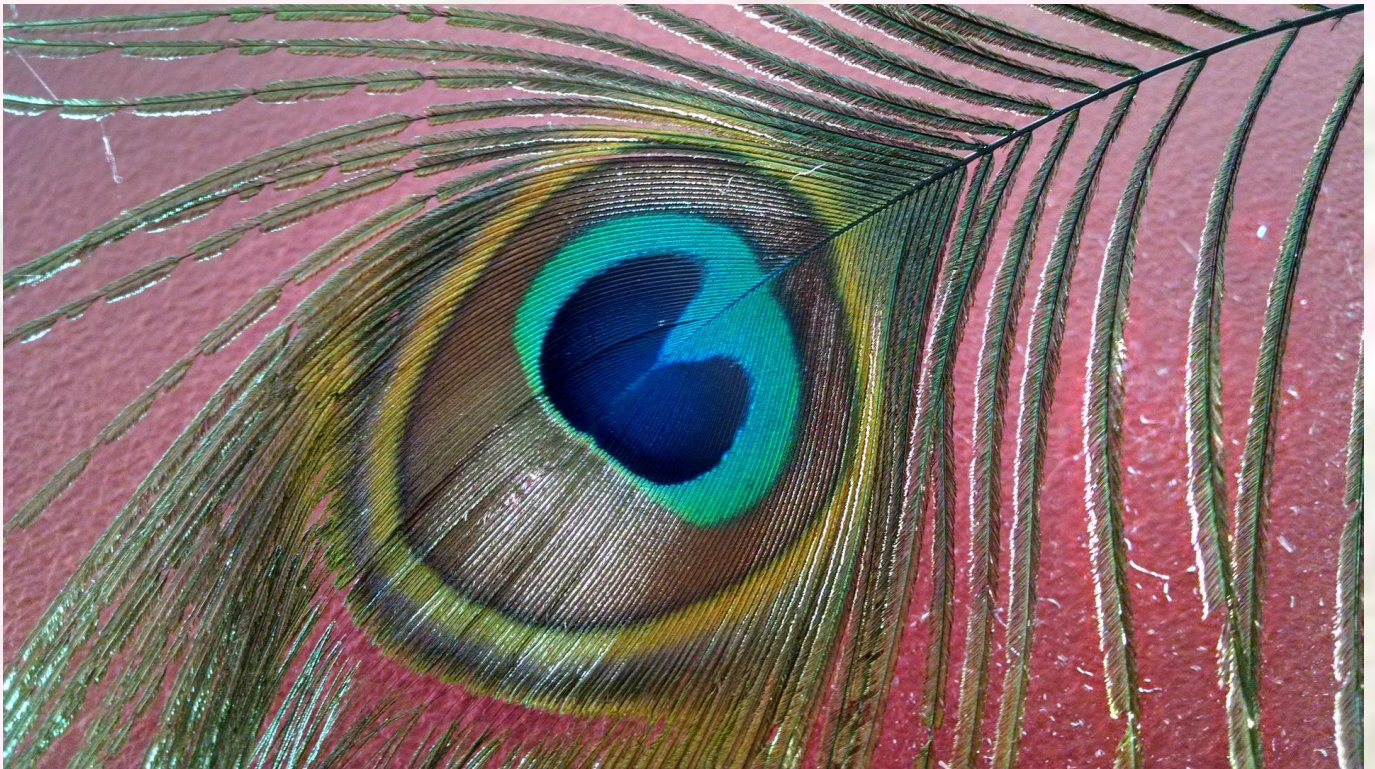




The Villablanca Connection

UNIT 1:

LIFE ON EARTH



**“Look deep into nature, and then you will understand everything better”
Albert Einstein**

Unit 1: Life on Earth.
Biology and Geology 1º ESO
Villablanca Connection

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Unit 1: LIFE ON EARTH.**1. The living beings' problem.**

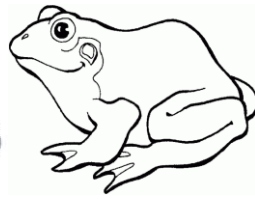
One of the most interesting Natural Sciences is called **Biology**.

Biology deals with life and all that we have learnt about the living beings. The persons that dedicate professionally to Biology are called biologists. Biologists study any aspect of life. They are interested in how an organ, as a human heart for instance, works; and also how a lion behaves to hunt a prey; and also what are the edible or the poisonous plants; and also what are the impacts if a forest is cleared and the trees are cut down...

