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Procedia - Social and Behavioral Sciences 46 (2012) 3677 – 3680

Procedia
Social and Behavioral Sciences

WCES 2012

Determining of the university freshmen students' misconceptions and alternative conceptions about Mitosis and Meiosis

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Abstract

The purpose of our study is to determine the misconceptions and inadequate information which the university freshmen students' held about mitosis and meiosis. We majored mostly on the numbers of chromosome potential and the DNA amount in our questions. In addition we wanted our students to interpret their past information about the subject. The results of our qualitative analyses show that students reword interphase as preparatory period but they don't recognize what happens in this period, precisely. Also, they don't explain DNA, chromosome and gene concepts. And they don't precisely recognize the importance of mitosis and meiosis for life.

Keywords: Mitosis, Meiosis, Misconceptions, Alternative conceptions, University freshmen student.

1. Introduction

A considerable amount of study has been carried out and will be carried out on education of Biology. These studies revealed that students have misunderstanding of and also difficulties in learning some concepts such as; genetics, evolution, cell, ecology, photosynthesis, plant and human development. (Flores,2003; Gelbart & Yarden, 2006; Saka et al, 2006). Explanations different from scientific opinions are named as misconceptions, alternative opinions, alternative concepts, wrong opinions, pre-cognitions, common notion concepts (Ayas et al, 2002). Misconceptions can be defined as knowledge contrary to the scientific facts, which students have learnt before or during the education process. Various factors such as preliminary information and insufficient level of cognitive enhancement of the student, language of the instructor teaching the concepts and irrelevant educational strategies can all result in misconceptions. (Selvi & Yakisan, 2004). According to Ausubel (1968), meaningful learning is an outcome of connection of the newly learnt data and the data which is learned previously (Gil-Perez & Carroscosa-Alis, 1994). Misconceptions of the students, significantly affect making correct link with the new concepts and hence disrupts meaningful learning. Foreknowledge of the misconceptions has a great place in learning of the knowledge wholly and permanently because of the removal of existing misconceptions and the prevention of the realization of new misconceptions (Hewson & Hewson, 1983; Cleminson, 1990).

In Biology education programme, mitotic and meiotic cell division subjects are of great importance as they contribute to growth, reproduction and genetics subjects. In addition, mitotic and meiotic cell divisions are occur in microscopic level, therefore, students may have obstacles to recreate them as concrete matter in mind as well as

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1877-0428 © 2012 Published by Elsevier Ltd. Selection and/or peer review under responsibility of Prof. Dr. Hüseyin Uzunboylu
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construct the concepts (Atilboz, 2004). Several studies show that, students mostly struggle with concepts of genes, chromosomes and mitotic and meiotic division (Tekkaya, Ozkan & Sungur, 2001; Atilboz, 2004). Learning the cell division is considered to be the most difficult one among all (Lewis et al, 2000). Basis of the learning disabilities related to the cell division subject relies on primary education (Oztas et al, 2004).

In literature, there are various studies that are based on the misconceptions or alternative opinions of the students about mitotic and meiosis division. This subject is highly prone to misunderstanding during the primary and secondary education. This study was conducted to investigate the aspects of cell division in first grade Biology students who have been familiar with the subject since secondary education and have some alternative opinions about it.

2. Methods

The work aimed to investigate the mitotic and meiotic cell division misconceptions or alternative opinions of the first grade students who are signed in 2011 – 1012 fall term year to Balikesir University, Department of Biology Teaching. 10 open-ended questions were asked to 28 students. Answers of these students were analysed with the help of our pre-made analysis table. Analysis table was constructed through the literature scan and analysis of the subject contents. Students` answers were considered as scientifically correct, scientifically correct but deficient, alternative opinion (misconception) and wrong information. Also, number of students who could not answer the questions was stated in the empty columns. And some students were interviewed for determining the alternative opinion (misconception) better. And oral answers were evaluated.

3. Results

According to the answers, number of the students who have scientifically correct, scientifically correct but deficient, alternative opinions and wrong information was given below. Number of the students who did not answer the questions was also noted.

