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META-ANALYSIS OF STUDENT'S MISCONCEPTIONS FOR BIOLOGICAL MATERIALS FOR SCIENCES CLASS SMA/MA

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ABSTRACT

Misconceptions result in poor student learning outcomes and become an obstacle in the other learning process. It is necessary to know exactly where the students' misconceptions lie. This type of research is a meta-analysis by collecting, analyzing, and summarizing the results of relevant research in the form of articles that have been previously researched. Of the six research results regarding misconceptions in Biology students of class XII IPA analyzed, it is inseparable from students' misconceptions that are quite varied. The catabolism sub material that experienced the largest and smallest student misconceptions, respectively, was the indicator identifying each step that occurred in cellular respiration and the indicator determining the ratio of fermentation and aerobic respiration. Catabolism contained quite complicated stages with complex terms. To be remembered and understood by students who can trigger misconceptions. The higher the percentage of students' misconceptions, the lower students' understanding of the concepts in the material. Overall, students' misconceptions are caused by internal factors (students themselves) and external factors such as teachers, textbooks, and the context of the material being studied. Further action is needed on the part of teachers and related organizations to ensure efforts are made to reduce misconceptions among students.

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INTRODUCTION

Concepts are abstractions of a group of objects or phenomena with similar characteristics. There are concrete concepts such as doors, houses, seas, lakes, and abstract concepts such as democracy, ideas, desires, happiness, etc. (Sharti et al., 2020). According to Simatupang (2019), the concept has symptoms in understanding and certain characteristics obtained from direct observation and experience. Lufri et al. (2020) state that the concept is the definition of general properties. Concepts can be in a general state to a particular state. Concepts are categorized into objects, events, people, ideas, and symbols. According to Chaniarosi (2014), abstract concepts make it difficult for students to understand concepts, which can interfere with forming scientific conceptions in students and teachers themselves, which causes misconceptions. General concepts are also found in Biology learning which is concrete and abstract, and difficult for students to understand.

A misconception is a person's understanding that is different from experts' concepts (Ibrahim, 2019). Misconception or misinterpretation is a concept that is not following scientific research or the way it is understood by experts (Jumini et al., 2009). One person's point of view may differ from that of an expert, and misunderstandings may arise. Someone resistant to misconceptions (always corrects mistakes and persists) finds it difficult to change his stance (Ibrahim, 2019). It can be concluded that a misconception or misinterpretation is someone's understanding of the concepts put forward by experts in a particular field of science. A person who experiences misconceptions thinks the concept is correct and resistant (always sticks with his concept and is difficult to change).

According to Jannah and Anandita (2018), the causes of student misconceptions can include many factors, including biases, abilities, preferences and learning thoughts, and study partners. Misconceptions caused by teachers may be caused by the teacher's incompetence and lack of understanding of teaching materials. The causes of misconceptions in textbooks can be seen in incorrect explanations or explanations in books. Sources of contextual misunderstanding in daily experiences, culture, religion, and language also affect students' misunderstandings. On the other hand, the cause of misconceptions is the teacher's inappropriate teaching method or the teacher's attitude towards students who do not relate well. According to Widiastutik and Isnawati (2021), the causes of student misconceptions are (1) students who have not read the material discussed. (2) some students do not understand the material quickly. (3) students' lack of initial understanding. The misconceptions that come from books are due to the following: (1) schools cannot recommend books that may or may not be used. (2) teacher and student textbooks may not be the same, and (3) many terms confuse students without explanation. According to the opinion of several researchers above, misconceptions are associated with many sources: students, teachers, textbooks, context, and teacher teaching methods.

Based on several studies, the researchers found that there were several misconceptions in textbooks. Misconceptions in textbooks can cause misconceptions in students. The following is a study on textbook misconceptions, research by Hajizah & Fauziah (2018) "Analysis of Misconceptions of Class XII Biology Textbooks on Genetic Materials in Public High Schools in Medan Kota District" found misconceptions in the book A 30% and B 15,63%. In the research of Suranti et al. (2017), "Misconceptions of Genetic Material in Class XII High School Biology Books Written Based on the 2013 Curriculum in Kulon Progo Regency", misconceptions were found in three textbooks, namely books A, B, and C. Five categories of misconceptions were found. The highest percentage of misconceptions was found in book B (18.99 %), book A (17.90%), and book C (14.50%).

