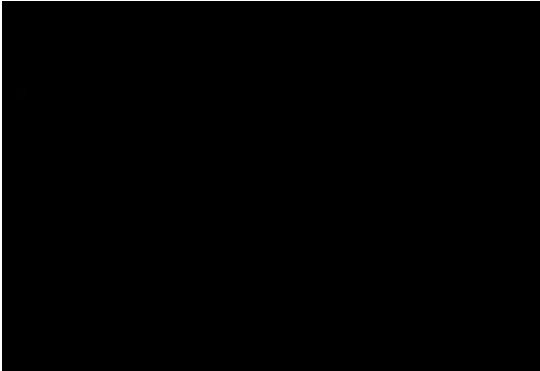


Cell Growth and Division

SC.912.L.14.3, SC.912.L.15.15, SC.912.L.16.4, SC.912.L.16.14, SC.912.L.16.16, SC.912.L.16.17, SC.912.L.16.8

Pre-AICE Biology & Biology Honors
Mrs. King

Mitosis & Meiosis



23 minutes

The need to grow!



Regulating the Cell Cycle

- A. Controls on Cell Division
- B. Cell Cycle Regulators
 1. Internal Regulators
 2. External Regulators
- C. Uncontrolled Cell Growth

Limitations to Cell Growth

- DNA Overload
 - must be enough DNA material in the nucleus
 - Larger the cell = information crisis
- Materials must be able to pass through the cytoplasm quickly
 - Speed is determined by size of cell
 - Rate at which food and oxygen are used is determined by volume
- Volume increases faster than surface area as cell's size increases
 - Cell's DNA no longer able to serve the increasing needs of the growing cell

Ratio of Surface Area to Volume in Cells

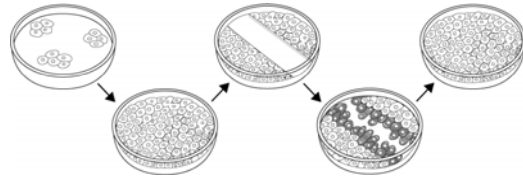
Cell Size	1 cm 1 cm 1 cm	2 cm 2 cm 2 cm	3 cm 3 cm 3 cm
Surface Area (length x width x 6)	1 cm x 1 cm x 6 = 6 cm ²	2 cm x 2 cm x 6 = 24 cm ²	3 cm x 3 cm x 6 = 54 cm ²
Volume (length x width x height)	1 cm x 1 cm x 1 cm = 1 cm ³	2 cm x 2 cm x 2 cm = 8 cm ³	3 cm x 3 cm x 3 cm = 27 cm ³
Ratio of Surface Area to Volume	6 / 1 = 6 : 1	24 / 8 = 3 : 1	54 / 27 = 2 : 1

- Surface area and volume do not increase at the same rate
- Larger cells have difficulty exchanging oxygen and waste in and out of the cell
- Before cell becomes too large it undergoes cellular division and forms 2 daughter cells

Cell Growth Rate

- Bacteria
 - E. Coli doubles every 30 minutes
- Heart & nervous system cells rarely divide, if at all
- Skin cells and digestive tract cells divide throughout life
 - Some every 6 hours
 - Grow to a certain size and stop
 - Controls are turned on and off
 - During injury, cells are stimulated and rapidly divide and grow – produces new cells, i.e. healing
 - After healing, cell growth slows and returns to normal
- Uncontrolled cell growth results in cancer
 - **Oncogene**

Control of Cell Division



Cells anchor to dish surface and divide (anchorage dependence).

When cells have formed a complete single layer, they stop dividing (density-dependent inhibition).

If some cells are scraped away, the remaining cells divide to fill the gap and then stop (density-dependent inhibition).

(a) Normal mammalian cells

(b) Cancer cells

Cancer cells do not exhibit anchorage dependence or density-dependent inhibition.

