushing which break down food in smaller pieces.

  - **Chemical digestion** involves chemical transformation complex nutrients into simpler ones through the action of the **enzymes** present in the digestive juices.

Most part of animals carries out digestion into their body (**internal digestion**), but some of them, such as spiders carry out it outside their body ingesting the nutrients already digested. This kind of digestion is called **external digestion**.

3rd) Absorption

It is the passage of simple nutrients from the digestive tube into the blood.

4th) Egestion

It is the elimination of undigested and waste products from the digestive tube. Most pat of animals transform these products into **faeces**. This type of egestion is called **defecation**.

b) Types of digestive systems:

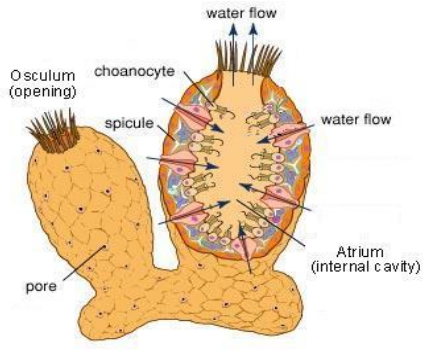
- Animals without digestive system:

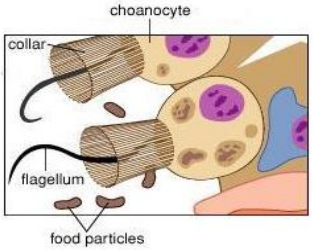
There is only an Animal phylum that does not have digestive system, *Poriferans*.

Their bodies are bag-shaped and they are hollow. The inner space is called **atrium**. The body wall is full of **pores**. They have a bigger opening called **osculum**.

They feed by **filtration**. Water enters by the pores and exits though the osculum.

Nutritive particles of water are caught by the cells that covered the atrium (**choanocytes**) and digested (**intracellular digestion**). These cells have a flagellum that is responsible for creating the water flow through the sponge.





- Animals with digestive system:

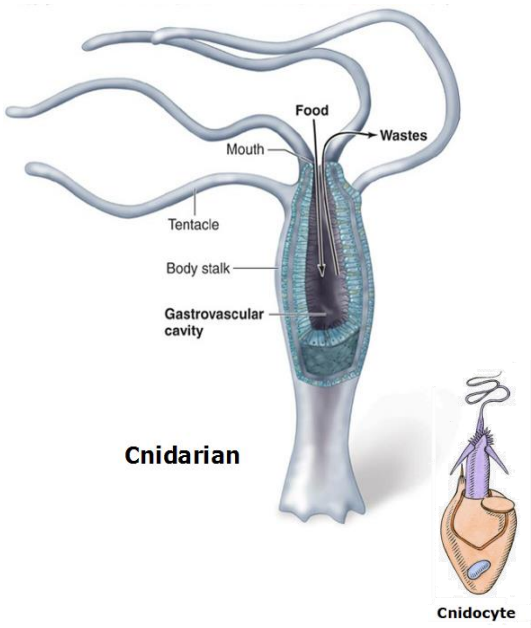
The digestive system can be:

- **Gastrovascular cavity.**

It is a body cavity lined by specialised cells with only one opening to the exterior that works at the same time as mouth and anus. This opening is surrounded by tentacles with stinging cells (**cnidocytes**) which functions are to capture prey and to defend from predators.

The specialised cells which lined the gastrovascular cavity produce enzymes that are released into the inside and act over the food, digesting it. These cells also absorb the nutrients and expel the waste substances.

It is characteristics of animals with **extracellular digestion**, such as *Cnidarians* (anemones, jellyfish and corals) and *Platyhelminthes* (planarian, taenia, etc)



