PROFILES

FACULTY OF EDUCATION
Masaryk University

Professional Reflection-Oriented Focus on Inquiry-based Learning and Education through Science

PROFILES IBSE Teaching/Learning Materials – Teacher Guide
Compiled by the PROFILES Working Group of the Masaryk University, Czech Republic

Carbon – nature of life

A Module for IBSE

Instruction: **Science** (especially **Chemistry and Biology**)
Grades: **5th to 9th**

Abstract

The essence of this module is to show students that carbon is the fundamental building block of living organisms. Students verify the presence of carbon in organic materials using simple experiments. Students become familiar with the composition of organic compounds. They look for a link between carbon, coal, and wood and burned dish in a pan. They draw conclusions about the importance of carbon. It is possible using simple experiments to present not only carbon but also hydrogen and oxygen in organic matter.

SEVENTH FRAMEWORK PROGRAMME

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MODULE DESCRIPTION:

This teaching material is intended as a guide for teachers to develop scientific literacy of students. It focuses on four areas - intellectual development, personal development, social development and acquiring of scientific methods. Teaching strategies used in the module is different from the classical style of teaching. Curriculum and teaching methods are designed in order to lessons would be attractive for students. Learning contents are selected to encourage the students to study organic chemistry and the popularization of chemistry. Access to the processing of the curriculum is intentionally based on the application of scientific knowledge to the problems of everyday life, which meets the requirements of students and supports science education of students.

1. Objective of the module:

To provide students and teachers with motivational content "Carbon – nature of life" based on science inter-disciplinarily, knowledge and skills application in everyday life.

To increase students' interest in chemistry linking the curriculum with everyday life.
To acquaint students with the basic composition of organic matter
Clarify to students' relationships and connections between coal and e.g. burned food.
Develop critical thinking based on the processing of information obtained from literature and experiments.
Using simple experiments to prove the presence of C, H and O in organic substances.
Development of inquiry skills through the implementation of (possibly designing) experiments with organic substances (wood, flour ...)
Develop skills related to teamwork.

Competencies: inquiry skills, team work, assessment and self-assessment, creative work, manual skills, communication skills.

2. Learning outcomes of the module:

Students will be able to:

- Understand and explain evidence of basic elements of organic compounds.
- Investigate the composition of organic substances.
- Linking knowledge of organic chemistry with the experience of everyday life.
- Design and conduct set of experiments to prove carbon (oxygen, hydrogen) in substances of daily life.

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3. Curriculum content:
Composition of organic substances; evidence C, an essential element of organic compounds.

4. Prior knowledge:
• Basic knowledge of the composition of hydrocarbons (not 100% necessary if we attempt to perform as a motivating introduction to organics, but it is necessary to adapt the questions)
• Knowledge of the properties of carbon, oxygen and hydrogen,
• Chemical properties of CO_2
• Knowledge of the difference between $CuSO_4 * 5\ H_2O$ and $CuSO_4 * ½\ H_2O$

5. Kind of activity:
Inquiring, experimenting, creating of hypotheses, development of experimental apparatus, group activities etc.

By examining ordinary well-known material we try to connect chemistry to everyday life and increase students' interest in chemistry. We familiarize students motivating way through experiments with organic substances to support positive relation to studying organic chemistry

6. Anticipated time:
4 hours (per 45 minutes) - 3 hours of instruction and 1 hour of homework.
The number of hours can be adjusted according to the conditions at the school.

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TEACHING GUIDE:

Scenario:

Read the stories and think about them:

Scenario (story) is used to motivate students and stimulate of problem situations, when students ask questions that they want to solve. A student should read a story in peace.

