

STUDENTS' IDEAS ABOUT RESPIRATION: A COMPARISON OF SLOVENE AND CZECH STUDENTS

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Abstract: *Many students and even adults have misconceptions about respiration. When referring to respiration they think of how animals and plants get oxygen into their body (lungs, grill, skin or stomata) rather than about aerobic metabolism, which requires oxygen to release the energy stored in food. They also often confuse respiration in plants with photosynthesis. Many investigations show that this topic is very difficult to understand, especially for children in lower secondary school. In our investigation we wanted to obtain information on preconceptions about this topic among students who had just entered the Faculty of Education and who intend to become primary school teachers. We wished to analyze the extent of any possible misconceptions on these subjects, and if there are any differences between the answers of Slovene and Czech students to the same questions. The results demonstrate significant errors and misconceptions among both groups of students and that it is essential to improve science teaching within the Faculty of Education to ensure that future primary school teachers possess a correct understanding of these fundamental topics, and so will teach children correctly about respiration.*

Keywords: *respiration, photosynthesis, plants, animals, misconceptions*

Introduction

Children and adults alike often have misconceptions about respiration, or what breathing is as a biological concept. In everyday life we say that we breathe with our lungs, fish breath with gills and amphibians breathe through their skin. This process is not breathing but inspiration and expiration, exchange of the air. Inhaled air, high in oxygen and low in carbon dioxide, travels through the respiratory tract deep into the terminal portions of the lungs; this is **inspiration**. There, oxygen diffuses across the lung surface into the blood. From the lungs, oxygenated blood is carried to the heart and then, via the systemic circulatory system, to all part of the body. The real biologically accepted definition of breathing is, in fact, at the cellular level. Each cell needs oxygen for living. During cellular respiration, oxygen moves from the blood into the cells,

and carbon dioxide and other wastes are released from the cell into the blood. Finally, deoxygenated venous blood, carrying its load of carbon dioxide, circulates back to the lungs, where carbon dioxide is exhaled during **expiration**.

Body tissue requires a constant supply of oxygen. Everyone knows that living organisms need oxygen, but they usually do not know why. Cells need oxygen because they require energy for metabolic processes. In the process of cell breathing/respiration the energy stored in carbon containing molecules, especially glucose is converted into high-energy bonds of ATP, the only usable energy source for many cellular activities. The process of converting the energy into ATP at the cell level we call cell breathing or respiration. The cell organelles in which the energy is converted into ATP are the mitochondria.

The process of cell respiration goes on in all the cells of both animals and plants. But many students confuse plant respiration and photosynthesis in green plants. From this they often state that plants breathe carbon dioxide whereas animals breathe oxygen. In fact, respiration is the same process in both animal and plants cells. Plants cells respire (ie breathe) all the time, because they need energy, but photosynthesis occurs only in the presence of light and in particular parts of cell particles called chloroplasts. Breathing and photosynthesis are, in fact, two distinct and opposite processes: in one the sun energy is stored in carbon containing molecules (especially glucose) and in another the energy is transformed into ATP which is needed for all cellular processes.

But these topics are very difficult for primary –and, indeed many post-primary - children to understand, and that is why they have misconceptions about breathing and photosynthesis (Marmaroti and Galanopoulou, 2006). Teachers must accordingly be aware of the problem and pay more time and attention to this and other fundamental topics, so that student will not continue their misunderstanding until entering university or even later. In our investigation we wanted to see what misconceptions, if any, first year Czech and Slovene students in the faculty of education have about respiration. Such students will, of course, on completing their degree, as teachers go on to teach children about respiration and photosynthesis. The accuracy of their knowledge and understanding about these basic processes will fundamentally affect their teaching and so the learning of their pupils.