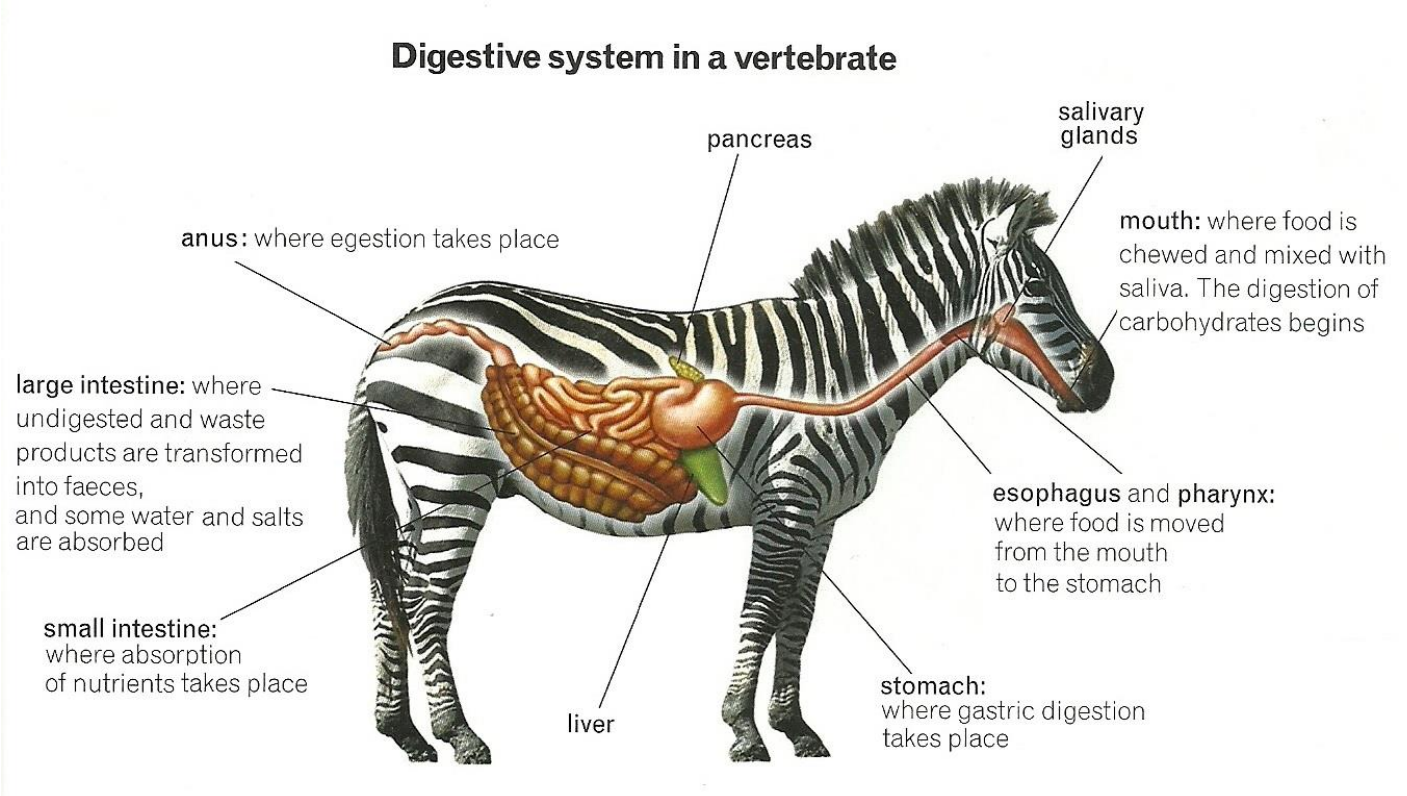
- **Digestive tube.**

It is a tube that runs through the body. It has an opening through which food enters the body (mouth) and an opening through which feaces are expelled to the exterior (anus).

The tube is divided into different parts with different functions (oesophagus, pharynx, stomach, small and large intestine). Along the tube there are **accessory glands** (salivary glands, pancreas and liver) that produce digestive juices which contain enzymes.

This system is characteristic of the rest of animals that have **extracellular digestion**.

The different types of feeding have provoked the development of **adaptations**:
- to catch food, such as tentacles, tongues, lips, etc.
- to ingest it such as teeth, beaks, etc.
- to digest it, such as the specialized stomach of ruminants that have four chambers.



READING ACTIVITIES

After reading the text, copy and answer the following questions into your notebook:

2.3. Why is necessary that animals digest the food they take in?

2.4. What is the difference between:

a. Excretion – Egestion

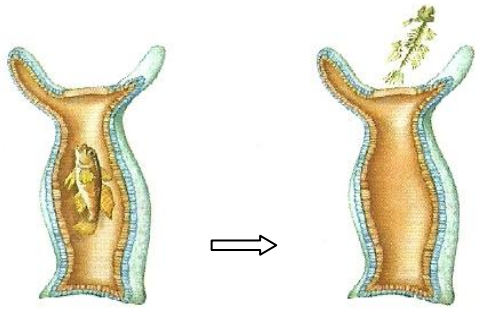
b. Mechanical digestion – Chemical digestion

2.5. Pictures represent an anemone digesting a prey.

a. What type of digestion is it?

b. Explain the process.

c. How is called this kind of digestive system? Why?



