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Identification of Biology Student's Misconception in Makassar State University on Cell Biology by Applying Two-Tier MCQs Method

Yusminah Hala¹, Arifah Novia Arifin², Suriyah Satar³, Sitti Saenab⁴

¹Department of Biology, Universitas Negeri Makassar, Makassar, 90222. Indonesia.

Email: yushala12@gmail.com

²Department of Biology, Universitas Negeri Makassar, Makassar, 90222. Indonesia

Email: arifahnoviaarifin@unm.ac.id

³Department of Biology, Universitas Negeri Makassar, Makassar, 90222. Indonesia

Email: satarsurya@gmail.com

⁴Department of Science Education, Universitas Negeri Makassar, Makassar, 90222. Indonesia

Email: sitti.saenab@unm.ac.id

Abstract. This study aims to know the level of understanding of UNM student's experiencing misconceptions, understand the concept and do not understand the concept about cell biology using Two-Tier MCQs method. This research includes descriptive research. In this study, the Two-Tier MCQs method to identify student's misconceptions. Population in this research is all student of study program of biology of UNM class 2015. Samples in this research as many as 20 people who tried randomly. Instruments used to test Two-Tier MCQs and interview methods to determine the causes of misconceptions. The result of data analysis shows that the highest misconception is in the material structure and function of mitochondria and the lowest is in the cell cycle material

1. Introduction

Understanding of basic concepts is very important in learning. The basic concept is a prerequisite for explaining a higher concept. According to constructivist learning, the old concept has a very important role to help students understand new information or experiences during learning [1]. But the concept that is owned is contrary to the existing scientific concept called misconception. Misconception is a misunderstanding caused by previous learning and one that learns the preconceptions in general [2]. Misconception results in acceptance in new concepts to be learned [3]. Cell biology is a basic concept that is very important in learning biology because the concept of cell biology is needed to understand other concepts in the field of biology [4].

Misconceptions that occur in the field of biology have been widely reported including the concepts of cell structure and function [5], the concept of energy [6], concepts of transportation systems and excretion systems [7], concepts vertebrates and invertebrates [8], concepts of diffusion and osmosis [9], concepts of photosynthesis [10], and misconceptions on the concept of cell metabolism [11]. The biological concept is very closely related to the concept of cells in general. If



there is a misconception in the cell concept, it is certain that misconceptions will develop in other material. In the cell concept it has been reported that misconceptions occur in students [4] [12].

Satar, Hala, Arifin (2018) has detected the misconception of biology students at FMIPA UNM using the CRI method [13]. In addition to the CRI method, another method of detecting misconceptions is using the Two-Tier Multiple Choice Question method. Two-Tier Multiple Choice Question instruments were developed by Treagust, Treagust used the two-tier multiple choice question to diagnose students' ability to understand the science concept [14]. The two-tier multiple choice question form consists of two levels of questions, the first level is the content of the question which has two alternative answers and the second level is the reason for the answer chosen on the basis of the first choice. Inclusion of reasons in the second level of the form of the question can be used to improve high-level thinking skills and see students' ability to give reasons [15]. One of the advantages of this method is that it can further diagnose understanding of material that experiences misconception [16]. Related to this, it is very important to know how much the level of misconception of biology students of Makassar State University (UNM) on Cell Biology concept using the Two-Tier Multiple Choice Questions Method and knowing the suitability of the methods used in identifying misconceptions in the concept of Cell Biology.

2. Method

This research is a descriptive research. This study describes misconceptions in the concept of cells. The population in this study were Biology students who were still actively participating in lectures. The study population will be all 2015 Biology students of Makassar State University. The selection of research samples was carried out by purposive technique. Basic consideration of researchers in determining the subject of research is the representation of biology education study programs, namely 20 students from educational study programs.