Misconceptions are not only found in textbooks, but misconceptions are also found in biology teachers themselves, such as in the research of Bukit (2011) "Identification of Biology Teachers' Misconceptions in Respiration and Photosynthesis Materials in High Schools in Medan City," the identification of misconceptions in teachers biology with low category. The misconceptions on respiration include the concept of reaction stages and respiration products, while the photosynthetic material includes the concept of the reaction process and the factors that affect photosynthesis. There was 78.13% of Biology teachers had misconceptions (CRI test) and 56.25% of Biology teachers experience misconceptions in understanding the image of a neuron cell (Hidayati, 2014). From the seven textbooks used in schools, misconceptions were identified on the structure and function of neurons, nerve impulses, the central nervous system, and the nervous system. Misconceptions should not be identified in biology textbooks and teachers. Misconceptions in textbooks and biology teachers will cause student's misconceptions.

According to Nusantari (2011), if misconceptions in students occur continuously and are left unattended, the consequences will be carried away by students at the next level and have a destructive impact on knowledge. This opinion is in accordance with Chaniarosi (2014) that the misconception will have a negative impact on student learning outcomes, becoming an obstacle for students in the further learning process. Based on Nusantari (2011) and Chaniarosi (2014) opinion, Misconceptions will cause students to have wrong concepts, misunderstand scientific phenomena, the occurrence of destructive knowledge in students, poor student learning outcomes, confusion, and incoherence in students and become obstacles in the further learning process. Based on these consequences, misconceptions should not exist in students, for that it is essential to overcome misconceptions in students, so it is necessary to know the exact location of misconceptions in students.

METHOD

This type of research is a meta-analysis. Meta-analysis is a technique that combines two or more similar research so that the same pattern is obtained from some of the research results (Rudito, 2015). A research or article search was carried out on Google Scholar using the keyword "student misconceptions in biology class XII science" obtained 20 articles related to student misconceptions in biology learning published nationally. Hence, the population in this study amounted to 20 articles. The technique used by researchers to determine the sample is purposive sampling, which is a technique to determine samples with specific criteria. The sample criteria in this study were in the form of articles that specifically examined students' misconceptions in learning biology in high school class XII. The sample of this study contained six of the 20 articles found. Sources of data are taken with titles and materials that are pretty varied but still within the scope of Biology material for class XII SMA.

Data analysis has three stages, namely: 1) descriptive analysis, where data is collected and analyzed; 2) content analysis, loaded with steps to review and conclude the article by determining the criteria for misconceptions on concepts/subconcepts/indicators of the material analyzed based on the criteria proposed by Arikunto (1996), namely 0-30% low criteria, 31-60% moderate, and 61-100% including high criteria. Next, determine the highest and lowest percentage of misconceptions, and continue by analyzing the factors that cause misconceptions in order to produce a conclusion, 3) critical analysis, namely critiquing the evidence obtained during the study of literature, as well as addressing a phenomenon data scientifically (Irani et al., 2020).

RESULTS AND DISCUSSION

The study results were obtained from relevant data sources by analyzing students' misconceptions in class XII Biology learning and its causal factors. The data from the analysis of misconceptions in class XII Biology students can be described on Table 1.

Table 1. Percentage of Students Of MAN 1 Mojokerto Class XII IPA Who Experience Misconceptions on The Concept of The Enzyme Submaterial

No	Concept	Misconception (%)	Criteria
1.	Enzyme Components	39,99	Moderate
2.	Enzyme Structure	40,00	Moderate
3.	Nature of enzyme	66,12	High
4.	The Role of Enzymes in Metabolism	35,00	Moderate
5.	Two Enzyme Formation Mechanisms, namely *Lock And Key* and *Induced Fit*	65,00	High
6.	According to the International Union of Biochemistry in 1961, based on the catalyst enzymes are divided into six	51,66	Moderate
7.	Graph of Decreased Energy Activation Energy Due to Enzymes in Metabolism	50,83	Moderate
8.	Factors Affecting Enzyme Work	59,16	Moderate
9.	Types of Inhibitors That Inhibit Enzyme Action	53,33	Moderate