2.2. Breathing.

Inside every cell, **cellular respiration** takes place. Thanks to this chemical reaction all living beings obtain energy from the organic matter. This energy is used to stay alive and to grow.

To carry out cellular respiration, living beings need oxygen that they have to take from the exterior through **breathing**. By the same mechanism, they expel the carbon dioxide that is produced during the process as waste substance.

In animals, breathing is performed by the **respiratory system**, because not all cells are able to take the oxygen from the external medium directly.

a) Characteristics of the respiratory surfaces:

Breathing requires surfaces where gas exchange can take place effectively. These surfaces are very **thin**, **moist** and covered in **blood vessels**. This makes it easier to take oxygen into the blood stream and to expel carbon dioxide out.

b) Types of respiratory systems:

The simplest animals (*Cnidarians* and *Poriferans*) do not have respiratory system. Gas exchange is performed by the whole **body surface**.

The rest of animals have a **respiratory system** adapted to the medium they live in, and associate to the circulatory system that transport gases to the cells and from them to the outside of the organism.

- Cutaneous respiration.

It belongs to *Annelids* (earthworms) and adult *Amphibians*, although they have pulmonary respiration too.

The **skin** of these animals is very thin and they keep it always moist.

In addition, there are numerous blood vessels close to it, which makes easier the gas exchange.

- Tracheal respiration.

It is exclusive of terrestrial *Arthropods* (Arachnids, Insects and Myriapods).

It is made through **tracheae**. This respiratory system consists on a system of tiny tubules that branch into the body. Tracheae open to the exterior by an orifice called **spiracle** where the air enters. As they enter into the body they turn more and more thin.

Tracheae carry oxygen directly to cells. So that, it is not necessary that the circulatory system transport neither the oxygen nor the carbon dioxide.

- Branchial respiration.

It belongs to aquatic animals, such as some *Annelids* (Bristle worms), *Molluscs* (clams, squids, sea snails, etc), *Crustaceans* (prawns, lobsters, crabs, etc), *fish* and young of *Amphibians* (tadpoles).

Gas exchange is made through the **gills**, thin extensions of the body surface with a lot of blood vessels. They can be internal or external gills.

