Examination of the Texts and Visuals in the "Cell Divisions" Unit in the 10th Grade Science High School Biology Text-Book in Terms of Scientific Content[1]

Ömer Seyfettin Sevinç
Duzce University, Turkey
http://orcid.org/0000-0002-7061-023X

Zübeyde Çiçek
Ministry of National Education, Turkey
https://orcid.org/0009-0007-9031-4503

OPEN ACCESS

Volume: 11

Special Issue: 1

Month: October

Year: 2023

E-ISSN: 2582-1334

Received: 21.08.2023

Accepted: 25.09.2023

Published: 20.10.2023

Citation:
Sevinç, Ö. S., & Çiçek, Z. (2023). Examination of the Texts and Visuals in the "Cell Divisions" Unit in the 10th Grade Science High School Biology Text-Book in Terms of Scientific Content. *Shanlax International Journal of Education*, 11(S1), 119–140.

DOI:
https://doi.org/10.34293/education.v11iS1-Oct.6659

Abstract
In this study, it was aimed to examine the visual content and expressions in the texts in the "Cell Divisions" unit in the 10th Grade Biology textbook of the Ministry of National Education, Secondary Science High School, taught in the 2022-2023 academic year, in terms of scientific content. The data sources of the research, in which the case study design and document analysis data collection technique, which are among the qualitative research designs, are used, constitute the relevant textbook. National and international reference books were used to evaluate the scientific conformity of the expressions and images in the texts in the relevant unit in the textbook, which was examined by descriptive analysis by three field experts in Biology and Science. According to the results of the research, it was determined that the scientific content of the texts and images in the "Cell Divisions" unit in the MoNE Secondary Science High School 10th Grade Biology textbook could not be created in full compliance with the required qualifications, and there were missing, incorrect expressions and representations. Since this situation will cause wrong learning and misconceptions in students, it is recommended to rearrange the relevant texts and visuals.
Keywords: Biology Textbook, Scientific Error, Cell Divisions, Wrong Learning, Misconceptions

Introduction

Textbooks are the main printed sources and effective teaching materials used for learning purposes in or outside formal education environments. Textbooks that support learning and teaching and cover the gains in the curriculum; It is an indispensable element in the curriculum in terms of increasing diversity in learning and attracting students' attention and attention. Textbooks by the Ministry of National Education [MoNE] (2021, p.4); It is defined as "a book and its supplements or model prototypes in printed or digital media, prepared within the framework of any education and training program and approved by the board to be taught in formal and non-formal education institutions."In the definition made by Demirel (2020, p. 33), the author of the educational dictionary, textbooks are; It is seen that he emphasizes the aspects of "knowledge, which is a phenomenon whose continuity,accuracy and variability can be discussed, as well as the sum of visual, perceptual, rational and mental achievements". According to Yalınkılıç (2020, p.5) textbooks; "Considering the mass dimension of education, it constitutes the easiest and

1 The summary of this study was presented virtually at the ERPA International Congresses on Education 2023 Cunda Island/Balıkesir 8-10 September, 2023.

most economical way to convey all the knowledge, skills and values surrounding individual and social life to individual individuals". İlhan and Yazar (2021) list the following points regarding the basic features of textbooks: they are among the most effective sources after the teacher in creating students' learning experiences. It ensures that information is given gradually and that the topics are repeated and reinforced. It helps teachers plan their lessons. It increases students' interest and attention in the course and allows them to study and do research outside of formal learning environments.

Şimşek (2020) states that the three basic elements of education systems are student, teacher and program (curriculum), and a deficiency or inadequacy in any of these elements can negatively affect the whole system."Curriculum is [an aspect of] a set of goals, content, and planning and organization of learning material that guides learning activity to achieve a specific educational goal" (Syafrina & Arono, 2017, p. 2).In this context, high school biology textbooks adapted as a central component of the curriculum have also played a critical role in science education (Chiappetta & Fillman, 2007). The fact that the elements such as text, graphics, visuals and the information they carry in biology textbooks, which are one of the basic elements of biology education and used by students as the primary source of access to information, are up-to-date and especially the scientific content is appropriate, is very important in preventing students from learning incorrectly and preventing misconceptions from occurring. It is important. Because students' learning is greatly affected by incorrect information and the presence of misconceptions. According to Özay and Hasenekoğlu (2007, p.80), in biology education, which is known to be an area where students have difficulties in understanding and teachers have difficulties in explaining (Yeşilyurt & Gül, 2012, p.20); It is stated that "most of the information taught is largely a reflection of the textbooks used by teachers, and it can be said that a large part of the information, true or false, is provided by the textbooks." Özel et al., (2020) also state that errors in visual elements, as well as errors in the texts of textbooks, can be the source of incorrect learning. Considering that "errors in textbooks have negative effects on students' learning of concepts" (Yılmaz, et al., 2018, p.3), it is of vital importance that the errors in the books are constantly checked and minimized, and if possible, not found at all.

According to Tekkaya, et al., (2000, p.140); "Misconceptions are concept definitions that students develop as alternatives to scientifically accepted concepts, and these alternative concepts (misconceptions) that students acquire as a result of their experiences create difficulty in understanding new subjects and significantly prevent meaningful learning." Incorrect or erroneous learning of a concept related to the field may gradually affect other related learning at the upper grade level. In addition, the education without considering the misconceptions may cause the learners to be deficient in terms of content knowledge. In fact, as Dikmenli (2010) states, "misconceptions are generally rooted, teaching-resistant barriers to the acquisition of scientific concepts and persist even after teaching."In addition, "scientific errors in the textbooks can make it difficult for students to learn the subject, as well as cause misconceptions about the subject (Gündüz, et al., 2017, p.1134).In this context, it is of primary importance to correct scientific errors in the textbooks in order to prevent the formation of alternative concepts in the student and to prevent the negativities in learning the subjects (Yılmaz, et al., 2017b, p.19).

According to Güneş (2022), scientific information is presented in three basic ways in a textbook. These are texts, images and various shapes. An important part of the textbook consists of texts. In texts, scientific knowledge is presented in written form. The majority of the information to be conveyed to students in textbooks is conveyed through texts and constitutes the largest part of the book. Again, according to the author, the second way used to convey scientific information in the textbook is visual tools such as photographs and pictures. These convey information in depth and visually, and here the information is given in various forms instead of text. İlhan and Yazar (2021, p.746) also emphasize that "visuals in textbooks have functions such as making the content of the text easier to understand, explaining, embellishing and ensuring permanence in the mind". In the context of the constructivist

teaching approach, the importance of the eye in the learning and teaching process has created a significant difference in all teaching environments and levels, therefore eye-appealing elements have become even more important in the preparation of teaching materials (İlhan & Yazar, 2021).Regarding this, in biology education, it is extremely important to visually convey to the student important organelles such as chromosomes, centromeres, ribosomes and chloroplasts, and to use some cell models and computer animations. The most important point to remember is that information given visually becomes much more permanent, and the memorized concept is quickly forgotten (Koç & Sönmez, 2018, p.348). In this context, the harmony, relationship and complementarity of the visuals in the textbooks with their texts are very important.

In recent years, global climate change, environmental problems, factors that threaten natural life, extinction of living species, and many problems related to food and health, whose effects have been observed all over the world, occupy the agenda of humanity. According to Öztaş et al., (2005, p.299), "it is not possible for these and similar situations not to affect the individual and society, and it is known to everyone that biological developments directly affect humans, the environment they live in, and the biosphere". The search for solutions to these and similar problems that affect the world is the duty of biological science as well as other basic sciences. According to Görgülü Ari and Arslan (2019, p.113), "biology has a special position among other science courses because it has both scientific and social aspects". Accordingly, the main goal of biology education is; Providing the necessary knowledge and skills, scientific thinking, research and equipment use skills at all levels of education; It can be said that the aim is to recognize and investigate the unknown aspects of living and inanimate beings and to ensure the realization of desired behavioral characteristics in individuals (Görgülü Ari & Arslan, 2019). As a result, the importance of biology education on such important issues that closely concern the individual and society/society is an undeniable fact. The subject of "Cell Divisions" that we are working on within this framework is related to the basic processes of life and the structure and functioning of basic biological mechanisms in the human body, and is closely related to many other topics (tissues, reproduction, genetics, biotechnology, immunity, cancer, health, etc.). It is also important to examine and research the subject in all its aspects, as it facilitates and/or affects their learning and understanding. Because the subject studied is, first of all, related to the biological structure of living beings and the individual.

There are some studies in the literature from past to present aimed at examining the biology topics in textbooks in terms of scientific content (Özay & Hasenekoğlu, 2006; Özay & Hasenekoğlu, 2007; Şen & Nakiboğlu, 2014; Gündüz et al., 2016; Gündüz, et al., 2017; Yılmaz, et al., 2017b; Yılmaz, et al., 2018; Gündüz et al., 2019; Pekel, 2019; Özel, et al., 2020; Zeynoğlu, et al., 2021; Çetin, et al., 2021, Sevinç, et al., 2022; Zeynoğlu et al., 2023).

Within the scope of this study, in which the texts and visuals of the "Cell Divisions" unit in the 10th Grade Science High School Biology textbook are examined in terms of scientific content, the explanations and explanations of structures such as the cell cycle, cell division stages, division in bacteria, formation of reproductive cells in the relevant unit are examined. Errors and/or omissions have been observed in the display.