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- Cells constantly divide
- Dead cells replaced by new cells
- Cancer
 - mistake in cell cycle
 - cancerous cells form tumors (masses of tissue)
 - tumors deprive normal cells of nutrients

Causes of Cancer

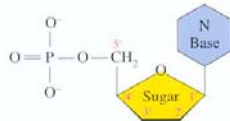
- Genetic
 - mutations
- Environmental
 - cigarette smoke
 - air and water pollution
 - UV radiation from the sun
 - viral infections
- A **carcinogen** is any substance that can induce or promote cancer
 - Most carcinogens are *mutagens*, substances that cause mutations

[Angiogenesis](#) video clip

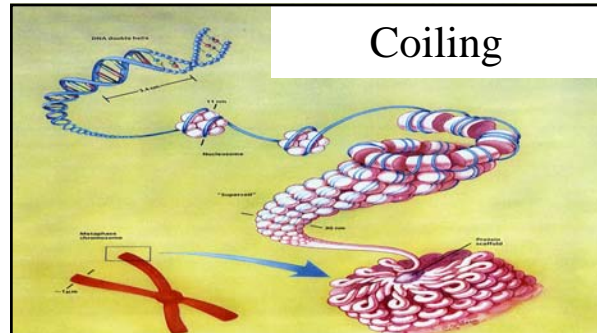
DNA

Made of nucleotides

- Phosphate
- Sugar
 - Deoxyribose
- Nitrogen base
 - Adenine
 - Guanine
 - Cytosine
 - thymine



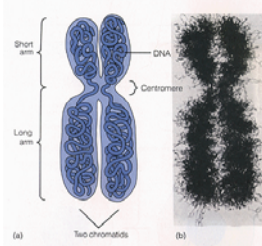
Coiling



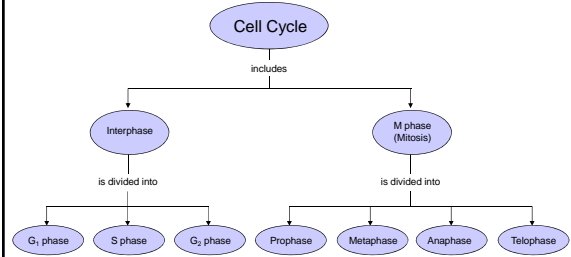
- Uncoiled DNA called chromatin- between cell divisions
- Happens during cell division
- DNA wraps tightly around proteins called histones

Chromosomes

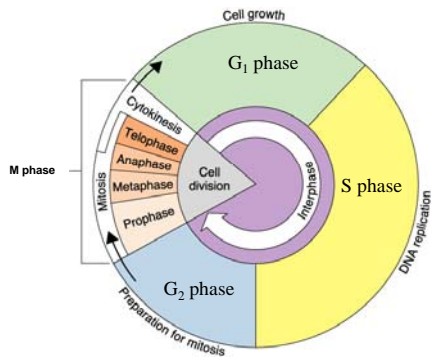
- **Chromosome**
 - two identical halves connected together by a centromere
- **Chromatid**
 - half of one chromosome
 - Contains one complete set of information
 - Copies itself to make the other chromatid



Concept Map



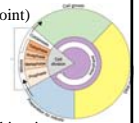
Cell Cycle Control System



Quality Control

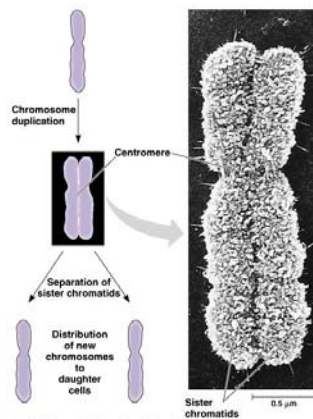
The cell has several systems for interrupting the cell cycle if something goes wrong

- Check point at end of S phase
 - Monitor for presence of Okazaki fragments on lagging strand during replication
 - Cell is not permitted to proceed in the cell cycle until fragments are gone
- DNA Damage checkpoints
 - Sense DNA damage before cell enters S phase (G₁ checkpoint)
 - During S phase
 - After DNA replication at G₂ checkpoint
- Spindle Checkpoints
 - Detect any failure of spindle fibers
 - Detect improper alignment of spindle itself and block cytokinesis
 - Trigger apoptosis if damage is irreparable

