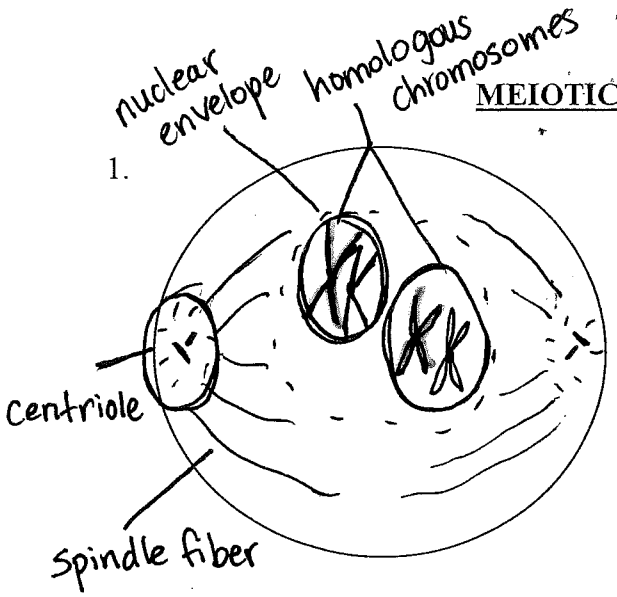
MEIOTIC STAGES and Their EVENTS

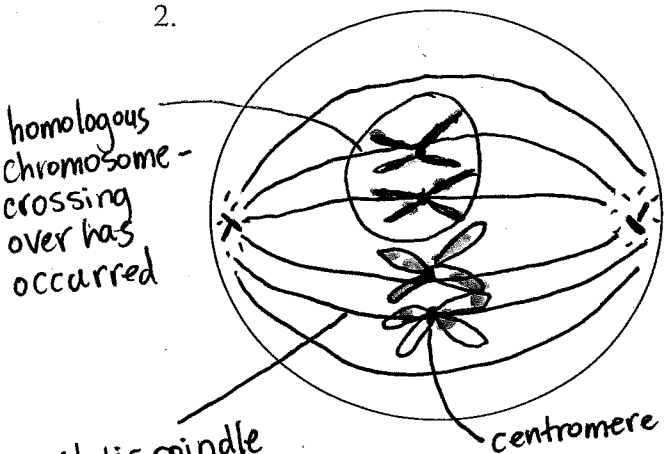
1.



STAGE: PROPHASE I

Events: Chromosomes condense
spindle fibers form (mitotic spindle)
centrioles move to opposite poles
nuclear envelope disappears
homologous chromosomes line up → CROSSING OVER

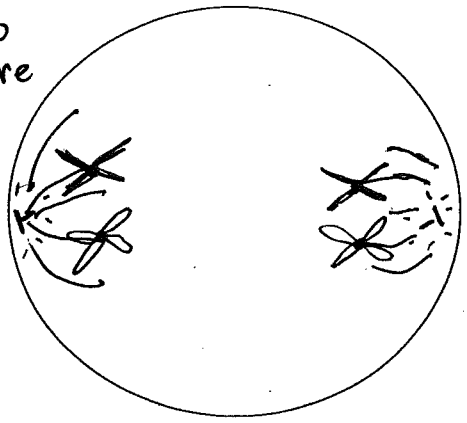
2.



STAGE: METAPHASE I

Events: paired homologous chromosomes move to the equator of the cell, spindle fibers attach to centromere, there will be areas on the chromatids where crossing over occurred.

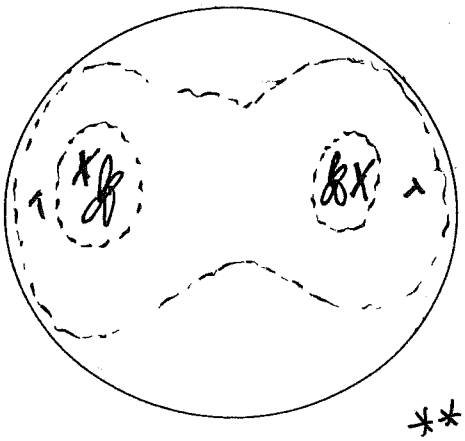
3.



STAGE: ANAPHASE I

Events: homologous chromosomes pull away from each other, sister chromatids are still attached, each side of the cell has 2 chromosomes instead of 4.

4.