(Sourcer: Puspitasari, 2020)

Table 1 shows that the percentage of students' misconceptions is in each concept of the enzyme sub material. The properties and characteristics of enzymes have the highest

percentage with high criteria, while the role of enzymes in metabolism has the lowest percentage of misconceptions with moderate criteria. The high and low percentage of students' misconceptions is due to several things: students have difficulty understanding and explaining concepts using terms, students' lack of memory of concepts, and incomplete information from the learning resources used. Percentage of students in the catabolism sub material who experience misconceptions shows in Table 2.

Table 2. Percentage of Class XII Science Students at SMA Negeri 1 Widang in The Catabolism Sub Material Who Experience Misconceptions

No.	Indicator	Misconception (%)	Criteria
1.	Determine each step that occurs in cellular respiration	91,89	High
2.	Analyzing the role of enzymes in the glycolysis stage	27,03	Low
3.	Determine the ratio of fermentation and aerobic respiration	5,41	Low
4.	Analyzing energy changes during electron transport in oxidative phosphorylation	72,97	High
5.	Analyze the steps that occur in the citric acid cycle	56,76	Moderate
6.	Analyze the function of glycolysis	24,32	Low
7.	Determine where each stage of anaerobic respiration occurs	39,19	Moderate
		43,24	Moderate
8.	Explain the meaning of the process of respiration	35,14	Moderate
9.	Determine the end result of the citric acid cycle process	21,62	Low
10.	Determine the molecular changes in alcoholic fermentation	43,24	Moderate
11.	Explain the meaning of catabolism	37,84	Moderate
12.	Analyzing the molecular changes in the glycolysis stage	45,95	Moderate
13.	Determine the final product of the glycolysis process	10,81	Low
14.	Determine the ratio of aerobic respiration and anaerobic respiration	64,86	High
15.	Analyzing changes to the citric acid cycle	78,38	High
16.	Determine the last electron acceptor in the electron transport chain	59,46	Moderate
17.	Determine the ATP yield of all stages of aerobic respiration	62,16	High
		51,35	Moderate
18.	Analyzing examples of alcoholic and lactic acid fermentation	27.03	Low
		27,03	Low
19.	Determine the ATP gain per glucose molecule	35,14	Moderate
20.	Assessing statements about ATP production in human muscle cells	13,51	Low
21.	Assessing statements about the function of the citric acid cycle	24,32	Low
22.	Assessing statements about obtaining the amount of ATP	27,03	Low
23.	Name the three enzymes involved in aerobic respiration	64,86	High
24.	Analyzing the results of the starch experiment	51,35	Moderate
25.	Analyzing the experimental results of anaerobic respiration	67,57	High

(Sourcer: Tridiyanti & Yuliani, 2017)

According to Puspitasari (2020), the low memory of students on a concept causes students to find it challenging to explain the properties of enzymes by using specific terms on the concept of enzyme characteristics containing the properties of enzymes. The number of misconceptions in students is caused by incomplete sources to obtain information related to the concept because it is not included in the student textbook. Even though the teacher has added an explanation, it still affects. Regarding the concept of enzyme classification based on IUB nomenclature, students do not understand the concept because the textbook does not include this concept. Moreover, the teacher also does not explain in detail, so students do not get much information for this concept. The concept that enzymes can reduce activation energy is presented in the form of an activation energy graph, then students are asked to analyze the graph, but in fact, students cannot interpret the graph presented.

According to Saputri et al. (2016), understanding biological concepts is fundamental and must be understood by students, but students often understand the wrong concepts, causing misconceptions. Misconceptions will hinder the process of receiving new knowledge by the students themselves. According to Puspitasari

(2020), students, teachers and how to teach teachers, textbooks, learning media and, as well as the context of related materials are factors that cause misconceptions in students.

