

Students' Alternative Concept on the Topic of Energy in Life

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Received: 17 Februari 2024; Revised: 22 Maret 2024; Accepted: 25 April 2024

Abstract: This research aims to get the alternative concepts of students regarding the concept of energy in life using integrative instruments. The concept of energy in life consists of two topics, photosynthesis and cellular respiration. A sample of 375 students was established using the random sampling technique. They were from 14 junior high schools in Palembang City using the stratified cluster sampling. The instrument used consists of 30 free-response. The results of this research show that students understand the concept that photosynthesis can only occur in leaves (23.70%) and takes place during the day (33%) by utilizing oxygen (25.80%) while existing sunlight functions as the lighting in the photosynthesis process (17.20%) and chlorophyll plays a role in providing coloring to plants (16.50%). On the topic of cellular respiration, students understand that cellular respiration is an activity for the formation and addition of energy in living things (30.40%) and can occur in all parts of the body of living things (31.30%). Both ordinary cellular respiration and fermentation are carried out utilizing oxygen (72.40%). The results show that the alternative concepts possessed by students are very diverse with basic concepts, even though these basic concepts have been studied at previous levels of education.

Keywords: alternative concepts, energy transform, free response, student prior knowledge.

How to Cite: Dewi, S.P., Saparini, S., Destiansari, E., Anjelina, E.L (2024). Students' Alternative Concept on the Topic of Energy in Life. *Jurnal Inovasi Pendidikan IPA*, 10(1), 98-110. doi:<https://doi.org/10.21831/jipi.v10i1.71417>



INTRODUCTION

The formation of conceptual understanding in students occurs not only in the teaching and learning process that takes place at school but also through experiences that take place in everyday life. This process of forming an understanding of various concepts from various sources forms various alternative concepts. Alternative concepts refer to ideas that arise from wrong understanding or scientific ideas that are based on the understanding and beliefs held by individuals, unscientific beliefs, presumptions, or understandings that are formed from experience, reading materials, or from the environment of everyday life (Soeharto et al., 2019a). Alternative concepts are formed starting primary education to higher education (Barrutia & Díez, 2021). This shows that the process of forming a correct understanding related to a concept is still difficult to do through the learning process without being preceded by a process of in-depth study of the students' prior knowledge which can be in the form of alternative concepts. In this phenomenon, the learning process in class plays a very important role in providing correct understanding and distancing students from various alternative concepts that are wrong because of understanding the wrong concept. This emerging alternative concept has a huge effect on the classroom learning process (Hoppe et al., 2020; Katsidima et al., 2023; Yudha et al., 2022). The understanding that is possessed is accompanied by beliefs which can result in the formation of a new understanding which is the correct understanding becoming more difficult to achieve, especially for concepts that are difficult for students to understand, for example, the concept of energy in life.

Analysis of the Merdeka curriculum that has been carried out previously shows that the concept of energy in life is at the junior high school level in class VII. The concept of energy in life also has high

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material complexity because this concept discusses not only biological concepts but also a unified scientific concept that has an overview of the fields of physics and chemistry (Erdogan & Koseoglu, 2012; Kurt, 2021; Sinay et al., 2023). The concept of energy in life includes two main topics, namely photosynthesis and cellular respiration. Photosynthesis is an important fundamental topic in science and educational environments (Jancaríková & Jancarík, 2022; Woldeamanuel et al., 2020a). Photosynthesis is one of the most challenging topics in education because it requires an interdisciplinary approach to understand the concept (Çokadar, 2012; Waheed & Lucas, 1992). Meanwhile, the concept of cellular respiration is a basic topic for understanding large-scale biological activities such as digestion and tissue (Brown & Schwartz, 2009). Cellular respiration is also an important material because this material is the basis for studying other materials such as plant physiology, animal physiology, biotechnology, or other allied materials (Rahmatan & Liliyasi, 2012).