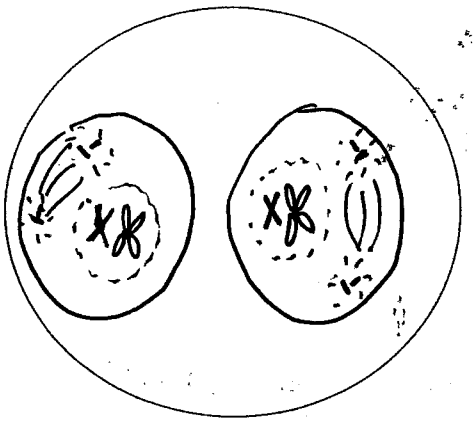


STAGE: TELOPHASE I

Events: spindle fibers disappear, nuclear envelope briefly reappears, cell pinches into 2 cells, cytokinesis occurs

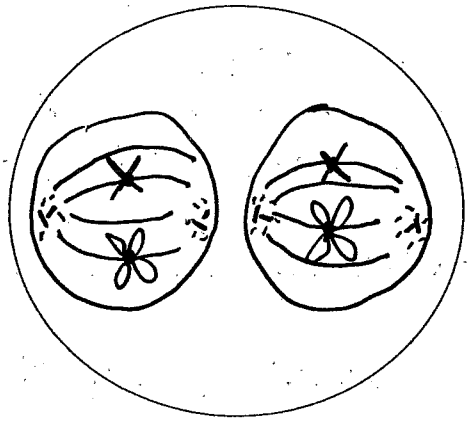
** 1 cell (diploid) → 2 cells (haploid) **
short INTERPHASE in between phases of MEIOSIS

MEIOSIS II : 2 cells (haploid) → 4 cells (haploid)

5. 

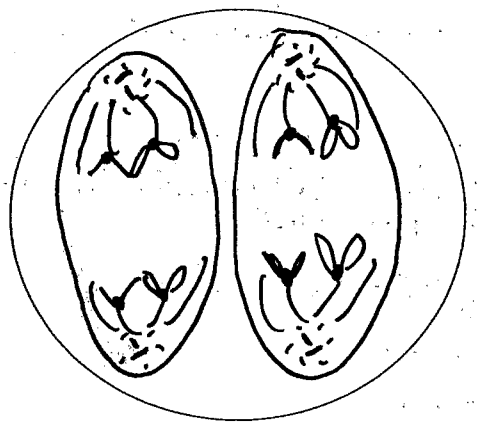
STAGE: PROPHASE II

Events: Similar to mitosis - nuclear envelope disappears, spindle fibers form, ~~centrioles~~ centrioles move, chromosomes condense

6. 

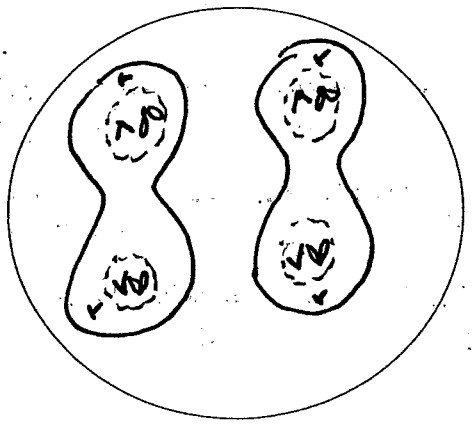
STAGE: METAPHASE II

Events: non-homologous chromosomes move to the middle of the cell, spindle fibers attach to the centromere.

7. 

STAGE: ANAPHASE II

Events: spindle fibers pull sister chromatids apart and move them to opposite poles of the cell.

8. 

STAGE: TELOPHASE II

Events: chromosomes at each pole decondense (chromatin), nuclear envelope reforms, cell membrane pinches in so you have 4 new cells.

Name_____ Period_____ Date Given_____ Due Date_____

Mitosis Verses Meiosis

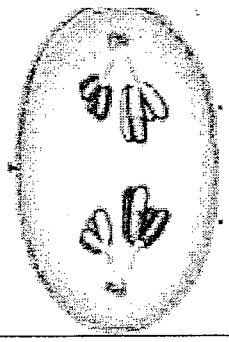
Directions: Write answers next to the question. Draw pictures on the back of this page, in order.

