PROFILES IBSE Learning Module

Teacher Notes

Suggestions:

For the proposed Module lessons, it is assumed that the students know the phenomenon of capillarity and photosynthesis (the physiologically process by which green plants synthesize organic substances from carbon dioxide and water using sunlight absorbed by chlorophyll and releasing the oxygen). Understanding photosynthesis mechanisms allows finding the most appropriate means for the plant growth.

Theoretical background and recommendations:

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 the Module, the content was presented to the students, they 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.

For choosing the computer experts, a questionnaire was applied (see *Annex 1*).
A list, designed to fast record the presence or absence of student's implication, is presented to the students (see *Annex 2*).
To be sure that each student has chosen the preferred role, based on his/her own scientific thinking and skills, a reflective sheetis provided (see *Annex 3*).
Additional indications for achieving a more structured approach were offered (see *Annex 4*).

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5.2.2.1 – SiS-2010-2.2.1, Grant Agreement No.:266589
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If the minerals usually dissolve into water, distributing on its volume, the organic liquids are rarely miscible with water. Usually they have a lower density than water and rises to the surface, in addition, due to their surface tension, tend to be spread on the water surface. If the water is calm, the top layer of organic liquid tends to be monomolecular (thickness equal to that of a molecule) making a small amount of liquid to cover a large area of water. If the organic molecule has a part that can form easy links with water (usually hydrogen bonds), this part called *hydrophilic* is turning to water, while the other part of the molecule, called *hydrophobic* is turning to outside water.
Another example is that of phospholipids, substances that play an important role in the functioning of cell membranes. These substances can strongly reduce the water surface tension coefficient. This effect is applied in current life when the detergents are used. For them to have an advanced effect is necessary that the liquid to wet the fabrics or materials to be washed and then to emulsify, dissolve and remove dirt or grease stains. Therefore the detergents should contain surfactants, which added in a small amount, causes a significant reduction in surface tension, resulting an increased capacity of water to wet the materials with which it comes in contact.
In other cases, on the contrary, substances found in water have the effect of increasing surface tension, making the surface more "rigid", behaving as an elastic membrane which makes it more difficult to get into the fluid.

Chemical fertilizers - another healthy food or not for the plants?!
N - needed during the growing;
P - intervenes in the formation of fruits and seeds;
K - necessary for the growth and development of roots, stems and leaves;

N, P, K are taken from the soil in the form of solutions (sap = natural food). When the soil is depleted the chemical fertilizers are used (chemical fertilizers = chemical food): nitrate, ammonium and calcium phosphate.
When choosing soil, we should take into account the nature of the soil and the plants will grow. The fertilizers excess can cause crop shortfalls. The rains can take soil fertilizers and transport them into surface waters or groundwater.
The role of phosphorus in plants:

- promotes nutrition, growth, flowering, fructification;
- decreases the specific water consumption of the plants;
- is accumulated in the young parts of the plant.

Phosphorus deficiency:

- in the absence of P, the plants remain small, have long and rare roots, rigid stems, small dark color leaves with reddish spots;
- premature leaves fall, sprouting and flowering is delayed;
- P in small amount is the limiting factor of vegetation development.

Factors that limit the availability of P:

- excessive clay soil;
- alkaline pH and lime in large quantity which determines the formation of insoluble compounds in soil;
- heavy rains who wash up phosphous from soil.

Conclusions:
The soil needs natural organic fertilizers that will enrich with N, P, K, adding also the nutrients in assimilable forms, along with K and Ca.

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Attention!

- high concentrations of P cause a rapid multiplication of algae;
- P from chemical fertilizers, accumulated in soil and water may be inhibiting the life processes of then plants, this leading to a Zn deficiency and consequently lower yields.

For plants and especially for the very tall trees, it is difficult to understand how sap reaches to climb up to heights of 50 or even 100 meters. The sap contains besides water, minerals and nutrients as well as waste that need to be disposed. The flow is two-way: bottom-up, sap flow uninterrupted through channels formed by dead cells and the up and down movement is done through structures composed of active cells. From a physical sense, only the first movement presents huge interest.

To explain the rise of sap in plants, at first sight, it could be imagined the following mechanism:

- the pressure difference between the atmospheric pressure (on the roots) and the pressure inside the plant channels. The principle of operation is similar to the mercury barometer: in a vacuum column (in our case the plant channels that are not in contact with the outside) liquid up to a height that equals column pressure due to external pressure.

For an external pressure equal to the atmospheric pressure (105 N/m^2), it rises a column of water around 10.33 meters, insufficient for the tall trees.