Table 1. Analysis of students` answers

Questions analyzed	Scientifically correct	Scientifically correct but deficient	Alternative opinion	Incorrect information	Not answered
Requirement for interphase for cell division	2	12	12 (%43)	1	1
Relationship between genes, chromosomes and DNA	1	2	7 (%25)	16	2
Concept that at the end of meiosis, chromosome number in produced cells is half of that of parental cell.	13	-	-	11	4
Which organism and cell type does meiosis occur in?	-	16	4 (%14)	6	2
Concept that at the end of mitosis, chromosome number in produced cells are the same as the parental cell.	1	7	5 (%18)	8	7
Which division includes crossing- over	-	23	1	4	-
Phase at which crossing over occurs	2	4	1	14	-
Relationship between tetrads and crossing-over	2	8	1	-	15
Phase at which homologous chromosomes segregate	2	2	8 (%28)	11	5
How number of chromosomes is halved during meiosis	1	7	6 (%21)	3	11
Cells where mitosis takes place	-	20	1	1	6

As it can be seen from Table 1, students have alternative opinions or incorrect concepts about cell division. Table 2 shows the most frequently detected misunderstood concepts. The misunderstood concepts were detected by analyzing the answers of students to broad questions related to the subject. The topic that students found most difficult to understand was observed to be the events occurring during interphase. The most frequently detected alternative opinions (% 43) were also in the interphase stage of division (Table 1). The first four statements in Table

2 are incorrect concepts about interphase.. These concepts were obtained by analyzing answers given to the question "Why interphase is essential for cell division? Table 2 demonstrates that seven students did not know that during interphase, together with DNA, the organelles are also duplicated and energy and cytoplasm shows an increase. It is also clearly seen from Table 2 that seven students had misunderstanding of relationships between genes, chromosomes and DNA, and eight students had misunderstanding of the phase where the homologous chromosomes segregate to the opposite poles of the cell.

Table 2. Concepts misunderstood by students.

	Frequency
Interphase is the first stage of cell division.	2
During interphase only DNA is duplicated.	7
During interphase chromatids are aligned on a plate.	1
During interphase the cell membrane disappears and organelles are destroyed.	2
DNA is composed of chromosomes.	3
DNA has a protein structure.	1
The smallest unit of chromosomes is called a gene.	1
Genes together form chromosomes, chromosomes together form DNA.	2
Meiosis takes place in somatic cells.	4
Crossing over takes place only in meiosis.	1
Homologous chromosomes are separated during Prophase-1.	3
Homologous chromosomes are attached together until Prophase of Meiosis II.	5

4. Conclusion and Suggestions

The work carried on first grade students of the University, reveals that students have some misunderstandings, deficient information, and alternative opinions about mitotic and meiotic cell division. Besides the open-ended questions, oral answers acquired from the students showed that the deficiencies arise from their high school educations and mainly as a result of the education method depending on memorizing. The other reason is considered to be the fact that subject is a difficult one to understand as it is at microscopic level and the animal cells are to be the preferred instances given to the students during the subjects.

Majority of the students were aware that during the Interphase, DNA and chromosomes duplicate themselves. Answers to the question "How the chromosome potential stays the same as it is in the parental cell within the mitotic division?" shows that students just know that the DNA doubles itself as a knowledge but do not know how the newly formed cells, are related to the main cell or the same chromosome bunch or the chromosome potential. As it is shown in the Table 1 and 2, students answered the question related to Interphase as scientifically correct and almost wholly full. These students stated that this phase is the initial phase and also said that there is not only a raise in the DNA quantity but also there is a change in the other sufficient factors (organelle synthesis, cytoplasm augmentation, energy increase etc.) during the cell division. However, these students could not explain how the cells have the same chromosome potential at the end of mitosis.

Table 2 shows that students have misconceptions about the concepts of chromosome, DNA and genes. When the answer given to the question, "What kind of relation is there among gene, chromosome and DNA?" were analysed it was observed that students were not able to explain these terms and aware of the relationship between them. In the orally taken test, students' answers showed that there are difficulties in understanding of these concepts, as a result of their previous knowledge. It could be argued that in the secondary education these concepts were not analysed deeply, no practise was held to vanish the question marks in the heads of the students and therefore these concepts were to not really understood.

A research carried out by Atilboz in 2004, on 139 first grade high school students with 25 open-ended questions and according to the outcomes of this research, chromosome-DNA relation, chromosome structure of the cells after mitotic and meiosis division, diploid and haploid cell concept, cell number after mitotic and meiosis division, homologous chromosome, structure of chromosomes and incidents happen during the mitotic and meiotic division are the hardest subjects to be grasped by the students and they have misconceptions.

In the study that Lewis and Robinson done in 2000 under the titles DNA-gene-chromosome, it comes clear that students cannot understand the concepts clearly. In the end of the study, the reasons for students not to be able to

understand the DNA, genes, chromosome, mitotic and meiotic division subjects are concluded to be the contents of the syllabus which are higher of the students' level and that there were no sufficient practises held.

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