1. Describe the purpose of mitosis to produce 2 identical cells (diploid)
2. How many times does the cell divide during mitosis? once
3. What kind of cells are produced at the end of mitosis? somatic (body)
4. What are sister chromatids? the condensed replicated chromosomes (X)
5. Briefly describe what happens during prophase the DNA condenses, mitotic spindle forms
6. Draw and label picture of what a cell looks like during prophase. Draw on the back of page.
7. Briefly describe what happens during metaphase the chromatids line up in the middle of the cell
8. Draw and label a picture of what a cell looks like during metaphase. Draw on the back of page.
9. Briefly describe what happens during anaphase the sister chromatids pull apart
10. Draw and label a picture of what a cell looks like during anaphase. Draw on the back of page.
11. Briefly describe what happens during telophase the cell starts splitting into 2
12. Draw and label a picture of what a cell looks like during telophase. Draw on the back of page.
13. Is cytokinesis part of mitosis it is right at the end / just after
14. Briefly describe what happens during cytokinesis the cytoplasm, organelles dispersed and cell splits into 2.
15. Draw a picture of what a cell looks like during cytokinesis. Draw on the back of page.
16. Describe the purpose of meiosis to produce 4 haploid cells.
17. How many times does the cell divide during Meiosis? 2 times
18. What kind of cells are produced at the end of meiosis? gametes
19. Briefly describe the difference of prophase I & II. homologous chromosomes pair up vs. formati of chroma
20. Draw and label a picture of prophase I & II. Draw on the back of page.
21. Briefly describe the difference of metaphase I & II. homologous chromosomes line up vs. chromatids line up
22. Draw and label a picture of metaphase I & II. Draw on the back of page.
23. Briefly describe the difference of anaphase I & II. homologous chromosomes separate vs. chromatids separate.
24. Draw and label a picture of anaphase I & II. Draw on the back of page.
25. Briefly describe the difference of telophase I & II. separate into 2 cells vs. Separate into 4 cells
26. Draw and label a picture of telophase I & II. Draw on the back of page.
27. What would happen to cell division if a chemical was put in the cell that did not allow for cell division to occur?

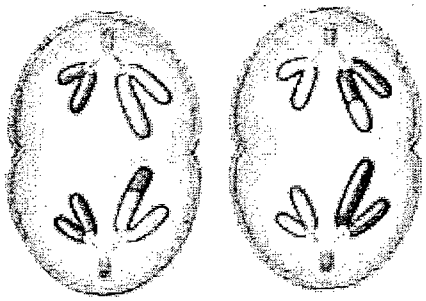
Name: _____

Phases of Meiosis

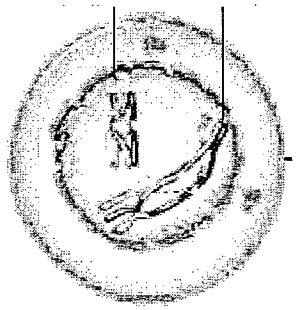
Name of Phase	Description
1. PROPHASE I	Homologous chromosomes pair up and form tetrad
2. ANAPHASE I	Spindle fibers move homologous chromosomes to opposite sides
3. TELOPHASE II	Nuclear membrane reforms, cytoplasm divides, 4 daughter cells formed
4. METAPHASE II	Chromosomes line up along equator, not in homologous pairs
5. PROPHASE I	Crossing-over occurs
6. ANAPHASE II	Chromatids separate
7. METAPHASE I	Homologs line up alone equator
8. TELOPHASE I	Cytoplasm divides, 2 daughter cells are formed