Personally, as a biologist myself, I am very much interested in the differences between living and non-living beings. What do you think about this? Is it easy to distinguish between living and non-living beings? Let's try to classify the following beings into living beings and non-living beings:



Ameba



Frog



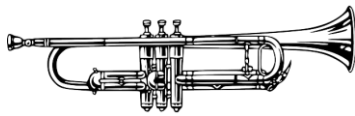
Lichen



Wasp nest



Sunflower seeds



Trumpet



Starfish



Microwave oven



Waterfall

Well, I am quite sure you did it right with the trumpet and the microwave oven (of course everybody *knows* they are non-living beings). But what about the waterfall? Yes, it is mostly water but is *water* alive? Is *water* a living being? Can we find *water* in living beings? Is the water only a place where some living beings live? Is it only a component of the living beings? The water of the waterfall moves, changes, reacts... Does it mean that waterfalls are in fact living beings? On the other hand, the sunflower seeds do not move, do not change and, under certain conditions, can remain equal to themselves for years to come... Are they *really* alive? And what do you think about the lichen or the ameba? Oh, my! What are they? They just look like the stains in my sport clothes! Are the biologists trying to tell us that they are truly alive?

You can have a break now with all those raveling thoughts. The question was a tricky one from the beginning. The fact is that the more you learn about biology the more difficult is to answer what life is. It is not that easy to distinguish between living and non-living things. How does it feel? It is probably one of your first days at the high school and you have just discovered that your Natural Science class is going to dedicate most of the school year to something that even the experienced biologists assume they do not fully understand: life. Isn't it crazy? Welcome to the real world. Can you see now why I entitled this very first point "The living beings' problem"?

2. Vital functions

Let's have a look into the 1º ESO typical pupil's mind: "So you are trying to tell me that science is complex, so what? Aren't you going to teach me something or what? I already knew all this high school stuff was a great waste of time. If all I have to remember is that (stupid) biologists cannot define life and that they are unable to distinguish between living and non-living things this is going to be easier than what I expected".

Hey, take it easy, kids. You do not need to feel that frustrated and, of course, you should not blame the biologists. They (we) are doing their (our) best. You will agree if you pay attention to the following.

In your primary school years you have learnt that living things usually move, grow, breath, reproduce, respond to stimuli, etc... That's why you have found so easy to distinguish living and non-living things till now. Biologists have studied a lot of these different characteristics and they have defined what living beings can do into three great groups of functions that can, as a whole, help us in this "living beings' problem". They are called the **vital functions** and biologists agree that any living being in this planet has to perform the three of them to qualify as "living".

The vital functions are:

Nutrition function: It is the process by which the living beings exchange matter and energy with their environment. One important thing that living beings need is to get materials for the continuous building of their bodies. Sometimes this process makes them bigger (growth), but not necessarily. Somehow, living things decay if they do not replace continuously the materials they are made of.

There are two kinds of nutrition:

Autotrophic nutrition lets the plants and other living things to produce their own materials from very simple inorganic substances they can get easily from the air and the soil. Namely, just water, CO₂ and minerals. We call “autotrophs” to the living beings with this particular type of nutrition.

Heterotrophic nutrition implies that the materials have to be taken already made from other living beings that owned them previously. The so called “heterotrophs” obtain materials and energy eating organic matter they get from other living things.

Interaction function: It is the process by which the living beings exchange information with the environment. Living beings need to detect the changes in the environment in order to react in an adequate way so the survival is possible. The lion has to know if there is a prey available in the surroundings, the plants have to produce flowers or fruits in the convenient season of the year, the mosquitoes can detect the gases of our breathing from incredible distances so they are directed exactly to the exposed part of our bodies where they’ll find the blood required for the hatching of their spring.

Also, living beings can produce signals to spread messages of their interest. Everybody knows that the growl of the dog means “don’t get so close to me” or that the beautiful colors of the peacock are a way to say to the females “come and let’s be friends”. There are thousands of other examples.

Reproduction function: It is the process by which the living beings produce new living beings (descendants) that are similar to them and maintain their characteristics. There are two main kinds of reproduction:

In the **asexual reproduction** one living thing produces identical descendants.

In the **sexual reproduction** two individuals produce specialized sexual cells (=gametes) that become a new living thing when they fuse together. The descendants are similar but not identical to their parents.