This instrument is in the form of reasoned MCQs. The use of choice reasons is intended to identify the suitability between the answers and the conception of UNM Biology students in cell biology material. The reasons given by students when answering are the basis for determining the level of understanding of students (understanding, misconception or not understanding). The structured interview process uses interview guidelines that are used to interview research subjects in this case Biology Students of Makassar State University. This guideline contains a number of questions or statements that ask respondents to respond or respond. The purpose of this interview is to obtain supporting data for misconceptions that occur in Biology Students of Makassar State University

Data collection techniques used in this study were interview techniques (non-test) using interview guide instruments and diagnostic test measurement techniques in the form of Two-Tier Multiple-Choice Questions. Qualitative data analysis is used to see the results of student interviews and is associated with quantitative data analysis. Interviews are carried out directly and or in writing. The results of the interviews were used to obtain supporting data for misconceptions to find out the causes of misconception in Biology Students of Makassar State University

3. Result and Discussion

3.1. Result

The results of data analysis on the level of understanding of students at Makassar State University on cell biology material using the Two-Tier MCQs method can be seen in Figure 4.1. Based on Figure 4.1 it can be seen that there are 36.67% of students who misconcept about cell biology material, 32.52% who understand cell biology material and 30.81% who do not understand cell biology material.

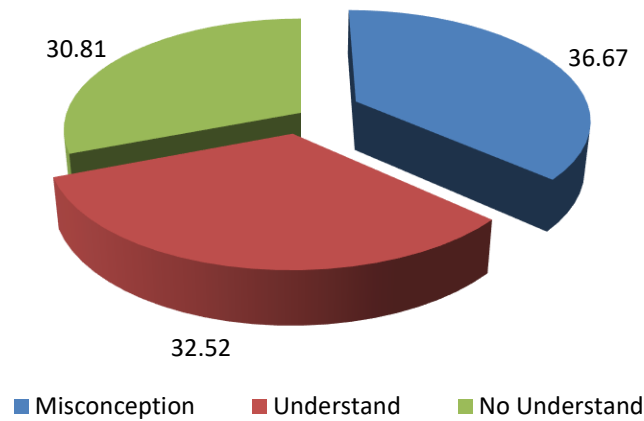


Figure 1. Average Level of Understanding of Biology Students at Makassar State University Based on Two-Tier MCQs Diagnostic Test Results on Cell Biology Material. (Source: Research Data 2018).

Understanding of biology students at Makassar State University on the 13 Competency Standards (CS) of cell biology materials using Two-Tier MCQs diagnostic tests can be seen in Figure 2 as follows:

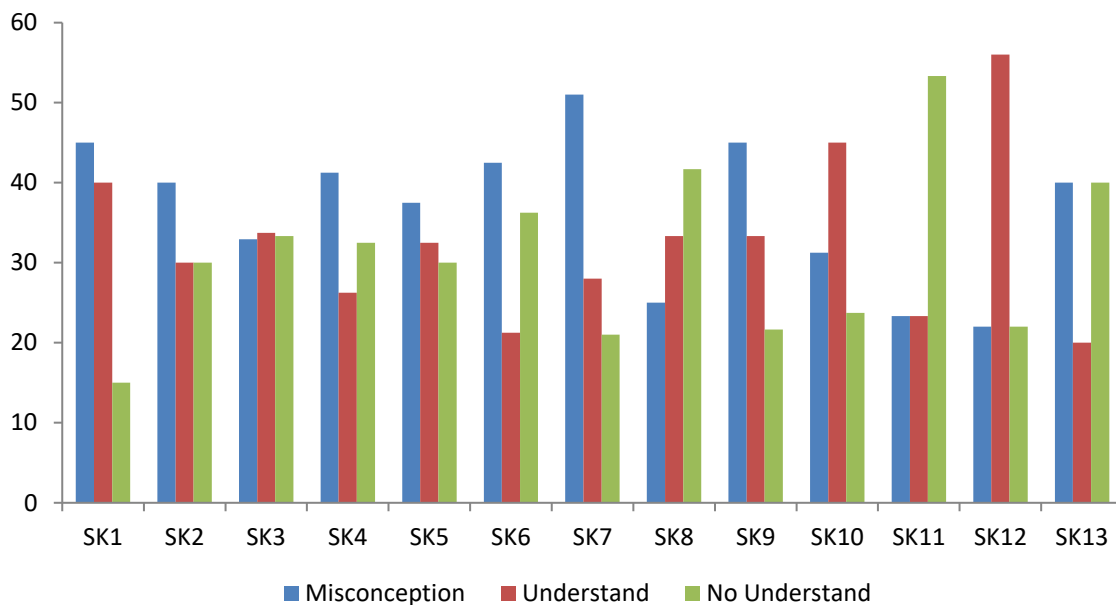


Figure 2. Level of Understanding of Biology Students at Makassar State University on 13 Competency Standards (CS) of Cell Biology Materials Using Two-Tier MCQs Diagnostic Tests (Source: Research Data 2018)

Figure 2 shows that the highest percentage of students who understand cell biology material is in CS number 12 by 56% and the lowest percentage of students who understand cell biology material is on Decree number 13 by 20%. Based on data analysis, it can be seen that the average percentage of students experiencing misconception is greater than the other two levels of understanding. The highest percentage of misconceptions in cell biology material experienced by biology students at the State University of Makassar is found in Decree number 7 by 51%.

3.2. Discussion

Based on the results of the study using the Two-Tier MCQs method, it is known that student misconceptions occur in all Competency Standards (13 CS) of cell biology material that the researcher studies. The highest percentage of misconception is in CS number 4 (41.25%) and the lowest percentage of misconception is in CS number 12 (22%).

Misconception of Biology Students in Competency Standard 1 (CS. 1)

In question number 1 based on the results of the study, there were 14 students who experienced misconceptions. There are 3 forms of misconception that occur (table 4.2), and the most misconception statement is to assume that water is a dispersion medium of the colloidal protoplasmic system because water is a transport medium of various dissolved or suspended substances to diffuse or move from one cell to the another cell. Whereas, the correct statement is that Water is a dispersion medium of the colloidal protoplasmic system because water is an ingredient of suspension of organic substances with large molecules such as protein, fat, and starch. So the researcher assumes that the conceptual error is about dispersion medium [17].

Similar to question number 1, question number 3, which is a question of the indicator, identifies cell characteristics, there are also 14 students who experience misconceptions. Some forms of misconception also occur in this problem, including (1) Cells are the smallest functional structures of a life when they have three components, namely DNA, cytoplasm and membrane, (2) Cells are the smallest functional structures of a life if they have three components, DNA / RNA, cytoplasm and membrane (3) Cells are the smallest functional structure of a life when it has three components, namely genetic material, mitochondria and membranes. While the real concept is that Cell is the smallest functional structure of a life if it has three components, namely genetic material, ribosomes and membranes.

a. Misconception of Biology Students in Competency Standard 2 (CS. 2)

CS 2 consists of 2 indicators, indicators are divided into 5 questions. The first question that experienced the most misconceptions was the number 7 question, 10 students who experienced misconceptions. Problem number 7 represents an indicator explaining the structure and function of plant cell walls with 3 forms of misconceptions including (1) Animal cells and plant cells placed in a solution with hypotonic osmosis causing normal plant cells and animal cells, (2) Animal cells and plant cells placed in solution with hypotonic osmosis pressure because it causes turgid plant cells and plasmolysis animal cells and (3) Animal cells and plant cells are placed in a solution with hypertonic osmotic pressure because they cause turgid plant cells and lysis animal cells. Whereas the actual concept is that animal cells and plant cells are placed in solution with hypotonic osmotic pressure because they cause turgid plant cells and lysis animal cells [17].