From all these points, the aim of this study is; The aim of the Ministry of National Education is to examine the visual content and explanations in the texts in the "Cell Divisions" unit in the Secondary Science High School 10th Grade Biology textbook in terms of scientific content and reveal their faults or deficiencies. In this study, "What are the visual and textual contents of the "Cell Divisions" unit in the Science High School 10th grade Biology textbook that may cause misunderstandings or misconceptions in terms of scientific content?" The answer to the question has been sought.

Method

Model of the Research

This research, in which the texts and visuals on the subject of "Cell Divisions" in the MoNE 10th Grade Science High School Biology textbook were examined from a scientific perspective, was organized according to the case study pattern, which is one of the qualitative research approaches. The purpose of case studies is to examine in depth

selected situations or situations/events in order to best understand a certain issue, problem, or any event (Creswell, 2016). The reason for choosing a case study is to conduct detailed research on the subject being studied.

Data Sources

The source of the research is a secondary school 10th grade Science High School Biology textbook recommended to be taught in the 2022-2023 academic year (Aktaş & Demiray, 2019). In the book, the texts and visuals on the subjects I- Mitosis and Asexual Reproduction, II- Meiosis and Sexual Reproduction in the 1st Unit "Cell Divisions" were examined.

In the analysis of the scientific content of the texts and images in the relevant textbook, widely accepted works around the world and books published by our country's national/international publishing houses and used as textbooks/resource books in universities were used. According to publication date, these books are: Molecular Cell Biology (Lodish et al., 2011), Life Science Biology (Sadava et al., 2014), Anatomy Basic Textbook (Gilroy, 2015), Zoology integrated principles (Hickman, et al. 2016), Campbell Basic Biology: With Physiology Addition (Simon et al., 2017), General Biology (Boynukara et al., 2017), Becker' in Cell World (Hardın & Bertoni 2019), Biology Laboratory Research Guide (Morgan & Carter, 2019), Campbell Biology (Urry et al., 2022).

Collection of Data

It was decided, with the opinion of experts, that the most appropriate data collection method for this research, which aims to examine and interpret in detail the texts and visuals in the 10th grade Science High School Biology textbook in terms of scientific content, is document review. Document analysis was used as the data collection technique in the research. Document review includes the analysis of written materials containing information about the phenomenon or phenomena that are targeted to be investigated (Yıldırım & Şimşek, 2013). In qualitative research, document analysis can be a stand-alone data collection method or can be used in combination with other data collection methods (Yıldırım & Şimşek, 2013).

Analysis of Data

The source of the research is a MoNE secondary school 10th grade Science High School Biology textbook recommended to be taught in the 2022-2023 academic year. The texts and visuals in the "Cell Divisions" unit of the textbook were examined by three field experts through descriptive analysis in terms of scientific content. In order to compare the texts and visuals in the reference books, which are accepted as references in the field, with the texts and visuals in the examined textbook, accompanied by expert evaluations (Miles et al., 2018), the works whose names are included in the data sources title were used.

Within the scope of the research, the evaluation of the text and visuals related to the subject studied in the course book individually by each expert; It was carried out according to the criteria of "correct expression in the text", "incomplete expression in the text", "scientific error in the text", "correct expression in the visual", "incomplete expression in the visual", "scientific error in the visual".Then, in a discussion session organized by experts, individual evaluations were compared and consensus was based. For this purpose, the texts and images that are seen as inaccurate or incomplete were compared with each other, and the consistent findings were included in the scope of the study, and the inconsistent ones were re-evaluated by the experts. After all these studies, the agreement rate of the experts was determined. In the evaluation made, the agreement among experts was determined unanimously as 90% (Miles & Huberman, 1994).

Ethics Committee Permission

Ethics Committee Permission was not declared because the study was a document review study and a systematic literature review. As is known, these types of studies are not included in the group of studies that require Ethics Committee Permission.

Findings, Explanation and Interpretation

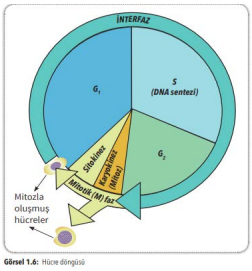
In this section, the findings obtained from the examination of the "Cell Divisions" unit in the 10th grade Science High School Biology textbook are presented in the form of tables in which erroneous or controversial texts and images are compared

with correct/reference images, explanations based on reference books about the tables, and expert evaluations/comments. Errors or controversial situations in the text and visuals detected as a result of the examination are included in the tables together with the page numbers in the works. In the Explanations section, inspections and examinations based on reference sources are presented in order to reveal the truth for statements such as missing information or scientific errors in texts and images that are thought to have erroneous content. The reason why an image or text is incomplete or incorrect, and what the truth is and/or should be, has been expressed within the framework of basic principles by making references to reference sources. In the evaluation section, in the light of the explanations, the authors' common views on why the text and image in the textbook are controversial or incorrect are included. MoNE 10th Grade Science High School Biology book, incomplete and incorrect information and page numbers with visuals; Page numbers of reference sources with correct information and images are shown in Table 1.

Table 1 Findings for the "Cell Divisions" Unit Incorrect Statements or Images in the Book Explanations and Evaluations in Reference Sources

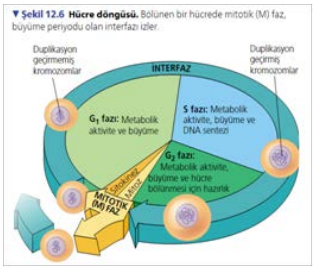
Incorrect Statements or Images in the Book	Explanations and Evaluations in Reference Sources
"In interphase, preparations are made for division, DNA replicates to itself, proteins and organelles are produced, and as a result, the cell grows. In animal cells, the centrosome replicates itself" (Aktaş & Demiray, 2019, p.19).	**Description:** "The centrosome organelle, which plays a role in the division of animal cells, consists of two perpendicular centrioles and aster threads (Boynukara et al., 2017, p.68). "Centrosomes determine the cell division plane" (Sadava et al., 2014, p.216). "The centrosome is the microtubule organizing center in animal cells and is a structure located close to the nucleus. The centrosome contains a pair of centrioles embedded in the protein matrix, and before mitosis, each duplicated centrosome forms a spindle pole" (Lodish et al., 2011). "Microtubules play an important role in distributing chromosomes to daughter cells during cell division, microtubules spread from the centrosome, a microtubule organizing center near the nucleus" (Hickman et al., 2016, p.42). **Evaluation:** The centrosome organelle was mentioned, but the function of the centrosome in division was not explained. According to the expression "Explains cellular structures and functions" (MoNE, 2018) in the 9th grade acquisitions of the secondary education science high school curriculum, students learned the function of the centrosome. However, since a year has passed, it is very likely that the task of the centrosome organelle has been forgotten by the students. For this reason, it would be appropriate to adapt it from the references about the centrosome organelle and add it to the textbook. At the same time, the expression "DNA replicates to itself" should be corrected to "DNA replicates to itself".
"In the G_2 phase, protein, enzyme and RNA synthesis continues. The number of cytoplasmic organelles increases" (Aktaş & Demiray, 2019, p.19).	**Explanation:** "Centrosome division occurs before cell division, then sister centrosomes separate, each forming part of the mitotic spindle" (Hardin & Bertoni, 2019, p.361)."G2 phase of interphase: Two centrosomes are formed by duplication of a single centrosome" (Urry et al., 2022, p.236). "Centrosomes self-replicate early in the cell cycle in preparation for mitosis" (Lodish et al., 2011). **Evaluation:** In animal cells, duplication of the centrosome is one of the prerequisites for mitosis. For this reason, it would be appropriate to add the phrase "Two centrosomes were formed by duplication of the centrosome in the G_2 phase" to the mentioned sentence.

<table>
<tr>
<td>“During the S phase, DNA replicates itself, creating a copy of each gene. The amount of DNA doubles” (Aktaş & Demiray, 2019, p.19).

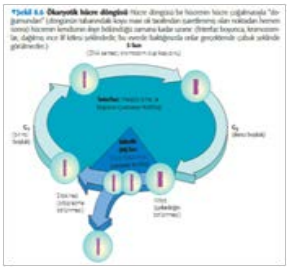
Image named “Image 1.6.: Cell cycle”
 

Görsel 1.6: Hücre döngüsü

(Aktaş & Demiray, 2019, p.19).</td>
<td>Explanation: While explaining the cell cycle, it was stated that DNA doubles in the S phase. However, cells are not shown in the stages in the cell cycle visual in the relevant unit. At the same time, it is understood that one of the cells shown to be formed in the mitotic phase has emerged from karyokinesis and the other from cytokinesis. In fact, the cells formed as a result of mitosis must come from the same place.
Evaluation: It would be appropriate to draw the cell cycle and the cells formed as a result of mitosis as shown in reference sources.