Based on Table 2, it can be seen that the highest student misconceptions about the stages that occur in cellular respiration, and the lowest student misconceptions about the comparison of fermentation and anaerobic respiration. The high percentage of students who experience misconceptions is because students do not fully understand the basic concepts of carbohydrate catabolism. The catabolism sub material has complicated stages with difficult terms for students to remember and understand, which can trigger misconceptions. In addition to the characteristics of the catabolism sub material which has quite complicated stages and terms, according to Tridyanti & Yuliani (2017), the misconceptions experienced by students in the catabolism sub material are also caused by several sources, such as; students, textbooks, context (learning materials), and teacher teaching methods. According to Tridiyanti & Yuliani (2017), cellular respiration has stages, namely glycolysis, oxidative decarboxylation, citric acid cycle, and oxidative phosphorylation. The glycolysis step produces pyruvic acid, oxidative decarboxylation to form acetyl CoA and CO2, then proceeds to the citric acid cycle and oxidative phosphorylation. Students answered incorrectly on the first and second-level questions and were sure of the answers given so that students could be categorized as having misconceptions. While the correct concept that cellular respiration has staged in the form of glycolysis, Krebs cycle, and oxidative phosphorylation because cellular respiration is sometimes only defined as a step that includes the citric acid cycle and oxidative phosphorylation. Percentage of Student Misconceptions at SMA N A Tangerang City on the submaterial of Photosynthesis and Plant Respiration shows in Table 3.

Table 3. Percentage of Student Misconceptions at SMA N A Tangerang City on the submaterial of Photosynthesis and Plant Respiration

No	Indicator	Misconception (%)	Criteria
1.	Determine the gas used for respiration	72,34	High
2.	Determine the gas that is the result of respiration	78,72	High
3.	Determine the gas that is the result of respiration	44,68	Moderate
4.	Know the chemical equation for photosynthesis	70,21	High
5.	Know the benefits to plants of photosynthesis	68,09	High
6.	Determine the life processes that produce CO2	29,79	Low
7.	Know the location of photosynthesis in leaves	34,04	Moderate
8.	Know the function of chlorophyll	55.32	Moderate
9.	Know the temporary storage place of photosynthesis	46,81	Moderate
10.	Determine the factors that have no effect on photosynthesis	44,68	Moderate
11.	Knowing the proof of photosynthesis experiment on Hydrilla sp.	51,06	Moderate
12.	Knowing the location of CO2 binding in photosynthesis	48,94	Moderate
13.	Identify the organelles in plants that capture light	57,45	Moderate
14.	Determine the part of the plant that functions to breathe	57,45	Moderate
15.	Making statements about breathing	48,94	Moderate
16.	Determine the location of respiration in plants	31,91	Moderate
17.	Know the meaning of respiration	46,81	Moderate
18.	Define a statement about respiration in plants	46,81	Moderate
19.	Determine when the plant breathes	59,57	Moderate
20.	Determine the chemical equation of respiration	63,83	High
21.	Know the difference between respiration and photosynthesis	34,04	Moderate
22.	Define respiratory organelles	31,91	Moderate
23.	Determine the gas released by plants	78,72	High
24.	Determine the gas used by plants	78,72	High
25.	Know Priestley's experimental proof of photosynthesis	25,53	Low

(Sourcer: Mustaqim et. al. 2014)

In Table 3, the percentage of students' misconceptions in the sub materials of Photosynthesis and Plant Respiration is quite varied. There are different misconceptions experienced by students because each student has

varying cognitive abilities (not the same/different) (Machshunah & Yuliani, 2019). The three highest indicators determine the gas resulting from respiration, determining the gas released by plants and used by plants with high criteria. The lowest indicator is knowing the proof of Priestley's research on photosynthesis with low criteria. Misconceptions in students can occur because students' understanding is different from the concepts put forward by experts.

This photosynthetic and respiration sub-material has complex and abstract characteristics that result in students' misconceptions. According to Yunia et al. (2019), The material on the concepts of photosynthesis and plant respiration has a relatively high level of difficulty because the explanations are complex and abstract, so that it triggers students' misconceptions. Misconceptions can make it difficult for students to learn the following material.