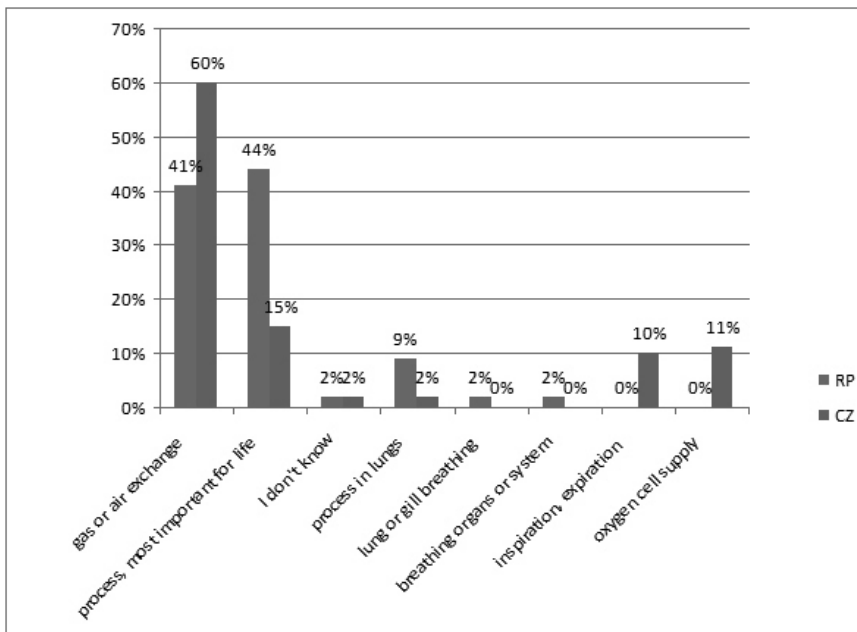
Methods

We gave the Slovene and Czech students the same questionnaire in their respective languages which included 6 open-ended questions about respiration. We obtained answers from 130 Slovene students and 85 students from the Czech Republic, with each student answering individually. They were not time limited. The responses to each question were divided into two or more categories, and are represented by graphs. The questions were:

1. What is respiration?
2. Do plants also respire?
3. Do animals and plants respire in the same way?
4. Why do organisms respire?

5. What are they respiring? What do they need for respiration?
6. When do plants respire?

Results

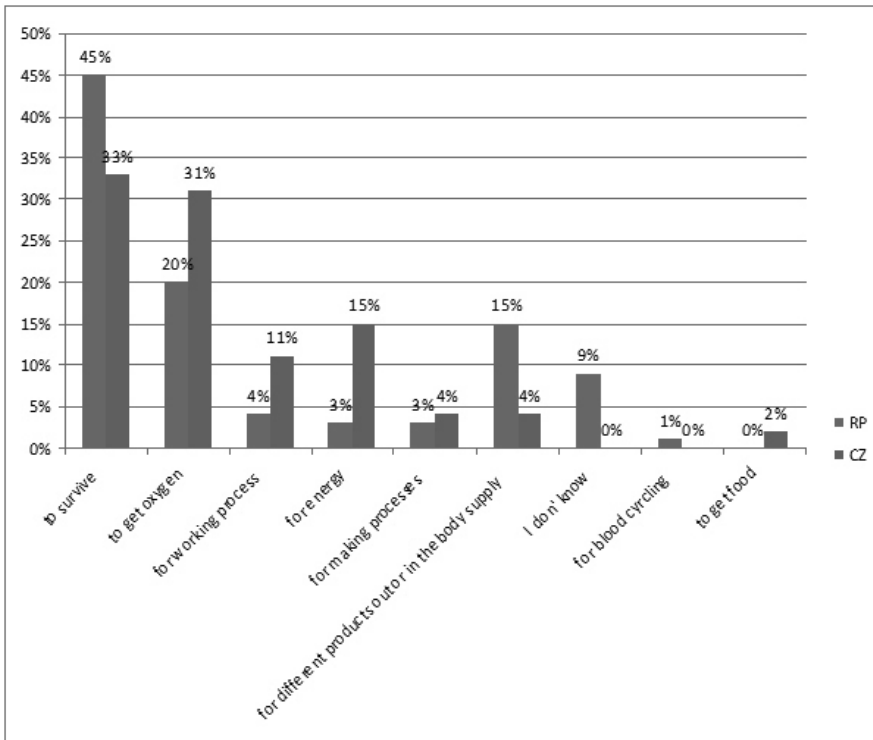


Graph 1: What is respiration?

For the first question “What is respiration?” “We got the answers we expected (graph 1). The answers were very general. 41 % Slovene and 60 % of Czech students answered that respiration is the exchange of gases, the second most common answer was that respiration is important for breathing (44 % Slovene and 15 % Czech students). 10 % of Czech and none of the Slovene students mentioned that this is the process where blood cells are provided with oxygen.