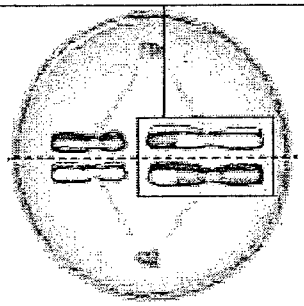
1. ANAPHASE I



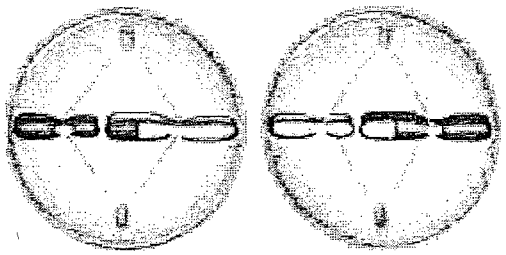
2. ANAPHASE II



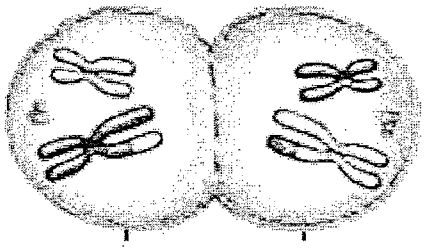
3. PROPHASE I



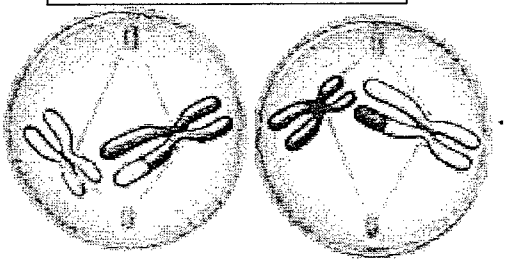
4. METAPHASE I



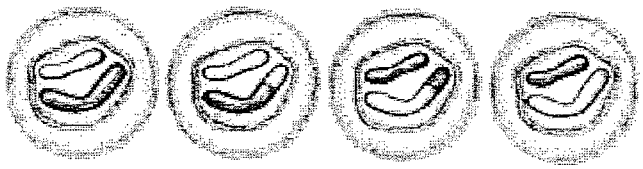
5. METAPHASE II



6. TELOPHASE I



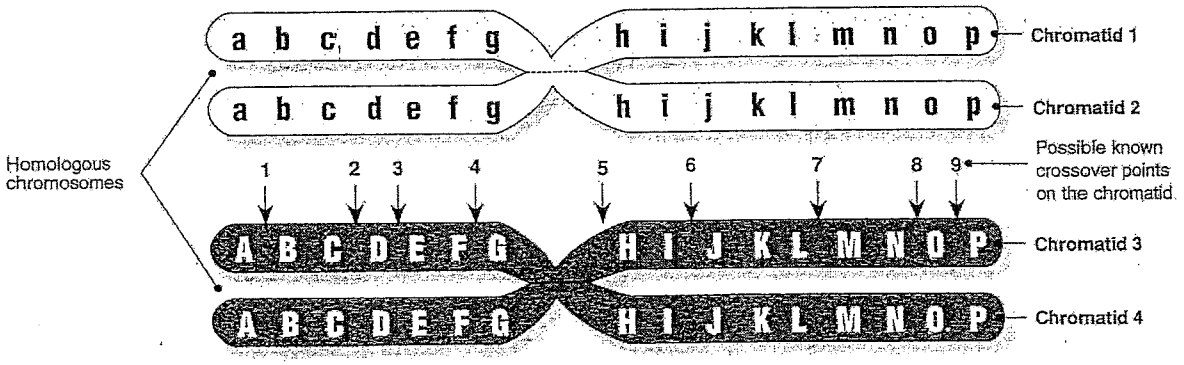
7. PROPHASE II



8. TELOPHASE II

Crossing Over Problems

The diagram below shows a pair of homologous chromosomes about to undergo chiasma formation during the first cell division in the process of meiosis. There are known crossover points along the length of the chromatids (same on all four chromatids shown in the diagram). In the prepared spaces below, draw the gene sequences after crossing over has occurred on three unrelated and separate occasions (it would be useful to use different colored pens to represent the genes from the two different chromosomes). See the diagrams on the previous page as a guide.

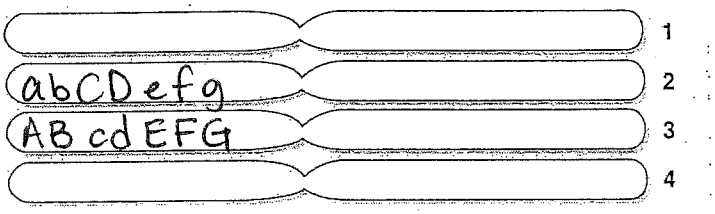


1. Crossing over occurs at a **single** point between the chromosomes above.

   (a) Draw the gene sequences for the four chromatids (on the right), after crossing over has occurred at crossover point: **2**

   (b) List which genes have been exchanged with those on its homologue (neighbor chromosome):

