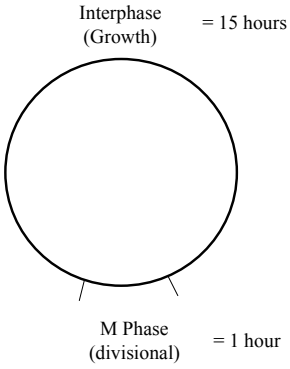
The Cell Cycle

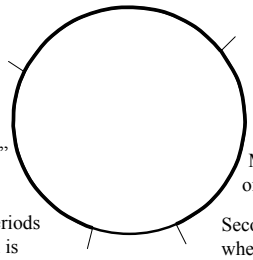


The Cell Cycle:

Interphase

S = 7 hours

"Synthesis" Phase when DNA is synthesized and each Chromosome is copied to completion.



G1 = 5 hours

Means "Gap 1" or "First Gap"

First of two periods when no DNA is synthesized.

G2 = 3 hours

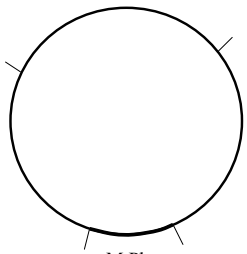
Means "Gap 2" or "Second Gap"

Second period when no DNA is synthesized.

The Cell Cycle:

M-Phase

S = 7 hours



G1 = 5 hours

G2 = 3 hours

M Phase
(divisional)

Mitosis

Formation of two identical daughter cells from single mother cell

Division of each Sister Chromatid pair between each of two daughter cells

Mitosis occurs most often in diploid cells, but can occur in haploid cells

Phases of Mitosis

Interphase S - replication of chromosomes creating sister chromatids

Prophase - chromosomes condense; centrioles migrate to opposite poles of cell; nuclear envelope and nucleolus disintegrate.

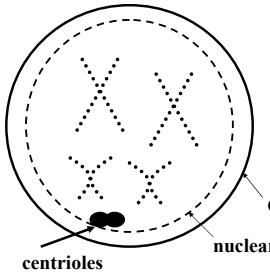
Metaphase - spindle fibers of tubulin attach to kinetochore; chromosomes migrate away from poles toward central plane of cell (metaphase plate).

Anaphase - centromeres split, separating sister chromatids, which are now daughter chromosomes; movement of daughter chromosomes to opposite poles of cell.

Telophase - end of chromosome movement; formation of new nuclear envelope and nucleolus associated with daughter nuclei.

Cytokinesis - division of cell cytoplasm and organelles between two daughter cells; cell furrow in animals, middle lamela and new cell plate at metaphase plate of plants.

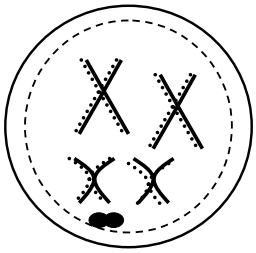
Interphase S



Assume that RED chromosomes are maternal in origin, and that BLUE chromosomes are paternal in origin.

replication of chromosomes creating sister chromatids

Prophase

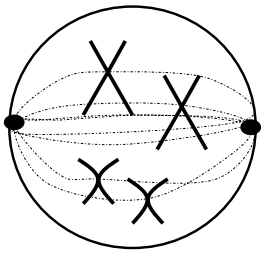


Chromosomes condense

Centrioles migrate to poles

Nuclear envelope and nucleolus disintegrate

Metaphase

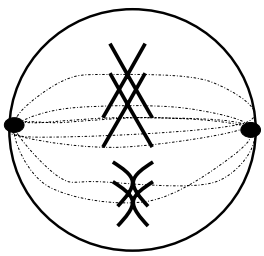


Spindle fibers attach

Chromosomes migrate in to metaphase plate.

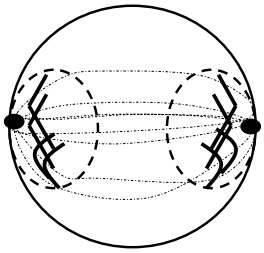
Chromosomes (centromeres) align on metaphase plate.

Anaphase



centromeres split, separating sister chromatids, movement of daughter chromosomes to opposite poles of cell.