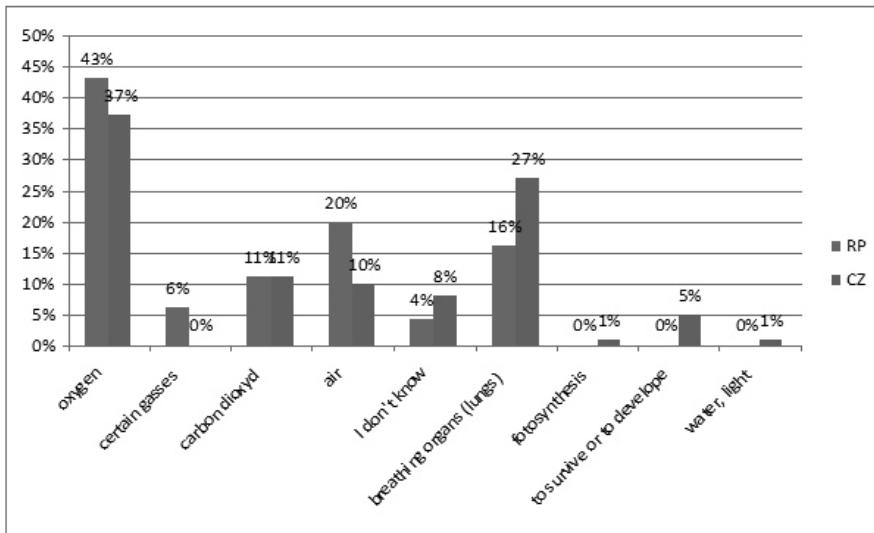
On the second question “Do plants also respire?” practically all the students answered ‘yes’. Only one Czech student answered that plants are not respiring

Most of the students (Slovene 97 % and Czech 98 %) answered that plants and animals are not respiring in the same way.



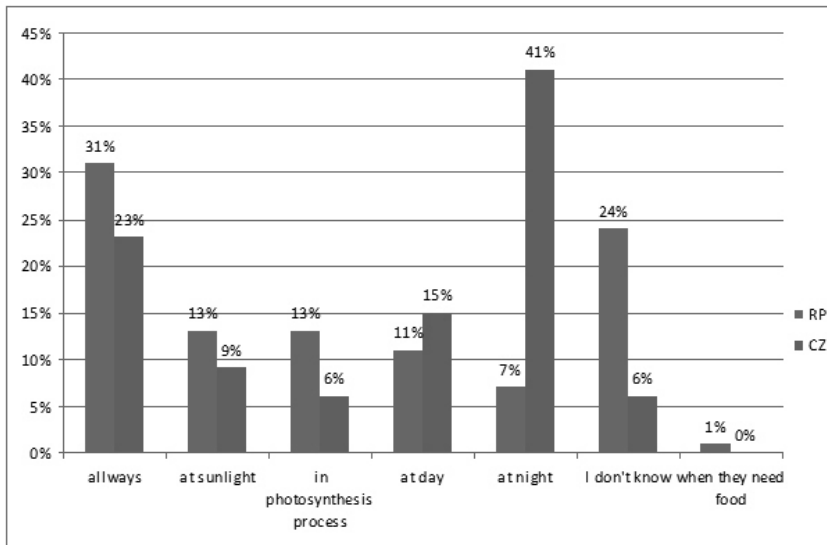
Graph 2: Why do organisms respire?

In response to the question 'Why do organisms respire?' 45 % Slovene and 33 % Czech students answered 'to survive.' 31 % of Czech students think that organisms respire to obtain oxygen, while 20 % of Slovene students are of the same view. Energy was mentioned by 15 % of Czech students and only 4 % of Slovene students. 15 % Slovene and only 4 % of Czech students think that organisms respire to obtain oxygen and excrete different products from the body (graph 2).



Graph 3: What are organisms respiring?

The apparently simple questions: “What are organisms respiring? What do they need for respiration?” in reality were not so easy to answer, with not even the half of the students giving the correct answers. 43 % Slovene and 37 % Czech student mentioned oxygen, but 11% of both groups of students answered that organisms are breathing carbon dioxide. Some students answered just air (20 % Slovene and 10 % Czech students), while 16 % Slovene and 27 % Czech students mentioned breathing organs, for instance lungs (graph 3).



Graph 4: When do plants respire?

Although students know that all living organisms need oxygen their answers to the question “When do plants respire?” showed that they confuse the different processes of respiration and photosynthesis. Only 31 % Slovene and 23 % Czech students answered that plants are always respiring, whereas 41 % of Czech and 7 % of Slovene students think that plants respire only during the night. 26 % Slovene and 15 % Czech students stated that plants respire during the process of photosynthesis or when sunlight is present. One quarter of Slovene and 6 % of Czech students did not know the answer (graph 4).