The results of previous research show that junior high school students still have a wrong understanding regarding this concept, including materials used in photosynthesis (17.65%), products produced in photosynthesis (47.05%), the location where photosynthesis occurs (35.30%) (Anjarsari, 2018). The results of this research also show that discussions about students' alternative concepts regarding the concept of energy in life are still separated from biological, chemical, and physical studies, whereas in its implementation in the learning process in class, this concept should be presented in an integrative manner so that students have a comprehensive understanding (Faisal & Martin, 2019; Setiawan & Faoziyah, 2020). Therefore, it is important to conduct a study of students' alternative concepts related to the concept of energy in life from the perspective of scientific concepts to improve students' understanding of the concept.

Exploring alternative concepts possessed by students can be done in various ways, namely by providing free-response questions, multilevel free-response questions, multiple-choice questions, open questionnaires, and multiple-tier questions (Al Faizah et al., 2019; Asghar et al., 2019; Franke et al., 2013; Kotsis & Panagou, 2022). The open-ended question format includes short answers, fill-in-the-blanks, free responses, concept mapping, and diagramming (Hubbard et al., 2017). Free-response questions more authentically capture students' knowledge because students construct their answers rather than choosing answers from several possible options (Weston et al., 2015). The free-response question has the potential to reveal students' complete understanding because their answers can be a combination of correct and incorrect ideas. Students' thinking is concluded based on the existence and truth of the same conception in addition to other conceptions that students may include in their responses to free-response questions so that alternative concepts can be identified by students (Pathare & Pradhan, 2010). Research conducted by (Regan et al., 2011) states that open description tests (free response) can find out alternative concepts that students have.

Increasing the efficiency and effectiveness of the learning process at school is expected to be able to increase students' understanding of the concepts being taught, which will ultimately fulfill the expected competency achievements in accordance with the applicable curriculum. This study can also help teachers choose learning experiences that suit student needs. It is very important to pay attention to the selection of learning experiences to maximize the achievement of learning competencies (Mutanaffisah et al., 2021). This can be done by conducting studies related to students' alternative concepts at the beginning of learning according to a certain level of education. Based on the applicable curriculum, junior high school science learning is carried out in an integrative manner between the fields of Physics, Chemistry, and Biology. Previous research regarding the study of alternative concepts on the concept of energy in life has been carried out at senior high schools and universities, while alternative concepts for junior high school students have not been implemented (Deanesia et al., 2021; Rahmatan & Liliyasi, 2012). Research on alternative concept studies at junior high schools in Indonesia is very rarely carried out. Much of the research conducted is only related to student misconceptions (Anjarsari, 2018; Haryono & Aini, 2021; Sari et al., 2024; Soeharto et al., 2019b; Soeharto & Csapó, 2022; Taqwim et al., 2022). This urgency attracted researchers to conduct research on alternative concepts for junior high school students using an integrative approach to the concept of energy in life. This research was conducted to obtain a true mapping of students' alternative concepts regarding the concept of energy in life.

RESEARCH METHOD

The study of junior high school students' alternative concepts on the topic of energy change aims to reveal a clear mapping of students' alternative concepts at the beginning of learning. This study was conducted using the qualitative approach from August to December 2023. The data from the research results were used to explain the various alternative concepts found and an in-depth study was carried out on each topic tested. The instrument was developed at the Faculty of Teacher Training and Education, Sriwijaya University, and data collection was carried out at junior high schools in Palembang City. The alternative concept study carried out in this research is focused on biological concepts, namely the concepts of photosynthesis and cellular respiration in living things.

The target population in this research is all grade VII students of junior high schools in Palembang City. The research sample was taken from a predetermined population so that the sample still has the same characteristics as the characteristics of the population. The total sample involved in this research is 375 students from 14 junior high schools in Palembang City who could be reached by researchers. The 14 junior high schools were determined by using the stratified cluster random sampling technique, with the provisions of school status (public and private) and school accreditation (A/B/C) as shown in Figure 1. Each school was taken into 1 class which was selected randomly.