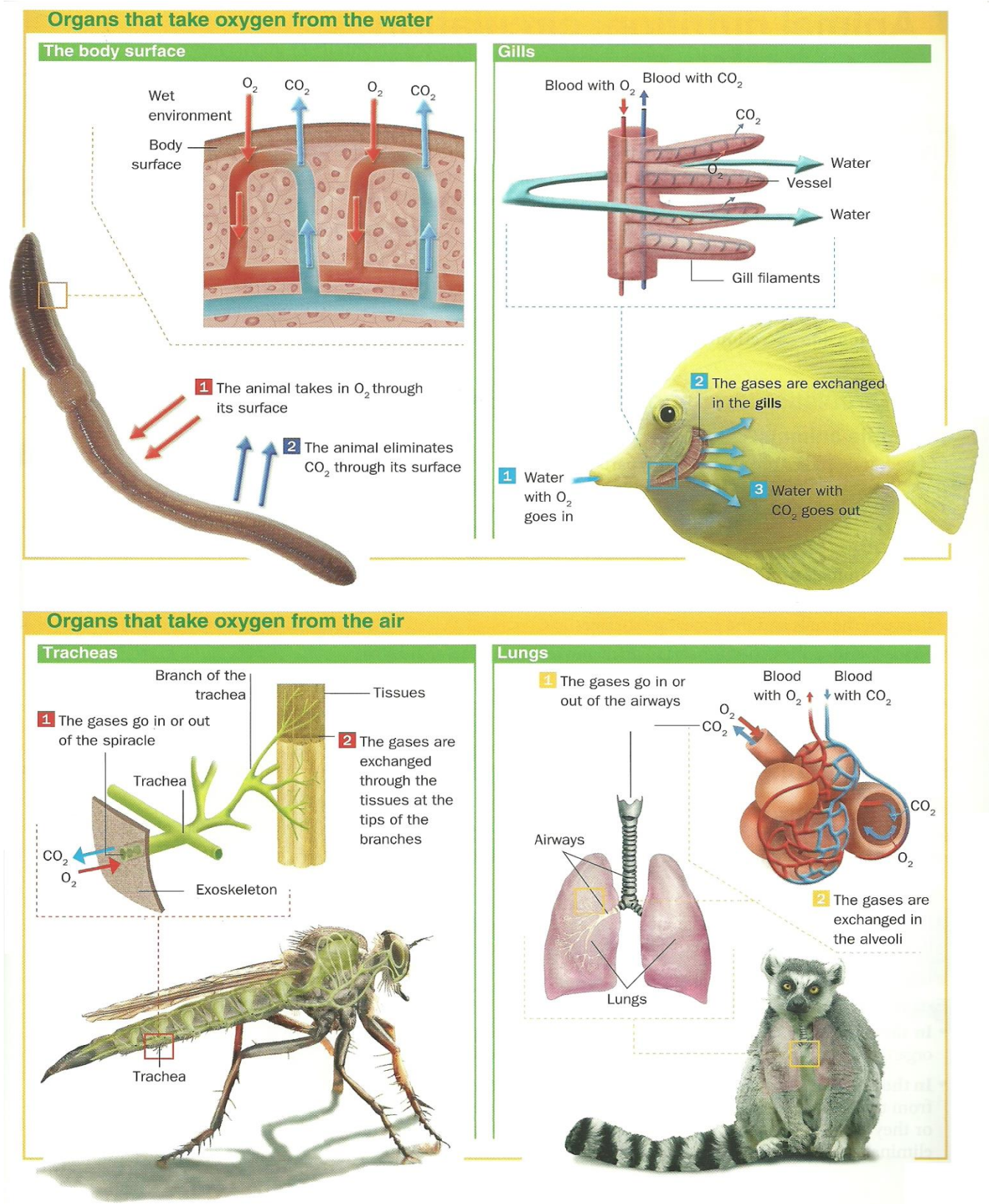
- Pulmonary respiration.

It is typical of most *Vertebrates* (Mammals, Birds, Reptiles, Amphibians), but also of some *Invertebrates* such as snails.

It is made through the **lungs**. These organs are internal cavities which have very thin and damp walls, full of blood vessels. Lungs are connected with the exterior by **airways**.

Respiration takes place in two different movements. **Inhalation**, when air is taken into the lungs and **exhalation** when air is expelled from them.

- *Amphibians*' lungs are simple hollow sacs. Their pulmonary respiration is very inefficient so that they complement it with cutaneous respiration.
- *Reptiles*' lungs have some internal folds. The exchange surface is larger and their respiration is more efficient.
- *Mammals*' lungs have a large exchange surface due to they have numerous tiny sacs (**alveoli)**.
- *Birds* have very specialized lungs with **air capillaries** and expansions (**air sacs**) that make the exchange much more efficient than in other groups of Vertebrates.



READING ACTIVITIES

After reading the text, copy and answer the following questions into your notebook:

2.6. Answer these questions:

a. Why do living beings need oxygen?

b. Why do sponges and jellyfish not have a respiratory system?

c. Why do Amphibians need to have cutaneous respiration if they have lungs?

2.7. List the characteristic that exchange gaseous surfaces have to have. Why do they have them?

2.8. When there is a lack of oxygen, some aquatic Annelids stretch their bodies until they have almost twenty times their original size.

a. What type of respiratory system do theses worms have?

b. What advantage do they obtain to stretch their bodies?

2.3. Circulation.

Once nutrients and oxygen have been absorbed, it is necessary carry them to every cell of the body.

The simplest animals (*Poriferans* and *Cnidarians*) do not need a circulatory system because most part of their cells is in contact with the external medium and the exchange can be direct.

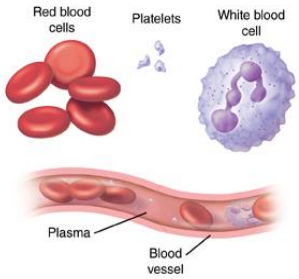
The rest of animals need a distribution system which assure the transport of useful substances from the absorption organs to every cell and of useless substances from cells to the excretory organs.

a) Components of the circulatory system:

The circulatory system is made up of:

- **Transport liquid**.

