

Supplemental Material

CBE—Life Sciences Education

Wright *et al.*

The following file is the Meiosis Assessment that was given to students pre-instruction in a mid-level Cell Biology course.

Correct answers are in red.

How much do you know about Meiosis already?

1. The figure at right represents a diploid precursor germ cell.

How many chromosomes are shown? 6

What is "N"? 3



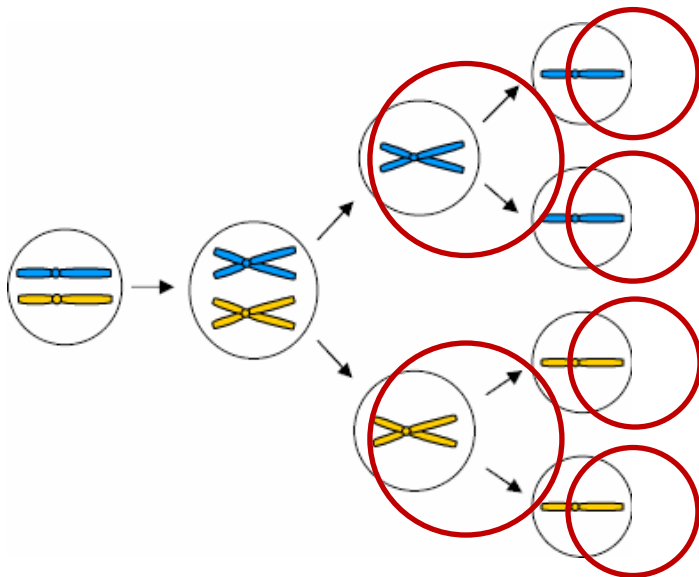
2. The figure at right represents the same cell after DNA replication.

How many chromosomes are shown? 6

What is "N"? 3



3. Circle all haploid cells in the figure of meiosis below.



4. What is the difference between homologous pairs and sister chromatids?

Sister chromatids are identical copies of a single chromosome that has undergone DNA replication. They are joined together at the centromere. Homologous pairs are nearly identical chromosomes at the DNA sequence level but which are derived from different parental sources. Thus they may contain different alleles of the same genes. They are not normally joined together except during crossing over.

5. Where do homologous chromosomes come from?

One member of each homologous pair is inherited from each parent in a diploid organism.

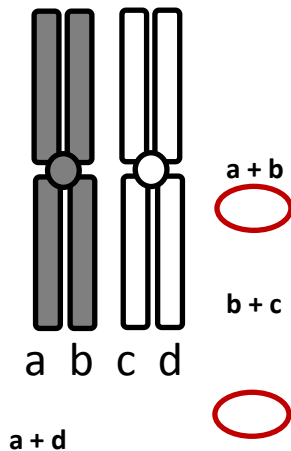
6. How do homologous chromosomes find each other to pair properly?

The nearly identical DNA sequence on homologous pairs allows for complementary base-pairing between homologues.

7. What determines where crossing over occurs?

Stretches of identical (or nearly identical) DNA sequences.

8. Consider the following pair of homologous chromosomes:



a. Which of the following combinations may undergo crossing over? Circle all that apply:

b. How many of these crossovers could occur simultaneously?

All of them

9. Is crossing over necessary for meiosis? Explain.

Yes, crossing over is necessary for the proper alignment of homologous pairs of chromosomes. If homologous pairs do not align properly they will not segregate properly during cell division.

10. What causes chromosomes to line up in the center of the cell?

Microtubules originating from the centrosomes connect with the kinetochore at the centromere of each chromosome. The balanced tension due to growing and shrinking of the microtubules results in the chromosomes eventually lining up at the center of the cell.

11. How similar are X and Y chromosomes? Why is this important?

While the X and Y chromosomes are non-homologous chromosomes they do share regions of identical DNA sequence (sequence homology). This is important because it allows X and Y to cross-over (pair) during meiosis and then segregate properly (one sex chromosome per gamete).

12. What is the end product of meiosis? What are these cells used for?

The end products are gametes. These cells are haploid and contain one full set of chromosomes. Gametes are used for the later process of fertilization.