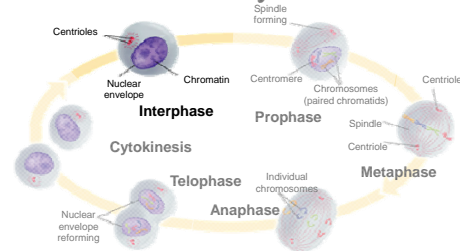


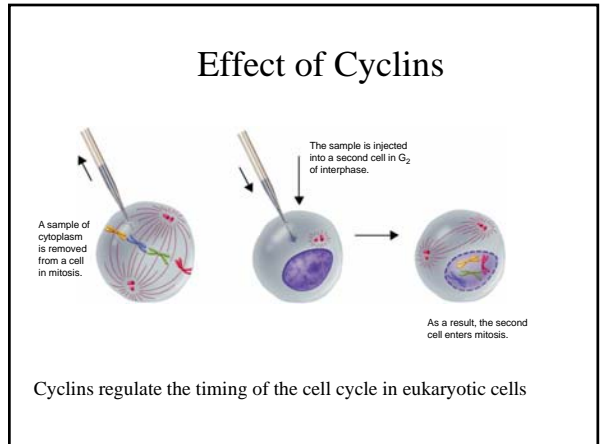
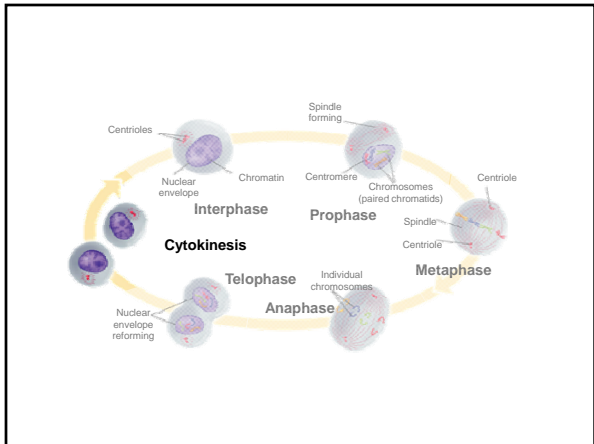
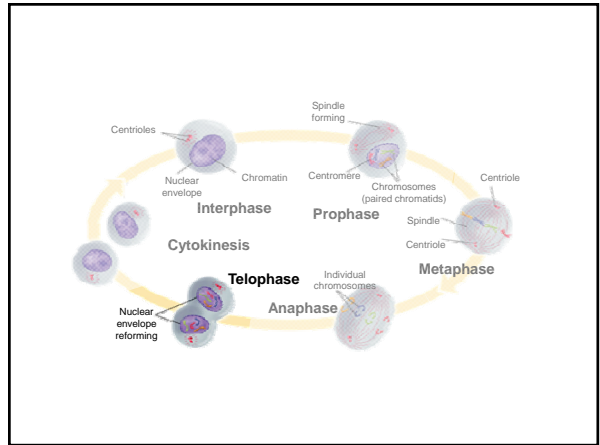
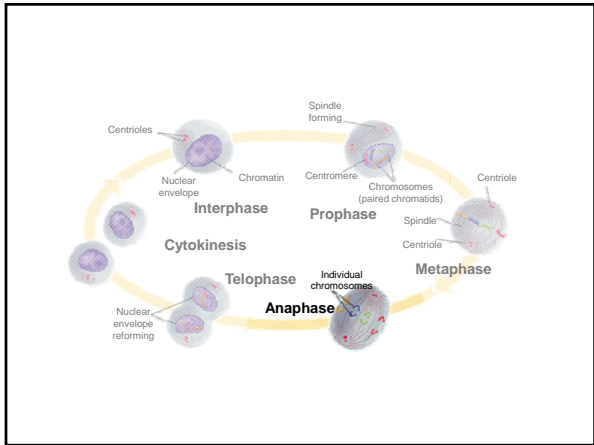
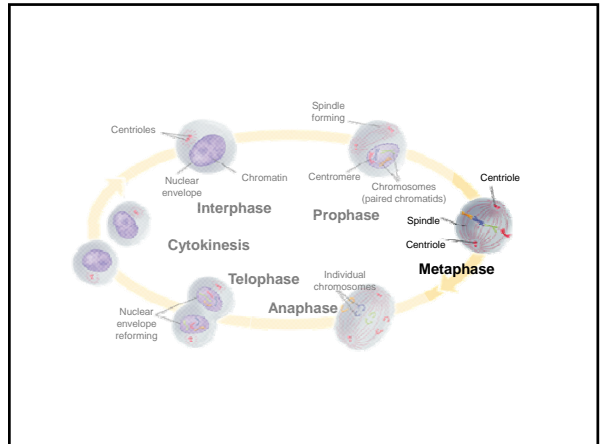
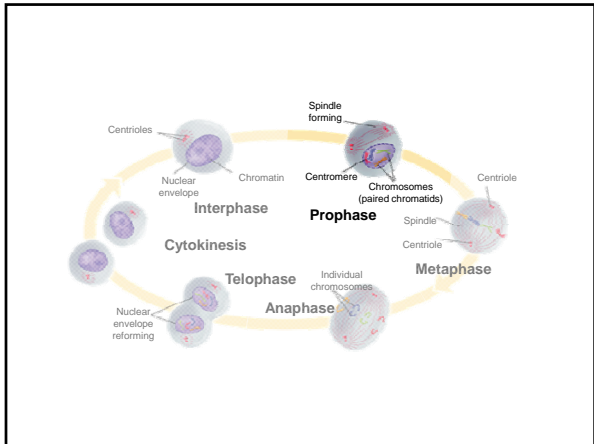
Chromosome duplication and distribution during mitosis