(Urry et al., 2022, p.237)

 
(Simon et al., 2017, p.125)</td>
</tr>
<tr>
<td>“Karyokinesis is examined in four phases, namely prophase, metaphase, anaphase and telophase, according to the main events that occur” (Aktaş & Demiray, 2019, p.19).</td>
<td>Explanation: In biology books taught in secondary schools in Turkey, mitosis is divided into 4 phases, but when reference sources are looked at, it will be seen that mitosis consists of 5 phases. Statements in some reference sources regarding this are as follows: “It has been a tradition to divide mitosis into five phases: prophase, prometaphase, metaphase, anaphase and telophase” (Sadava et al., 2014, p.216; Urry et al., 2022, p.237).
“Mitosis is divided into five stages based on the change in appearance and behavior of chromosomes; these five stages are; prophase, prometaphase, metaphase, anaphase and telophase” (Hardın & Bertoni, 2019, p.719). According to Lodish et al. (2011, p.782-783), mitosis can be divided into several stages to facilitate understanding of cell division; these phases are: prophase, prometaphase, metaphase, anaphase, telophase. “Mitosis is divided into five phases: prophase, prometaphase, metaphase, anaphase and telophase” (Morgan & Carter, 2019, p.164).
Evaluation: Examining mitosis in 4 stages in secondary school biology textbooks may be appropriate and easier for students to understand. However, the subject is science high school students. Science high school students are potential scientists of the future. It would be appropriate to convey the subject of cell divisions, an important subject of biology, to science high school students in a more detailed and accurate manner.</td>
</tr>
</table>

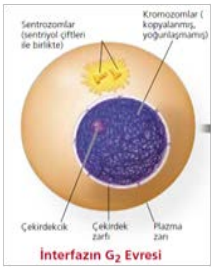
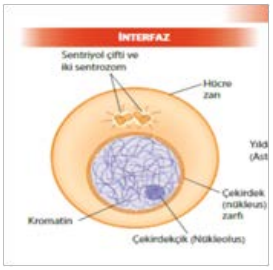
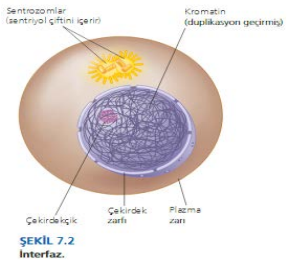
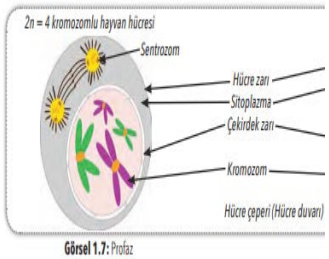
"Mitosis consists of successive phases that start with the end of interphase" (Aktaş & Demiray, 2019, p.19).	**Explanation:** On page 19 of the textbook, the interphase phase is mentioned and then it is explained that the transition to mitosis will occur. However, the prophase phase is explained without showing the shape of the interphase phase. At the same time, the characteristics of the cell and chromosomes in interphase have not been explained. **Evaluation:** Moving to the prophase phase without showing which phase the cell is in may cause incomplete learning in students and students may have difficulty establishing the connection between phases. In this context, in order to understand mitosis correctly, it would be appropriate to add the shape of the G2 phase, which is the last part of the interphase phase, to the book for correct learning. Some sample drawings of the G2 phase are given below.  (Urry et al., 2022, p.238)  (Hardın & Bertoni, 2019, p.718)  (Morgan & Carter, 2019, p.163)
"Prophase: When paired chromatin threads begin to shorten and thicken, they become visible as chromosomes. Each chromosome has two chromatids that are copies of each other. In animal cells, centrioles that form the centrosome move towards the poles, forming spindle fibers. Since there are no centrosomes in plant cells, spindle fibers consist of microtubule proteins. The nuclear membrane and endoplasmic reticulum are disintegrated. The nucleolus disappears. Prophase is the longest phase of mitosis." (Aktaş & Demiray, 2019, p.20).	**Description:** "Prometaphase: The nuclear envelope disintegrates, chromosomes become more dense" (Urry et al., 2022, p.238). In the textbook, the event that centrioles move towards the poles by forming spindle fibers is given in prophase, but this event actually takes place during prometaphase. "In prometaphase, the centrioles are at the poles of the cell" As the shuttle continues to form, the nuclear envelope breaks down" (Morgan & Carter, 2019, p.165). **Evaluation:** Due to the criticism regarding the number of stages of mitosis, it is believed that the prometaphase stage should be added to the science high school biology textbook. Because the majority of the events described in the prophase phase in the 10th Grade Science High School biology book actually take place in the prometaphase phase. Again in the textbook, nuclear membrane fragmentation is given in the prophase phase, but this event actually takes place in the prometaphase.

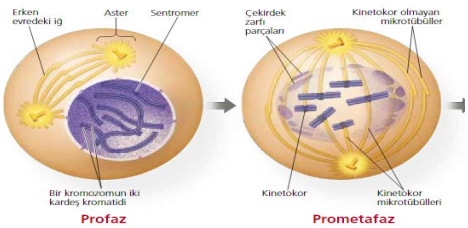
Image named “Image 1.7: Prophase”



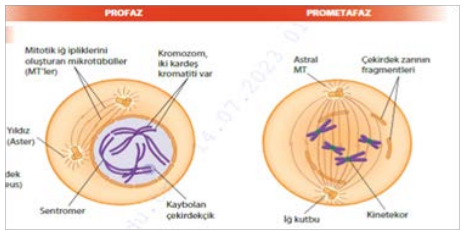
(Aktaş & Demiray, 2019, p.20).

Explanation: The image given of the prophase phase is actually the image of the prometaphase phase. “Prophase: Chromosomes become more dense” (Urry et al., 2022, p. 238).

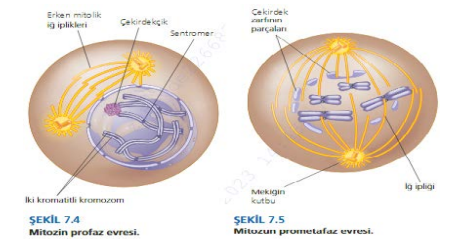
Evaluation: It would be appropriate to change the image in the textbook (image 1.7) by adapting it from the reference images below.



(Urry et al., 2022, p.238)



(Hardın & Bertoni, 2019, p.1718)



(Morgan & Carter, 2019, p.164-165)

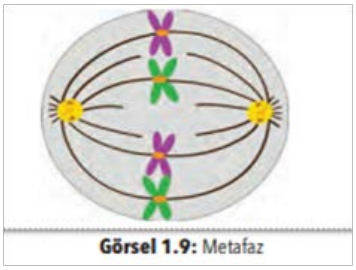
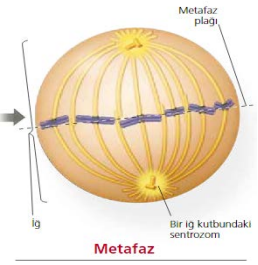
“Metaphase: Chromosomes are lined up side by side in a single row on the equatorial plane of the cell (metaphase plate) thanks to the spindle fibers connected to their kinetochores” (Aktaş & Demiray, 2019, p.20).

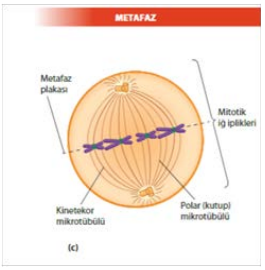
Explanation: In the text of the textbook, the word kinetochore, a new concept in metaphase, is used in a sentence. However, students do not yet know what this concept means.“Towards the end of prophase, specialized structures called kinetochores develop in the centromere region, one on each chromatid, and these structures are important for the movement of the chromosome.” (Sadava et al., 2014, p.216-217).

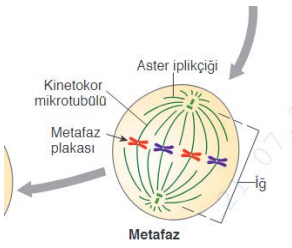
“The kinetochore consists of specialized proteins in the centrosome” (Urry et al. 2022, p.238).

“Kinetochore: It is a multi-protein complex located in the centromere region of a chromosome, which forms the adhesion site of spindle microtubules during mitosis or meiosis” (Hardın & Bertoni, 2019).

Evaluation: In order to explain an unknown concept, known concepts should be started. To start teaching, students should move from what they know to what they do not know (Çepni & Çil, 2009). In order to understand the metaphase stage, the concept of kinetochore must first be defined at least. In this context, it would be appropriate to adapt the kinetochore concept from reference sources and add it to the textbook before the metaphase title.

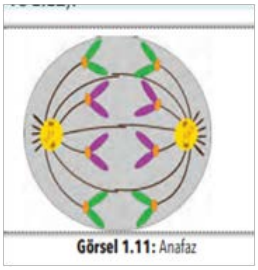
<table>
<tr>
<td>“Metaphase: Chromosomes are lined up side by side in a single row on the equatorial plane of the cell (metaphase plate) thanks to the spindle fibers connected to their kinetochores” (Aktaş & Demiray, 2019, p.20).</td>
<td>Explanation: In the text where the metaphase phase is explained, the concept of metaphase plate is mentioned in parentheses. According to Urry et al. (2022, p.240); “The centromeres of all self-replicated chromosomes line up on the plane located at the midpoint of the spindle fibers between the two poles in metaphase.“This plane is called the metaphase plate and it is an imaginary structure, not a real one.”“As tubulin dimers are added to kinotochore microtubules during metaphase, condensed sister chromatids are moved to the middle of the nuclear region called the metaphase plate” (Hickman et al., 2016, p.51).
Evaluation: In order for the students to understand the metaphase plate correctly, the definition of the metaphase plate must first be given.</td>
</tr>
<tr>
<td>Image named “Image 1.9: Metaphase”
 
Görsel 1.9: Metafaz
(Aktaş & Demiray, 2019, p.20).</td>
<td>Explanation: The term “metaphase plate” is mentioned in the text, but it is not mentioned in the image. This indicates that the text and images used are not consistent.
Evaluation: In the metaphase image, the metaphase plate should be shown as in the reference sources in the description.
 