   C and D

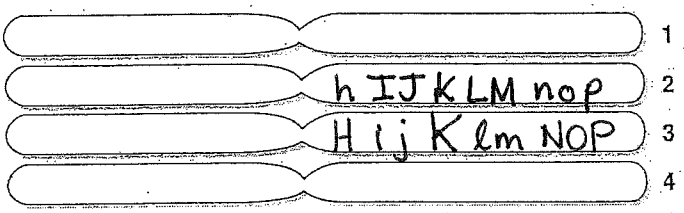


2. Crossing over occurs at **two** points between the chromosomes above.

   (a) Draw the gene sequences for the four chromatids (on the right), after crossing over has occurred between crossover points: **6** and **7**

   (b) List which genes have been exchanged with those on its homologue (neighbor chromosome):

   I and J K and M

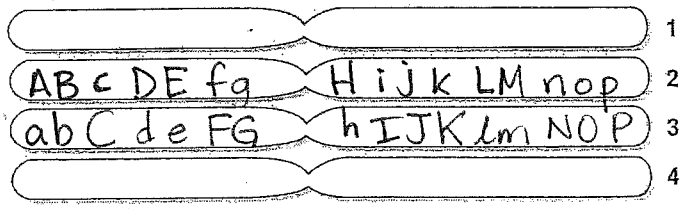


3. Crossing over occurs at **four** points between the chromosomes above.

   (a) Draw the gene sequences for the four chromatids (on the right), after crossing over has occurred between crossover points: **1** and **3**, and **5** and **7**.

   (b) List which genes have been exchanged with those on its homologue (neighbor chromosome):

   A and B, D and E, H & L and M



4. Explain the genetic significance of **crossing over**: alleles switch, so there may be an expression of a different phenotype. Allows for genetic variation.

Crossing over refers to the mutual exchange of pieces of chromosome and involves the swapping of whole groups of genes between the **homologous** chromosomes. This process can occur only during the first division of **meiosis**. Errors in crossing over can result in **block mutations** (see activity *Chromosome Mutations*), which can be very damaging to development. Crossing over can upset expected frequencies of offspring in dihybrid crosses. The frequency of crossing over (COV) for different genes (as followed by inherited, observable traits) can be used to determine the relative positions of genes on a chromosome and provide a genetic map. There has been a recent suggestion that crossing over may be necessary to ensure accurate cell division.

Pairing of Homologous Chromosomes

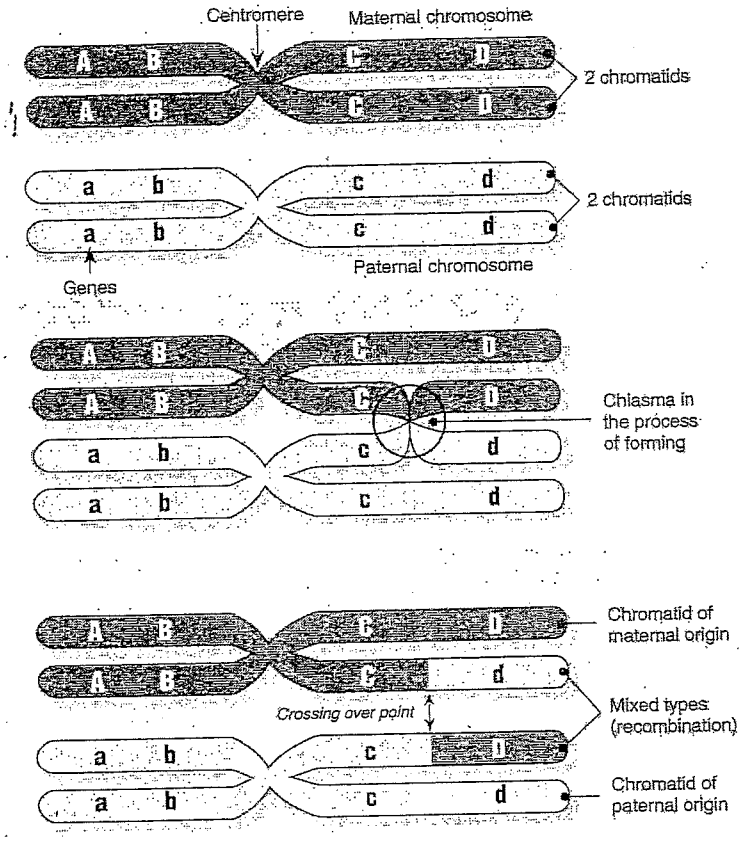
Every somatic cell has a pair of each type of chromosome in its nucleus. These chromosome pairs, one from each parent, are called **homologous** pairs or **homologues**. In prophase of the first division of **meiosis**, the homologues pair up to form **bivalents** in a process called **synapsis**. This allows the chromatids of the homologous chromosomes to come in very close contact.