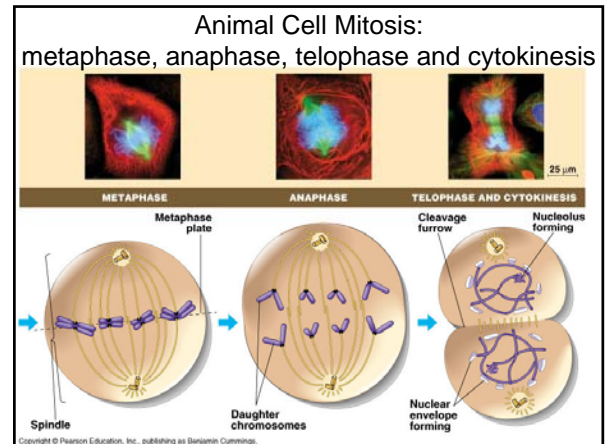
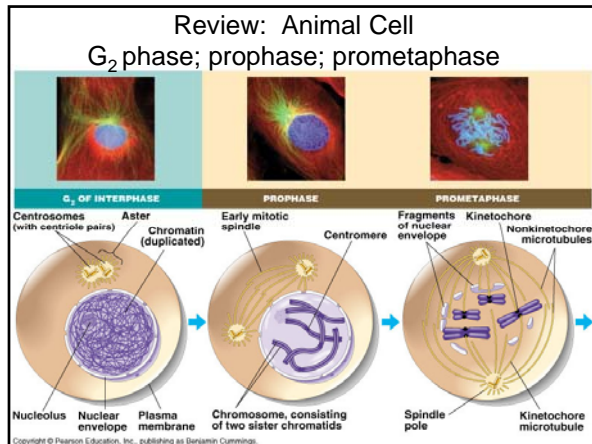
[Video Clip](#)



Animal Cell Mitosis and Cytokinesis







Mitosis

Plant Cell

Plant Interphase

Cell prepares for division by:

- replicating DNA and organelles
- increasing cell size

Plant Prophase

Cell prepares for nuclear division by:

- condensing DNA into movable packages called **chromosomes**

Plant Metaphase

Cell prepares chromosomes for division by:

- aligning chromosomes at cell equator
- attaching spindle fibers from each new daughter cell pole to each chromosome at the centromere

Plant Anaphase

Chromosomes divide:



- spindle fibers pull chromosomes apart
- one-half of each chromosome (chromatid) moves to a new daughter cell

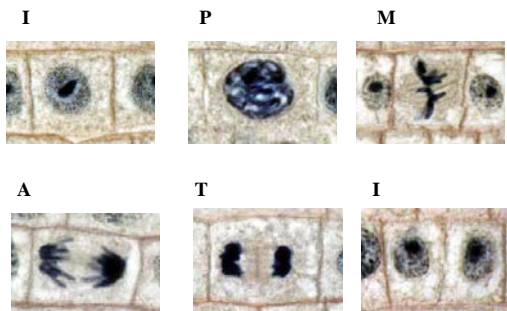
Plant Telophase

Cytoplasm divides:

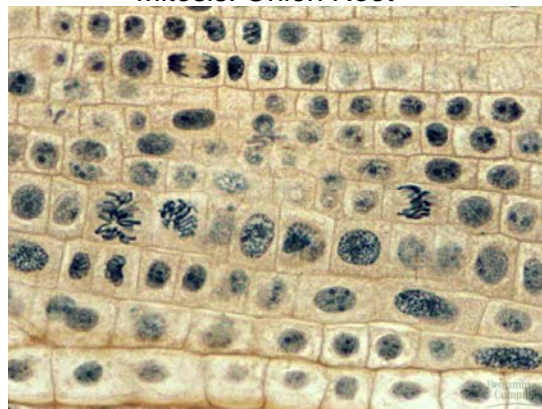
- DNA decondenses and two nuclei form
- new cell wall (cell plate) appears between the two nuclei to form two new daughter cells



Plant Mitosis -- Review



Mitosis: Onion Root



Meiosis

- Chromosome Number
- Phases of Meiosis
 - Meiosis I
 - Meiosis II
- Gamete Formation
- Comparing Mitosis and Meiosis

Meiosis

All cell division is *not* the same

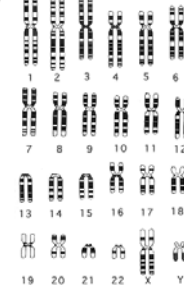
- Cells can divide by **mitosis**
 - each daughter cell retains a full set of chromosomes
- or by **meiosis**
 - Halves chromosomes and produces **sperm and eggs**
 - Reduction & division
 - Producing offspring (baby) with the correct number of chromosomes is crucially dependent on meiosis

Chromosome Number

- *Homo sapiens* (human) 46
- *Mus musculus* (house mouse) 40
- *Zea mays* (corn or maize) 20
- *Drosophila melanogaster* (fruit fly) 8
- *Xenopus laevis* (South African clawed frog) 36
- *Caenorhabditis elegans* (microscopic roundworm) 12
- *Equisetum arvense* (field horsetail, a plant) 216
- *Saccharomyces cerevisiae* (budding yeast) 32
- *Canis familiaris* (domestic dog) 78
- *Arabidopsis thaliana* (plant in the mustard family) 10
- *Myrmecia pilosula* (an ant) 2
- *Parascaris equorum* (parasitic roundworm) 2
- *Cambarus clarkii* (a crayfish) 200

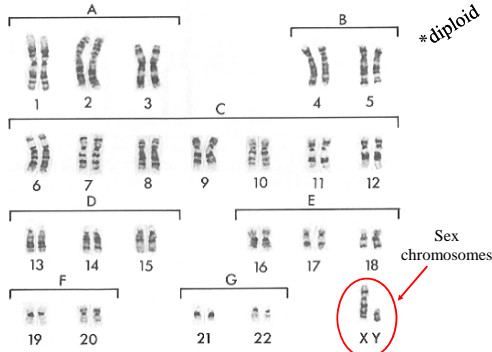
Human Karyotype (haploid)

- The karyotype of a normal human **female** contains 23 pairs of homologous chromosomes:
 - 22 pairs of autosomes
 - 1 pair of X chromosomes
- The karyotype of a normal human **male** contains:
 - the same 22 pairs of autosomes
 - one X chromosome
 - one Y chromosome

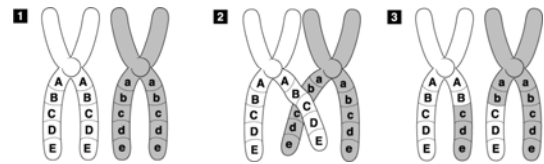


Human Karyotype

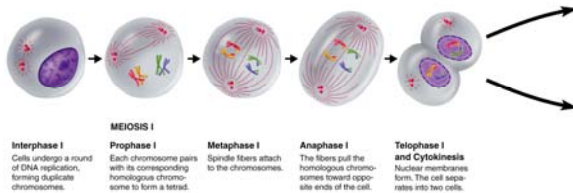
22 pairs of autosomes and 1 pair of sex chromosomes