(Urry et al., 2022, p.239)
 

(Hardın & Bertoni, 2019, p.719)
 

(Hickman et al., 2016, p.5)</td>
</tr>
<tr>
<td>“Anaphase: Separation of sister chromatids at this stage ensures the formation of cells with the same chromosome number and chromosome structure” (Aktaş & Demiray, 2019, p.20).</td>
<td>Explanation: The given statement may lead to a misunderstanding that as a result of mitosis, two new cells are formed in the anaphase phase and that the division is completed. In the reference source, this phase; It is explained as “at the end of anaphase, both ends of the cell have an equal number of full sets of chromosomes” (Urry et al., 2022, p.239).
Evaluation: Correcting the anaphase phase as in the reference source will prevent misunderstandings and learning. Cell and Cell divisions are the basic biology subjects asked in the university entrance exams of high school students. For this reason, it is very important to teach the subject without causing misunderstanding.</td>
</tr>
</table>

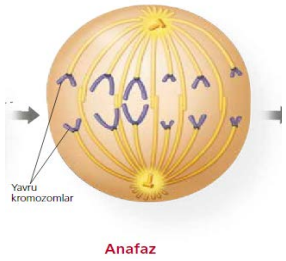
Image titled “Image 1.11: Anaphase”



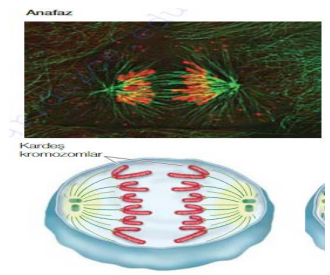
(Aktaş & Demiray, 2019, p.20).

Explanation: The cell drawn in the image of the anaphase phase is drawn at the same size as the metaphase phase. However, during the anaphase phase, the cell lengthens. “During the anaphase phase, the length of the cell increases due to the elongation of microtubules that are not attached to the kinetochore” (Urry et al., 2022). At the same time, since the structure of the chromosome shown in prophase changes, it should be shown with arrows that this structure is sister chromatids or daughter chromosomes. “Anaphase begins when cohesin proteins are broken off. This event allows the sister chromatids in each pair to separate suddenly. Thus, each chromatid becomes an independent chromosome” (Urry et al., 2022, p.239). “Paired sister chromatids separate from each other and new daughter chromosomes begin to move towards the poles” (Sadava et al., 2014, p.219). “During the anaphase phase, the spindle fibers that are not attached to the chromosomes lengthen, pushing the poles further away and allowing the cell to elongate” (Simon et al., 2017).

Evaluation: The visual of the anaphase phase should be drawn as shown in reference sources.



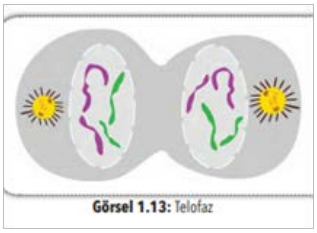
(Urry et al., 2022, p. 239)



(Sadava, 2014, p.219)

“During the telophase phase, nuclear membranes and nucleolus re-form” (Aktaş & Demiray, 2019, p.20).

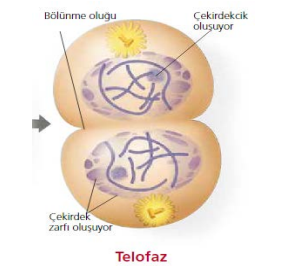
Image titled “Image 1.13: Telophase”



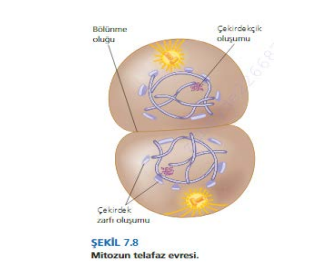
(Aktaş & Demiray, 2019, p.20)

Explanation: “Telophase is the opposite of prophase: The nuclear envelope forms, chromosomes dissolve and spindle fibers disappear” (Simon et al., 2017, p.127). “Chromosomes begin to unravel and nucleoli reappear, a nuclear envelope forms around each new chromosome cluster, telophase ends when the nuclear envelopes are completed” (Morgan & Carter, 2019, p.166).

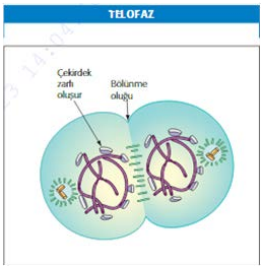
Evaluation: It is stated that “nuclear membranes and nucleolus re-form” in the telophase phase, but these formed structures are not shown in the image; The nucleolus needs to be added to the image. At the same time, the formation of the nuclear envelope (membrane) should also be indicated with arrow signs.

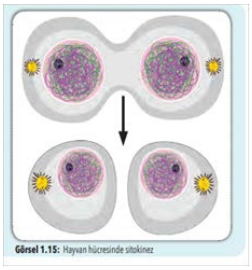


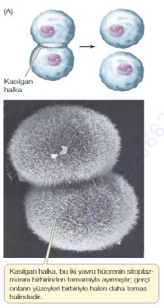
(Urry et al., 2022, p.239)

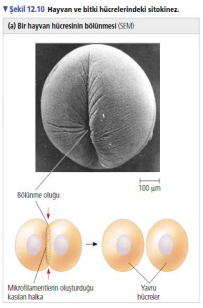


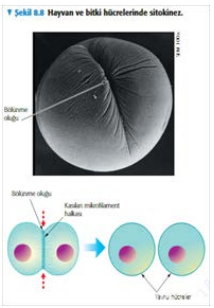
(Morgan & Carter, 2019, s.166)

<table>
<tr><td></td><td> 

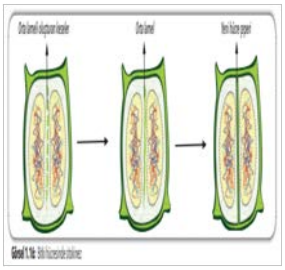
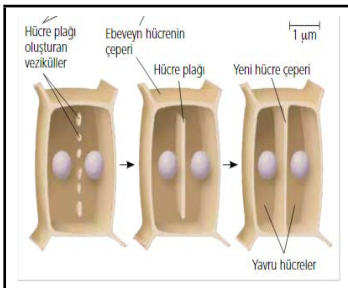
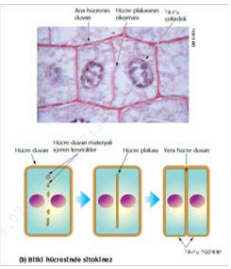
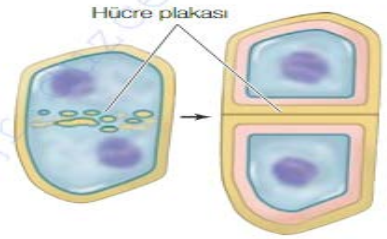
(Simon et al., 2017, p.127)</td></tr>
<tr><td>“During the division of the cytoplasm in the animal cell, a groove begins to form in the cell, this event is called nodule” (Aktaş & Demiray, 2019, p.20).</td><td>Description: “The division groove formed during cytokinesis in animal cells divides the cell into two” (Urry et al., 2022: p.239). “A “contractile ring” is formed in animal cells, this ring squeezes the cell and divides it into two” (Sadava et al., 2014: p.220). “The process of cytokinesis in animal cells is known as cell division. The first sign of cell division is when the division groove begins to appear; Meanwhile, a groove forms at the equator of the cell” (Simon et al., 2017, p.128). “In animal cells, a division groove forms at the equator and the cytoplasm is divided into two” (Morgan & Carter, 2019, p.167).
Evaluation: When the reference sources are examined, the concept of cleavage groove is used to initiate the cytokinesis event, but the concept of internode is not used. Instead, the term ‘articulation’ should be changed to ‘cleavage groove’ or ‘contractile ring’. When looking at Karataş and Karataş (2023) “Biology Terms” dictionary, there is no concept of articulation. Of the sources examined, the concept of articulation groove was used only in the study of Hardın and Bertoni (2019).</td></tr>
<tr><td>Image titled “Image 1. 15: Cytokinesis in animal cell”
 