Textbook, authors (whole list), publishers, year, level (introductory or mid/upper

(GENES IX GOT OMITTED BECAUSE IT IS IDENTICAL TO LEWIN'S ESSENTIAL GENES)

| Textbook | Authors | Publisher | Year | Level |
|--|---|-------------------------|------|--------------|
| The Living World, 7 th ed. | Johnson | McGraw Hill | 2011 | Introductory |
| Biology: Concepts and Connections, 6 th ed. | Campbell, Reece, Taylor, Simon, Dickey | Pearson | 2008 | Introductory |
| Scientific American Biology: Biology for a Changing World, 1 st ed. | Shuster, Vigna, Sinha, Tontonoz | W.H. Freeman & Co | 2012 | Introductory |
| Biological Sciences, 3 rd ed. | Mader | Pearson | 2014 | Introductory |
| Biology, 2 nd ed. | Brooker, Widmaier, Graham and Stiling | McGraw Hill | 2010 | Introductory |
| Principles of Life, 1 st ed. | Hillis, Savada, Heller, Price | W.H. Freeman & Co | 2011 | Introductory |
| Essential Cell Biology, 3 rd ed. | Alberts, Bray, Hopkin, Johnson, Lewis, Raff, Roberts and Walter | Garland Sciences | 2010 | Mid/Upper |
| Molecular Biology of the Gene, 6 th ed. | Watson | Pearson | 2007 | Mid/Upper |
| Lewin's Essential Genes, 2 nd ed. | Lewin, Krebs, Goldstein, and Kilpatrick | Jones and Bartlett | 2009 | Mid/Upper |
| Molecular Biology: Genes to Proteins, 4 th ed. | Tropp | Jones and Bartlett | 2012 | Mid/Upper |
| Molecular Biology of the Cell, 5 th ed. | Alberts and Johnson | Garland Sciences | 2007 | Mid/Upper |
| Molecular Biology: Principles of Genome Function, 1 st ed. | Craig, Cohen-Fix, Green, Greider, Storz, Wolberger | Oxford University Press | 2010 | Mid/Upper |
| Human Molecular Genetics, 4 th ed. | Strachan and Read | Garland Science | 2011 | Mid/Upper |
| Essentials of Genetics, 8 th ed. | Klug, Cummings, Spencer and Pallidino | Pearson | 2013 | Mid/Upper |

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| <i>The Living World</i> , 7 th edition | Johnson | McGraw Hill | 2011 | Introductory |
| <i>Biology</i> , 2 nd edition | Brooker, Windmaier, Graham and Stiling | McGraw Hill | 2011 | Introductory |
| <i>Campbell's Biology</i> , 10 th edition | Reese, Urry, Cain, Wasserman, Minorsky and Jackson | Pearson | 2013 | Introductory |
| <i>How Life Works</i> , 2 nd edition | Morris, Hall, Knoll, Lue and Michael | W.H. Freeman | 2016 | Introductory |
| <i>Biological Science</i> , 6 th edition | Freeman, Quillin, Allison, Black, Podgorski and Taylor | Pearson | 2017 | Introductory |
| <i>Principles of Life</i> , 2 nd edition | Hillis, Sadava, Heller and Price | W.H. Freeman | 2014 | Introductory |
| <i>Biology</i> , 10 th edition | Solomon, Martin, Martin and Berg | Cengage | 2015 | Introductory |
| <i>Lewin's Essential Genes</i> , 2 nd edition | Krebbs, Goldstein and Kilpatrick | Jones and Bartlett | 2010 | Mid/Upper |
| <i>Concepts of Genetics</i> , 1 st edition | Brooker | McGraw Hill | 2012 | Mid/Upper |
| <i>Essential Cell Biology</i> , 3 rd edition | Alberts, Bray, Hopkin, Johnson, Lewis, Raff, Roberts and Walter | Garland Science | 2010 | Mid/Upper |
| <i>Molecular Biology: Genes to Proteins</i> , 4 th edition | Tropp | Jones and Bartlett | 2012 | Mid/Upper |
| <i>Molecular Biology: Principles of Genome Function</i> , 1 st edition | Craig, Cohen-Fix, Green, Greider, Storz and Wolberger | Oxford | 2010 | Mid/Upper |
| <i>Essentials of Genetics</i> , 8 th edition | Klug, Cummings, Spencer and Pallidino | Pearson | 2013 | Mid/Upper |
| <i>Human Molecular Genetics</i> , 4 th edition | Strachan and Read | Garland Science | 2011 | Mid/Upper |
| <i>Introduction to Genetics: A Molecular Approach</i> , 1 st ed | Brown | Garland Science | 2012 | Mid/Upper |
| <i>Becker's World of the Cell</i> , 9 th edition | Hardin and Bertoni | Pearson | 2016 | Mid/Upper |