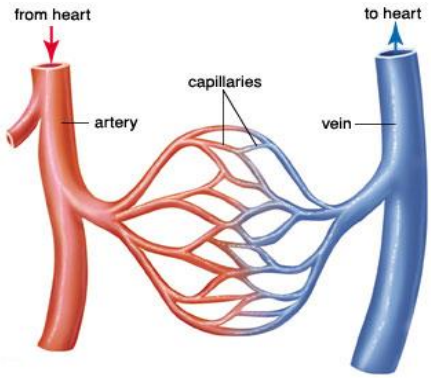
It is a fluid which flows within the body carrying nutrients and wastes.
Echinoderms have **hydrolymph** and *Arthrophods* have **hemolymph.**
Vertebrates and *Annelids* have **blood.**
Blood is composed by water with different substances (blood plasma) and different kinds of cells:



- Red blood cells (they transport oxygen)
- White blood cells (they defend the body against infection)
- Platelets (they coagulate the blood)

- **Vessels**.

They are the ducts through which the transport liquid flows.
Vertebrates have three types:

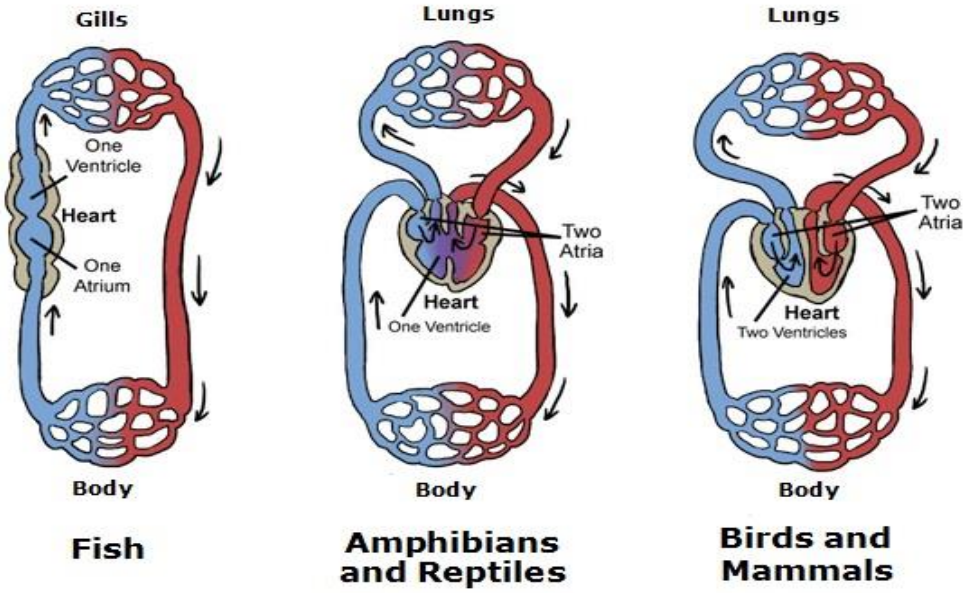


- Arteries. They are the vessels through which blood exits from the heart.
- Veins. They are the vessels through which blood enters into the heart.
- Capillaries. They are the smallest vessels of very thin walls through which substance exchange is made between blood and tissues.

- **Heart**.

It is muscular organ which pumps the transport liquid.
It is a simple vesicle in *Invertebrates* and has several chambers in *Vertebrates*.

- Fish's heart has an atrium and a ventricle.
- Amphibians and Reptiles' heart has two atria and one ventricle.
- Birds and Mammals' heart has two atria and two ventricles.



b) Types of circulatory system:

There are two kinds of circulatory systems:

- **Open circulatory system**.

It is characteristic of most of the invertebrates, such as *Molluscs* and *Arthropods*.

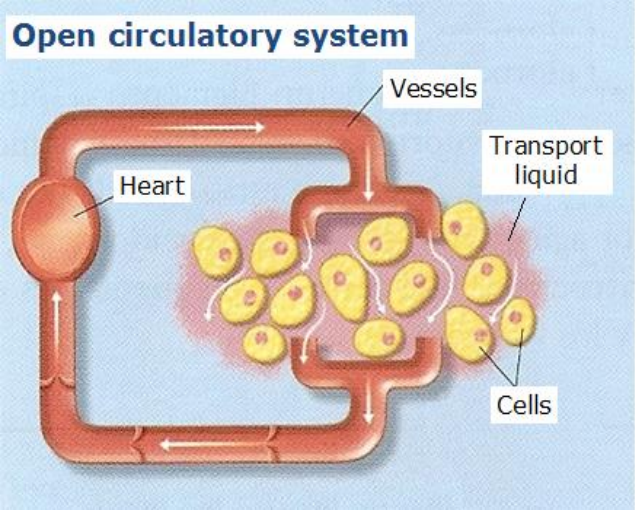
Vessels do not form a close circuit. There are not capillaries.