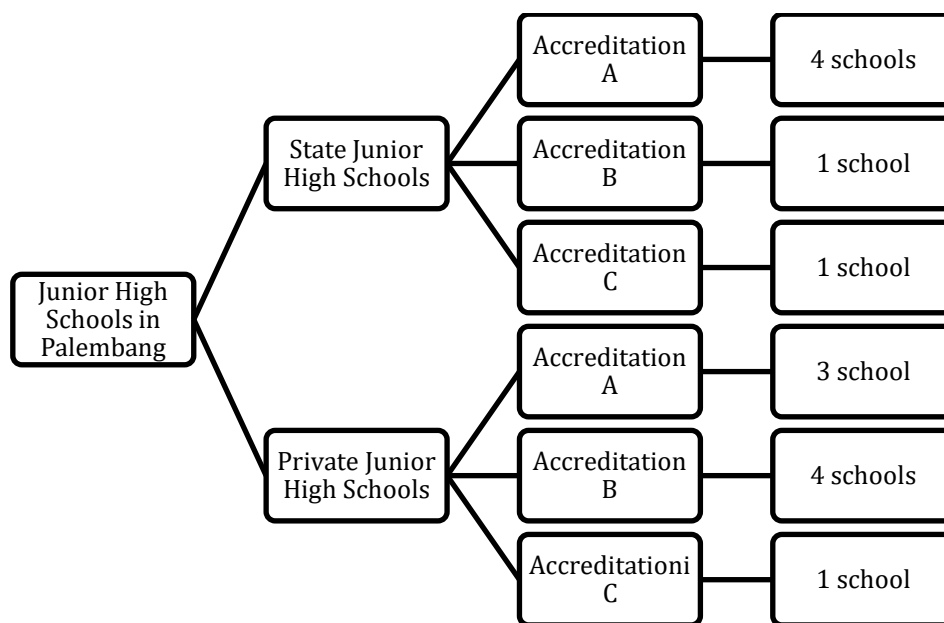


Figure 1. Determining the number of school samples using the stratified cluster random sampling method.

Research Instrument

The research instrument to reveal alternative concepts held by students on the topic of energy transformation is a test in the form of multiple free responses which allows students to provide reasons for their answers to the questions given. Choosing a free-response question form also allows students to express their understanding without being limited by alternative answers. The number of questions worked on by students is 30 questions consisting of 15 questions on the concept of photosynthesis and 15 questions on the concept of cellular respiration. The distribution of questions based on topics and concepts of material tested is presented in Table 1.

Instrument Development

The test used to reveal students' alternative concepts on the topic of energy transformation was developed through instrument development procedures using the Treagust framework (Treagust, 1988). Instrument development steps taken include identifying proportional knowledge from textbooks, developing concept maps, connecting proportional knowledge and concept maps, content validation, reviewing previous research results, semi-structured interviews, question validation, and testing the

readability of questions. Identifying proportional knowledge was carried out by reviewing textbooks with the results obtained that on the topic of photosynthesis, there were four major propositions and 16

Table 1. Distribution of questions based on sub-topics and topics.

No.	Topic	Sub-topic	Question Number
1.	Photosynthesis	Definition of photosynthesis	1
		Organisms that carry out photosynthesis	2
		Materials needed in photosynthesis	3,6,7
		The role of sunlight	14,
		Where photosynthesis occurs	4,15
		Photosynthetic organelles	8,9,10
		Products produced by photosynthesis	5, 13
		Dark reactions and light reactions	12
		The role of photosynthesis in Life	11
		2.	Cellular Respiration
Cellular respiration process	3,4,6,7,8,9,10		
Carbohydrate, protein, and lipid metabolism	15		

minor propositions, while on the topic of cellular respiration, there were six major propositions and 38 minor propositions. The concept map was made based on the results of the textbook review that had been carried out so that the concept map and the results of the concept analysis had a clear connection. Content validation aims to see that the content selected to be developed into an instrument is appropriate to the depth of the material and the student's cognitive level. This validation was carried out by one junior high school science teacher and one biology education lecturer. The results of content validation show that in the concept of photosynthesis, there are two major propositions and four minor propositions, while in the concept of cellular respiration, there are four major propositions and six minor propositions. The number of references from previous research reviewed for instrument development was 12 with various data collection techniques to reveal students' alternative concepts. Interviews to obtain basic data on instrument development were also conducted with 10 students. After the interview process was carried out, it was continued with instrument development, however, the instruments were not directly used in the data collection process. The instrument was then validated and the readability testing of the questions was carried out. The results of the validation show that the instrument is valid with an average of 96.33% (content validation 95%, construct validation 96%, and language validation 98%). The question readability testing was carried out through interviews with 10 students. The readability test results show that all questions can be understood and read by students.