Based on research by Mustaqim et al. (2014), question indicator in determining the gas used for respiration. Overall, students have answers that are not the same as scientific conceptions. In the concept of plant respiration with an indicator of determining gas resulting from respiration, students who have misconceptions students give reasons that plants release carbon dioxide at night. The question indicator determines the gas used by plants, students who have misconceptions answer that plants need CO2 during the day and O2 at night. Students still think that plants photosynthesize during the day and carry out respiration at night. Percentage of Student Misconceptions in Each Concept of Protein Synthesis Submaterial at SMA N 1 Driyorejo Class XII Science shows in Table 4.

Table 4. Percentage of Student Misconceptions in Each Concept of Protein Synthesis Submaterial at SMA N 1 Driyorejo Class XII Science

No	Indicator	Misconception (%)	Criteria
1.	Determining the Functions and Characteristics of RNA in Protein Synthesis	31,70	Moderate
2.	Determining Nitrogen Bases in DNA	61,70	High
3.	Analyzing the Role of tRNA	39,15	Sedang
4.	Analyzing DNA Strand Type on Transcription Initiation	65,00	High
5.	Analyzing the Codons Formed in the Transcriptional Elongation Process of DNA. 3'-5' ribbon template to 5'3' mRNA	56,70	Moderate
6.	Determine the characteristics of the stages of transcription termination	55,00	Moderate
7.	Analyzing the stages of transcription	43,30	Moderate
8.	Analyzing Ribosome Structure at the Initiation of Translation	56,70	Moderate
9.	Analyzing the stages of translation initiation	54,15	Moderate
10.	Determine the characteristics of the translation termination stage	61,70	High
11.	Determine the mechanism of protein synthesis	76,70	High
12.	Formulate the sequence of protein synthesis processes	61,70	High

(Sourcer: Widiastutik & Isnawati, 2021)

Based on Table 4 above, it can be seen that students have misconceptions on each indicator of protein synthesis material with medium and high criteria. The indicator determining the mechanism of protein synthesis has the highest percentage of students' misconceptions. Students are asked to distinguish between the transcription process and the translation process. Students are still found wrong in determining the difference between the two. According to Widiastutik & Isnawati (2021), on indicators determining the mechanism of protein synthesis, students are required to differentiate between transcription and translation processes. Students have the assumption that the transcription stage is a process that involves antisense chains in DNA to print mRNA, while translation is a process of binding amino acids that are soluble in plasma. This assumption is wrong or has misconceptions. The correct concept is that the transcription stage is the translation of the nitrogenous base sequence of DNA into the base sequence of an RNA molecule, while the translation phase is translating the mRNA base sequence into the amino acid sequence of a protein. The transcription stage is divided into three stages, namely initiation, elongation, and termination.

Based on the research of Madukubah et al. (2018) on the Protein Synthesis sub-concept,

students have not been able to explain the events that occur during protein synthesis and describe the DNA-RNA-Polypeptide relationship. Students who experience misconceptions assume that the anticodon chain undergoes the transcription process. This shows that students do not fully understand transferring genetic information from DNA to RNA and protein. According to Hidayat & Kasmiruddin (2020), protein synthesis material has difficult concepts for students to understand because they have complex concepts. The protein synthesis material covered in genetic material is difficult for students to understand because it is abstract, the development of the science of gene expression is so rapid, and many use foreign terms, which makes students' interest in genetics lessons low.

The indicator of the lowest percentage of students' misconceptions on the indicator determines the function and characteristics of mRNA in protein synthesis. This means that the student's understanding of the protein synthesis sub-concept is high. Similar to that found by Madukubah et al. (2018), students' misconceptions about the RNA subconcept discuss the differences between DNA and RNA, the functions and characteristics of RNA, which is 17.15% with low criteria. Most students still do not understand the role of messenger RNA and transfer RNA and the differences in the constituent components between DNA and RNA. When teaching genetic material, without exception the subject matter of protein synthesis, the teacher must explain all the stages of the protein synthesis process in detail so that students get the entire concept and reduce misconceptions. Teachers should be familiar with explaining foreign terms that are often used in protein synthesis process materials, such as DNA, RNA, mRNA, sense, antisense, enzyme names, and other terms (Suhermiati et al., 2015).