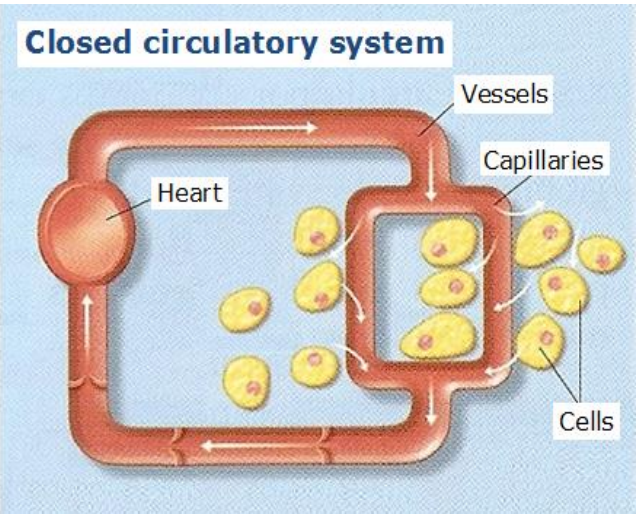
Hemolymph exits from the vessels to the tissues, where the substance's exchange is made directly between the cells and the transport liquid and then, it is pick up by other vessels and returns to the heart.

- **Closed circulatory system.**

It is characteristic of *Vertebrates*, *Annelids* and *Cephalopods* (octopuses, squids, etc)

Blood vessels form a closed circuit. Blood never exits of them. Substance exchange is made between the cells and the blood through the capillaries.





In *Vertebrates*, the circulatory system can be simple or double:

- **Simple closed circulatory system**.

Blood passes through the heart once, completing one loop.

The blood goes from the heart round the body, passes through the gills, where it is oxygenated and then returns to the heart.

It is the circulatory system of *Fish*.

- **Double closed circulatory system**.

Blood passes through the heart twice, completing two loops:

- Pulmonary or **minor circulation.**
The blood goes from the heart to the lungs where it picks up oxygen and releases carbon dioxide. Then it returns to the heart.

- Systemic or **major circulation.**
The blood goes from the heart to the body bringing oxygen to the cells and collecting carbon dioxide from them. Then it returns to the heart.

Amphibians and *Reptiles* have a heart with only one ventricle where oxygenated and deoxygenated blood mix. They have **incomplete circulation**.

In contrast, *Birds* and *Mammals* which heart has two ventricles, has **complete circulation** because the oxygenated blood never mixes with the deoxygenated blood.

READING ACTIVITIES

After reading the text, copy and answer the following questions into your notebook:

2.9. Which are the circulatory system functions?

2.10. Which are the components of a circulatory system?

2.11. What is the difference between:

a. Arteries – Veins

b. Closed circulatory system - Open circulatory system

2.12. Explain why:

a. Insects have a very little developed circulatory system

b. It is said that frogs have incomplete circulation

2.4. Excretion.

Excretion is the process of collecting waste products and expelling them outside the body.

Wastes include carbon dioxide (CO_2) and substances rich in nitrogen, such as ammonia and urea. Carbon dioxide is eliminated by the respiratory system and nitrogen-containing substances are eliminated by the **excretory system**.

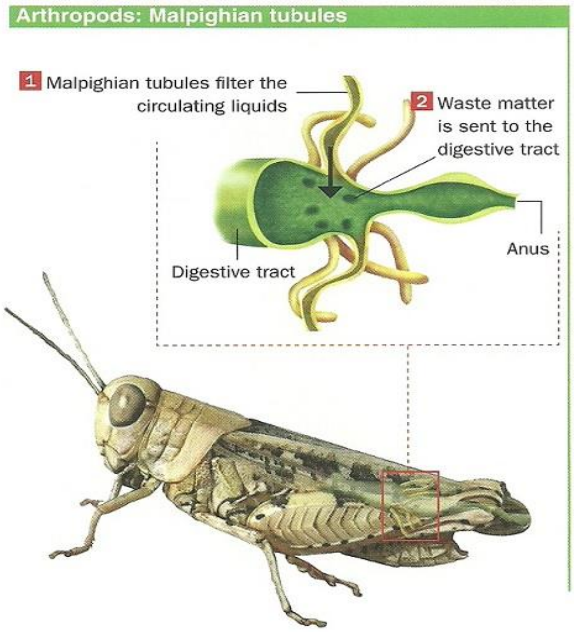
Simplest animals (*Poriferans* and *Cnidarians*) expel waste substances directly from each cell to the external medium, so that they do not need an excretory system. The rest of animals need a system which filters the blood and expel these wastes outside of their bodies.

