PROFILES IBSE Learning Module

Student Activities

Preliminaries and explanations:

Plants - a miracle on Earth

They delight us everywhere and anytime... Their existence makes life possible to other beings on this planet.

At the beginning of Module, the content was presented to the students, the being divided into 4 groups consisting of 6 experts learning - in each group, it takes part a physicist, a chemist, a biologist, a scientist, a computer expert and a reporter (rapporteur). Each group has received the information resources, in order to develop a successful investigative approach.
Starting from the idea that plants are organisms who prepare their own food from minerals, water and carbon dioxide in the process of photosynthesis, students will investigate: "What happens when there is not enough food?" and " Is the plant food always natural or not?".
In this investigative approach, students will work in groups and individually, chemists will study substances that are food plants, physicists will study the surface tension of water, biologists, capillarity, and scientists will make a transdisciplinary food plants processing. The computer experts will take care of data recording and processing, the completion of their presentation materials and the use of those in other didactic activities. The rapporteur will be the speaker of the group and considered as having scientific thinking.
After they study according to their role in this process, the experts will gather in groups of experts (expert chemists, physicists, biologists, and computer scientists). The students will present a report on what the individuals studied independently. Discussions are based on available information, new items will be added and established how those knowledge will be forwarded to members of the original team.
Each student is a member of a group of experts and, at the same time, part of a learning team. Each will present to his/her group what he/she thinks that is best for the proposed theme and will decide jointly what activities best fit the experimental approach.

SEVENTH FRAMEWORK PROGRAMME

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The common goal of each expert group is to train as well, taking responsibility for their own learning, and also for the teaching / learning of the initial team colleagues. The experts spread the aquired knowledge among the other expert categories. The way used for transferring the information / knowledge must be short, concise, attractive, and could be supported by various materials (audio, video, written text).
The experts from a specific category can support their ideas, reports, using computer (diagrams, tabels and pictures). The members are stimulated to debate, ask questions, take notes, making their own workplan. After that, they will return to their initial teams, will start working, all teams making the same experimental activities previouslly established inside the expert groups.
The teams will present the results to the entire classroom. In this stage, the students are ready to show what they have learned. The teacher asks questions and makes oral evaluation of each student who must be able to respond without team support.

Scenario:

The parents of a student are owners of two carnation greenhouses. The number of flowers obtained in the first two years was considerably higher even than the expected figures. In the last two years, the number of flowers was very small. Owners are going to give up this kind of business, even if they invested a lot in it. How do you fix it? What do you think should be investigated? In your opinion, does it worth doing the investigation or giving up to the cultivation of carnations, or - on the same ground - trying anything else?

The students will investigate:

- plant nutrition (which involves experimental studies of photosynthesis, respiration and transpiration of plants);
- why water droplets are round?;
- how water moves (flows down from the force of gravity, can climb because of the plant capillaries transporting food and thus ensuring optimum life support).

Tasks:

First part

The investigation of photosynthesis to Elodea Canadensis (common name:Water Plague)

Procedure: Some Elodea branches will be placed into an Erlenmayer glass filled with water. To accelerate the photosynthesis, the glass will be placed on to a sunny ledge or light up with a bulb.

Observe what is happening in the glass after couple minutes!

Oxygen bubbles become visible.

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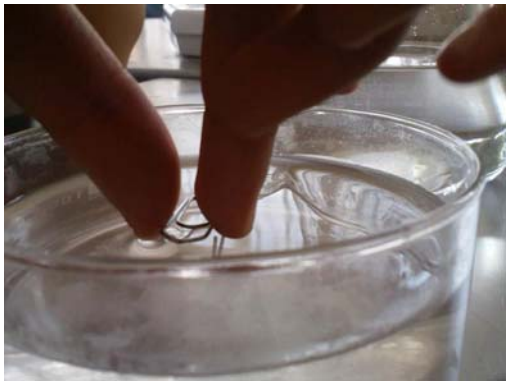
Why water droplets are round?