Data Analysis

Analysis of the free responses instrument with two levels produces two data for one question given to students, namely data on the answers to the questions given and the reasons for the answers at the first level. These two data were then tabulated into the table provided and the frequency of each answer given by students was calculated. The frequency data were then calculated as a percentage and described to form the findings of this research. The percentage of achievement for each alternative concept recorded in this research was then grouped into achievement criteria.

Table 2. Alternative concept achievement criteria

No.	Percentage	Criteria
1.	0 – 33.33%	Low
2.	33.34 – 66.66%	Moderate
3.	66.67 – 100%	High

FINDINGS AND DISCUSSION

In the study of alternative concepts for junior high school students related to the concept of energy in life using an integrative approach, it focuses on two main topics, namely photosynthesis and cellular respiration. The study of students' alternative concepts was carried out using a free-response instrument to obtain as much data as possible about alternative concepts of middle school students on this topic.

This testing was carried out on junior high school students who had not received these two materials, meaning the testing was carried out at the beginning of learning. The results of this research provide not only an overview of students' alternative concepts at the beginning of learning but also an overview of students' prior knowledge. Students' alternative concepts regarding the concept of energy changes in life are presented in Table 3.

Table 3. Students' alternative concepts on the topic of Photosynthesis

No	Question	Photosynthesis		Question	Cellular Respiration	
		Result	%		Result	%
1	Definition of Photosynthesis	Reproduction and growth in plants and animals	39% (medium)	Definition of cellular respiration	The process of forming and adding energy.	30.40% (low)
		The process of making food in plants	20.40% (low)		Respiratory process	26% (low)
		The process of absorbing carbon dioxide and oxygen	13.20% (low)		Energy changes into movement	21% (low)
		Photosynthesis is related to plants	6.20% (low)		The process of food into energy	6% (low)
2	Types of organisms that can carry out photosynthesis	Plants and animals	13.70% (low)	Similarities between aerobic and anaerobic cellular respiration	Aerobic respiration and anaerobic respiration are two of the same thing	24.00% (low)
		Plant	47.20% (medium)		Aerobic respiration and anaerobic respiration are two different things	67.00% (high)
		All living creatures	10.90% (low)			
		Animal	8.10% (low)			
3	How water enters the plant body	Root	38.80%	The end result of cellular respiration	Energy	27% (low)
		Land	22.79% (low)		Air escape	22.80%
		Plant	4.90% (low)		Oxygen	23.30%
		Flower	2.30% (low)		Carbon dioxide	16.90%
4	Location of photosynthesis	Plant	29.50% (low)	Where cellular respiration occurs	Anywhere	31.30% (low)
		Leaf	23.70% (low)		Respiration	18.60% (low)
		Where there is light	7% (low)		In the human body	17.50% (low)
		Root	10.70% (low)		In all living things	13.60% (low)
5	Results of photosynthesis	Energy	8.80% (low)	Oxygen requirements in the cellular respiration process	Oxygen is needed in cellular respiration	72.40% (low)
		Food	7.70% (low)		Oxygen is not required for cellular respiration	22.40% (low)
		Develop and grow	35.80% (medium)			
		Glucose	14.10% (low)			
		Oxygen	11.90% (low)			