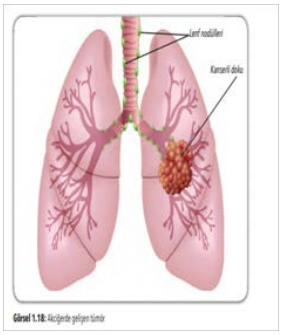
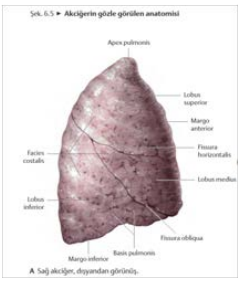
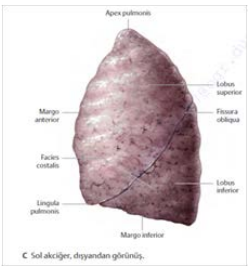
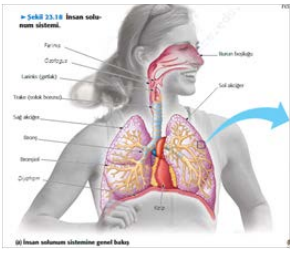
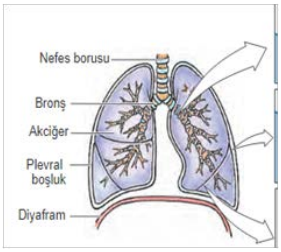
(Aktaş & Demiray, 2019, p.21)</td><td>Explanation: In the cytokinesis image, the names of the division groove (contractile ring) and the resulting daughter cells should be shown with arrow signs.
Evaluation: In order to understand the cytokinesis phenomenon correctly, images must be drawn in accordance with reference sources.
<table>
<tr><td> 

(Sadava, 2014, p.220)</td><td> 

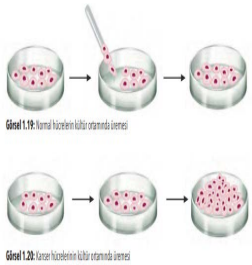
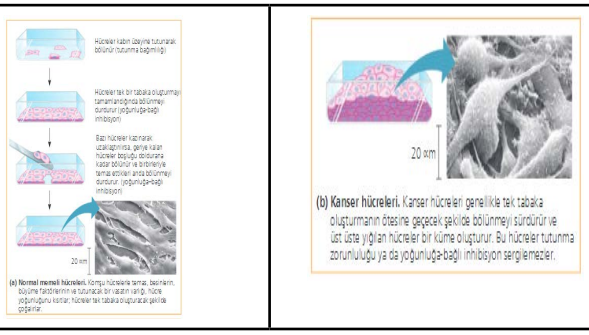
(Urry et al., 2022, p.242)</td><td> 

(Simon et al., 2017, p.128)</td></tr>
</table></td></tr>
</table>

"In plant cells, the middle lamella divides the cytoplasm and cytoplasm content into two equal parts" (Aktaş & Demiray, 2019, p.21).	**Explanation**: Middle lamella and cell plate are two separate concepts. The plant cell divides during telophase by forming a cell plate. "There is no division groove in plant cells. "Instead, during telophase, vesicles originating from the Golgi apparatus advance along microtubules and fuse in the middle of the cell, forming a cell plate." (Urry et al, 2022, p.241-242). "At the end of cytokinesis, two daughter cells are separated from each other by a cell plate" (Sadava et al., 2014, p.723). "Cytokinesis in plant cells occurs in a different way. Vesicles containing cell wall substances gather in the middle of the cell. "These vesicles fuse to form a membranous disc called the cell plate" (Simon et al., 2017, p.128). The concept of middle lamella, used instead of cell plate, is a thin layer in plant cells that appears as a result of the formation of adhesive substances inside the cell plate. This layer separates two neighboring plant cells. "A glue-like substance formed inside the cell plate forms the middle lamella. The middle lamella remains as a thin layer between the walls of the two daughter cells" (Sadava et al., 2014, p.723). "Between the primary walls of neighboring cells is a thin layer called the middle lamella, rich in sticky polysaccharides called pectins. The middle lamella glues neighboring cells together" (Uryy et al., 2022, p.118). **Evaluation**: This misuse has caused concepts to be learned and taught incorrectly. It is important to correct scientific errors in books as they may lead to incorrect learning. The phrase cell plate should be used instead of the phrase middle lamella.
Image titled "Image 1.16: Cytokinesis in plant cell"  (Aktaş & Demiray, 2019, p.21)	Explanation: In the image showing cytokinesis in the plant cell, the expression cell plate should be used, as in the reference sources, not middle lamella.  (Urry et al., 2022, p.242)  (Simon et al., 2017, p.128)  (Sadava, 2014, p.220) **Evaluation**: The relevant visual must be arranged as shown in reference sources.

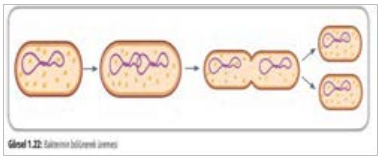
<table>
<tr>
<td>Image titled “Image 1.18: Tumor developing in the lung”
 
(Aktaş & Demiray, 2019, p.24)</td>
<td>Explanation: The lung photo shown in the image shows that the lung consists of three parts: the right lobe and the left lobe. However, the right lobe of the lung consists of three parts and the left lobe consists of two parts. Even in the Secondary School 6th Grade Science book, it is detailed that the right lung consists of three lobes and the left lung consists of two lobes. “The right lung consists of three parts called lobes. The left lung has two lobes” (Çiğdem et al., 2018). However, this detail was not taken into consideration in the 10th Grade Science High School book. “Fissura horizontalis and fissura obliqua divide the right lung into lobus superior, lobus medius and lobus foriora” (Gilroy, 2015). “Fissura obliqua divides the left lung into lobus superior and lobus forior” (Gilroy, 2015).
Evaluation: The structure of the lungs should be drawn in accordance with the scientific content, as shown in reference sources
 
(Gilroy, 2015, p.90)
 
(Gilroy, 2015, p.90)
 
(Simon et al., 2017, p.510)
 
(Hickman et al., 2016, p.687)</td>
</tr>
<tr>
<td>“Normal cells divide until they form a single layer of cells on the inner surface of the culture vessel, and mitosis stops in these cells” (Aktaş & Demiray, 2019, p.24).</td>
<td>Explanation: The concept that cells planted in tissue culture must adhere to the tissue culture before they begin to divide should be explained. There is incomplete concept teaching here. Likewise, before the phrase “mitosis stops” in the sentence, the concept of density-dependent inhibition should be given. By explaining conceptually why mitosis stops, correct learning can occur and the connection between events can be established more easily. “Many animal cells have to hold on to something. “Such cells must adhere to the surface of the culture vessel in order to divide” (Uryy et al., 2022, p.247). “Density-dependent inhibition is the phenomenon where crowded cells stop dividing” (Uryy et al., 2022, p.247).
Evaluation: The definition of the missing concept should be given and explained and correctly conveyed to science high school students. The obligation to hold on and density-dependent inhibition are explained indirectly. These two events should be explained directly and the names of the concepts should be taught.</td>
</tr>
</table>

<table>
<tr>
<td>Visual 1.19: Reproduction of normal cells in culture medium and Visual 1.20:

Images titled “Proliferation of cancer cells in culture medium”
 
(Aktaş & Demiray, 2019, p.24)</td>
<td>Explanation: In the textbook image 1.19, it is seen that tissue culture consists of three steps, but reference sources show that it consists of four steps. According to Visual 1.19;
In step 1, density-dependent inhibition does not occur as soon as the cells are seeded; First, a few cells are planted and then these cells divide by mitosis and cover the surface of the container. The phenomenon of covering the entire surface is called density-dependent inhibition. In the image, initially 9 cells were shown, then three of them were scraped and a new one was created again, giving an erroneous representation. At the beginning, less than 9 cells should be shown, then it should be shown with arrow signs that they cling to the container (the necessity of clinging), and finally, it should be shown that they multiply again with mitosis and the number increases to 9 again.
In Step 2, it is shown that three cells were scraped from the tissue dish, but what they represent is not specified using arrow signs.
In the 3rd step, it is necessary to explain that the transplanted tissue cells will no longer divide because they cover the surface of the container, that is, density-dependent inhibition. “If some cells are scraped away, the remaining cells divide until they fill the gap and stop dividing as soon as they come into contact with each other (density-dependent inhibition)” (Reece et al., 2015).
According to Visual 1.20;
It should be noted that the formed and proliferating cancer cells do not show adherence or density-dependent inhibition. “Cancer cells do not exhibit adherence or density-dependent inhibition” (Reece et al., 2015).
Finally, it should be noted that the cells shown in “Image 1.19” and “Image 1.20” are drawn very large. “Drawings of cells displayed in tissue culture are shown disproportionately large” (Reece et al., 2015).
Evaluation: While explaining tissue culture, missing definitions and deficiencies in the visual must be completed and presented to the students.
 
(Reece et al., 2015, p. 241)</td>
</tr>
<tr>
<td>“Escherichia coli bacteria, which can live in the human intestine, multiply by dividing every 20 minutes under suitable conditions” (Aktaş & Demiray, 2019, p.27).</td>
<td>Explanation: It means that Escherichia coli bacteria multiply in the human intestine as if every 20 minutes, but this statement is incomplete. In the human intestine, this bacteria can divide every 12-24 hours. “Escherichia coli divides every 20 minutes under ideal laboratory conditions, but in its natural environment, the human intestine, it can divide every 12-24 hours” (Reece et al., 2015, p.560).
Evaluation: Misunderstandings should be prevented by correcting the expression as in the reference source.</td>
</tr>
</table>

<table>
<tr>
<td>"As replication continues, the length of the bacterium increases" (Aktaş & Demiray, 2019, p.27).