Materials: tweezers, paper clips, glass, water.
Procedure: The glass will be filled up with water and using the tweezers, the paper clips is placed gently on the water surface (if you don't manage that, try to put first the paper clips on a small paper and after gently push the paper to the bottom so that the paper clips to remain on water surface)

What is happening? The paper clips floats on the water surface



Why? Water molecules form a film on the surface able to support bodyweight. The force that holds molecules united is called surface tension. When the cup is filled, the surface curvature can be observed closely, the surface tension tends to shut down water like a sack and very small water volume adopt a round shape - drop of water. A strong enough membrane occurs because of the surface tension of water.

A barrier fabric

Materials: napkin, rubber band, glass, water.
Procedure: The napkin will be moisted and squeezed. Fill the cup with water and put the napkin over the glass tight fixed with the rubber band. Upside downs the glass quickly.

What is happening? Water remains trapped in the glass like tissue could be waterproof.

Why? Water that was soaked into the tissue has filled the spaces between material fibers. Due to surface tension, a compact barrier has created that water from inside the glass water cannot pass.

How the soap interacts with the surface of the water?

Holes in the Water
Materials: pepper, water, liquid soap, crystallizing apparatus.
Procedure: Fill with water the crystallizing apparatus and sprinkle pepper on the water surface. Put a finger in the water.

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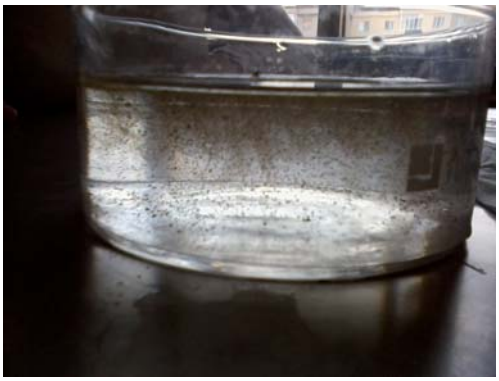
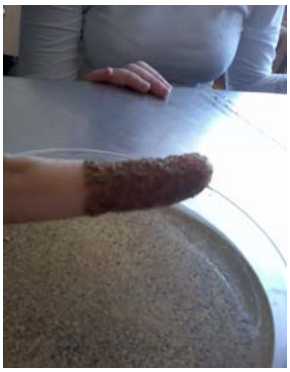
What is happening? If only fingering the film formed on the surface, it deforms and no wetting.

Why? The surface tension is an intensive force who is intrerrupted only when the finger is stick in. Take a drop of liquid soap on a clean finger and stick into the water through the pepper spread on to the surface. It can be observed that the pepper is moving away from the finger spot; if the finger motion is repeted on the pepper surface, it can be noticed some water holes.

Second part

How is the water moving? Water rising

Materials: a branch of celery (Apium graveolens) with leaves (aprox. 20 cm in length), Erlenmeyer glass, blue and red ink.
Procedure: The glass is filled with water and few drops of ink will be added. The celery is put into the coloured water and the glass is placed into a worm place.

What is happening? In time the branch and the celery leaves become coloured like the ink.



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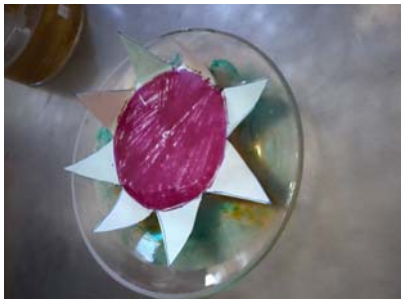
Why? If you cut the celery branch, it can be observed that is composed by small tubesby which the coloured water was rised to the leaves. Into the thin capillary tubes, the water is rising as if she's drawing up; this is the capillarity phenomenon who allows the plants to absorb the water by roots from the soil and to transport it to the leaves.