Discussion

Our investigation showed that when considering respiration students think about inspiration and expiration (the exchange of gases) and not the process at cellular level where respiration really occurs. Students were also unaware of the differences between respiration and photosynthesis. Although they had learned about both processes in school they had not grasped the fundamental point that these are two opposite processes, during which in photosynthesis energy is stored, and in respiration energy is realised. In the process of cell respiration the energy stored in carbon containing molecules, especially glucose, is converted into the high-energy bonds of ATP, which is the only usable energy source for many cellular activities. The conversion of energy into ATP at the cell level is cell breathing or respiration, with the process occurring within cell mitochondria. The students had learned about cell components, including mitochondria and other organelles, but they did not connect their knowledge of cell respiration with everyday life and the importance of survival. So we used oxygen because of the energy which keeps organisms alive, whether they are animals and plants.

One of the problems about understanding such a fundamental topic as why we respire is that during their secondary school studies students have to learn many details about cell structure and function but they do not see the important facts that are crucial for understanding the living world. In response to the question “What do you think respiration is?” nobody mentioned cell respiration and the conversion of energy to ATP. It is surprising that in reply to the question “Why do organisms respire?” 15 % Czech and only 3% Slovene students mentioned energy although in upper secondary school they had been taught that respiration is an oxidative process in which the oxygen is necessary to convert the energy stored in carbon containing molecules into ATP. Moreover, when they were asked about plant respiration they forget that the process is similar in plants and animals and located in mitochondria. Instead students confused respiration in plants with photosynthesis. Only 31 % of Slovene and 23 % of Czech students knows that plants respire day and night and it is surprising that 41 % of Czech and 7 % Slovene still think that plants respire only during the night.

It is further surprising that 11 % of the students answered that organism need carbon dioxide for respiration. The answers to the question about whether plants and animals respire in the same way showed that most of the students (Slovene 97 % and Czech 98 %) were thinking about the process of inspiration and expiration, and not about cell respiration. In every day life we do not think of a process at cellular level but only about receiving oxygen and releasing carbon dioxide, with this exchange occurring

via the lungs in mammals and many other land vertebrates, through gills in fishes, and in some animals through the skin while land plants receive air through stomata.

We can conclude then that both Slovene and Czech students have some significant misconceptions about respiration. The Czech students were more aware than the Slovene students that respiration is connected with energy. On the other side, more Czech than Slovene students think that plants only respire during the night. The results indicate that students do not bring sufficient knowledge about the process of respiration from their upper secondary school experience to the university. As future primary school teachers they must be aware of their misconceptions, and as their university educators we must pay more attention to respiration and other fundamental topics to help our students understand basic biological processes so that they will, in turn, provide correct information to their pupils in school.

CO ZNAJÍ STUDENTI O DÝCHÁNÍ: SROVNÁNÍ SLOVINSKÝCH A ČESKÝCH VYSOKOŠKOLÁKŮ

Abstrakt: Mnoho studentů, a dokonce i dospělých, má mylné představy o dýchání. Při odpovědích o vlastním vnímání pojmu dýchání se vyjadřují převážně tak, že živočichové a rostliny dostávají kyslík do těla (plícemi, kůží nebo póry), a opomíjejí existenci procesů aerobního metabolismu, který předpokládá kyslík potřebný k uvolnění energie uložené v potravě. Také si často pletou pojem respirace v rostlinách s fotosyntézou. Mnohé výzkumy prokázaly, že toto téma je velmi obtížné pochopit, a to zejména pro děti na 2. stupni základní školy. V našem šetření jsme chtěli získat informace o představách na toto téma mezi studenty, kteří právě vstoupili na pedagogickou fakultu a kteří mají v úmyslu stát se učiteli základních škol. Chtěli jsme analyzovat rozsah případných mylných představ a výsledky případných rozdílů mezi odpověďmi slovinských a českých studentů na stejné otázky. Výsledky anketních analýz ukazují významné chyby a nepochopení u studentů obou národností, nezbytnost zlepšit výuku v přírodních vědách na pedagogických fakultách tak, aby vysoká škola zajistila u budoucích učitelů základních škol správné pochopení těchto základních témat. Děti by se měly správně učit i o dýchání.

Klíčová slova: dýchání, fotosyntéza, rostliny, živočichové, mylné představy