According to Madukubah et al. (2018), several things that cause misconceptions in the protein synthesis subconcept, namely, (1) students have wrong reasoning on a concept, (2) students have less interest in the concept of protein synthesis, (3) lack of teacher confirmation of student understanding, such as rarely corrects students' homework, (4) the teacher explains quickly during the learning process, (5) the textbook used has some misconceptions (not precise in the use of terms). According to Widiastutik & Isnawati (2021), the factors that cause students' misconceptions about the protein synthesis sub-concept are students, textbooks used, learning media that support the learning process, teachers and how the teacher teaches, and context (material being studied). The role-playing learning method and audio-visual media are quite effective in avoiding students' misconceptions about protein synthesis material. Percentage of Students of SMA N 1 Tondon, North Toraja Regency who have misconceptions on genetic concepts shows in Table 5.

Table 5. Percentage of Students of SMA N 1 Tondon, North Toraja Regency Who Have Misconceptions on Genetic Concepts

No	Sub concept	Misconception (%)	Criteria
1.	The meaning and scope of genetics	13,33	Low
2.	Genetics materials and chromosome	26,67	Moderate
3.	Cell division	20,00	Moderate
4.	Inheritance	35,57	High
5.	Mutation	43,33	High

(Sourcer: Hala et al., 2018)

Based on table 5, students' misconceptions were found in each genetic concept at SMA N 1 Tondon, North Toraja Regency. The highest percentage of students' misconceptions with high criteria is found in the mutation subconcept, while the lowest student misconceptions with low criteria are found in the genetics meaning and scope subconcept. The high number of misconceptions in mutations is since students catch mutations as events that are only detrimental to living things. Mutations can be beneficial or detrimental to living things, although most mutations are more likely to cause harm, such as defects or abnormalities. According to the research results of Waskito et al. (2020), in general, the understanding of high school students of class XII science in Pontianak City on genetic material is still low. This is caused by the high level of misconceptions in students. According to the results of Maulidi's (2014) research, a misconception that often occurs is the concept of explaining beneficial mutations. Examples of beneficial mutations are producing plants with seedless fruit, plants, and animals that are not susceptible to disease. The student's answer includes the misconception that there is no benefit

from the mutation. Students understand that mutations are detrimental. Students think mutations are synonymous with defects or abnormalities.

The low number that shows the percentage of students' misconceptions on the meaning and scope of genetics shows the high level of students' understanding of this subconcept. This means that the lower students' misconceptions about the material, the higher students' understanding of the material. According to Candramila & Prayogi (2021), the increasing understanding of students' concepts decreases the percentage of students who experience misconceptions. On the contrary, an increase follows the decrease in students' understanding of concepts in students who experience misconceptions. Based on Maulidi (2014), it was also found that students who experienced misconceptions in the subconcept of the meaning and scope of genetics were only 6.35%. This percentage number was categorized as low. This is because from what the teacher has taught, students get a new understanding of genetics and follow the concepts of scientists. Misconceptions in this concept are classified into two types: interpreting genetics as the old sense as something that dictates human traits inherited from parents (parents) and the second interpreting genetics as the study of cells (cytology). The old concept of genetics is obtained by students from the previous level of learning. Teachers have taught the latest understanding of genetics to students. However, the conceptions that students have brought from the previous level of learning are difficult to change or are resistant to. In addition, the biology books that are currently circulating are still with the old concept. The second type of conception is classified as a misconception because students say that genetics is a branch of biology that refers to the study of cells (cytology). Students say the concept is obtained from books. This sentence is interpreted differently by students to think that genetics is the same as the study of cells. In this case, it shows that the cause of misconceptions can come from books or learning resources.