Chiasma Formation and Crossing Over

The pairing of the homologues allows **chiasmata** to form between the chromatids of homologous chromosomes. These are places where the chromatids become criss-crossed and the chromosomes exchange segments. In the diagram, the chiasma are in the process of forming and the exchange of pieces of chromosome have not yet taken place. Every point where the chromatids have crossed is a **chiasma**.

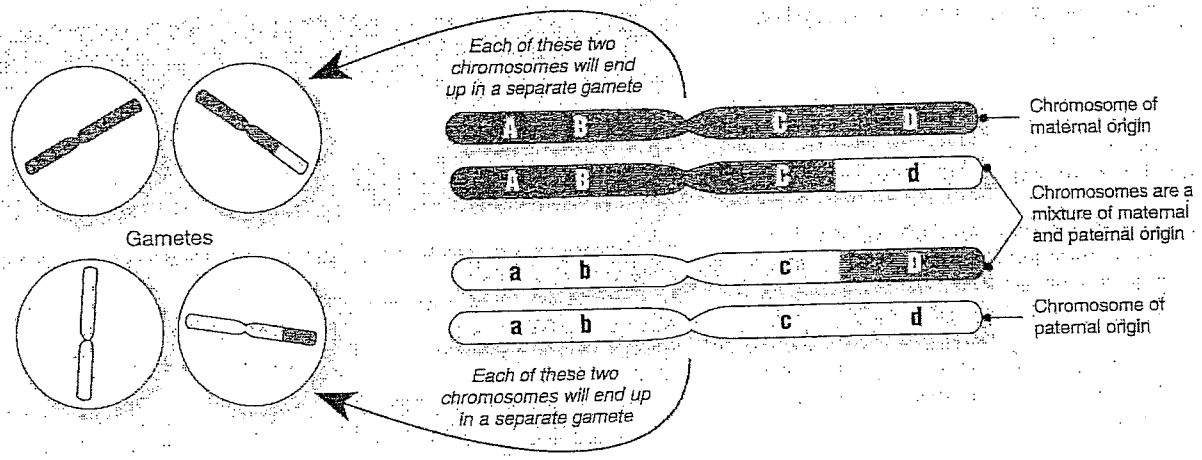
Separation

New combinations of genes arise from crossing over, resulting in what is called **recombination**. When the homologues separate at anaphase of meiosis I, each of the chromosomes pictured will have new genetic material (mixed types) that will be passed into the gametes soon to be formed. This process of recombination is an important source of variation for the gene pool of a population.



Gamete Formation

Once the final division of meiosis is complete, the two chromatids that made up each replicated chromosome become separated and are now referred to as chromosomes. Because chromatid segments were exchanged, four chromosomes that are quite different (genetically) are produced. If no crossing over had occurred, there would have been only two types (two copies of each). Each of these chromsomes will end up in a different gamete (sperm or egg).



1. Briefly explain how the process of crossing over is going to alter the genotype of gametes: when the chromatids split there may be a different allele.

2. Describe the importance of crossing over in the process of evolution: mutations may have been blocked & an increase in genetic variation