No	Question	Photosynthesis		Question	Cellular Respiration	
		Result	%		Result	%
6	The role of light in photosynthesis	Accelerating growth	12.60% (low)	Definition of energy	Which makes the body strong	42.40% (medium)
		Providing light for the photosynthesis process	17.20% (low)		Something needed to move	27% (low)
		Growing plants	15.80% (low)		The energy needed by living things	14.50% (low)
		Providing energy	26.30% (low)		Something that living creatures need for daily activities	10% (low)
7	Gas needed in the photosynthesis process	Oxygen	25.80% (low)	Source of energy in living things	Food and Drink	41.50% (medium)
		Oxygen and carbon dioxide	5.30% (low)		Food	22% (low)
		Natural gas	10.70% (low)		Food and rest	19.60% (low)
		Carbon dioxide	29.30% (low)		Sport	5.30% (low)
8	Definition of chlorophyll	Pigment	27.40% (low)	The role of energy in living things	The body will feel weak and limp	34.30% (medium)
		Leaf green substance	28.90% (low)		Living creatures will die	24% (low)
		Discoloration	5.80% (low)		Can't do activities	20.50% (low)
9	Location where chlorophyll is found	Leaf	25% (low)	The function of energy for living things	Can't move	11.30% (low)
		All parts of the plant are green	11% (low)		So that you can carry out daily activities	36% (medium)
		Plant	19% (low)		So that living things can move	32.30% (low)
10	The role of chlorophyll in the photosynthesis process	Plant	19% (low)	Cellular respiration in plants	Be more enthusiastic	10.4 (low)
		The continuation of plant life	11.70% (low)		As stamina or energy	7.60% (low)
		Gives green color	16.50% (low)		Plants perform cellular respiration	65.40% (high)
		Gives color to plants	22% (low)		Plants do not perform cellular respiration	29% (low)
11	The role of photosynthesis for life	Absorbs sunlight	8.60% (low)	Definition of Fermentation	Plants perform cellular respiration	65.40% (high)
		Oxygen for living things	25% (low)		Plants do not perform cellular respiration	29% (low)
		Living things can reproduce	9.50% (low)		Food spoilage process	30.40% (low)
		Provide food	17.70% (low)		Preserved beverages	22.60% (low)
12	The role of photosynthesis for life	Plants can grow	14.40% (low)	Fermentation and oxygen	Preparations that are left for a certain time	16% (low)
		When there is light	13% (low)		The process of making yogurt/tempeh/tape	8.50% (low)
					Fermentation requires oxygen	68.60% (high)

No	Question	Photosynthesis		Cellular Respiration		
		Result	%	Question	Result	%
	The time when photosynthesis occurs	Midday	33% (low)		Fermentation does not require oxygen	27.20% (low)
		Morning	9% (low)			
		Anytime	5.90% (low)			
13	The function of glucose produced from photosynthesis	Fertilize plants	20% (low)	The source of the sweet taste on the tape	A fermentation process occurs	36.60% (medium)
		Plant reproduction	5.10% (low)		Because it is given sugar or glucose	28% (low)
		Energy sources	5.60% (low)		Because of the presence of yeast	19% (low)
		Plant sweeteners	16.50% (low)		Made from sweet potatoes	7% (low)
14	Most light is absorbed for photosynthesis	Red	9.80% (low)	The function of adding yeast in making bread	Because yeast has the property of expanding	35.30% (medium)
		Yellow	43% (medium)		Because of fermentation	26.30% (low)
		Green	21% (low)		Yeast helps the fermentation process	19,80%
15	If the leaves on a spinach plant fall, will photosynthesis still occur?	Still happening	31% (low)	The role of carbohydrates, proteins, and fats in life	As food necessary for life	17.30% (low)
		Not occurring	42% (medium)		To produce energy	
		Reproduction and growth in plants and animals			Make our life healthy	34% (medium)
		The process of making food in plants			Provides nutrients and vitamins	22.40% (low)

Alternative concepts that students have regarding the concept of photosynthesis from the results of various research that have been carried out. The questions in the instrument used in this research were grouped into two categories, namely questions related to basic concepts and questions related to advanced concepts. Some of the basic concepts asked include the definition of photosynthesis, living things that carry out photosynthesis, where photosynthesis occurs when photosynthesis occurs, and the results of the photosynthesis process. Meanwhile, advanced concepts in this research include the process of absorbing water for photosynthesis, the role of light, gas, and chlorophyll, and concepts related to the results of photosynthesis. In general, the results of this research show that alternative concepts in basic concepts are very diverse for various reasons, although the number of alternative concepts found is insufficient with a lower frequency of alternative concepts when compared to topics related to advanced concepts. The basic concepts asked about in this research have been learned from previous education. Some of the advanced concepts asked about in this research have also been studied in previous education, although not in great depth. In ideal conditions, if we refer to the achievement of basic competencies and the achievement of KKM in the previous education, students should have understood the basic concepts well so that it is expected that at the next level of education, they can minimize alternative concepts that exist in students. This phenomenon can be caused by concepts that have been understood over time moving from short-term memory to long-term memory without students realizing it (Norris, 2017). Recalling these concepts can be done so that there is a transfer from long-term memory to short-term memory according to a person's needs (Albajes-Eizagirre et al., 2014), however, this recall process takes time. This is because many attributes need to be analyzed by someone during the recalling process (Unsworth, 2016). Apart from that, understanding stored in long-term memory can experience