The flower that blooming in the water

Materials: sheet of paper, filter paper, markers, scissor, crystallizing apparatus.
Procedure: Make two indentical flowers using the papers (like in the figure bellow) and colour them. Bend the flower petals to the inside and put the flowers on to the water surface.

What is happening? The flower made from filter paper is bursting suddenly while the other is open slowly.

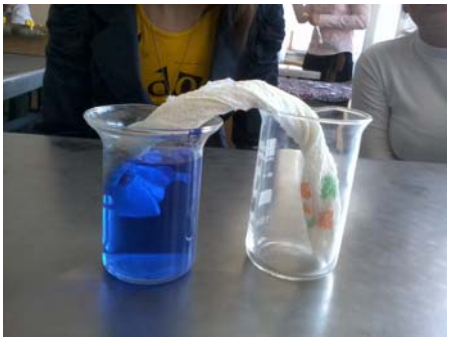


Why? The water penetrates by the capillary tubes from the empty spaces in the paper fibres and extend them making that the petals to redress and the flower to bloom.

Water and solutions transportation by porous materials

Materials: two Erlenmeyer glasses, water, ink, ammonium nitrate, calcium hydrogen phosphate, cleanser, napkins.
Procedure: One glass will be filled half with water, ink solution, ammonium nitrate and cleanser solutions. Near the glass containing the solution it will be set the second glass. By twisting a napkin make a connection between the two glasses.

What is happening? The water and other solutions will be transported into the empty glass by the napkin bridge.



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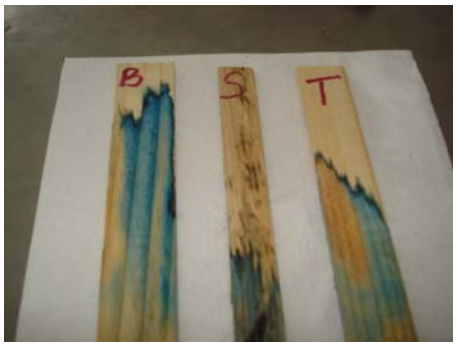
Why? The water penetrates throw the capillary tubes from the empty spaces in the napkin fibres, extends them, and consequently those tubes will allow that the water and other solutions to pass into the empty glass.

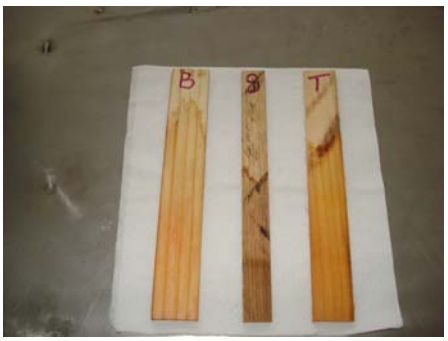
Third part

The rising of the sap by different wood essences

Materials: three Erlenmeyer glasses, red and blue ink, ammonium nitrate (chemical fertilizers), cleanser, perches from different wood essences (fir tree, linden tree, oak tree).
Procedure: In each glass will be prepared one kind of sap: water with red or blue ink, water with chemical fertilizers, water with cleanser. The perches (three of each kind) will be put in each glass.

What is happening? The sap from each glass will rise in time in different manner from glass to glass and perch to perch.





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Why? For plants, and particularry for high trees, it is hard to understand the manner in which the sap manage to rise up to heights of 50 or even 100 meters. The sap contains beside water, minerals and nutritive substances, also residues that must be eliminated (the sap composition varry from essence during a year). The circulation is made in both ways. From bottom to up, the sap flows by continously channels, composed by dead (inactive) cells. From up to bottom, the circulation takes place by structures composed from living (active) cells. From the physical point of view, it is important only the first way (down to up).
In order to explain the rising of the sap in plants, it can be imagined the following considerations:

- the difference between atmospheric pressure at roots level and the pressure from internal plant channels;
- the capillar rising - offered by the Jurin's law - the channels by which the sap is asscending have around 20-200 μm thickness and the sap has a surface tension coefficient comparable with the water;
- the osmotic pressure.