Meiosis Quiz
Answer Section

MULTIPLE CHOICE

1. ANS: D PTS: 1 DIF: Average OBJ: Section 5.1
   LOC: LS-R-01 TOP: The Cell Cycle and Mitosis KEY: mitosis
2. ANS: C PTS: 1 DIF: Average OBJ: Section 5.1
   LOC: LS-R-01 TOP: The Cell Cycle and Mitosis KEY: mitosis
3. ANS: A PTS: 1 DIF: Average OBJ: Section 5.1
   LOC: LS-R-01 TOP: The Cell Cycle and Mitosis KEY: mitosis
4. ANS: D PTS: 1 DIF: Average OBJ: Section 5.1
   LOC: LS-R-01 TOP: The Cell Cycle and Mitosis KEY: mitosis
5. ANS: B PTS: 1 DIF: Easy OBJ: Section 5.1
   LOC: LS-R-01 TOP: The Cell Cycle and Mitosis KEY: growth | interphase
6. ANS: C PTS: 1 DIF: Easy OBJ: Section 6.1
   LOC: LS-R-01 TOP: Meiosis KEY: inherit | genes
7. ANS: A PTS: 1 DIF: Average OBJ: Section 6.1
   LOC: LS-R-01 TOP: Meiosis KEY: replication | mitosis
8. ANS: C PTS: 1 DIF: Average OBJ: Section 6.1
   LOC: LS-R-01 TOP: Meiosis KEY: meiosis
9. ANS: B PTS: 1 DIF: Easy OBJ: Section 6.1
   LOC: LS-R-01 TOP: Meiosis KEY: chromosomes
10. ANS: A PTS: 1 DIF: Easy OBJ: Section 6.1
    LOC: LS-R-01 TOP: Meiosis KEY: gametes | meiosis
11. ANS: C PTS: 1 DIF: Easy OBJ: Section 6.1
    LOC: LS-R-01 TOP: Meiosis KEY: chromosomes | sperm
12. ANS: D PTS: 1 DIF: Average OBJ: Section 6.2
    LOC: LS-R-03 TOP: Sexual Reproduction
    KEY: sexual reproduction | gamete | chromosome
13. ANS: B PTS: 1 DIF: Easy OBJ: Section 6.1
    LOC: LS-R-01 TOP: Meiosis KEY: gamete | sperm
14. ANS: A PTS: 1 DIF: Average OBJ: Section 6.1
    LOC: LS-R-01 TOP: Meiosis KEY: meiosis | chromosomes
15. ANS: C PTS: 1 DIF: Easy OBJ: Section 6.1
    LOC: LS-R-01 TOP: Meiosis KEY: meiosis | sperm | egg
16. ANS: D PTS: 1 DIF: Difficult OBJ: Section 6.1
    LOC: LS-R-01 TOP: Meiosis KEY: meiosis | chromosomes
17. ANS: C PTS: 1 DIF: Difficult OBJ: Section 6.1
    LOC: LS-R-01 TOP: Meiosis KEY: meiosis | chromosomes
18. ANS: D PTS: 1 DIF: Easy OBJ: Section 6.1
    LOC: LS-R-01 TOP: Meiosis KEY: mitosis
19. ANS: C PTS: 1 DIF: Average OBJ: Section 6.1
    LOC: LS-R-01 TOP: Meiosis KEY: mitosis
20. ANS: B PTS: 1 DIF: Average OBJ: Section 6.1
    LOC: LS-R-01 TOP: Meiosis KEY: meiosis | cross over

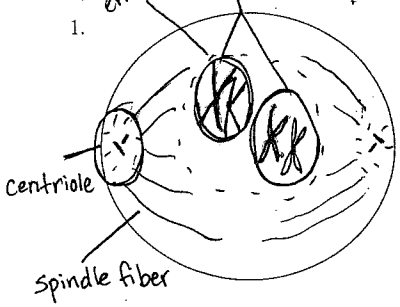
21. ANS: B PTS: 1 DIF: Average OBJ: Section 6.1
LOC: LS-R-01 TOP: Meiosis KEY: meiosis | diploid | chromosomes
22. ANS: D PTS: 1 DIF: Average OBJ: Section 6.1
LOC: LS-R-01 TOP: Meiosis KEY: meiosis | haploid | chromosomes
23. ANS: B PTS: 1 DIF: Easy OBJ: Section 6.1
LOC: LS-R-01 TOP: Meiosis KEY: egg | sperm | fertilization
24. ANS: A PTS: 1 DIF: Average OBJ: Section 6.1
LOC: LS-R-01 TOP: Meiosis KEY: fertilization | chromosomes | homologous

MATCHING

25. ANS: L PTS: 1 DIF: Easy OBJ: Section 6.1
LOC: LS-R-01 TOP: Meiosis KEY: telophase II
26. ANS: C PTS: 1 DIF: Easy OBJ: Section 6.1
LOC: LS-R-01 TOP: Meiosis KEY: cytokinesis
27. ANS: B PTS: 1 DIF: Average OBJ: Section 6.1
LOC: LS-R-01 TOP: Meiosis KEY: anaphase II
28. ANS: G PTS: 1 DIF: Difficult OBJ: Section 6.1
LOC: LS-R-01 TOP: Meiosis KEY: metaphase II
29. ANS: I PTS: 1 DIF: Difficult OBJ: Section 6.1
LOC: LS-R-01 TOP: Meiosis KEY: prophase I
30. ANS: F PTS: 1 DIF: Average OBJ: Section 6.1
LOC: LS-R-01 TOP: Meiosis KEY: metaphase I