If you have been able to keep your attention to this point you will probably have noticed that I began talking about “living beings” and suddenly I changed to “living things”. You don’t have to worry about it. Both expressions are equivalent. We can use both of them referring to “something with life or something that lives”. There is also the word “organism” meaning exactly the same. As an exercise you can look for some sentences above with “living being” or “living thing” and rewrite them with “organism” instead.

Before going further, let’s have a look to these activities:

Activity 1.

Write “autotroph” or “heterotroph” according their type of nutrition:

Sharks		Whales	
Frogs		Algae	
Pines		Butterflies	
Mushrooms		Roses	
Horses		Cows	
Ferns		Humans	

Activity 2.

Choose the vital function related with these situations. If you choose “interaction” write also the stimulus, the response and, in the case of animals, the sensory organ.

Situation	Vital function	Stimulus	Response	Sensory organ
A maple tree absorbing CO ₂				
A cheetah chasing a fox				
A plant closing its flowers at the sunset				
Mould growing on an orange				
A marine alga absorbing water				
A frog laying eggs				
A couple of deer copulating				
A driver stopping at a traffic light				
The light in the rear of a light worm				
A human with perfume in a party				

Activity 3.

Animals have a particular way to move. Match in your notebook.

a) Salmons	1) Jump
b) Falcons	2) Slither
c) Caterpillars	3) Walk
d) Kangaroos	4) Run
e) Horses	5) Hop
f) Snakes	6) Fly
g) Frogs	7) Crawl
h) Humans	8) Swim

Activity 4.

Write in your notebook the definition of each of the vital functions and get sure you understand and remember them.

Activity 5.

¿Have you heard of the Ebola virus? ¿Are virus living things? Try to find out in the Internet.

3. Chemical composition of the living beings. Organic and inorganic matter.

As you have heard before, organisms are formed by cells –we will talk about them later- but even the cells are made of a handful of chemical substances. In the chemistry laboratory scientists can analyze what are these chemical substances and, surprisingly, they have found out that all of the living beings –it doesn't matter how different they look- are composed of the same six different compounds (=biomolecules). Two of them are very common in rocks and soils of the Earth surface, but the other four are only to be found in organisms. These are the **biomolecules** or immediate principles present in terrestrial living things:

1. **Water**. It is the most abundant biomolecule in the body of the living beings.
2. **Mineral salts**. A small amount is essential to be alive.
3. **Glucids** or carbohydrates. Cells need them to produce or store energy.
4. **Lipids**. Like oils or fats, they play important roles in the living things.
5. **Proteins**. The building blocks of life and the chemical operators in the cell factory.
6. **Nucleic acids**. Like the famous **DNA**. They are needed to preserve inheritance.

Guess which two are also present in non-living things and which four are only present in organisms... Yes, you are right: water and mineral salts are known as **inorganic immediate principles** (=inorganic biomolecules) because they are everywhere in rocks, soils and oceans. On the other hand, glucids, lipids, proteins and nucleic acids are known as **organic immediate principles** (=organic biomolecules) because only can be found in organisms or remains of organisms.

Please, note that this terminology is a little bit confusing (not my fault, I promise). How come that the water, which is the most abundant biomolecule in the organisms, is in fact considered inorganic? Do not worry about the reason now, just be careful when you memorize this classification of biomolecules.

Anyway, you will have noticed that “organic” and “organism” are related somehow and that “inorganic” sounds like the opposite to “organic”. Let's make our minds clear about these words. When we analyze in the lab non-living beings we always find small and simple chemical substances (=inorganic molecules) made of 2, 3 or maybe... 10 atoms (did you know that molecules are made of atoms joined by chemical bonds?). It is the case of water (3 atoms, only two different) or the mineral salts (one of the most common, the sodium chloride, has two different atoms: sodium and chlorine). But, on the other hand, if we analyze living beings we find water and mineral salts, of course, but also there are huge complex molecules made of tens, hundreds and even thousands of atoms where three or more can be different (=organic molecules). These molecules are so complex because carbon atoms form linear and circular chains where other carbon chains can be inserted like the branches in a tree.

As we have already learnt, living things exchange materials with the environment (nutrition). That means that there has to be a way to produce organic materials from the inorganic ones and vice versa. Plants and other organisms with **autotrophic nutrition** take from the air and the soil inorganic nutrients (small and simple molecules) and combine them to produce organic materials (very big, complex molecules with chains of carbon atoms). You already know that it is possible thanks to a process called **photosynthesis** that requires energy in the form of sunlight. And both autotrophic and heterotrophic organisms are continuously using these organic materials as a fuel to perform the vital functions, cutting up the complex molecules into simple ones to get the energy of their chemical bonds. As a result organic matter is becoming inorganic matter and we call this process **respiration**.