Image titled "Image 1.22: Reproduction of bacteria by division"

 
(Aktaş & Demiray, 2019, p.27)</td>
<td>Explanation: In the statement given, it is explained that the bacteria has grown in length, but the image has not been drawn accordingly. "Replication continues. Each of the origin copies is now located at one of the two ends of the cell. Meanwhile, the cell grows in length" (Reece et al., 2015, p.237).
Evaluation: It should be shown that the bacterial cell lengthens during division. At the same time, in Visual 1.22, which cell (bacteria) the shown cell belongs to should be indicated with an arrow sign. Inconsistency between the explanations in the books and the visuals given may cause students to learn incorrectly and have misconceptions. For this reason, attention should be paid to visual selection and expression.

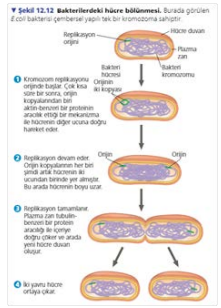
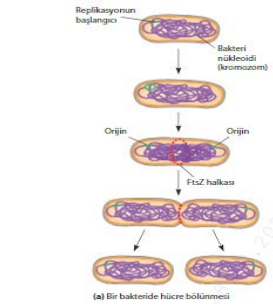
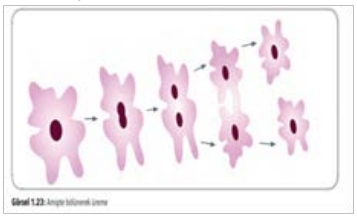
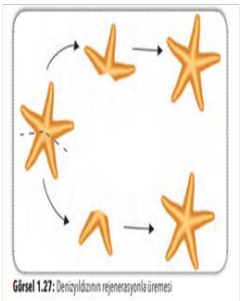
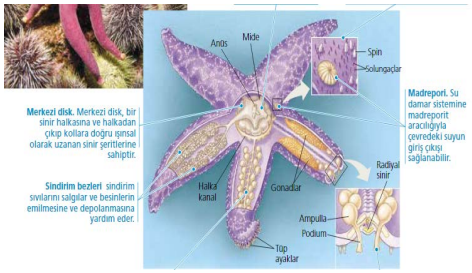
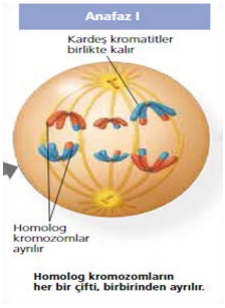
 
(Reece et al., 2015, p. 237)
 
(Hardın & Bertoni, 2019)</td>
</tr>
<tr>
<td>Image titled "Image 1. 23: Reproduction by division in amoeba"
 
(Aktaş & Demiray, 2019, p.27)</td>
<td>Explanation and evaluation: In the amoeba division visual, the cell parts of the amoeba are not shown with arrow signs. As such, it is not fully understood what events occur during the division process in the amoeba and the order of the process. It is important that the figures drawn in the visuals given in the textbooks are descriptive of the subject and compatible with the text, and the names of the structures in the figure should be shown with arrow signs in order to fully understand how the division process takes place.</td>
</tr>
<tr>
<td>"Starfish, which have one-fifth of the central discs, can complete their severed arms" (Aktaş & Demiray, 2019, p.27).

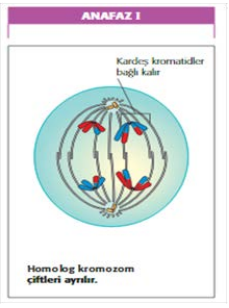
Image titled "Image 1.27: Reproduction of starfish by regeneration"
 
(Aktaş & Demiray, 2019, p.28)</td>
<td>Explanation and evaluations: The concept of "central disk" is mentioned in the given statement. However, the central disc is not shown in the image. The given image, which also shows the central disc of the starfish, should be added to the book as in the reference sources.
At the same time, it is necessary to indicate with arrow signs how the event shown in Visual 1.27 took place and which living creature it belongs to. The harmony between visual and text is important for learning.

 
(Urry et al., 2022, p.714)</td>
</tr>
</table>

<table>
<tr>
<td>"With meiotic cell division, reproductive cells with haploid (n) chromosomes are formed from reproductive mother cells (sexual mother cells) with diploid (2n) chromosomes. Thus, the constancy of the number of chromosomes is ensured across generations" (Aktaş & Demiray, 2019, p.36).</td>
<td>Explanation: Ensuring the constancy of the chromosome number within the species is not meiosis cell division alone, but meiosis and fertilization together. "With each generation, meiosis reduces the number of chromosomes from 46 (two sets) to 23 (one set). As a result of fertilization, the two gametes fuse and the chromosome number increases again to 46" (Reece et al., 2015, p.230). "An advantage of meiosis in sexually reproducing organisms is that it prevents the chromosome number from doubling with each generation when fertilization occurs" (Morgan & Carter, 2019, p.173).
Evaluation: If only meiosis is mentioned, students will ask "meiosis reduces the number of chromosomes in half and how come the number of chromosomes remains constant?" It may cause a misconception. Related explanation; It would be appropriate to correct it as "meiosis and fertilization events together ensure that the number of chromosomes remains constant."</td>
</tr>
<tr>
<td>"During the anaphase phase, sister chromatids of homologous chromosomes remain connected to each other and move towards opposite poles" (Aktaş & Demiray, 2019, p.37).

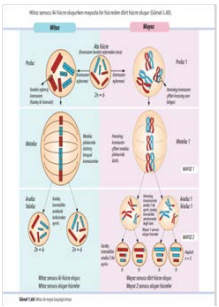
Image titled "Image 1.53: Anaphase 1
 

(Aktaş & Demiray, 2019, p.37)</td>
<td>Explanation: It has been said that sister chromatids remain connected to each other in anaphase 1, but the image given is not drawn accordingly. "The link between the homologous chromosomes of each pair is broken and the chromosomes now migrate towards the poles of the cell. "Unlike in mitosis, sister chromatids migrate in pairs rather than separated from each other" (Simon et al., 2017, p.132).
Evaluation: The structures in the relevant visual should be shown one by one with arrow signs, as in the reference sources. In this state, it is not clear which structures are sister chromatids and which are homologous chromosomes. With correct representations, permanent learning is achieved by preventing memorization of the stages of mitosis and meiosis.
 

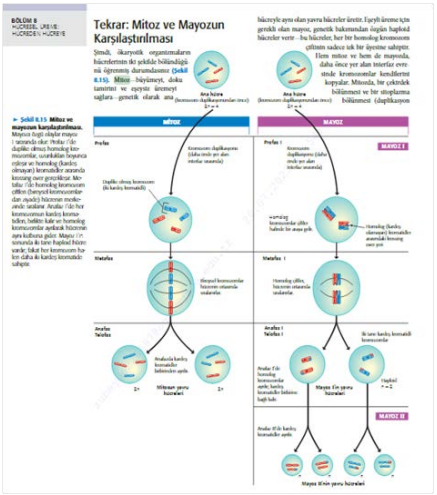
(Urry et al., 2022, p.260)
 

(Simon et al., 2017, p.132)</td>
</tr>
<tr>
<td>"While two cells are formed as a result of mitosis, four cells are formed from one cell with meiosis" (Aktaş & Demiray, 2019, p.39).</td>
<td>Explanation and Evaluation: While explaining meiosis, Visual 1.60 was added without any other title. Image 1.60 shows the differences between mitosis and meiosis. The differences between meiosis and mitosis cover the basic topics of biology. For this reason, it would be appropriate to include a text explaining the differences between mitosis and meiosis before Visual 1.60, and a title called "Differences Between Mitosis and Meiosis" before that. When the reference books are examined, a side heading is given to distinguish the features of the two divisions and the differences between the divisions are explained, except for the visual.</td>
</tr>
</table>

Image titled “Image 1.60: Comparison of mitosis and meiosis”



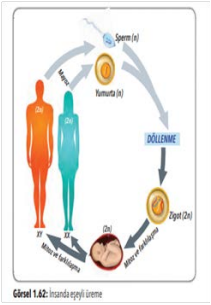
(Aktaş & Demiray, 2019, p.37)



(Simon et al., 2017, p.134)

“There are reproductive mother cells in the reproductive organs of male and female individuals, and these cells form reproductive cells through meiosis” (Aktaş & Demiray, 2019, p.42).

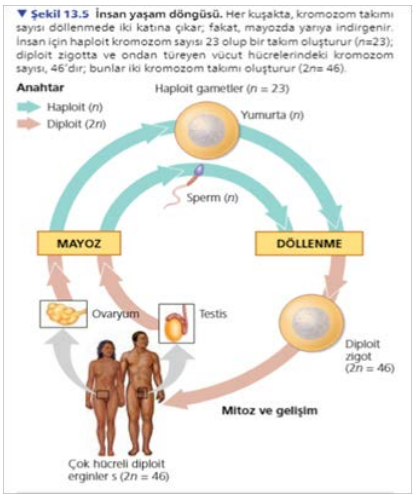
Image titled “Image 1.62: Sexual reproduction in humans”



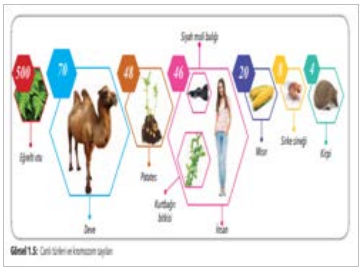
(Aktaş & Demiray, 2019, p.42)

Explanation: An explanation was made as follows: “Reproductive cells are formed in the reproductive mother cells by meiosis.” However, the given image 1.62 is not drawn accordingly. In Visual 1.62, arrow signs are drawn on the bodies of male and female individuals and meiosis is written on them. As it is known, meiosis occurs in the reproductive/ sex mother cells in the reproductive organs, testicles and ovaries. “The halving of the number of chromosomes in reproductive mother cells occurs during meiosis” (Boynukara et al., 2017, p.82). In addition, the expression “mitosis and differentiation” was used in the stage after the embryo was formed. Since the expression of differentiation here can be understood as metamorphosis, it would be appropriate to correct it as “growth and development”.

