Chromosomes & Cell Division

BIO 105
Chapter 19

Organization of the cell’s genetic material

Chromatin vs. chromosomes
Human karyotype

Vocabulary
- **Diploid** – cell containing 2 of each kind of chromosome
- **Haploid** – cell with one of each kind of chromosome
- **Sex chromosomes** – X, Y
- **Autosomes** – other 22 pairs of chromosomes

The Cell Cycle

**Interphase**

- **G1**
  - Cell growth
  - RNA & protein synthesis
Interphase

G1
- Cell growth
- RNA & protein synthesis

S
- Chromosomes are duplicated
- Sister chromatids attached by centromeres

G2
- Centrioles divide
- Protein synthesis

One chromosome (unduplicated as in G1)

Replication (S phase)

One chromosome (duplicated as in G2)

Centromere

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Mitosis

1. Prophase
2. Metaphase
3. Anaphase
4. Telophase

Prophase
1. Chromatin condenses
2. Nuclear envelope degenerates
3. Nucleolus disappears
4. Centrioles migrate
5. Mitotic spindle begins forming

Metaphase
1. Chromosomes attach to spindle fibers
2. 46 chromosomes line up along metaphase plate
**Anaphase**
1. Spindle fibers shorten and the centromeres break
2. Chromosomes move to opposite poles

**Telophase**
1. Spindle fibers disassemble
2. Chromosomes uncoil
3. Nuclear membrane reforms

**Cytokinesis**
A ring of microfilaments contracts and constricts the cell at the midline.
Microfilaments continue to contract until the ring pinches the cell into two daughter cells.
Each daughter cell has two copies of each chromosome.

**Review**
How many daughter cells are produced?
Are these cells considered diploid or haploid?
Are the daughter cells the same or different from the parent cell?
In what kinds of cells does mitosis take place?
Meiosis

1. Keeps chromosome number constant from generation to generation.
2. Increases genetic variability in the population.

Meiosis
A series of two cell divisions in which 4 daughter cells are produced that have half the genetic material of the parent.

preceded by Interphase.
Prophase I

- Duplicated chromosomes condense and intertwine which produces genetic variation
- **Crossing over:** genetic material is exchanged between the homologous chromosomes

Metaphase I

- Homologous chromosomes line up side by side across the metaphase plate
- Independent assortment occurs (promotes genetic diversity)
Anaphase I

- Homologous chromosomes migrate to opposite poles
- This is different from Mitosis

Telophase I & Cytokinesis

- The cell divides into two cells, each containing 23 duplicated chromosomes
- Following a brief Interphase (interkinesis), Meiosis II begins
Review

How many daughter cells are produced?

Are these cells considered diploid or haploid?

Are the daughter cells the same or different from the parent cell?

In what kinds of cells does meiosis take place?

Gametes

The gametes contain 23 chromosomes (not in the duplicated form)

- 22 are autosomes, 1 is a sex chromosome

- Oocytes will contain 22 autosomes and an X chromosome

- Sperm cells will contain 22 autosomes and either an X or a Y chromosome
Nondisjunction

The failure of homologous chromosomes to separate during Meiosis I or of sister chromatids to separate during Meiosis II is called **nondisjunction**.

Down Syndrome

- Growth failure
- Hypotonia
- Flat back of head
- Abnormal ears
- Many organs on right side
- Small palate
- Special angle of hair
- Undescended testicles or ovaries
- Vascular anomalies
- Abnormal pancreas
- Cornstalk muscle tone

Photos show individuals with Down Syndrome.
Turner Syndrome
Turner Syndrome

- Short stature
- Low hairline
- Shield-shaped thorax
- Widely spaced nipples
- Shorter forearm length
- Small finger nails
- Brown spots (pubic hair)
- Characteristic facial features
- Poor heart development
- Thicker neck
- High arched palate
- No menstruation

Klinefelter Syndrome

- Breast development
- Poor beard growth
- Narrow shoulders
- Small testicular size
- Long arms and legs
- Wide hips
- Female-type pubic hair pattern
- Tendency to grow fewer chest hairs
- Poor arm development