MEIOTIC STAGES and Their EVENTS

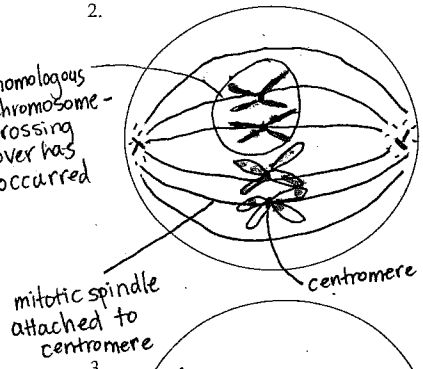
1.



STAGE: PROPHASE I

Events: Chromosomes condense
spindle fibers form (mitotic spindle)
centrioles move to opposite poles
nuclear envelope disappears
homologous chromosomes line up → CROSSING OVER

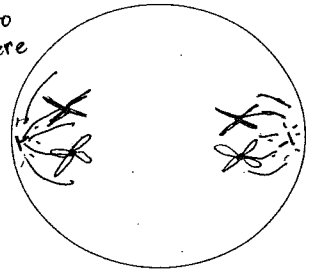
2.



STAGE: METAPHASE I

Events: paired homologous chromosomes move to the equator of the cell, spindle fibers attach to centromere, there will be areas on the chromatids where crossing over occurred.

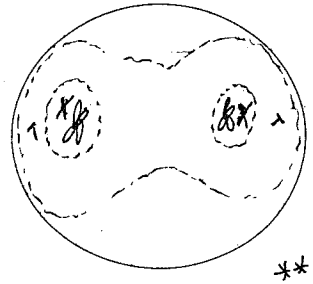
3.



STAGE: ANAPHASE I

Events: homologous chromosomes pull away from each other, sister chromatids are still attached, each side of the cell has 2 chromosomes instead of 4.

4.



STAGE: TELOPHASE I

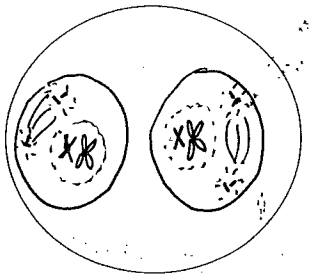
Events: spindle fibers disappear, nuclear envelope briefly reappears, cell pinches into 2 cells, cytokinesis occurs

** 1 cell (diploid) → 2 cells (haploid) **

INTERPHASE in between phases of MEIOSIS

MEIOSIS II : 2 cells (haploid) → 4 cells (haploid)

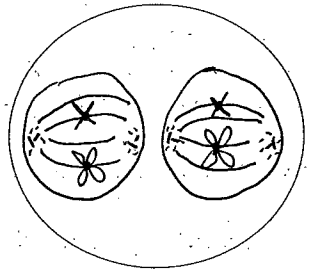
5.



STAGE: PROPHASE II

Events: Similar to mitosis - nuclear envelope disappears, spindle fibers form, ~~centrioles~~ centrioles move, chromosomes condense

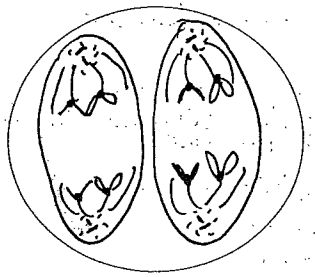
6.



STAGE: METAPHASE II

Events: non-homologous chromosomes move to the middle of the cell, spindle fibers attach to the centromere.

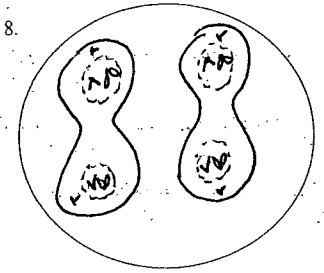
7.



STAGE: ANAPHASE II

Events: spindle fibers pull sister chromatids apart and move them to opposite poles of the cell.

8.



STAGE: TELOPHASE II

Events: Chromosomes at each pole decondense (chromatin), nuclear envelope reforms, cell membrane pinches in so you have 4 new cells.