- the capillary rise according to the Jurin's law. The columns by which sap rise up have thicknesses between 20 and 200 μm and the sap has a the surface tension coefficient almost as water;
- the osmotic pressure.

The sap composition varies throughout the year, depending on the species.

The pressure at which rupture occurs is of the order of 700 atmospheres, or in other words, if the breaking strength is its own weight, the liquid could form a column of kilometers.

In case of an actual plant, the sap rising columns go flawlessly from roots to leaves. Here an important part of the water evaporates, causing a strong suction. The slightest interruption of the column leads to the rise of sap final stop on that channel.

Data recording

Learning group 1: the students will study the water rising through three types of wood (fir, oak and lime) and they will measure the height of sap rising.

For lime:

Error of measurement:

d_1: h=10,3cm; d_2: h=10,4cm; d_3: h=10,3cm; d_4 : h=10,5cm ;

d_5: h=10,4cm.

$$h = \frac{h1+h2+h3+h4+h5}{5} = \frac{10,3+10,4+10,5+10,3+10,4}{5} = 10,38 \text{ cm}$$

h_1= |10,3 - 10,38|= 0,08

h_2= |10,4 -10,38 |= 0,02

h_3 = |10,5 - 10,38| = 0,12

h_4 = |10,3 - 10,38| = 0,08

h_5 = |10,4 - 10,38 |= 0,02

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$\Delta h_m = \frac{0,08 + 0,02 + 0,12 + 0.08 + 0,02}{5} = 0,064$ cm

h = h $\pm$ Δh_m

h = (10,38 $\pm$ 0,064) cm

The determination of the surface tension, according to the Jurin's law:

σ = $\frac{\rho rgh}{2}$

ρ_{lime}= 0,55kg/dm3

σ = 0,069N/m

For fir: h_1 = 14,8cm; h_2 = 15cm; h_3 = 14,9cm; h_4 = 14,8cm; h_5= 14,6cm

Error of measurement:

h = $\frac{h1 + h2 + h3 + h4 + h5}{5} = \frac{14,8 + 15 + 14,9 + 14,8 + 14,6}{5} = 14,82$ cm

h_1= |14,8 - 14,82|= 0,02

h_2= |15 - 14,82 |= 0,18

h_3 = |14,9 - 14,82| = 0,08

h_4 = |14,8 - 14,82| = 0,02

h_5 = |14,6 - 14,82 |= 0,22

$\Delta h_m = \frac{0,02 + 0,18 + 0,08 + 0.02 + 0,22}{5} = 0,104$ cm

h = h $\pm$ Δh_m

h = (14,82 $\pm$ 0,104) cm

The determination of surface tension - with the Jurin's law

σ = $\frac{\rho rgh}{2}$

ρ_{fir}= 0,55kg/dm3

σ = 0,078N/m

Learning group 2: the students will study the rising of a solution made from water and ink through three types of wood (fir, oak and lime) and celery, and they will measure the height of the sap rising.

For lime: h_1 =10,5cm; h_2 =10,4cm; h_3=10,6cm; h_4=10,5cm ; h_5=10cm.

Error of measurement:

h = $\frac{h1 + h2 + h3 + h4 + h5}{5} = \frac{10,5 + 10,4 + 10,6 + 10,5 + 10}{5} = 10,4$ cm

h_1= |10,4 - 10,5|= 0,1

h_2 = |10,4 -10,4 |= 0

h_3 = |10,4 - 10,6| = 0,2

h_4 = |10,4 - 10,5| = 0,1

h_5 = |10,4 - 10, |= 0,4

$\Delta h_m = \frac{0,1 + 0 + 0,2 + 0.1 + 0,4}{5} = 0,16$ cm

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$h = h \pm \Delta h_m$

h = (10,4 ± 0,16) cm

The determination of surface tension - with the Jurin's law

σ = $\frac{\rho r g h}{2}$

ρ_{lime}= 0,55kg/dm3

σ = 0,09284 N/m

For fir: h_1 = 13,8cm; h_2 = 13,5cm; h_3 = 13,9cm; h_4 = 12,5cm; h_5= 13cm

Error of measurement:

