The Villablanca Connection

UNIT 5:

ALGAE FUNGI AND LICHENS

“A truly good book is something as wildly natural and primitive, mysterious and marvelous, ambrosial and fertile, as a fungus or a lichen.”
Henry David Thoreau.

Unit 5: Algae, fungi and lichens.
Biology and Geology 1º ESO
Villablanca Connection

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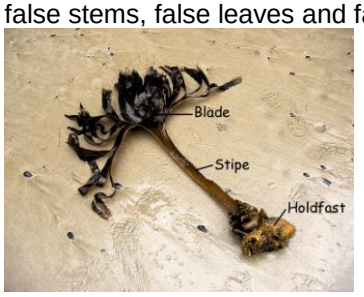
Unit 5: ALGAE, FUNGI AND LICHENS.

1. Algae.

Algae are classified into the **Protista** or **Protoctista** kingdom. Most of them are unicellular and we have studied them in the previous unit. But multicellular algae are very common aquatic living beings and I am sure you have seen them many times before. Most people think of them as some kind of aquatic vegetables and very often they consider them as aquatic plants. In fact, some algae have something like a root, a stem and even something like leaves, and all of them perform **photosynthesis**, so the differences between multicellular algae and aquatic plants are not obvious and we have to discover them by a very close look.
Algae are **eukaryotic** living beings. They can be unicellular (see Unit 4) or multicellular and their cells have a cellulose cell wall and chloroplasts with chlorophyll. They are **autotrophic** and can produce their own organic matter using the energy from the sunlight because they can perform photosynthesis (="produce with light" in Greek). They live both in fresh water and salt water where they are the **producers** of the aquatic ecosystems providing organic matter to the herbivores.
The reason why biologists classify algae in a kingdom different than plants is that algae have not real tissues neither they have real organs. Their entire body is formed by a **thallus** (=multicellular non-moving body in which there is no organization of tissues or organs). However, the thallus can sometimes develop plant-like structures like false stems, false leaves and false roots.



Saccorhiza polyschides, a brown alga, showing the **holdfast** (=false roots), the **stipe** (=false stem) and the **blade** (=false divided leaf).

Algae have both sexual and asexual reproduction. They often can reproduce asexually by fragmentation of the thallus, but they can also produce gametes that can fuse together to form the zygote.

1.1. Classification of the multicellular algae.

Multicellular algae are classified according to the pigments that are present in their cells. All of them have **chlorophyll** in order to perform photosynthesis, but sometimes other pigments are also present and colors different than green can result. We distinguish three main groups of multicellular algae:

- **Brown algae**: Most of them live in salt water. Besides the chlorophyll there is another pigment in the chloroplasts called fucoxanthin that is responsible for the different shades of brown that we can find in the members of this group. Some algae of this group are very big like *Macrocystis sp.* that forms prominent underwater forests of kelp (the common name of this type of algae) or *Sargassum sp.*, which creates unique habitats in the tropical waters of the Sargasso Sea, in the Atlantic Ocean.

Giant kelp (*Macrocystis pyrifera*).

Fucus vesiculosus. (See the gas-bladders).

Saccharina latissima on a beach.

- **Red algae**: Most of them live in salt water. They have phycoerythrin (a red substance) and other pigments in the chloroplasts besides the chlorophyll. They are often attached to the ocean floor or on animal shells. Most of the algae that can be found in coral reefs belong to this group and contribute to the construction of the reef secreting calcium carbonate.

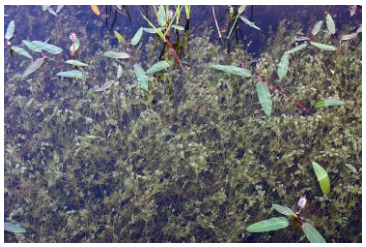
← *Palmaria palmata*

Corallina officinalis →

Mesophyllum sp.