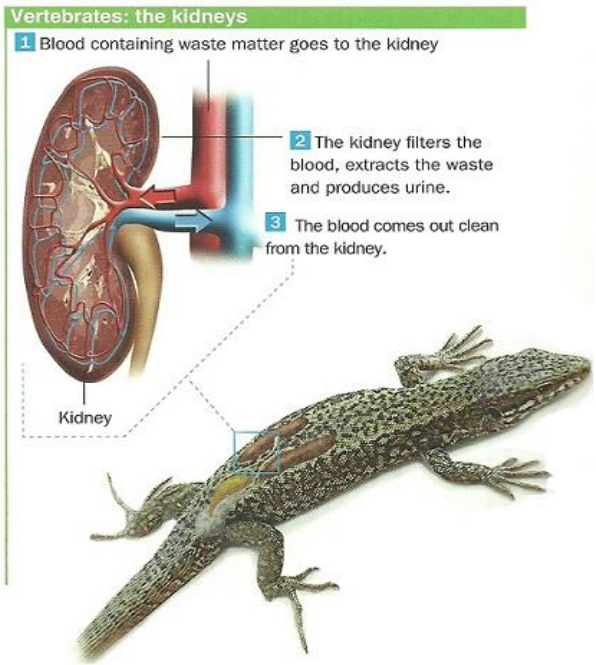
Different types of invertebrates have different excretory organs. For example:

- *Insects* have **Malpighian tubules**. They are tiny blind tubules distributed inside the abdominal cavity. These tubules filter the hemolymph and pour the waste substances to the digestive tract.
- *Crustaceans* have two excretory organs near antennae (**green glands**) that make the same function.

Vertebrates have different ways to expel waste substances. The main one is the **urinary system**. It is composed by the kidneys, the ureters, the urine bladder and the urethra. Kidneys filter blood and produce urine constantly. Urine is stored in the urine bladder and when it is full, urine is expelled to the exterior.

Mammals also have **sweat glands** which produce sweat, a substance similar to urine but much more diluted. Marine *Birds* and *Reptiles* and some *Fish* which drink salt water have specialised organs (**salt glands**) which expel the excess of salt from their bodies.





READING ACTIVITIES

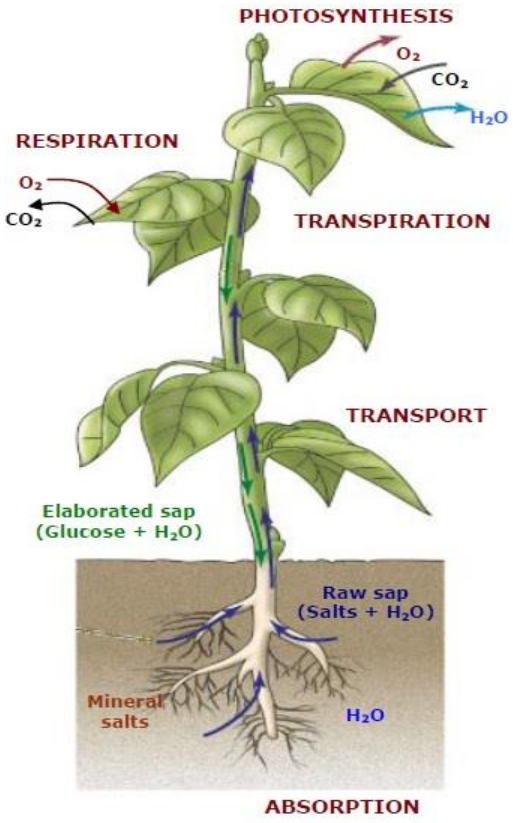
After reading the text, copy and answer the following questions into your notebook:

2.13. Indicate why:

a. It is said that the respiratory system have excretory function.
b. Marine birds can drink salt water.
c. Although kidneys produce urine constantly, this is eliminated only from time to time.