Maulidi (2014) mentions students and student handbooks on the Biology learning process, including factors that cause students' misconceptions on genetic material. According to Alonemarera (2020), genetic material has abstract characteristics, so it is prone to misconceptions. Several descriptions of the factors that cause misconceptions from students are students' passive attitude in getting information (43.5%), abstract genetic material (26.1%), students do not understand the material but memorize (17.4%), high school textbooks used (8.7%), and students are not able to translate the contents of the reading (4.3%)—the percentage of the highest factor in the passive attitude of students in the learning process. Therefore, the need for direct awareness from within students to be actively involved in independence in finding information related to the material being studied. Therefore, the involvement of visual learning media is essential to minimize students' misconceptions about genetic material. Percentage of students in class XII science at SMA Don Boso Sanggau on the evolutionary subconcept who have misconceptions shows in Table 6.

Table 6. Percentage of students in class XII science at SMA Don Boso Sanggau on the evolutionary subconcept who have misconceptions

No	Sub concept	Misconception (%)	Criteria
1.	Theory of Evolution	58, 33	Moderate
2.	Evolution mechanism	73, 81	High
3.	The evolution of plantae and animalia	42, 06	Moderate

(Sourcer: Putri & Nur, 2020)

Based on Table 6, some students have misconceptions about the evolution sub-concept. This is because this evolutionary subconcept contains concepts related to the mechanism or process of evolutionary events so that the possibility of students' misconceptions is quite large.

Similarly, the results of research by Adrianto et al. (2017) and Jannah & Anandita (2018) found misconceptions in students with high criteria on evolutionary material. High misconceptions illustrate that students' understanding is still low. This misconception is found in Madrasah Aliyah and SMA Don Bosco Sanggau, which are located in Kubu Raya Regency. According to Putri & Nur (2020), the sub-concept of the evolution mechanism has the characteristics of concepts in processes. Concepts in evolutionary material include natural selection, mutation, sexual recombination, gene flow, and genetic drift. The vulnerability of students to misconceptions on these concepts is quite significant, which is

dominated by the mechanism of gene flow and genetic drift. Students' doubts in identifying examples of evolutionary processes that occur through these mechanisms. Things that trigger students' misconceptions in the form of students' reasoning abilities are still low, learning resources that are used as references during the learning process are still lacking, as well as the concept of evolution which includes many foreign terms that are difficult for students to understand.

The lowest misconceptions on the evolution of Plantae and Animalia with moderate criteria are also seen in table 6. This means that students also have difficulty understanding this material but in a tolerable state. This is because students are required to have a basic understanding of evolutionary material, and the subconcepts of Plantae and Animalia evolution are concepts obtained from the addition of concepts obtained in the previous lesson. Putri & Nur's research (2020) also found that the sub-concepts of Plantae and Animalia evolution became the sub-concepts with the fewest misconceptions compared to other sub-concepts. The low percentage of students' misconceptions is because the concepts in the evolutionary material are related to other branches of biology and science, so understanding the concepts in this section is not too much of a problem for students. The concept obtained by students is an addition to the concepts that have been there before. This means that students' initial understanding of concepts related to evolutionary material will have a significant influence on student acceptance of evolutionary material. If the previous concept has been well understood, it will be beneficial to understand the following concept.

Students' misconceptions on evolutionary material are also greatly influenced by the characteristics of evolutionary material itself. Evolutionary material has its characteristics, namely concepts containing complex material. This means that the concepts of evolution are a suitable material from various studies of other biological sciences. This makes the concepts in evolutionary material quite tricky for students. Thus the vulnerability to errors in understanding them is tremendous, which causes misconceptions in students (Putri & Nur, 2020). Apart from the causes of misconceptions in the sub-concept of evolutionary material, which are complex, the misconceptions of the sub-concept of evolutionary material are also influenced by other internal and external factors. According to Adrianto et al. (2017), Students' misconceptions are influenced by internal and external factors. The grouping of these factors is based on the source. Internal factors come from the students themselves, such as the low cognitive ability of students to develop an understanding of concepts that need high understanding. External factors come from the student's environment, such as (1) inaccurate and complete information provided by textbooks on several evolutionary concepts; (2) the teacher who provides the information is not following the concept that should be. If this happens, it is undeniable that the teacher in question also experiences misconceptions; (3) the ease of students in accessing information through the internet that is not filtered also has the opportunity for misconceptions to occur.