Evaluation: The correct drawing should be made on the testicles and ovaries, which are important parts of male and female reproductive organs, as in the reference source. This is also important for students to know their bodies and their reproductive systems and organs accurately.



(Urry et al., 2022, p.257)

Image titled "Image 1.5: Living species and chromosome numbers"  (Aktaş & Demiray, 2019, p.18)	**Explanation:** According to Image 1.5, the chromosome number of the hedgehog is given as 4. "The number of chromosomes in somatic cells varies between species, this number is 90 in hedgehogs" (Urry et al., 2022, p.236). In karyological studies conducted on some hedgehog species in Turkey, this number is stated as 2n = 48 (Ulutürk and Coşkun, 2011). **Evaluation:** When reference books and literature are examined, the chromosome number of the hedgehog differs from the chromosome number given in the textbook. Therefore, this figure needs to be corrected.

Discussion, Conclusion and Suggestions

In this study, in which the texts and visuals in the "Cell divisions" unit of the Secondary Science High School 10th grade Biology textbook were examined in terms of scientific content, missing or incorrect expressions and representations were detected in the texts and visuals in the relevant unit of the textbook. Preparing the visuals and content in the biology sections of textbooks in a way that does not contain scientific mistakes ensures that students understand and learn the concepts correctly (Özay & Hasenekoğlu, 2007). Mitosis and meiosis concepts and processes have an important share in studies investigating misconceptions about biology (Alkan et al., 2016). When the literature is examined, there are studies showing that students have misconceptions about many concepts about mitosis and meiosis (Tekkaya et al., 2000; Temelli, 2006; Gül et al., 2014; Alkan et al., 2016). In these studies, misconceptions about biology; gene, allele, homologous chromosome, replicated chromosome, chromosome number and DNA strand, chromosome-DNA relationship, chromosome structure of cells formed as a result of mitosis and meiosis, diploid-haploid cell concept, number of cells formed as a result of mitosis and meiosis, chromatid, nucleotide and It has been determined that the size relationship between chromosome concepts is related to the concepts of sperm cell and DNA amount of the cell that has undergone crossing-over (Tekkaya et al., 2000; Atılboz, 2004; Temelli, 2006; Aydın & Balım, 2013; Gül et al. 2014; Alkan et al. 2016). Similarly, in this study, missing or incorrect expressions and representations were determined regarding the concepts of cell cycle stages, mitosis and meiosis cell division and stages, kinetochore, middle lamella, and cytokinesis. Similarly, in a study conducted by Pekel (2019), he included criticisms regarding the visuals of "Nucleotide, gene DNA and chromosome relationship", "Transfer of sex chromosomes", "Structure of DNA" in the 8th grade Science Textbook.

In their study, Gündüz et al., (2016) revealed scientific errors regarding plant cell division, cell cycle, division of sea stars, meiosis, and parthenogenesis. Yilmaz et al. (2017b), in a study where they examined the biology topics in the 8th Grade Science textbook; They determined that there was incorrect information and representations regarding DNA replication and cell division in the Human Reproduction, Growth and Development unit. In addition, they determined in the study that there were scientific errors that could cause students to create incorrect information and alternative concepts about mitosis and meiosis. Again, in this study, scientific errors and deficiencies were detected in the visuals and texts of subjects such as living species and chromosome numbers, reproduction in tissue culture, reproduction by division of bacteria and amoeba, sexual reproduction in humans, tumor developing in the lung. Explanations and evaluations based on international reference sources regarding the errors in the relevant texts and visuals, which we have reached in line with and even supporting the literature, are presented together in the findings section.

Regarding the importance of the subject, in recent years in the literature, there have been studies on scientific errors that are only included in visuals regarding biology subjects in textbooks (Özel et

al., 2020; Çetin et al., 2021; Zeynoğlu et al., 2021; Sevinç, et al., 2022; Zeynoğlu et al., 2023). In their study, Yılmaz et al., (2021) stated that the visual in the section where the "Peripheral Nervous System" is explained contains some scientific errors. In addition to the correct scientific content of the texts in the textbooks, drawings, figures, symbols, graphics and pictures must also be used correctly (Köseoğlu et al., 2003). Just as scientific errors in textbooks cause misconceptions in students (Özay & Hasenekoğlu, 2006; Ozay Kose et al., 2009; Yılmaz et al., 2017a), similarly, the use of faulty visuals causes incorrect and/or erroneous learning and misconceptions. it could be.

Misconceptions are deep-rooted and persistent obstacles to students learning concepts correctly, and these misconceptions do not end after teaching (Dikmenli, 2010). Misconceptions can be increased through textbooks and teachers' practices (Bahar, 2003; Wandersee et al., 1994). Cell, one of the fundamental subjects of biology; It is a subject with many misconceptions because it includes many sub-topics (Gül & Özay Köse, 2018). In order to minimize misconceptions about the cell division issues examined in this study, it is very important that the texts and visuals of the textbooks are presented correctly to students and teachers. According to Kabapınar (2007), scientific errors in textbooks are the main reason for misconceptions in all students, from primary school to undergraduate level. Minimizing scientific errors and incorrect representations in textbooks will significantly reduce misconceptions.

Some suggestions we will offer within the scope of this study carried out within this framework are as follows:

- Due care should be taken to ensure that the text and visual contents of textbooks are accurate, understandable and scientifically appropriate.
- Visuals in national and international bedside reference sources should be adapted and used in textbooks when necessary, and the expressions in the texts should be reviewed and checked again and again.
- The suitability of text and visuals should be evaluated by both education field experts and relevant scientific field experts, in addition to visual-art experts.
- It should be ensured that there is consistency between the information explained in the textbooks and the visuals given on the subject.
- Misinformation should be prevented by making teachers aware of the mistakes in the textbooks.
- New textbooks to be written; It should be checked by field experts, taking into account misconceptions and common misconceptions.

References

Aktaş, E., & Demiray, F. (2019). *Secondary School Science High School Biology 10th Grade Textbook*. Ankara: Ministry of National Education Publications.

Alkan, İ., Akkaya, G., & Köksal, S. (2016). Determining misconceptions of prospective science teachers by using modeling approach as a data collection way. *Ondokuz Mayis University Journal of Faculty of Education*, 35(2), 121-135.

Atılboz, N. G. (2004). 9th grade students' understanding levels and misconceptions about mitosis and meiosis. *Gazi University Journal of Gazi Educational Faculty*, 24(3), 147-157.

Aydin, G., & Balım, A. G. (2013). Students' misconceptions related to subjects of cell division and heredity. *Journal of Research in Education and Teaching*, 2(1), 338-348.

Bahar, M. (2003). Misconceptions in biology education and conceptual change strategies. *Educational Sciences: Theory & Practice*, 3(1), 55-64.

Boynukara, Z., Başar, A., Bozkurt, O., Cansaran, A., Darçın, E., Hamalosmanoğlu, M., Polat, F., Temur, A., Türkmen, L., & Yıldırım, C. (2017). *General Biology*. Pegem Academic Publishing.

Chiappetta, E. L., & Fillman, D. A. (2007). Analysis of five high school biology textbooks used in the United States for inclusion of the nature of science. *International Journal of Science Education*, 29(15), 1847-1868.

Creswell, J. W. (2016). *Qualitative Research and Evaluation Methods* (B. Mesut, & S. B. Demir, Trans. Eds.). Pegem Publishing.

Çepni, S., & Çil, E. (2009). *Science and Technology Program Primary School 1st and 2nd Grade*

Teacher Handbook. Pegem Academic Publishing.

Çetin, A., Sevinç, Ö. S., & Aksoy, E. (2021). Examining the images of the structure of flowers in secondary school 7th grade science textbooks in terms of scientific content. *8th International Instructional Technologies and Teacher Education Symposium.*

Çiğdem, C., Balçık, G. M., & Karaca, Ö. (2018). *Science 6th Grade Textbook*. Sevgi Publications.

Demirel, Ö. (2020). *Educational Dictionary*. Ankara: Pegem Academic Publishing.

Dikmenli, M. (2010). Misconceptions of cell division held by student teachers in biology: A drawing analysis. *Scientific Research and Essay*, 5(2), 235-247.

Gilroy, A. M. (2015). *Anatomy Basic Textbook* (C. Denk, Trans.). Ankara: Palme Publishing.

Gül, Ş., Özay-Köse, E., & Konu, M. (2014). The effect of using concept cartoons on biology teacher candidates in teaching the genetics unit. *Journal of Science Teaching*, 2(1), 1-22.

Gul, Ş., & Özay-Köse, E. (2018). A Content Analysis of Misconception Articles towards Biology Subjects in Turkey. *Iğdır University Journal of Social Sciences*, (15), 499-521.