3. Nutrition in plants

We can differentiate several phases in plant nutrition:



a) Absorption:

Plants take *water* and *mineral salts* from the soil through their roots. The mixture of these substances is called **raw sap**.

b) Transport:

Raw sap ascends from roots to leaves through the conductive vessels of the **xylem**.
Once transformed in **elaborate sap** is distributed to every cell through the conductive vessels of the **phloem**.

c) Transpiration:

The excess of water that plants absorb through their roots is expelled to atmosphere through the **stomata**, in a process called transpiration. This process helps raw sap to ascend.

d) Photosynthesis:

Plants use the energy from sunlight and inorganic matter (carbon dioxide and water) to produce organic matter (glucose) through this chemical process. All green parts of the plant perform photosynthesis.

This process is done within the **chloroplasts** that contain **chlorophyll**. This pigment can catch the energy of sunlight and transform it in chemical energy. Then this energy is used to make organic substances from the inorganic ones.

Raw sap provides water for the photosynthesis and carbon dioxide is absorbed by the stomas.

During the process, besides glucose, **oxygen** is produced and plants expel it to the atmosphere.

We can represent the reaction of photosynthesis as:

$$\mathbf{H_2O + CO_2 + Sunlight \rightarrow Glucose + O_2}$$

In this way, raw sap is changed into **elaborated sap** that is a mixture of water and glucose.

e) Respiration:

As all living beings, plants need energy to carry out vital functions. To obtain it, every cell burns organic matter in their **mitochondria**. This process is called **cellular respiration** and produces water and carbon dioxide besides energy. To do it, the cell needs oxygen that is absorbed by the stomas.

The reaction of respiration is:

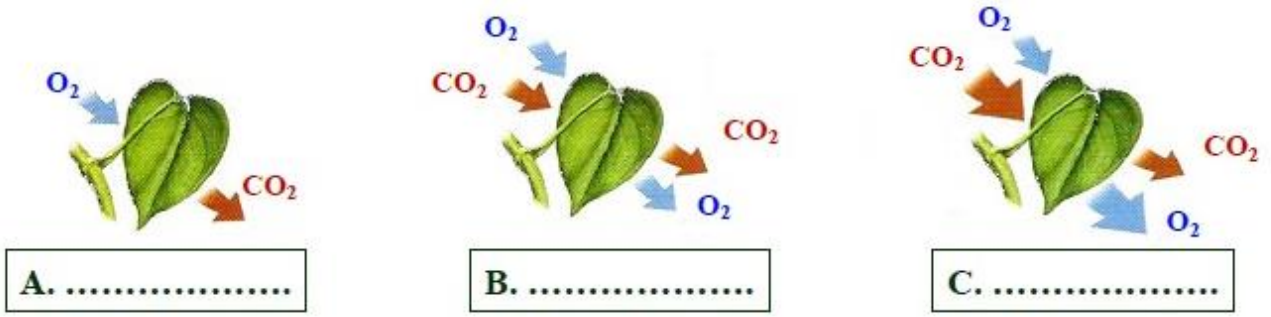
$$\mathbf{Glucose + O_2 \rightarrow Energy + H_2O + CO_2}$$

Plants perform respiration during the day and during the night, but only can perform photosynthesis while they have sunlight.

READING ACTIVITIES

After reading the text, copy and answer the following questions into your notebook:

3.1. The following pictures represent the gaseous exchange produced in a leaf in different moments of the day: dawn, noon and night. Which of them correspond to every one?



a. Do plants perform *respiration* during the day? Do they do it during the night?

b. Do they perform *photosynthesis* during the day? Do they do it during the night?

3.2. Order the steps of plants nutrition. Copy them in the correct order:

d. Oxygen is expelled to the atmosphere.	c. Cells of leaves make photosynthesis	b. Raw sap is made, from water and mineral salts.	a. Raw sap goes up from the root to the leaves.
g. Glucose is produce and elaborated sap is made	h. Elaborate sap is carried to every cell.	f. Carbon dioxide goes into trough the stomas.	e. Root absorbs nutrients from soil.

3.3. Indicate the differences between:

a. Raw sap-Elaborate sap

b. Xylem –Phloem

c. Respiration - Photosynthesis