According to Jannah & Anandita (2018), the causes of students' misconceptions in the three evolutionary concepts are as follows: (1) students' initial understanding is wrong; (2) erroneous (context) of personal experiences and students' friends during discussions; (3) the way the teacher presents learning, and; (4) teaching materials used by students during the learning process. Evolutionary material contains many concepts, not to mention the debate about the theory of evolution also has a significant role in learning evolution in the classroom. This can affect students' understanding of evolutionary material, causing students to misunderstand the concept of evolution and make students experience misconceptions (Adrianto et al., 2017). The common understanding of students on the concept of evolution in this study needs to be addressed, especially those related to misconceptions. Handling misconceptions, among others, can be done with more exciting learning approaches such as stories and analogies on certain concepts suitable for students' conditions. Further research needs to be done on the effect of a more exciting learning approach and analogies on increasing students' understanding of concepts in evolutionary material.

According to Jannah & Anandita (2018), the causes of students' misconceptions in the three evolutionary concepts are as follows: (1) students' initial understanding is wrong; (2) erroneous (context) of personal experiences and students' friends during discussions; (3) the way the teacher presents learning, and; (4) teaching materials used by students during the learning process. Evolutionary material contains many concepts, not to mention the debate about the theory of evolution also has a significant role in learning evolution in the classroom. This can affect students' understanding of evolutionary material, causing students to misunderstand the concept of

evolution and make students experience misconceptions (Adrianto et al., 2017). The common understanding of students on the concept of evolution in this study needs to be addressed, especially those related to misconceptions. Handling misconceptions, among others, can be done with more exciting learning approaches such as stories and analogies on certain concepts suitable for students' conditions. Further research needs to be done on the effect of a more exciting learning approach and analogies on increasing students' understanding of concepts in evolutionary material.

The role of the teacher is essential to deal with misconceptions in students quickly and appropriately (Pradina & Yuliani, 2020). In biotechnology, teachers can use inquiry-based interactive multimedia to overcome misconceptions in students (Ferliyati et al., 2014). Based on the literature review, effective learning methods for teaching protein synthesis are role-playing and audio-visual media such as interactive PowerPoint slides and animated videos. By playing a role, students are unconsciously involved in the protein synthesis process, so that it helps students think and understand the role of each component of protein synthesis and its stages. Protein synthesis is an abstract material, so that media is needed to visualize the components and stages that occur in it. Audio-visuals make it easier for students to visualize the components of protein synthesis. The stages in protein synthesis resemble the actual situation (Widiastutik & Isnawati, 2021).

Several ways are pretty accurate to minimize misconceptions in students, namely 1) teachers need to reveal misconceptions to students, 2) teachers must find the location of errors and factors that cause student misconceptions, and 3) teachers determine the best solution to overcome student misconceptions. Some appropriate solutions to minimize students' misconceptions are changing students' concepts, conducting experiments or experiences in the field, identifying cognitive problems, establishing constructivist strategies, Predict Observe Explain (POE), Bridging analogy (connecting analogy), Predict Discuss Explain Observe Discuss and Explain (PDEODE), using concept maps, and problem solving-based learning (Widiastutik & Isnawati, 2021).

CONCLUSION

Based on the six research result regarding misconceptions in Biology students of class XII IPA analyzed, it is inseparable from students' misconceptions that are quite varied. Catabolism is a sub material that experienced the highest and lowest student misconceptions. The indicator of catabolism with the highest misconception is found in determining the stages of cellular respiration, and the indicator of catabolism with the lowest misconception is in comparing fermentation and aerobic respiration. The high level of student misconceptions about catabolism material is because this material has characteristics in complicated stages with difficult terms for students to remember and understand, which can trigger misconceptions. The higher the percentage of students' misconceptions, the lower students' understanding of the concepts in the material, and vice versa, the lower the students' misconceptions, the better students' understanding of the material. Overall, students' misconceptions are caused by internal factors (students themselves) and external factors such as teachers, textbooks, and the context of the material being studied. Further action is needed on the part of teachers and related organizations to ensure efforts are made to reduce misconceptions among students.

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