Gündüz, E., Yılmaz, M., & Çimen, O. (2016). The investigation of the 10th year biology text book of National Education Ministry (MEB) as regards to scientific concept. *Bayburt Faculty of Education Journal*, 11(2), 414-430

Gündüz, E., Yılmaz, M., Çimen, O. & Şen, U. (2017). An investigation of the 11th grade biology text book of National Education Ministry (MEB) with regards to scientific content. *Gazi University Journal of Gazi Education Faculty*, 37(3), 1115-1140.

Gündüz, E., Yılmaz, M., Çimen, O., & Karakaya, F. (2019). Examining of subjects in 11th grade biology textbook in terms of scientific content. *Bolu Abant İzzet Baysal University Journal of Faculty of Education*, 19(3), 999-1015.

Güneş, F. (2022). *Characteristics and Analysis of Textbooks*. Ankara: SEAD Publications.

Görgülü Arı, A., & Arslan, K. (2019). Determination of students' views on biology subjects and processing in science courses. *International Journal of Social Science*, (74), 111-134.

Hardin, J., & Bertoni, G. (2019). *Becker's Cell World* (A. Beldüz, Trans.). Ankara: Palme Publishing.

Hickman, C. P., Roberts, L. S., Keen, S. L., Eisenhour, D. J., Larson, A., & I'Anson, H. (2016). *Zoology Integrated Principles* (E. Gündüz, Trans.). Ankara: Palme Publishing.

İlhan, E., & Yazar, İ. (2021). Investigation of the text-visual relationship used in basic education Turkish lesson books in terms of visual design elements. *The Journal of Buca Faculty of Education*, (52), 744-763.

Kabapınar, F. (2007). A look at the literature on students' misconceptions about chemical bonding I: Intramolecular bonds. *Journal of National Education*, 176, 18-35.

Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Scott, M. P., Bretscher, A., Ploegh, H., & Matsudaira, P. (2011). *Molecular Cell Biology* (H. Geçkil, M. Özmen & Ö. Yeşilada, Trans.). Ankara: Palme Publishing.

Karataş, A., & Karataş, A. (2023). *Dictionary of Biology Terms*. Ankara: Palme Publishing.

Koç, Y., & Sönmez, E. (2018). Conceptual comprehension levels of prospective science teachers on the subject of cell organelles. *Karabük University Journal of Institute Social Sciences*, 8(2), 338-351.

Köseoğlu, F., Atasoy, B., Kavak, N., Akkuş, H., Budak, E., Tümay, H., Kadayıfçı, H., & Taşdelen, U. (2003). *How a Science Textbook should be for Teachers-Students-Parents for Constructive Learning Environment*. Ankara: Asil Publishing Distribution.

MoNE. (2021). *Official Newspaper (Date: 14 October 2021 – Issue: 31628)*.

MoNE. (2018). *Secondary Education Science High School Biology Course (Grades 9, 10, 11, and 12) Curriculum*.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative Data Analysis: An Expanded Sourcebook*. Sage Publications.

Miles, M. B., Huberman, A. M., & Saldaña, J. (2018). *Qualitative Data Analysis: A Methods Sourcebook*. Sage publications.

Morgan, J. G., Carter, M. E. (2019). *Biology Laboratory Research Guide* (E. Gündüz, Trans.). Ankara: Palme Publishing.

Özay, E., & Hasenekoğlu, İ. (2006). Examination of the contents of high school biology textbooks in terms of scientific accuracy. *Journal of Educational Sciences and Practice*, 5(9), 111-123.

Özay, E., & Hasenekoğlu, İ. (2007). Some problems observed in the visual presentation in high school-3 biology textbooks. *Journal of Turkish Science Education*, 4(1), 80-91.

Ozay Kose, E., Pekel, O., & Hasenekoglu, I. (2009). Misconceptions and alternative concepts in biology textbooks: Photosynthesis and respiration. *Journal of Science Education*, 10(2), 91-93.

Özel, E., Sevinç, Ö. S., & Baykurt, Ö. (2020). Examining the visuals of the circulatory system in our body in 6th grade science textbooks in terms of scientific content. *1st International Pedagogical Research Congress*.

Öztaş, F., Yel, M. & Öztaş, H. (2005). The effects of biology education upon human ethical concerning the environment and other creatures. *Gazi University Journal of Gazi Educational Faculty*, 25(3), 295-306.

Pekel, F. O. (2019). Examination of the 8th grade science textbook in terms of educational, visual, linguistic and narrative aspects. *EKEV Academy Journal*, 78, 221-260.

Reece, J. B., Urry, L. A., Cain, M. L., Wasserman, S. A., Minorsky, P. V., & Jackson, R. B. (2015). *Campbell Biology* (E. Gündüz & İ. Türkan, Trans.). Ankara: Palme Publishing.

Sadava, D., Hillis, M. D., Heller, H. C., & Berenbaum, M. R. (2014). *Life Science Biology* (E. Gündüz & İ. Türkan, Trans.). Ankara: Palme Publishing.

Sevinç, Ö. S., Zeynoğlu, E., & İmert, M. N. (2022). Investigation of circulatory system images in secondary education 11th grade biology textbooks in the context of scientific content. *Asian Journal of Instruction*, 10(2), 21-40.

Simon, E. J., Dickey, J. L., Hogan, K. A., & Reece, J. B. (2017). *Campbell's Basic Biology: With Additions of Physiology* (E. Gündüz & İ. Türkan, Trans.). Ankara: Palme Publishing.

Syafrina, E., & Arono. (2017). Features of English textbooks for the first-year of senior high school implementing the 2013-curriculum. *Journal of Applied Linguistics and Literature*, 2(2), 1-13.

Şen, A. Z., & Nakiboğlu, C. (2014). Analyze of high school chemistry textbooks in terms of science process skills. *Journal of Turkish Science Education*, 11(4), 63-80.

Şimşek, H. (2020). Current developments in the teaching profession and teacher training. In H. B. Memduhoğlu & K. Yılmaz (Eds.), *Introduction to Education*. Ankara: Pegem Academic Publishing.

Tekkaya, C., Çapa, Y., & Yılmaz, Ö. (2000). Misconceptions of prospective biology teachers about general biology subjects. *Hacettepe University Journal of Faculty of Education*, (18), 140-147.

Temelli, A. (2006). Determination of misconceptions concerning genetic subjects of high school students. *Kastamonu Education Journal*, 14(1), 73-82.

Ulutürk, S., & Coşkun, Y. (2011). A comparative morphological and karyological study on hedgehogs, *Erinaceus concolor* Martin, 1838 and *Hemiechinus auritus* (Gmelin, 1770) (Erinaceomorpha: Mammalia) in Diyarbakir Province. *KSU Journal of Natural Sciences*, 14(4), 46-52.

Urry, L. A., Cain, M. L., Wasserman, S. A., Minorsky, P. V. & Orr, R. B. (2022). *Campbell's Biology* (E. Gündüz & İ. Türkan, Trans.). Ankara: Palme Publishing.

Wandersee, J. H., Mintzes, J. J., & Novak, D. (1994). Research on alternative conceptions in science. In D. L. Gabel (Ed.), *Handbook of Research on Science Teaching and Learning* (pp. 177-210). New York: Macmillan.

Yalınkılıç, K. (2020). Textbook as a teaching tool. In H. Ülper (Ed.), *Turkish Textbook Analyzes*. Ankara: Pegem Publishing.

Yeşilyurt, S., & Gül, Ş. (2012). Secondary school students' misconceptions about the "transportation and circulatory systems" unit. *Journal of Theoretical Educational Science*,

5(1), 17-48.

Yıldırım, A., & Şimşek, H. (2013). *Qualitative Research Methods in Social Sciences*. Ankara: Seçkin Publishing.

Yılmaz, M., Gündüz, E., Çimen, O., & Karakaya, F. (2017a). Examining of biology subjects in the science textbook for grade 7 regarding scientific content. *Turkish Journal of Education*, 6(3), 128-142.

Yılmaz, M., Gündüz, E., Diken, E. H., & Çimen, O. (2017b). The analysis of biology topics in the 8th grade science textbook in terms of scientific content. *Erzincan University Journal of Faculty of Education*, 19(3), 17-35.

Yılmaz, M., Gündüz, E., Üçüncü, G., Karakaya, F., & Çimen, O. (2018). Investigation of the biology subjects in eighth grade science textbook in terms of scientific content. *Anatolian Journal of Teacher*, 2(2), 1-16.

Yılmaz, M., Gündüz, E., Çimen, O., Karakaya, F., & Aslan, İ. (2021). An analysis of 6th grade science textbooks in terms of scientific content and learning outcomes. *e-Kafkas Educational Research Journal*, 8, 101-122.

Zeynoğlu, E., Sevinç, Ö. S., & İmert, M. N. (2021). Examination of images of the circulatory system in secondary school 11th grade biology textbooks in the context of scientific content. *14th National Science and Mathematics Education Congress*.

Zeynoğlu, E., Sevinç, Ö. S., & İmert, M. N. (2023). Evaluation of images of the skeletal system in science and biology textbooks in the context of scientific content. *3rd Educational Research Congress: Education from Past to Future*.

Author Details

Ömer Seyfettin Sevinç, *Duzce University, Turkey,* ***Email ID****: omersevinc@duzce.edu.tr*

Zübeyde Çiçek, *Ministry of National Education, Turkey,* ***Email ID****: zubeyde.cicek321@gmail.com*