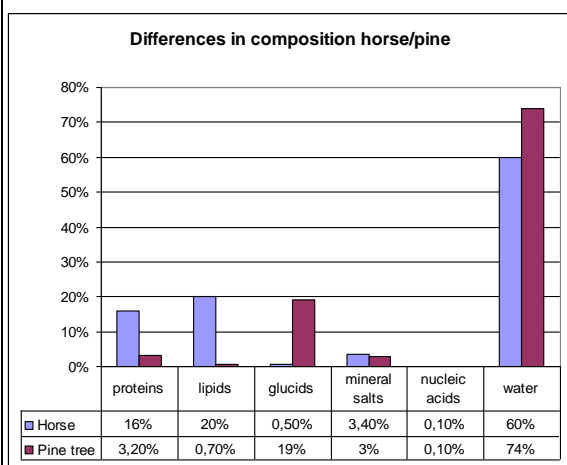
Too much information for you? Let's try to summarize this organic-inorganic issue in a simple useful chart.

Type of matter	In non-living things	In living things	Molecules	Carbon atoms	Autotrophic nutrition	Heterotrophic nutrition	Photosynthesis	Respiration
Inorganic matter	present	present (water and minerals)	small and simple	absent or not forming chains	takes	produces	takes	produces
Organic matter	absent	present	big and complex	present and forming chains	produces	takes	produces	takes

It is time for the following activities:

Activity 6.

In this graph the differences in composition between a horse and a pine tree are shown:



a) How are they alike?

b) How are they different?

Activity 7.

Classify these things as organic or inorganic matter:

1. The fin of a fish	14. A plastic cap	27. A can of sardines
2. Bottled water	15. The fire	28. The shell of an egg
3. Red paint	16. A wool sweater	29. Olive oil
4. The sound of a bell	17. The cork of a bottle	30. A pair of leather shoes
5. Cut grass	18. A brick in a wall	31. The ghost of a castle
6. An elephant's tooth	19. A cotton handkerchief	32. The flour of a cake
7. The stones of a river	20. A seed	33. The images in the TV
8. A golden ring	21. A wooden fork	34. Your favorite song
9. Orange juice	22. The skin of a snake	35. The hair of a tiger
10. A sugar cube	23. The glass of a window	36. The echo of a voice
11. A cat's skull	24. A silver tray	37. The screen of your cell-phone
12. An olive's pit	25. The salt in a salad	38. The rubber of a tyre
13. The air we breath	26. A mussel shell	39. The sheets of a book

Activity 8.

Complete the sentences with organic/inorganic and autotrophic/heterotrophic:

- a) The shark feeds on fish that is _____ matter. That's why the shark has _____ nutrition.
- b) The oak feeds on CO₂ that is _____ matter. That's why the oak has _____ nutrition.
- c) The deer feeds on grass that is _____ matter. That's why the deer has _____ nutrition.
- d) The bacteria in our intestine feed on the leftovers of our food that are _____ matter. That's why these bacteria have _____ nutrition.
- e) The olive tree feeds on water that is _____ matter. That's why the olive tree has _____ nutrition.
- f) The mushrooms feed on dead leaves that are _____ matter. That's why the mushrooms have _____ nutrition.
- g) The Iberian lynx feeds on rabbits that are _____ matter. That's why the Iberian lynx has _____ nutrition.
- h) The yeast feeds on sugar that is _____ matter. That's why the yeast has _____ nutrition.
- i) The moss feeds on CO₂ and water that are _____ matter. That's why the moss has _____ nutrition.
- j) The whale feeds on krill that is _____ matter. That's why the whale has _____ nutrition.
- k) The mosquito feeds on blood that is _____ matter. That's why the mosquito has _____ nutrition.
- l) The bacteria of the yogurt feed on milk that is _____ matter. That's why these bacteria have _____ nutrition.
- m) Algae feed on CO₂ that is _____ matter. That's why the algae have _____ nutrition.
- n) A mould feeds on orange skin that is _____ matter. That's why the mould has _____ nutrition.
- ñ) The panda bear feeds on bamboo that is _____ matter. That's why the panda bear has _____ nutrition.

Activity 9.

Classify the 15 living beings of the previous activity according their type o nutrition.

Autotrophs	
Heterotrophs	

Activity 10.

Certain types of mould grow and feed on food leftovers.