$h = \frac{h1+h2+h3+h4+h5}{5} = \frac{13{,}8+13{,}5+13{,}9+12{,}5+13}{5} = 13{,}34$ cm

h_1= |13,34 - 14,8|= 0,46

h_2= |13,34 – 13,5 |= 0,16

h_3 = |13,34 - 13,9| = 0,56

h_4 = |13,34 – 12,5| = 0,84

h_5 = |13,34 - 13 | = 0,34

$\Delta h_m = \frac{0{,}46+0{,}16+0{,}56+0.84+0{,}34}{5} = 0{,}472$ cm

$h = h \pm \Delta h_m$

h = (13,34 ± 0,472) cm

The determination of surface tension - with the Jurin's law

σ = $\frac{\rho r g h}{2}$

ρ_{brad}= 0,55kg/dm3

σ = 0,08821 N/m

For oak: h_1 = 6,6; h_2 = 7cm; h_3 = 7,1cm; h_4 = 7cm; h_5= 6,9cm

Error of measurement:

$h = \frac{h1+h2+h3+h4+h5}{5} = \frac{6{,}6+7+7{,}1+7+6{,}9}{5} = 6{,}92$ cm

h_1= |6,92 – 6,6|= 0,32

h_2= |6,92 – 7 |= 0,08

h_3 = |6,92 – 7,1| = 0,18

h_4 = |6,92 – 7| = 0,08

h_5 = |6,92 – 6,9 | = 0,02

$\Delta h_m = \frac{0{,}32+0{,}08+0{,}18+0.08+0{,}02}{5} = 0{,}136$ cm

$h = h \pm \Delta h_m$

h = (6,92 ± 0,136) cm

The determination of surface tension - with the Jurin's law

σ = $\frac{\rho r g h}{2}$

ρ_{oak}= 0,9kg/dm3

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σ = 0,62 N/m

For celery: h_1 = 4cm; h_2 = 4,8cm; h_3 = 4cm; h_4 = 4,8cm;
h_5= 5cm
Error of measurement:

$$h = \frac{h1 + h2 + h3 + h4 + h5}{5} = \frac{4,6 + 4,8 + 4,6 + 4,8 + 5}{5} = 4,76\,\text{cm}$$

h_1= |4,76 - 4,6|= 0,16
h_2= |4,76 – 4,8 |= 0,04
h_3 = |4,76 – 4,6| = 0,16
h_4 = |4,76 – 4,8 |= 0,04
h_5 = |4,76 - 5 | = 0,24

$$\Delta h_m = \frac{0,16 + 0,16 + 0,04 + 0.04 + 0,24}{5} = 0,128\,\text{cm}$$

$h = h \pm \Delta h_m$
h = (4,76 ± 0,128) cm

The determination of surface tension - with the Jurin's law

$$\sigma = \frac{\rho r g h}{2}$$

σ = 0,03 N/m

Learning group 3: the students will study the rising of a solution made from water and chemical fertilizers through three types of wood (fir, oak and lime) and celery, and they will measure the height of the sap rising.

Data processing
The students have determined that the salt water solution increases the surface tension coefficient.

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Annex 1

Skills checklist

Description: Checklist made from the student persepective - it reflects the student's skills related to the use of new technologies resources.
Instructions: Mark with **X** the utterances that fit you
Level: VIIth class
Name and surname: _____
School: _____

	Very good	Good	Satisfactory	Insufficient
I use word processing software				
I use spreadsheet programs				
I use presentation programs				
I manage documents and files (create, save, delete)				
I insert images and movies in documents				
I use image processing software				
I can use projection equipment				
I can print documents				
I can scan documents				
I use Internet				
I use e-mail service				
I can create webpages				
I can make bibliographies				
I use Wiki				

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Annex 2

Observing the students during the investigative approach

Student's name	Communication	Collaboration	Critical thinking	Participation / Involvement	Meeting deadlines	Compliance with the rules	Tasks solving

Annex 3

Name:…….

Date:……..

Reflection journal

- I work better when……..
- I like to work with others when……..
- The thing that I like best…….
- The most interesting part of this approach is……..
- I would like to learn more about……
- I want to improve my……..
- I must work at……..
- The hardest thing to do is……...
- I need help at……...
- When do not understand something……
- Before starting to investigate I will……
- I learned that I could……...
- I'm good at……..
- I learned how to……..
- I can help others with……..
- I want to work at……
- I want to learn how……
- I want to help at……..

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Annex 4

Additional indications: use the following questions in order to guide the investigation work

- What I need to know?
  - I can formulate questions to help me think about what I already know;
  - I organize knowledge;
  - I guess what I'm going to learn.
- What are my options?
  - I identify the opportunities;
  - I explore the options ;
  - I make choices;
  - I create opportunities.
- What do I need to find out?
  - I plan search strategy;
  - I collect the necessary information to make informed decision;
  - What choice I will make and how I will implement it?
- Further?
  - I evaluate the results of activities;
  - I appeal to learning to set new goals or activities.

Experimental work:

The experimental work is detailed within the *Student Activities* unit.

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