- **Green algae**: This is the most diverse group of algae. There are many species of green algae that live in fresh water and also there are many species that live in salt water. The green color is due to the presence of chlorophyll in the chloroplasts without any other pigments in quantity enough to superpose their color.

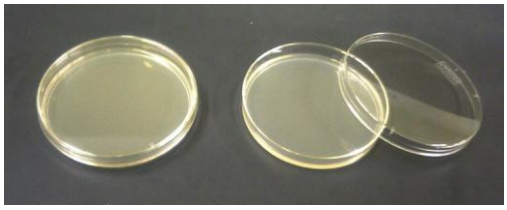
Ulva lactuca.



Chara vulgaris.

1.2. Algae and humans.

Some species of algae have been used as food for humans for thousand of years. China consumes more than 70 species, Japan 20 species; and algae are also eaten in Ireland, Wales, Korea, Chile, New Zealand, etc. And they are a good source for vitamins and bioelements. There is also a taste for algae nowadays in modern cuisine.



Microbiologists throughout the world use agar as a medium on which to grow bacteria and fungi. Agar is obtained from red algae.

Agar Plates (agar medium in 100mm Ø Petri-dish) for bacterial culture.

Stabilizing substances, pigments, additives, excipients and gelling agents obtained from the algae are also of interest for industrial purposes. Besides, dried algae have been used for centuries in agriculture as fertilizers and today there is a deep interest in a bio-fuel obtained from algae oils as a possible substitute of the fossil fuels.

Activity 66.
Why are not algae classified into the plant kingdom?

Activity 67.
If the algae are autotrophic organisms, why some of them are not green?

Activity 68.
In the picture of *Fucus vesiculosus* of the previous page we can see in the thallus of the alga a number of structures filled with gas. What are they for?

Activity 69.
Draw in your notebook an alga with holdfast, stipe and blade.

2. Fungi.

Fungi are sessile organisms, living in the soil, on the dead leaves or in the carcasses of dead animals or plants. They do not look like animals, but they are not plants either.
Fungi are eukaryotic heterotrophic organisms. Some can be unicellular (yeasts: see the previous unit) and many others are multicellular. Their cells have a cell wall, but it is made of **chitin** instead of cellulose, and they never form real tissues or organs. Fungi present so many differences with animals and plants that biologists classify them in their own kingdom: the fungi kingdom.

Fungi forming small mushrooms on the fallen leaves

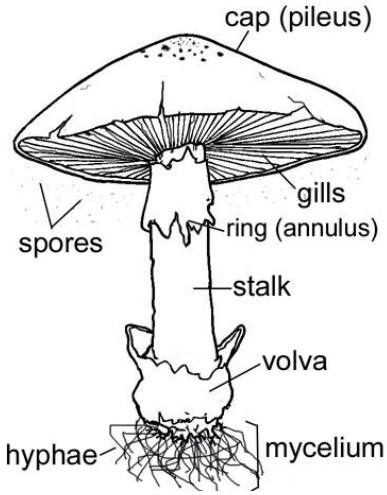
	Similarities and differences between animals, plants and fungi		
	Animals	**Plants**	**Fungi**
Type of cell	Eukaryotic	Eukaryotic	Eukaryotic
Cell wall	No	with cellulose	with chitin
Type of nutrition	Heterotrophic	Autotrophic	Heterotrophic
Chlorophyll	No	Yes	No
Tissues	Yes	Yes	No

Fungi are heterotrophic and they feed in different ways:

- **Saprotrophs**: They feed on the remains of dead organisms or discharged organic matter like dead leaves, excrements, etc. They secrete enzymes that decompose the animal or plant remains and absorb their nutrients. A lot of inorganic matter is then produced fertilizing the soil, because this inorganic matter is directly available for the plants. They are part of the decomposer organisms that recycle the matter in the ecosystems.
- **Parasites**: They feed on living organisms (animals or plants) producing a harm to them. Some of them can kill the plants that we use for our food, ruining the crops, and others can produce illnesses in humans.
- **Symbionts**: They establish a mutual positive relationship with other species (symbiosis) that provides them with their food. For instance some fungi form mycorrhizal symbiosis with the roots of the plants in the soil. The **mycorrhiza** is a structure surrounding the roots where an exchange of substances takes place between the fungus and the plant. Fungi provide the plant with minerals and water and the plants provide carbohydrates and other organic nutrients to the fungi. In other cases the fungi can establish a symbiosis with an animal. It is the case of the leafcutter ants. These ants cultivate the fungus inside their ants' nest providing it with cut leaves and the fungus produces food for the colony. Of course there are also fungi and algae living in symbiosis forming the lichens, but we will have a look to them later in this unit.

The body of the multicellular fungi is formed by a huge number of very fine filaments called **hyphae** that are usually underground and cannot be easily seen. The set of the hyphae is called the **mycelium** of the fungus, and sometimes looks like a spider web, but most of the times it is inconspicuous because of the small size of its hyphae. The visible part of many fungi is actually their reproductive organ and it is called the **mushroom** or carpophorus (="fruit bearer" in Greek). The mushroom produces microscopic spores that float in the air until they eventually come down to the soil where, given the proper conditions, they can germinate producing the hyphae of a new fungus.

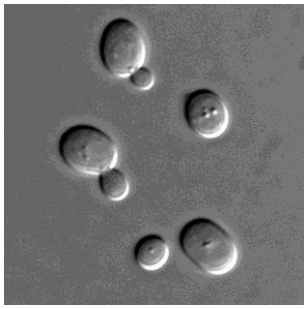
Parts of a mushroom



A mushroom growing on a dead tree
(see the gills where spores are produced)

Fungi are classified into three main groups:

- **Yeasts**: They are unicellular and we studied them in the previous unit (see Unit 4 to review how yeasts can be useful or dangerous for humans)
- **Moulds**: They never form conspicuous reproductive structures but they can be easily observed when food spoils.
- **Mushrooms**: They form big aerial reproductive structures to guarantee the adequate dispersion of the spores.



Saccharomyces cerevisiae (a yeast)

Stilton cheese veined with *Penicillium roqueforti*

Amanita phalloides accounts for the majority of fatal mushroom poisonings worldwide.

2.1. Fungi and humans.

We have discussed earlier (see Unit 4) how yeast can be used to produce several kind of food. Multicellular fungi can also be used to produce food (like cheese) and many of them are considered by themselves a delicatessen both in modern and traditional cuisine.
Many fungi are a source for pharmacological substances like antibiotics (penicillin), immunosuppressants (cyclosporine) or cholesterol inhibitors (statin).
Many fungi species are poisonous to humans, with effects ranging from slight digestive problems or allergic reactions as well as hallucinations to severe organ failures and death.
In agriculture some species are used to control pests like insects, mites, weeds or other pathogenic fungi.
In industry some fungi are used to obtain industrial chemicals like citric acid.

3. Lichens.

Lichens are organisms that result from the symbiosis of a fungus and a cyanobacteria and/or an alga. The fungus and the alga establish a mutually beneficial relationship where the alga (or the cyanobacteria) obtains water, minerals and protection from the environment while the fungus obtains the products of the photosynthesis performed by the alga or the cyanobacteria.
Lichens can live in extreme environmental conditions where neither the fungus nor the alga would survive. They can grow on the bare rocks and are usually among the first organisms to appear on fresh rock exposed after an event such as a landslide or a volcanic eruption. They can also grow in walls, roofs and exposed surfaces where no other organisms can grow. We can find lichens in every ecosystem in this planet. They live in Antarctica and in the Sahara desert as well as in the rainforest or the alpine elevations. There are even lichens living inside certain rocks among the grains of its minerals.
Lichens are both resistant and sensitive. As an example of the former, in 2005 an experiment of the European Space Agency, designed by a Spanish researcher, took place in orbit and two different species of lichen were directly exposed to the vacuum of space with its widely fluctuating temperatures and cosmic radiation. Fifteen days later the lichens were brought back to earth and were found to be in full health with no discernible damage from their time in orbit.
On the other hand, lichens have been used as **bio-indicators** of the quality of the air because the different species of lichens have a different tolerance to the presence of pollutants in the air. Fruticose lichens are often more sensitive to pollutants than foliose or crustose lichens.
Lichens are often classified depending on the form and development of the thallus. There are five main types of lichens according to their growth:

- Fruticose
- Foliose
- Crustose
- Leprose
- Gelatinous

Common lichen growth forms*					
					
This lichen grows like a multiply branched tuft or leafless mini-shrub, so has a **fruticose** growth form.	This lichen has leaf-like structures, so is **foliose**.	This lichen grows like an orange crust coating the rock, so is **crustose**.	This lichen grows like a crust, and in a pattern that radiates outward from the center, so has a **crustose placodioid** growth form.	This lichen grows like powder dusted on the rock so is a **leprose** lichen.	This lichen is **gelatinous**, without internal structure for its parts.

* The images and texts of this table have been taking from http://en.wikipedia.org/wiki/Lichen

Activity 70.
Draw a mushroom in your notebook and write the names of its different parts.

Activity 71.
a) Are the fungi autotrophs or heterotrophs?
b) Explain the different types of nutrition in the fungi.

Activity 72.
Summarize in a table the differences between algae, plants and fungi.

Activity 73.
a) Name a type of unicellular fungi.
b) What is the mycelium?
c) Explain one symbiosis in which a fungus gets a benefit.
d) Name a pharmaceutical drug that human can obtain from fungi.

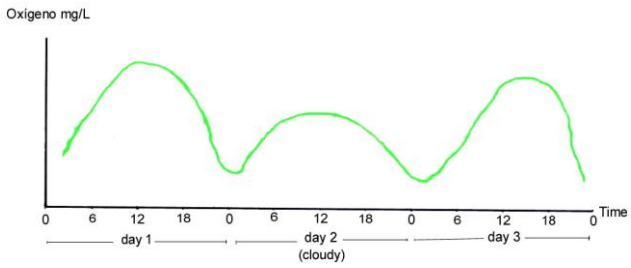
Activity 74.
What is agar used for? In what organisms can we find agar?

Activity 75.
Describe what type of organisms are lichens.

Activity 76.
There are no algae and no lichens in the bottom of deep seas. How can you explain this?

Activity 77.
Classify these sentences in true or false and correct the false ones.
a) Lichens are unicellular organisms.
b) Algae have heterotrophic nutrition.
c) The spores of the fungus are produced in the gills of the cap of the mushroom.
d) Fruticose lichens are more sensitive to the pollutants of the air.
e) Red and brown algae have not chlorophyll.
f) Lichens are composite organisms that result from the symbiosis of an alga and a cyanobacteria.

Activity 78.



A group of students have been collecting data in a pond for 3 days. When they represent the results of their measures of the oxygen released by the algae of the pond they obtain this graph:

Explain the results for the three days.

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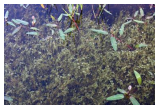
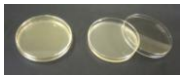
 By Christian Fischer. This file is licensed under the Creative Commons Attribution-Share Alike 3.0 Unported license.

 By Y tambe. This file is licensed under the Creative Commons Attribution-Share Alike 3.0 Unported license.

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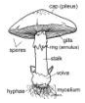 By JLD. This file is licensed under the Creative Commons Attribution-Share Alike 3.0 Unported license.

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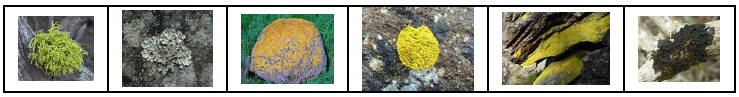 Taken from http://en.wikipedia.org/wiki/Lichen.