interference due to increased understanding of other concepts originating from the learning process at school or the learning process from students' field experiences. This incident can result in an understanding of the concept being distracted by other concepts due to errors in connecting one concept with another (Kurniawan et al., 2018; Prabha, 2020).

The phenomenon of misunderstanding the concept can be seen in Question 1. Question 1 is a very basic question about photosynthesis, namely related to the definition of photosynthesis. The answers given by students to this question varied widely. This finding is in line with research that has been conducted previously regarding alternative concepts in photosynthesis, that the concepts related to the definition of photosynthesis have various alternative concepts (Karakaya et al., 2021; Marzuki & Diknasari, 2022; Urey, 2018). In this research, 39% of students understood that photosynthesis is a process of growth and reproduction in plants and animals. This is because students consider plants to be living creatures that must reproduce. Students have the idea that photosynthesis is a reproductive process. This result was also found in previous research which stated that students had an alternative concept by defining photosynthesis as a process in which plants develop (ALKhawaldeh, 2019). As many as 20.4% of students also mentioned that photosynthesis was the process of making food in plants because photosynthesis was the source of life, namely making food. Some students also think that photosynthesis is the process of absorbing carbon dioxide and oxygen. Students reasoned that it was cool under the tree. Students also assume that photosynthesis is a change in the form of living things. Some students also think that photosynthesis is a process of absorbing carbon dioxide and oxygen, a biochemical process, and a process to increase immunity and that photosynthesis occurs in humans. The correct concept is that photosynthesis is the process of converting light energy into chemical energy in food (Campbell et al., 2011).

Student responses to this question were like Question 5 (35.8%), even though these two questions had a different focus. Question 1 focuses on the definition of photosynthesis, while Question 5 focuses on the results of the photosynthesis process. If viewed from the actual concept, this question wants students to answer oxygen and glucose as the results of the photosynthesis process (Campbell et al., 2011). Several students gave correct responses according to the concept, namely glucose (14.1%) and oxygen (11.9%). This shows that students connect the products of the photosynthesis process with the goals of the photosynthesis process itself, but the responses given by students to this question are very far from the actual concept and lead to students' alternative concepts. Students have confidence that the product referred to in the question leads to the goal of the photosynthesis process. This error in linking the concept of definition and purpose of photosynthesis shows that the knowledge at the beginning of learning that students have is still very limited and the concepts that students can remember are also still limited (Halmo et al., 2018; Parker et al., 2012). The time gap between students studying this concept at the previous level of education and the implementation of testing or implementation of learning at the current level of education allows some concepts to be forgotten by students or existing concepts to be disturbed by other similar concepts either obtained from classroom learning or experience owned by students in the field.

Question 2 asks about what living creatures can carry out photosynthesis. Students have alternative concepts on this topic. As many as 47.2% of students think that living creatures that can carry out photosynthesis are plants because plants are living creatures that reproduce. Previous research also stated that only plants could carry out photosynthesis because students saw only large plants around them and did not see algae and algae which are relatively small (Anwar et al., 2023; Karakaya et al., 2021). As many as 15.3% of students also think that animals also carry out photosynthesis because students assume that plants and animals are living creatures without looking at what is needed for the photosynthesis process. There is one student who believes that photosynthesis can be carried out by non-mammal living creatures. Some students think that all living creatures, including humans, can carry out the process of photosynthesis. The correct concept is that photosynthesis can occur in all living creatures that have chloroplasts because in the chloroplasts there is chlorophyll which functions to capture sunlight in the photosynthesis process. The captured light is used to convert solar energy into chemical energy. The light energy absorbed by chlorophyll facilitates complex chemical reactions that occur during the photosynthesis process (Campbell et al., 2011).