1 350 million years ago

It's warm, maybe hot and the air smells damp. Why not? We are in marshes and wetlands and there are huge Equisetaceae and Lycopodiophyta around us. The trees are not small at all. They have grown to 20 m, and some are probably 10 m more. The tree trunk has a diameter of more than 1 m. Giant dragonflies fly among the trees. If there was a man, he would be scared of a plane hurtling at him. This Meganeura has the wingspan of about 75 cm and the body length of about 250 cm. But it is no time to look at Meganeura. Suddenly, the wind rises and brings storm clouds. It starts thundering and becomes overcast. It starts pouring with rain. The water falls from the sky and the wind blows. It looks like a hurricane. Suddenly, trees start falling down. They fall into the swamp and start slowly sinking. Suddenly, the storm fades as quickly as it came.

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Some 20 years ago in the coal region near the city of Ostrava

Coal miners work in a deep mine. They break off smaller and larger pieces. Suddenly they break off a piece with a nicely visible leaf. Where did it come from? Is this the magic of dwarves?

http://cs.wikipedia.org/wiki/Soubor:Neuropteris.JPG

Yesterday in our kitchen

I feel like eating something nice. What will I prepare? Maybe I like to have cocoa. I pour a little milk into a saucepan and heat it on an electric stove. Ring, ring. Who is calling? Well, Eva. "How are you?" We keep talking. Suddenly I smell burnt milk. I hang up and hurry to the kitchen. What a mess! When my mother comes home, she will tell me off - I have to wash everything quickly!

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Problems and questions:

Carefully re-read the stories and write down the questions that occur to you:

All students have again carefully read the text of stories with a challenge to subsequently write their questions which occur to them during reading stories.

1.....

2.....

3.....

4.....

5.....

Students write down their questions into the table.

If you have just no ideas, select one of the following questions:

Less able students, who cannot create their questions about the story they can choose from a compiled questions that are directed to the core problem of both stories.

(a) Is it possible to find the piece of coal with a visible leaf? Which natural process is responsible for the things on the picture number one?

(b) What was the appearance of the saucepan from the short story „Yesterday...”? To what colour has the milk changed? What was the reason for this change?

(c) Is it possible to consider described experiments as an evidence of the presence of carbon in organic materials?

(d) Is it possible to consider described experiments as an evidence of the presence of carbon in organic materials?

(e) How is possible to prove the presence of oxygen in organic substances? What simple compound containing oxygen can help to prove it?

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These overviewed questions will be together answered at the end of module in the whole class and linked to students' questions.

Tasks and experimenting:

The following experiments help to answer questions:

In this place series of experiments are presented, using those students discover necessary phenomena and laws. Experiments are selected and arranged so that their results help to answer students' questions. These are the model experiments, which support linking theory and everyday life. It is the application of the second and third level IBSE, where student using exploration (experimentation) is looking for answers to the assigned questions or own questions.

❖ Experiment 1: A Evidence of Carbon, Oxygen, Hydrogen in Paraffin

***Equipment and chemicals*:** beaker, petri dish, lime water, paraffin wax candle, pliers

***Procedure*:**

- Place a burning candle in a beaker.
- After a moment, cover this beaker using Petri dish.
- After the extinction of the candle, observe the sides of the beaker.
- Then remove the candle, pour lime water in a beaker, cover it and shake it.
- Write down observed changes, and explain them, if it is possible take the photos.

Worksheet	**Evidence of Carbon, Oxygen, Hydrogen in Paraffin**
Chemicals:	
Chemical equipment:	
Observations: *1. Describe what happened in the beaker when you cover it using Petri dish.* *2. Describe the appearance of the lime water before pouring into a beaker and after pouring into beaker with products of burning.* *3. Which substance was proved by this reaction?*	
Conclusion: *This reaction is able to demonstrate the presence of certain elements in paraffin. What elements are they?*	

❖ Experiment 2: Evidence of carbon in wood

Equipment and chemicals: 2 test tubes, plug with the hole, glass tube , wood shavings or sawdust , lime water , burner , laboratory stand , $CuSO_4 * 0.5\ H_2O$, swab

Procedure:

- *Pour sawdust into about two thirds the height of the test tube and the close it using stopper with a glass tube.*
- *According to the scheme assemble the apparatus and carefully pour lime water into a second test tube.*
- *Heat the mixture of solids and observe changes in both test tubes.*
- *Drops of liquid have formed on the walls of the tube with shavings. Gently wipe off them with a cotton swab, which is covered with anhydrous $CuSO_4$.*
- *Write down observed changes, and explain them, if it is possible take the photos.*

Worksheet	**Evidence of carbon in wood**
Chemicals:	
Chemical equipment:	
Observation: *1. Describe the appearance of the solid which will heat.* *2. Describe the changes in the second test tube with lime water. Which substances this reactions is able to demonstrate?* *3. Describe the appearance of anhydrous CuSO4 before reaction and after reaction with liquid.* *4. Which substance was proved by this reaction?*	
Conclusion: *This experiment is able to demonstrate the presence of certain elements in dry wood. What elements are these?*	

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❖ Experiment 3: Evidence of carbon in organic materials

Equipment and chemicals: candle, sugar, flour, piece of plastic (cup), chemical pliers, porcelain shard (porcelain bowl), matches, 3 test tubes, burner, test tube holder

Procedure:

- Using the pliers grab the porcelain and insert it into the flame of candles.
- After removing the porcelain from the flame observe changes on its surface.
- Pour sugar, flour and a piece of plastic (only when the hood is available!) into individual test tubes.
- Hold gradually the test tubes into the holder and strongly heat in the flame of the burner.
- Observe changes in individual test tubes.

Worksheet	**Evidence of carbon in organic materials**
Chemicals:	
Chemical equipment:	
Observation: *1. What was the difference between porcelain before and after this experiment? For which element is this colour typical?* *2. Explain what has proved by this reaction?* *3. Describe appearance of substances in the test tubes before heating and after heating.* *4. Which element was proved by this change?*	
Conclusion: *This reaction is able to demonstrate the presence of one element in organic substances. Which element is it?*	

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Decision making:

Students individually write down answers to the questions before starting the inquiry.

Answers to questions:

- **Briefly answer the questions that you are expressed at the beginning of your inquiry.**

1.....
Answer:

2.....
Answer:

3.....
Answer:

4.....
Answer:

5.....
Answer:

(a) Is it possible to find the piece of coal with a visible leaf? Which natural process is responsible for the things on the picture number one?
Answer:
(b) What was the appearance of the saucepan from the short story „Yesterday...”? To what colour has the milk changed? What was the reason for this change?
Answer:
(c) Is it possible to consider described experiments as an evidence of the presence of carbon in organic materials?
Answer:
(d) Is it possible to consider described experiments as an evidence of the presence of carbon in organic materials?
Answer:
(e) How is possible to prove the presence of oxygen in organic substances? What simple compound containing oxygen can help to prove it?
Answer:

Conclusions and recommendations to the stories:

- **In the left column of the table write down your suggestions and recommendations that in your opinion belongs to these stories. Discuss with classmates and teachers about your opinions. Corrections and additions write down in the right column.**

Worksheet: 1 350 million years ago		
	My opinion:	**Correction and supplement after the discussion**
1.		
2.		
3.		
4.		
5		

Worksheet: Some 20 years ago in the coal region near the city of Ostrava		
	My opinion:	**Correction and supplement after the discussion**
1.		
2.		
3.		
4.		
5		

Worksheet: Yesterday in our kitchen		
	My opinion:	**Correction and supplement after the discussion**
1.		
2.		
3.		
4.		
5		

Based on own inquiry, the student the earliest fills himself/herself worksheets (tables) in the left part. Then during the discussion student conclusions are clarified and repaired.

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COMMENTS AND RECCOMENDATIONS:

Description of tasks

Students work in groups. First, students revise their knowledge of photosynthesis. This task can be entered as homework. Students compare their findings each other in groups, then create a simple presentation, poster. Under the guidance of teachers divide the substances involved in photosynthesis depending on the organic and inorganic. They understand basic features of elements and compounds occur in the organic substances. Brainstorming about the properties of these elements and their simple compounds under the guidance of a teacher (with his assistance) can help to devise a simple experiment for proof of elements in the organic compounds. Then, in the laboratory to perform the selected experiments and discuss findings.