The second problem which experienced the most misconceptions was the question number 6, namely the indicator of understanding plant cell walls with misconceptions including (1) the flexibility of the primary wall was lower than the secondary wall in plant cells because of the high content of hemicellulose and pectin, (2) primary wall flexibility higher than the secondary wall in plant cells because the content of microfibrils is low, (3) Flexibility of the primary wall is higher than the secondary wall in plant cells because the protein content of the structure is low, and (4) Flexibility of the primary wall is higher than the secondary wall in the cell plants because of the high cellulose and pectin content. While the actual concept, the flexibility of the primary wall is higher than the secondary wall in plant cells because of the high content of hemicellulose and pectin [17].

b. Misconception of Biology Students in Competency Standards 3 (CS. 3)

CS 3 consists of 12 questions divided into 3 indicators. The indicator that experienced the most misconception was the question number 13 on the indicator describing the components and functions of cell membranes with misconceptions namely (1) The component of lipids that can maintain cell membrane fluidity is cholesterol because it is a simple fat that can resist the movement

of the phospholipid tail at high temperatures and prevent the membrane becomes hard at low temperatures, (2) the component of lipids that can maintain the fluidity of the cell membrane is cholesterol because it is a glycolipide that can withstand the movement of the phospholipid tail at low temperatures and prevent the membrane from becoming hard at high temperatures (3) cell membrane fluidity is cholesterol because it is a glycolipid fat which can withstand the movement of the phospholipid tail at low temperatures and prevent the membrane from becoming hard at high temperatures, and (4) The lipid component that can maintain cell membrane fluidity is sphingolipida because it is a steroid lipid that can resist movement phospholipida tail at high temperatures and prevents the membrane from becoming hard at low temperatures. While the real concept is that the component of lipids that can maintain the fluidity of cell membranes is cholesterol because it is a steroid lipid that can resist the movement of the phospholipid tail at high temperatures and prevent the membrane from becoming hard at low temperatures [17].

c. Misconception of Biology Students in Competency Standard 4 (CS. 4)

CS 4 consists of 2 indicators, divided into 4 questions. The problems that experienced the most misconception, 10 students namely the questions representing indicators of RE function with misconceptions include (1) Polypeptide translation results of ribosomes in the cytosol will move on their own towards the translocation channel on the RE membrane because SRP will recognize the polypeptide and will be accepted by the Receptor and (2) Polypeptide from the translation of ribosomes in the cytosol does not move itself towards the translocation channel on the RE membrane because there is a ribophorin port as a place for attaching ribosomes to the RE membrane. While the actual concept is Polypeptide the result of translation of ribosomes in the cytosol does not move itself towards the translocation channel on the RE membrane because there is an SRP that will recognize the polypeptide and will be accepted by the Receptor [17].

d. Misconception of Biology Students in Competency Standard 5 (CS. 5)

CS 5 consists of 4 questions representing indicators explaining the Golgi apparatus structure and explaining the functions of the Golgi apparatus. the most common misconception is in question number 27 with the form of misconceptions, namely (1) One source that is thought to be the origin of the Golgi apparatus, namely from the core outer membrane because it originates from the fusion of the endosome vesicular membrane, (2) One source suspected to be origin the golgi apparatus is from the core outer membrane because it originates from other vesicles or cytoplasmic structures (3) One source that is thought to be the origin of the golgi apparatus, namely from the core outer membrane because it originates from the cleavage of the golgi apparatus that already exists in in cells, and (4) Core salutary membranes are not one source that is thought to be the origin of the Golgi apparatus, that is, because it originates from the membrane of the endoplasmic reticulum. Whereas the concept should be One source that is thought to be the origin of the Golgi apparatus, namely from the core outer membrane because it comes from the membrane of the endoplasmic reticulum [17].

e. Misconception of Biology Students in Competency Standards 6 (CS. 6)

