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(REVIEW ARTICLE)

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Meiosis and preimplantation genetic testing

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Abstract

This commentary was mainly written to clarify a fundamental concept related to meiosis, which is the type of cell division for the production of gametes. Meiosis consists of two nuclear and cell divisions without an intermediate phase, starting with a diploid cell while giving rise to four haploid cells. Each division (meiosis I and meiosis II) consists of four stages: a) prophase, b) metaphase, c) anaphase and d) telophase. Recently, we noticed that there is an error in some schematic diagrams depicting meiosis I. These diagrams connect oocytes and polar bodies in different ways. For example, in a recent article, we noticed that in both the text and the schematic diagram "primary oocyte" and "polar body I" and "secondary oocyte" and "polar body II" appear in parallel. However, this is incorrect. Actually, the secondary (not primary) oocyte corresponds to polar body I. This is a fundamental knowledge that is necessary to understand the whole miracle of meiosis and the steps of preimplantation genetic testing.

Keywords: Oocytes; Meiosis; Prophase; Metaphase

1. Introduction

We feel the need to write this commentary to clarify some fundamental concepts related to meiosis and some central differences from mitosis. Actually, to understand some forms of preimplantation genetic testing, it is necessary to comprehend meioses (I and II). In females, meiosis is a type of cell division that produces haploid cells to form theegg, which combine with the sperm to produce the offspring. In broad strokes, meiosis is the type of cell division for the production of gametes (in sexual reproduction), where as mitosis is the type of cell division for somatic cells (and the asexual reproduction of unicellular eukaryotic cells). In meiosis, the first step, which separates homologous chromosomes, is referred to as meiosis I, a type of cell division which results in the reduction of the number of chromosomes. During meiosis, pairs of chromosomes separate randomly to produce gametes with one chromosome from each pair. Meiosis consists of two nuclear and cell divisions without an intermediate phase, starting with a diploid cell while giving rise to four haploid cells. Each division (meiosis I and meiosis II) consists of four stages: a) prophase, b) metaphase, c) anaphase and d) telophase. These stages are similar to those of mitosis; however, there seem to be important and notable differences between them(1).

During the prophase I of meiosis I, the nuclear envelope begins to break down and the chromosomes condense and slowly a spindle forms.What happens is unique to prophase I, because, in the same phase of meiosis II and mitosis, the homologous chromosomes do not form pairs in this way. Actually, in mitosis, the chromosomes condense intensely, producing a set of sister chromatids with prominent centromeres (2).During the Metaphase I, the paired chromosomes line up along the equator of the cell and this also occurs only in this stage. To compare, in metaphase of mitosis, the nuclear envelope begins to break down, and the mitotic spindle forms from an array of microtubules. Metaphase of mitosis differs from metaphase I of meiosis I in that in mitosis, individual chromosomes align at the equator, whereas

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in meiosis I, pairs of homologous chromosomes align at the equator of the cell. The spindle fibers in the anaphase phase shorten and the chromosomes of each homologous pair begin to separate from each other causing them to move to opposite poles. Similarly, in anaphase of mitosis, once every sister chromatid pair is fully attached and aligned in the center of the cell, with one chromatid bound to each pole, the sister chromatids separate and are pulled to opposite poles. Finally, during the telophase I, new nuclear membranes are formed by the breakdown of the spindle and the cytoplasm divides, giving rise to two haploid daughter cells each having a random arrangement of chromosomes from each homologous pair(1), (3), (4). Almost similarly, during telophase and cytokinesis of mitosis, the mitotic spindle breaks down, the chromosomes decondense, a new nuclear membrane forms around each set of daughter chromosomes (2) and the cell membrane forms a separating "wrinkle"of the daughter cells.