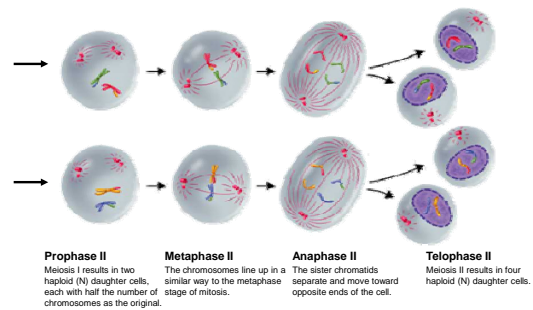
Crossing Over

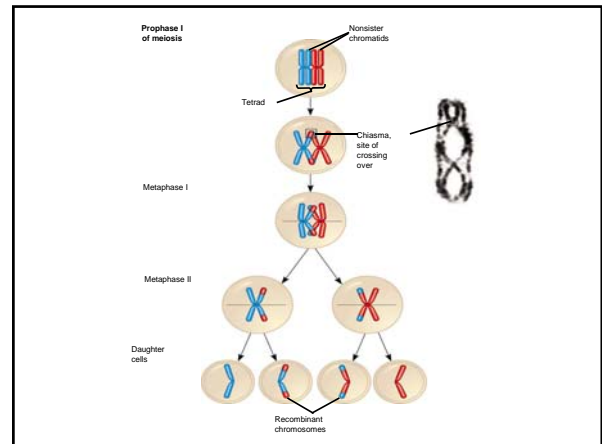
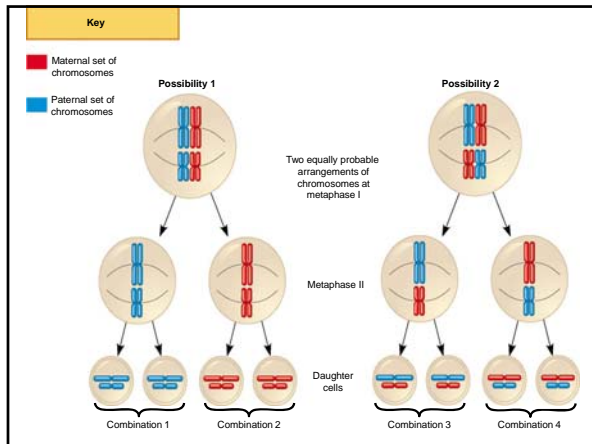


Meiosis I

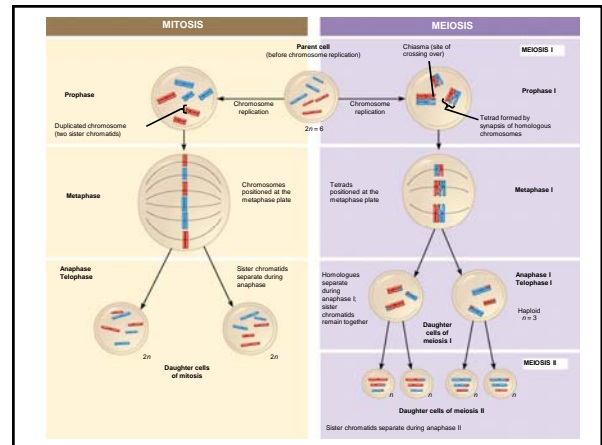


Meiosis II





Comparing Mitosis & Meiosis



Make up lab

Link found on daily assignment page

- Online [Onion Tip Mitosis](#)
- Do entire exercise
- Print final page
- Calculate percentages
- Due _____

Try these Tutorial links...

- <http://taggart.glg.msu.edu/bs110/meiosis.htm>
- <http://www4.ncsu.edu/unity/users/b/bnchorle/www/inter.htm>
- http://www.biology.arizona.edu/cell_bio/tutorials/meiosis/page3.html
- <http://www.emc.maricopa.edu/faculty/farabee/BIOBK/BioBookmeiosis.html>
- <http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/M/Meiosis.html>
- <http://biology.about.com/library/weekly/aa101200a.htm>
- <http://biology.nebrwesleyan.edu/benham/mitosis/>
- http://www.carolina.com/calendar_activities/2001/0111.asp
- <http://www.teachersdomain.org/9-12/sci/life/cell/mitosis/index.html>

Resources

Mitosis and Meiosis. Ancient Lights. (1994). Retrieved August 27, 2009, from
Discovery Education: <http://streaming.discoveryeducation.com/>