CS 6 consists of 2 indicators and is divided into 4 items (Table 4.2). the most common conception is in question number 33, the indicator describes the function of lysosomes. Forms of misconceptions are (1) Autolysosomes which become residual bodies will undergo a process called cellular defecation because it becomes a residual material without hydrolase material, (2) Autolysosomes which become residual bodies will undergo a process called cellular defecation because it hydrolyzes the content perfectly to be able to diffuse again and (3) Autolysosomes which become residual bodies will undergo a process called cellular defecation because they are released back into the cytoplasm and used again in the metabolic process. While the actual concept of Autolysosom which is a residual apparatus will undergo a process called cellular defecation because it will empty its contents by exocytosis [17].

f. Misconception of Biology Students in Competency Standards 7 (CS. 7)

CS 7 consists of 2 indicators and is divided into 5 items (Table 4.2). the most common conception is in question number 38, which is an indicator of understanding 12 mitochondrial functions. Forms of misconception for question number 38 are (1) Mitochondria are considered semi-autonomous organelles because mitochondria have their own genetic material, (2) Mitochondria are considered semi-autonomous organelles because mitochondrial ribosomes differ from cell ribosomes and (3) Mitochondria are considered semi-autonomous organelles because mitochondria can do cell respiration without the help of proteins from their own cells. Whereas the actual concept of mitochondria is considered a semi-autonomous organelle because the mechanism of transcription and translation in mitochondria depends on the genetic nucleus [17].

g. Misconception of Biology Students in Competency Standard 8 (CS. 8)

CS 8 consists of 2 indicators and is divided into 3 items (Table 4.2). the most common conception is that in question number 40 the indicator understands the function of chloroplasts as many as 6 students. The form of misconception for question number 40 is (1) In a photosystem reaction, every one photon will cause an electron to be infected because every one photon can absorb p680 light, (2) In a photosystem reaction, every one photon will cause an electron to be due to one photon can absorb P700 light, (3) In a photosystem reaction, every one photon will cause an electron to be infected because every one photon can absorb some light, and (4) in a photosystem reaction, some photons will cause an electron to be absorbed because each molecule can only absorb one photon. Whereas the real concept is that in photosystem reactions, each one photon will cause an electron to be infected because each molecule can only absorb one photon [17].

h. Misconception of Biology Students in Competency Standard 9 (CS. 9)

CS 9 which experienced misconception occurred in questions number 42, 43, and 44, each of 9 students who experienced misconceptions, namely the indicator understood the microbial structure and understood the function of microbes. The form of misconception for question number 42 is (1) Peroxisomes are resistant to H₂O₂ molecules that are toxic to cells because they contain isocitrate, (2) Peroxisomes are resistant to H₂O₂ molecules that are toxic to cells because they have hydrolase enzymes, and (3) Peroxisomes resistant to molecules H₂O₂ is toxic to cells because it contains malic synthase while the actual concept according to Adnan (2010) is that Peroxisomes are resistant to H₂O₂ molecules that are toxic to cells because they contain the enzyme catalase.

The form of misconception for question number 43 is (1) High-level animals cannot carry out the synthesis of glucose from fatty acids because the animal does not have a lipase enzyme, (2) High-level animals cannot carry out glucose synthesis from fatty acids because they do not have protease enzymes, (3) High-level animals cannot carry out the synthesis of glucose from fatty acids because the animal does not have hydrolase enzymes and (4) High-level animals can carry out glucose synthesis from fatty acids because the animal does not have glioksisom enzymes, whereas the actual concept is level animals height cannot carry out the synthesis of glucose from fatty acids because the animal does not have the enzyme glioksisom [17].

Forms of misconception for question number 44 are (1) Glyoxisomes play a role in high plant metabolism due to the addition of long intercalary meristems, (2) Glioksisom plays a role in high plant metabolism because it activates cambium tissue in secondary growth and (3) Glioksisom does not play a role in plant metabolism high level because it plays a role in activating endosperms in germination, while the actual concept) is that Glioksisom plays a role in high-level plant metabolism because it plays a role in activating endosperms in germination [17].

i. Misconception of Biology Students in Competency Standards 10 (CS. 10)

CS 10 consists of 2 indicators and is divided into 4 items (Table 4.2). the most common concept of conception is in questions number 46 and 48, the indicator describes the function of the cytoCSeleton. Forms of misconception for question number 46 are (1) Together with microfilaments,

microtubules function in motility because they are able to bind to myosin to contract, (2) Together with microfilaments, microtubules function in motility because they are able to bind to structural proteins on the plasma membrane and (3) Together with microfilaments, intermediate filaments function in motility because they are able to bind to motor proteins that are capable of moving other components, while the actual concept), namely Together with microfilaments, microtubules function in motility because they are capable of binding to motor proteins capable of moving other components [17].