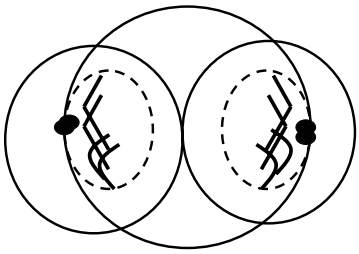
Telophase



spindle fibers disintegrate

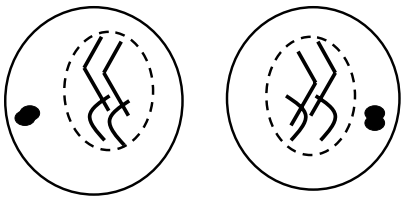
nuclear envelope develops around each daughter nucleus

Cytokinesis



cell cytoplasm and contents separate into two daughter cells

Result of Mitosis



Mitosis results in two cells each containing the full diploid number of chromosomes.

Each daughter cell is identical to the other and to the original mother cell

Meiosis

Formation of Gametes

Reduction of Chromosome Number to Haploid Number

Reduction of Chromosome Homologs to One per Cell

Meiosis

Meiosis begins after chromosomes have duplicated (i.e. after chromosome number has doubled)

Meiosis goal is cells with half of the original chromosome number

Each cell division will half chromosome number, so cell must go through two divisions.

Meiosis I: reduction of centromeres and homologous chromosomes to half

- Prophase I
- Metaphase I
- Anaphase I
- Telophase I
- Cytokinesis

Meiosis II: reduction of chromosome material to half

- Prophase II
- Metaphase II
- Anaphase II
- Telophase II
- Cytokinesis

Meiosis I:

Prophase I: most complex stage of Meiosis involving:

- chromosome condensation
- homology search
- movement to metaphase plate
- crossing over

Leptonema:

Zygonema:

Pachynema:

Diplonema:

Diakinesis:

Prophase I:

Leptonema: condensation of chromatin begins
homology search begins

Zygonema: condensation continues (bivalents initially visible)
rough pairing of homologs
lateral elements appear between homologs

Pachynema: bivalents form tetrad – **synapsis** occurs
crossing-over is accomplished

Diplonema: chiasmata of crossing-over events visible
non-sister chromatids begin to separate

Diakinesis: terminalization of chiasmata
final alignment of homologous centromeres
nuclear envelope and nucleolus disappear
spindle fibers attach to centromeres

Metaphase I

Endpoint of Prophase I where alignment on equatorial (metaphase) plate has been achieved; spindle fibers attached to centromeres; future movement of homologs will be to poles of mother cell.

Anaphase I

movement of non-sister chromatids to opposite poles

centromeres still intact

tetrads each become two dyads

ends with dyad sets at each pole equal to half diploid number

Telophase I / Cytokinesis

division of mother cell into two independently active daughter cells

daughter cells: unlike chromosome content and half of original chromosome number

but still twice the chromosome material necessary

Meiosis II:

Prophase II: movement of sister chromatids to new equatorial plane

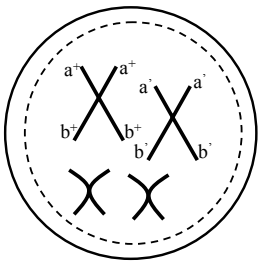
Metaphase II: final alignment of sister chromatids (or centromeres) along metaphase plate

Anaphase II: splitting of centromeres: sister chromatids become daughter chromosomes

movement of daughter chromosomes to poles

Telophase II: division of Meiosis I daughter cells into two Meiosis II daughter cells with half the type and number of chromosomes of original, Mother cell.

Assume that RED chromosomes are maternal in origin and that BLUE chromosomes are paternal in origin.

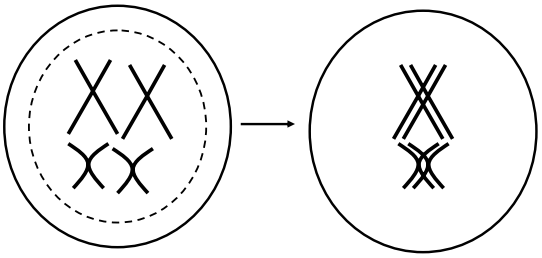


if we wanted, we could track alleles through independent assortment by designating alleles on each chromosome arm.