Recently, we noticed thatthere is an error in some schematic diagrams depicting meiosis I. These diagrams connect oocytes and polar bodies in different ways. For example, in a recent article(5) we noticed that in both the text and the schematic diagram "primary oocyte" and "polar body I" (Figure 1 including primary oocyte in a red cycle) and "secondary oocyte" and "polar body II" appear in parallel. However, this is incorrect. In correct diagrams, the secondary (not primary) oocyte corresponds to polar body I (6) (Figure 2). This is a fundamental knowledge that is necessary to understand the whole miracle of meiosis and the steps of preimplantation genetic testing. The authors of the incorrect diagrams may have fallen into an etymological trap, matching the primary oocyte to the first (i.e.prime) polar body and the secondary oocyte to the second polar body (this error was pointed out to the author of the diagram in (5)). Furthermore, this error was also observed in a recent conference, in which we noticed the same confusion of some experts in the field (7).

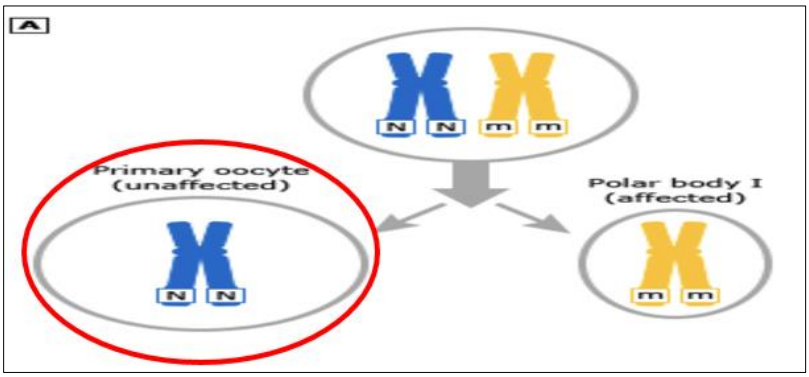

Figure 1 Schematic diagram of meiosis I(incorrect)
(https://www.uptodate.com/contents/images/OBGYN/53222/Principlspolarbodybiopsy.gif)

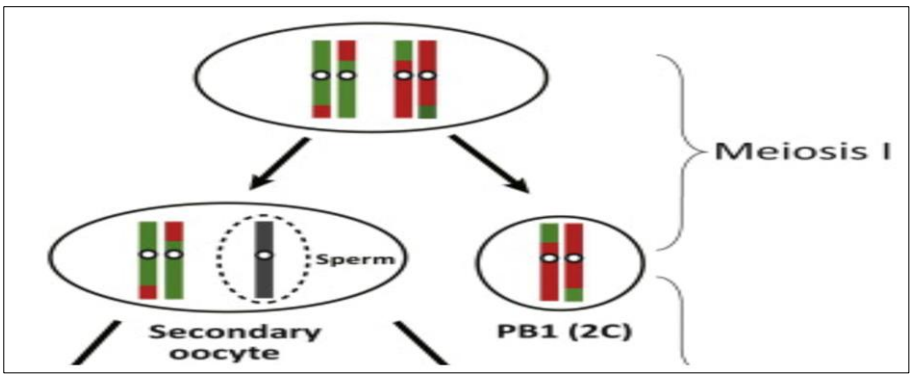

Figure 2 Schematic diagram of meiosis I (correct) (https://ars.els-cdn.com/content/image/1-s2.0-S0092867413015262-gr1.jpg

Considering that some knowledge portals serve both to improve knowledge and inform experts, as well as to educate students, we wanted with this intervention to correct wrong information that is widely circulated and that can confuse and mislead readers.

Considering that certain paid knowledge portals are advertised as being vetted by experts, a double check of what is written in these sources is absolutely necessary. It is important to note that these errors can be corrected without delay. Nonetheless, the incorrect diagrams could be used in teaching students to avoid this pitfall.

2. Conclusion

We noticed that in an otherwise reliable article, “primary oocyte” and “polar body I” and “secondary oocyte” and “polar body II” appear in parallel, which is wrong. This commentary was mainly written to clarify the fundamental concept that the secondary (not primary) oocyte corresponds to polar body I.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest.

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