The form of misconception for question number 46 is (1) Intermediate filaments are important in maintaining the position of certain organelles, such as the nucleus because they vary depending on the condition of the cell cytoplasm, (2) Intermediate filaments are important in maintaining the position of certain organelles, such as the nucleus (3) Intermediate filaments are important in maintaining the position of certain organelles, such as the nucleus because they change so that they move depending on the condition of the plasma membrane, whereas the actual concept is important in maintaining the position of certain organelles, for example nucleus because it is more permanent in cells than other types of cytoskeleton [17].

j. Misconception of Biology Students in Competency Standards 11 (CS. 11)

CS 11 consists of 2 indicators and is divided into 3 items (Table 4.2). the most common concept of conception is that in question number 49 the indicator identifies the structure of the nucleus with the number of students whose misconceptions are 5 students. The forms of misconception are (1) the nucleus membrane is related to the endoplasmic reticulum membrane because both do not have the glucose-6-phosphatase enzyme, for elongation of the polynucleotide chain (2) the nucleus membrane is related to the endoplasmic reticulum membrane because the nucleus membrane contains the cytochrome P 450 enzyme, no endoplasmic reticulum membranes and (3) nucleus membranes are not related to the endoplasmic reticulum membrane because both contain NADH, cytochrome c reductase, cytochrome B5 reductase NADH and NADPH-cytochrome c reductase while the actual concept of nucleus membrane is associated with the endoplasmic reticulum membrane - both contain NADH, cytochrome c reductase, cytochrome B5 NADH reductase and NADPH-cytochrome c reductase [17].

Problem number 51 there are also 5 students who experience misconceptions in the form of misconceptions, namely gamete cells contain half of the number of somatic cell chromosomes, not called diploid. While the correct concept is gamete cells contain half of the number of somatic cell chromosomes, not called haploid.

k. Misconception of Biology Students in Competency Standards 12 (CS. 12)

CS 12 consists of 5 questions from 2 indicators (Table 4.2). The most common misconception is that in question number 54, the indicator identifies the mitotic and miosis phases with the number of students with misconceptions as many as 7 students. The forms of the misconception are (1) the Anaphase phase shows the chromosome moving into the equatorial plane of the spindle thread (division), (2) the Anaphase phase shows the chromosome located in the equatorial area in order to divide the amount of DNA information into the sapling (3) metaphase phase shows the kinetochor pair on each chromatid being pushed slowly towards the spindle pole. Whereas the actual concept of the Anaphase phase shows that the kinetochor pair in each chromatid is pushed slowly towards the spindle pole [17].

l. Misconception of Biology Students in Competency Standard 13 (CS.13)

CS 13 consists of 1 question from 1 indicator (Table 4.2). Problem 57, which is an indicator that understands the process of protein synthesis as a genetic basis with the number of students who misconception as many as 8 students. The forms of misconception are (1) The process of protein synthesis in eukaryotic cells is more complex than prokaryotic cells because of protein synthesis in prokaryotic cells without passing the transcription stage while in eukaryotic cells through transcription, (2) The protein synthesis process in eukaryotic cells is more complex than cells prokaryotes because transcription and translation in eukaryotic cells occur simultaneously, whereas in

prokaryotic cells begins transcription and ends translation and (3) Protein synthesis process in eukaryotic cells is more complex compared to prokaryotic cells because protein synthesis in prokaryotic cells begins with transcription and continues with translation on eukaryotic cells instead. Whereas the actual concept is that the protein synthesis process in eukaryotic cells is more complex compared to prokaryotic cells because transcription and translation in prokaryotic cells occur continuously, whereas in eukaryotic cells transcription begins and translates to end [17].

m. Factors Causing the occurrence of Misconception in Biology Students of Makassar State University on Cell Biology Material.