(but I don't want to)

Prophase I condensation

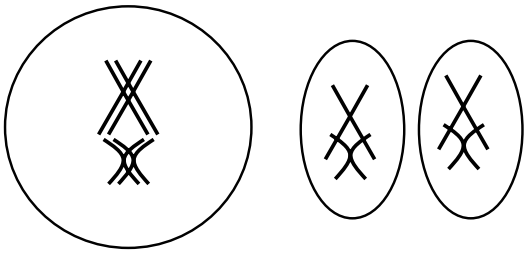
Metaphase I alignment



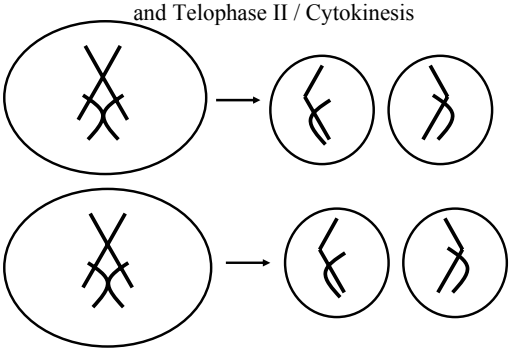
Spindle fibers and centrioles ***NOT*** illustrated

Metaphase I alignment

Result after Telophase I

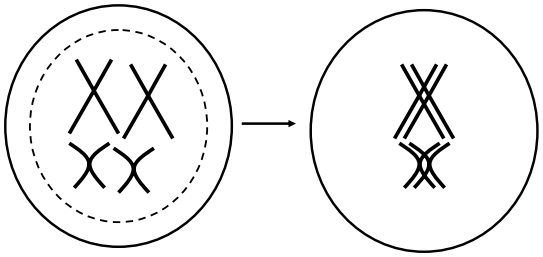


Meiosis II: Results of Anaphase II
and Telophase II / Cytokinesis



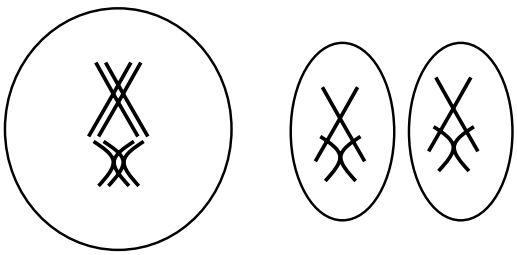
Prophase I condensation

Metaphase I alignment (alternative)

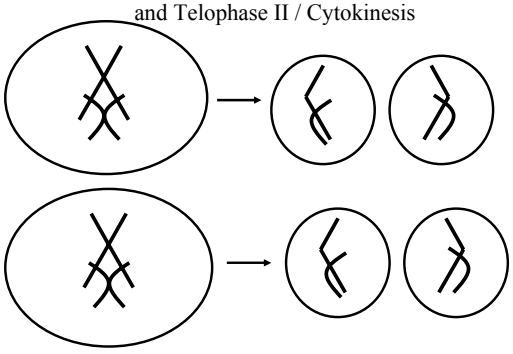


Metaphase I alignment

Result after Telophase I



Meiosis II: Results of Anaphase II and Telophase II / Cytokinesis



Linkage and Crossing-Over

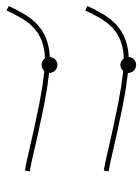
Basic Terms:

Tetrad

Linkage and Crossing-Over

Basic Terms:

Sister Chromatids



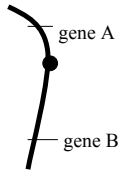
Non-Sister Chromatids

Linkage and Crossing-Over

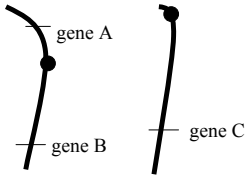
Basic Terms:

Genes on the *same* chromosome are "**linked**"

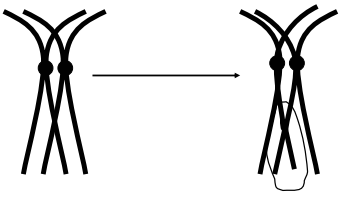
Genes on the *different* chromosomes are "**unlinked**"



'A' and 'B'



'A' and 'C'



Crossing-Over