Question 3 concerns the material used in the photosynthesis process, namely water, asked how water enters the plant. As many as 38.8% of students understand that water is absorbed by roots, but students do not know the exact reason why roots can absorb water. 22.79% of students think that the

water needed for the photosynthesis process in plants is absorbed by the soil. This is because students reason that soil easily absorbs water. These results are in line with previous research which states that water is absorbed by the soil during photosynthesis (Woldeamanuel et al., 2020b). Some students think that water is absorbed by plants through flowers as much as 2.3%. Students also think that water is absorbed by plants through leaves, stems, and thorns. The correct concept is that water is absorbed through the roots and transported to the leaves through the vessels (xylem) (Campbell et al., 2011).

The question about the location where photosynthesis occurs in Question 4 is studied in more depth in Question 15 and is also related to Questions 9 and 10. The findings in Question 4 show that photosynthesis occurs in plants (29.5%) and leaves (23.7%). These findings indicate that students' knowledge about the location where photosynthesis occurs is still very general and limited. This can be caused by the depth of knowledge they learned at previous levels of education only reaching this concept. These two responses are closer to the actual concept although they do not yet show a more specific response regarding the location where photosynthesis takes place, namely in the chlorophyll in plants. This student response can perhaps be explained in Questions 8 and 10 which ask for the definition and function of chlorophyll in plants. Students understand that chlorophyll found in plants is a substance that gives color.

In photosynthesis, light and carbon dioxide gas play an important role in the process. The results of this research show that students already know that carbon dioxide is a gas used for the photosynthesis process (29.3%) however, as many as 25.8% of students understand that the gas needed is oxygen. This phenomenon shows that students' understanding is reversed and confused between the gas needed and the gas produced from the photosynthesis process. Apart from that, this can be caused by students' mixed understanding of the concept of respiration in plants. Meanwhile, students' understanding of light from the results of this research shows a good understanding. As many as 26.3% of students already know that sunlight in photosynthesis plays a role as an energy provider, several alternative concepts emerged related to the role of light in photosynthesis, namely providing light in photosynthesis (did not provide answers to the questions given) (17.2%) and plays a role in the process of plant growth and development (12.6%-15.8%). The results of this research also show that students understand that the light most absorbed for photosynthesis is yellow (43%), but only 9.8% of students have a correct understanding of this concept, namely red light. The number of students who answered yellow as the most absorbed light was related to Question 12 regarding the timing of photosynthesis and Question 6 regarding the role of sunlight in photosynthesis. Students believe that photosynthesis is very dependent on the presence of sunlight as an energy source, therefore, photosynthesis must occur during the day (33%) or only when there is light (13%). Photosynthesis will take place even if there is no sunlight as long as there is other light that can replace the role of sunlight with the criteria of having a wavelength of 680 and 700 (Campbell et al., 2011).

This research not only focuses on the topic of photosynthesis but also discusses the topic of cellular respiration as a form of energy transformation that occurs in living things. Table 2 shows that students also have various alternative concepts in almost every question on the topic of cellular respiration. Students have alternative concepts related to the meaning of cellular respiration, which is defined as the process of forming and adding energy. Apart from that, some students think that cellular respiration is breathing. Students also assume that all cellular respiration and fermentation require oxygen. Students assume that cellular respiration is very dependent on the presence of oxygen, while anaerobic respiration is respiration that does not use oxygen at all in the process. On this topic, especially on Question 11 related to understanding fermentation, 30% of students define fermentation as a process of decay, and this is of course quite far from the actual answer where fermentation is a biochemical process in which microorganisms, such as bacteria or yeast, decompose or convert organic compounds into other products by producing energy under conditions anaerobic (without oxygen) but there are also students whose answers are close to the actual concept where students define fermentation as changing chemical substances in a substrate to become simpler, this is of course quite far from the actual answer where fermentation is a catabolic process and partial breakdown of sugar, which occurs without the use of oxygen (Campbell et al., 2011).