The results of the analysis show the tendency of students to experience misconceptions due to a lack of understanding of cell biology material. This is also supported by the results of interviews that there are very many things that must be understood in studying cell biology, especially in knowing the relationship between the structure of organelles and their functions. The lack of reasoning for the material being studied can lead to a misconception in a person [18]. Their retention in remembering various things related to terms and names that are rarely heard so that it can be one of the causes of misconceptions. This agrees with Yangin's statement which states that the lack of mastery of the material being studied can lead to a misconception in a person [19]. In addition to reasoning activities, the tendency of students to experience misconceptions also occurs because they see pictures / diagrams from other sources / books that are not appropriate, such as organelles that are not in accordance with the actual description, so students who are interested in drawing understand something by looking at pictures without reading description. Textbooks can cause good misconceptions of the language of books which are difficult to understand and can be explained incorrectly [20]. The results of the analysis show that CS 6 is one of the competency standards that more students do not understand the material than those who experience misconceptions, due to the large number of students not getting information both in learning and learning resources. Information limitation is one of the causes of misconception. A person's lack of interest in learning certain concepts or subjects can lead to misconceptions in that person [20].

The results of the analysis show that CS 8 is one of the competency standards that causes students to misconcept because it is wrong in reasoning a relation between structure and function, their retention in remembering various things related to terms and names that are rarely heard, and lack of reasoning to the material. The results of the interviews also show that students are sometimes wrong in relating the structure and function of an organelle. In addition to reasoning activities, the tendency of students to experience misconceptions also occurs because explanations in textbooks are considered difficult to understand. Textbooks can cause good misconceptions of the language of books which are difficult to understand and can be explained incorrectly [20].

The results of the interviews indicate that the misconceptions experienced in the Decree. 4 is caused because the initial assumption about the material brought from the middle school, most likely obtained from the teacher's explanation at the middle school level. The misconception that the teacher gets is continuous and passed on to students who are taught [4]. Misconceptions obtained from previous education will settle on a person [21], supported by the opinion of Naz that if a person's misconception is not converted into a correct understanding of the concept it will remain inherent in them [22].

4. Conclusion

Student misconceptions occur in all Competency Standards (CS) of cell biology material that researchers examine with a percentage of misconceptions of 36.67. The highest percentage of misconception is in CS number 4 and the lowest percentage of misconception is in CS number 12.

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Table 1. Percentage of Understanding of Biology Students in Makassar State University Based on Diagnostic Test Results with Two-Tier MCQs Methods on 13 Competency Standards (CS) on Cell Biology Material

No	CS	Level of understanding		
		Misconception (%)	understand (%)	No Understand (%)
1	Understand cell structure and function as the smallest unit of life	45	40	15
2	Understand the structure and function of cell walls	40	30	30
3	Understand the structure and function of cell membranes	32,92	33,75	33,33
4	Understand the structure and function of RE	41,25	26,25	32,5
5	Understand the structure and function of Aparatus Golgi	37,5	32,5	30
6	Understand the structure and function of lysosomes	42,5	21,25	36,25
7	Understand the structure and function of Mitochondria	51	28	21
8	Understand the structure and function of chloroplasts	25	33,33	41,67
9	Understand the structure and function of microbody	45	33,33	21,67
10	Understand the structure and function of the cytoskeleton	31,25	45	23,75
11	Understand the structure and function of the nucleus	23,33	23,33	53,34
12	Understanding cell cycle processes	22	56	22
13	Understanding genetic basic mechanisms	40	20	40
	Average	36,67	32,52	30,81

Source: Research Data, 2018.