Step 1: Photosynthesis

Students work in groups of three-to five-member groups. They discuss about the substances involved in photosynthesis - reactants and products. It is at the discretion of the teacher whether the students will have available the literature or computer connected to the Internet. According to the school equipment, students' abilities and teachers choices each group creates outputs (posters, computer presentations). Work can be entered as homework.
The output includes:
• Writing of the equation
• naming of substances
• Subdivision of the organic and inorganic substances
• An overview of the elements that make up the individual molecules and their basic physical and chemical properties

Step 2: Students present their previous work before the whole class.

Step 3: Brainstorming

Students still work in the same groups. Under the guidance of teacher students compile reports about all properties of the elements which they have in their outputs. They study features of simple compounds CO_2 and H_2O. Students suggest a simple reactions for proving the presence of both elements and compounds.

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Step 4 - Evidence

Students perform designed simple experiments which identify the presence of selected elements in common organic materials - wood, paraffin, etc.

Precautions!

Students keep to laboratory rules and all safety precautions described in the descriptions of experiments.

Recommendations:

❖ **EXPERIMENT 1**

- sometimes students do not leave the candle to burn long enough and lime water is not cloudy
- to prepare fresh lime water

❖ **EXPERIMENT 2**

- perform exactly assembly of the apparatus
- amount of sawdust in test tube is only about two thirds the height of the tube
- to explain to the students that experiment ends when the lime water turbid and on the walls of the tube timber appears sufficiently large drops of water
- $CuSO_4$ * 5 H_2O must be well dried.

❖ **EXPERIMENT 3**

- Explain that the experiment ends at the first observable change in the test tube, otherwise it releases an unpleasant odour.
- Experiment with plast is necessary to carry out only in the hood.

Step 5 - Evaluation of experiments, interpretation of observations

• When drawing up protocols should be noted rules for elaboration.
• It is necessary to be "guide" for students during their independent work - to help and to correct them.
• It is necessary to discuss and then to correct students´ conclusions. Sometimes it is necessary to explain content again.
• It is necessary to explain what is more and less important. Sometimes students have a tendency to pay attention to secondary things, because they are not able to recognize the importance of individual information.

Questions

Questions designed as the final summary lead students to a "scientific conclusions" and hypotheses about what they are able to discuss on an adequate level.

Based on the experiments students express their

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conclusion about evidence of the elements using selected experiments. The students carry out self-evaluation.

The following table presented possible answers to questions which are intended to verify the inquiry skills of students and whether they understand the nature of performed experiments.

1.	*Is it possible to find the piece of coal with a visible leaf? Which natural process is responsible for the things on the picture number one?*	*Yes, it is the result of natural process - carbonisation.*
2.	*What was the appearance of the saucepan from the short story „Yesterday...”? To what colour has the milk changed? What was the reason for this change?*	*Saucepan was change into brown to black. This change was caused scorching of milk. Carbon in the milk was reduced to its elemental form.*
3.	*Is it possible to consider described experiments as an evidence of the presence of carbon in organic materials?*	*Yes, it is possible; carbon had to be a part of compounds from which it has been separated.*
4.	*Is it possible to consider described experiments as an evidence of the presence of carbon in organic materials?*	*Yes, it is possible; carbon had to be a part of compounds from which it has been separated.*
5.	*How is possible to prove the presence of oxygen in organic substances? What simple compound containing oxygen can help to prove it?*	*The appearance of the water is an evidence of presence of oxygen.*

Final summary

Which elements were able to demonstrate in the presented materials?
Which of confirmed elements is probably the most important?
Which branch of chemistry examines substance such as wood flour, wax, plastic, but other materials in which carbon is the most important element?

Possible areas for discussion:

- Importance of photosynthesis for producing organic compounds.
- General characteristics of organic compounds
- The differences between organic and inorganic substances, etc.