The next topic is the cellular respiration process. Students also still connect cellular respiration with the respiratory process where they have an alternative conception that the result of the cellular respiration process is carbon dioxide because oxygen turns into carbon dioxide, but some of them know that one of the results of cellular respiration is ATP (Adenosine triphosphate). The research results show

that in Question 1, 30.4% of students define cellular respiration as the process of forming and adding energy because this cellular respiration process will produce energy. This shows that the concept that students have regarding the definition of cellular respiration is close to the actual concept because of the result. The same thing was also found in the research conducted by (Tridiyanti & Yuliani, 2017). Students have an alternative concept regarding the place where the process of cellular respiration occurs. Cellular respiration itself occurs in mitochondria because enzymes embedded in the organelle membrane called mitochondria function in cellular respiration (Campbell et al., 2011). In the cellular respiration process, the result of cellular respiration is the production of energy in the form of ATP (adenosine triphosphate). The answer to Question 1 is also supported by answer number three, where 27% of students answered that the result of cellular respiration is energy. Students can also differentiate between respiration and cellular respiration, where in Question 2, 67% of students state that respiration and cellular respiration are not the same. Something different was found in previous research conducted by (Dewi et al., 2019) where 66.1% of prospective science teachers understood that respiration and cellular respiration are the same thing.

In Question 4 related to organelles (where) cellular respiration occurs, there are already several students who know correctly that cellular respiration occurs in the mitochondria, but the students who answer that cellular respiration occurs anywhere are many more. This shows that students do not know specifically where the process of cellular respiration occurs. The same thing was also found in research conducted by (Tridiyanti & Yuliani, 2017). The students have alternative concepts regarding where the cellular respiration process occurs. Cellular respiration occurs in mitochondria because enzymes embedded in the organelle membrane called mitochondria function in cellular respiration (Campbell et al., 2011). In Question 15, which relates to the topic of carbohydrate, protein, and fat metabolism, students experience the least alternative concepts, which shows that even though they do not have initial knowledge that is directly related to cellular respiration itself, they have sufficient knowledge, which is separate and relevant, for example, the food they eat will produce energy.

Based on the results obtained, students have alternative concepts for all photosynthesis concepts. The concept of photosynthesis has been studied in elementary school, but students do not yet have a correct understanding of the concepts of photosynthesis and cellular respiration. This is because the material on photosynthesis and cellular respiration is difficult. After all, it is abstract and contains many chemical reactions, and this causes students to have many alternative concepts (Deanesia et al., 2021), and the process cannot be observed directly (Dewi et al., 2019). Students must connect ideas and facts that form concepts to achieve a meaningful conception of the topic of photosynthesis so that they do not have a wrong understanding of photosynthesis. Students' understanding of the concepts that are close to the truth is because they have studied several concepts at previous levels of education (Rahmatan & Liliyasi, 2012).

The alternative concepts that exist are generated because they are obtained from various sources, including the students themselves, material obtained at school, family, and textbooks used in the teaching and learning process. These results are in line with previous research which finds that the source of students' alternative concepts comes from experience, understanding of pedagogical content, educational and cultural background, teaching materials, and learning resources (Anwar et al., 2023; Soeharto et al., 2019a).

CONCLUSION

Research on students' alternative concepts at the beginning of learning on energy changes in living things covers two main topics, namely photosynthesis and cellular respiration. On the topic of photosynthesis, students understand that photosynthesis is part of the growth and reproduction process of plants and can occur in all living things. Photosynthesis can only occur in leaves and takes place during the day by utilizing oxygen, while existing sunlight functions as lighting in the photosynthesis process and chlorophyll plays a role in providing coloring to plants. On the topic of cellular respiration, students have an understanding that cellular respiration is an activity for the formation and addition of energy in living things and can occur in all parts of the living creature's body. Both regular cellular respiration and fermentation are carried out utilizing oxygen. Fermentation is also defined as a decaying process due to the bread development process. The results of this research indicate that it is necessary to develop diagnostic instruments to study in more depth the categorization of students' understanding

at the beginning of learning and that it is necessary to develop appropriate teaching materials to provide understanding that is on actual concepts.

ACKNOWLEDGEMENTS

This research/publication of the article was funded by DIPA of the Public Service Agency of Universitas Sriwijaya 2023, SP DIPA-023.17.2.677515/2023. On November 13, 2022. In accordance with the Rector's Decree Number: 0189/UN9.3.1/SK/2023. On April 18, 2023.

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