- a) Would you say the nutrition of these moulds is autotrophic or heterotrophic?
- b) Explain why.

Activity 11.

Remember the differences between sexual and asexual reproduction and decide what type of reproduction is present in these cases:

- a) A bacterium divides and produces two identical bacteria.
- b) A female bird is laying eggs in the nest.

Activity 12.

Make a chart in your notebook with the classification of the biomolecules or immediate principles.

4. The Earth: a home for life.

Before discussing more amazing common characteristics of the living beings we need to dedicate this last part of the unit to the conditions of our planet that make life possible.

The fact is that after quite a few years of exploration of the universe we have failed in finding living beings out of our planet. Well, the universe is so big and our technological means so limited that most of the scientists agree that it is only a matter of time that we succeed in our search of living and even intelligent beings. But in science a fact is a fact. And the reason why it is the Earth the only known planet with life is worth an explanation.

Living beings in the Earth (the only ones that we know, I insist) need to survive:

- Liquid water
- Oxygen
- Carbon dioxide (CO₂)
- Light
- Mineral salts
- Not too high and not too low temperature

All these requirements for life as we know it are fulfilled in the Earth thanks to two important circumstances:

- The presence of the atmosphere
- The distance from the Earth to the Sun is in the habitable zone.

If the Earth was 1 % nearer to the Sun all the water in the planet would be in a vapor state. If the Earth was 1 % farther to the Sun all the water in the planet would be in a solid state. Due that we are in the habitable zone the mean temperature in the Earth surface is 15° C, a comfortable temperature to perform the vital functions.

On the other hand, the atmosphere protects life from the harmful radiations of the Sun. As you already know, without the **ozone layer** life would be impossible on the terrestrial ecosystems. Scientists have discovered that this ozone was originated, from 2000 to 700 million of years ago, using the oxygen produced by ancient cyanobacteria. From the beginning of life on Earth, living beings and their environment are in permanent interaction. Changes in the environment have consequences in life and changes in life have consequences in the environment. This delicate balance is unique, as far as we know, in the universe; and makes the Earth the only precious planet where a **biosphere** exists. The biosphere is the zone of the Earth where living beings exist and where the interaction between life and environment brings the ideal conditions for the continuity of life.

But although we are talking in general about the living beings, you know very well that not all of them require the same conditions of water, light, soil or food. We call **habitat** to the place where a particular living being lives because it is in that specific place where adequate conditions are found to its survival.

The conditions that we find in a particular place are called **environmental factors**. Environmental factors are classified into:

- **Biotic factors**: are determined by the presence of other organisms like the competition for food or the collaboration in feeding the offspring, for instance.

- **Abiotic factors**: they depend on chemical or physical circumstances like the amount of light, the concentration of oxygen or the speed of the wind, for instance.

On the Earth we can find two major types of environment: aquatic and terrestrial environments.

In the **aquatic environment** water is abundant and temperature fluctuations are small because the water regulates very well the exchanges of heat. But light cannot reach depths beyond 150 m because it is absorbed by the water. That means that photosynthesis is only possible in this so called **photic zone** and the available oxygen dissolved in the water is always scarce.

In the **terrestrial environment** organisms have to find a way to get water and to deal with oscillations of temperature during the day and the different seasons.

Activity 13.

Have you ever seen a pill bug? It is a small terrestrial crustacean that curls up in a ball when threatened. In this experiment 25 pill bugs were randomly situated in this box with half the bottom covered with a wet cloth. After two hours they were placed as is shown in the picture.



- a) What are the conditions in each of the numbered zones?
- b) What conditions do the pill bugs prefer?
- c) What do you think is the habitat of these pill bugs?

Activity 14.

- a) What are the differences between the photic and the aphotic zones?
- b) Can animals live in the aphotic zone? And plants?
- c) How are the leaves of the plants that live in the desert? Why?
- d) What is the habitat of the zebra, the lion and the giraffe?

Activity 15.

A group of ecologists have studied the conditions of the water in a river from its place of birth to the sea.

zone	flow	temperature	oxygen
High upper course	very fast	less than 10°C	12 mg/L
Low upper course	fast	less than 15°C	9 mg/L
Middle course	slow	15°C	6 mg/L
Lower course	very slow	20°C	5 mg/L

- a) The trout needs 9 mg/L of oxygen to survive. In which zones of the river can it live?
- b) Describe the changes in temperature and amount of oxygen as we get closer to the sea
- c) What is the relationship between temperature and oxygen dissolved in the water?

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