Fourth part
Data acquisition. Data processing

The students will measure the height reached by the sap in each case; they will calculate the measure error and the surface tension coefficient according to the Jurin's law.

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Homework sheet:

Inside a capillary tube (0.5 mm diameter), the petroleum (0,0245 N/m surface tension coefficient) is rising on a h height. Which is the value of this height? (the petroleum density is $0.8 \cdot 10^3$ kg/m^3)

Conclusions

Maintaing the water quality is one of the most important aspects in preserving the ecological balance. Beyond the general aspects related with the effects of the surface tension, there are particularier related with the functioning of some biological systems like sap rising in plants.
The existence of the surface tension is important not only in common activities, industrial or domestic, but also very important in biological processes from vegetal and animal world.
In order to solve the greenhouse problems, the students have suggested that:

- the soil must be choosen based on his composition / nature and the plant types that will be cultivated;
- the excess use of fertilizers can harm the plants;
- the rains can carry out the fertilizers from soil into the surface or underground waters (e.g. the phosphorous deficiency can lead to: smaller plants, few long roots, rigid steam, small leaves with redish spots, falling early leaves, the delay of offspings and blooming, the limitative factor in vegetation development);
- the soil needs organic natural fertilizers that will bring N, P, K elements in order to supplement, beside K and Ca, the nutrients in asimilated forms.
- Attention! High phosporous concentrations lead to a rapid development of algas; the P accumulated in soil and water (from chemical fertilizers) can inhibit the plants vital processes leading also to Zn deficiency and poor crops.

The smile of succes

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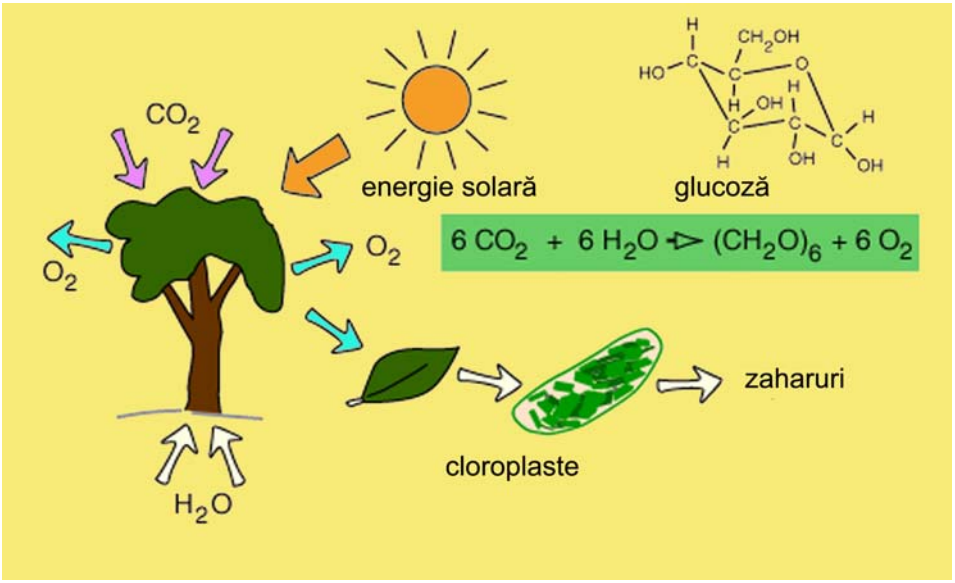
Other considerations

The photosynthesis is the physiological process by which green plants sythesize organic substances from carbon dioxide and water using solar light absorbed by chlorophyl and realeasing oxygen. The leaves of a green plant can be considered real factories where food and oxigen are made.
The understanding of the phosynthesis mechanism allows finding the most suitable ways for plant growing.



The solar energy conversion during photosynthesis

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