

Mitosis and the Cell Cycle

How cells replace or "clone" themselves

Functions of Cell Division

- Asexual Reproduction, Growth, Embryological Development, and Repair
 - Reproduction
 - Unicellular divide from one to two to reproduce entire organism (fission, budding)
 - Multicellular organisms grow and develop or replace damaged or dead cells.
 - Cell Division results in identical hereditary material and two daughter cells.

Cell Division

- Replicates the DNA exactly.
- Allocates two copies of DNA to opposite ends of the cell.
- Separates into two daughter cells.

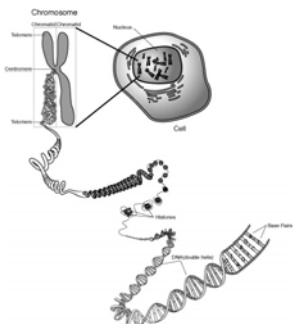
Heredity

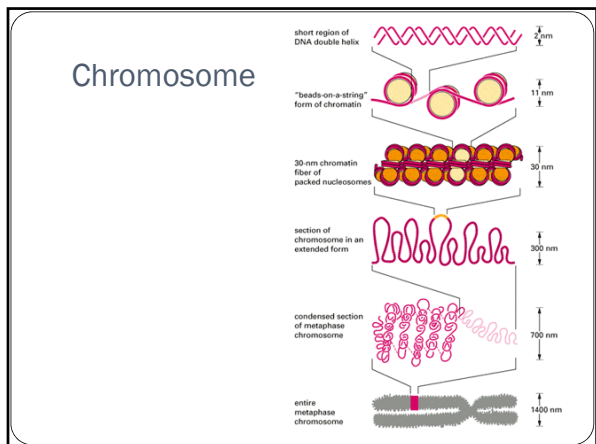
- Total hereditary material of a species is called its genome.
 - Some are very small (bacteria) while others are very large (eukaryotes)
 - Division of large eukaryotic genomes are possible because of smaller units called chromosomes.

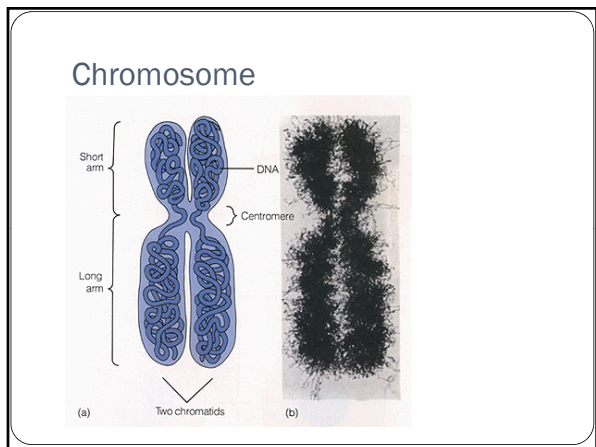
Heredity

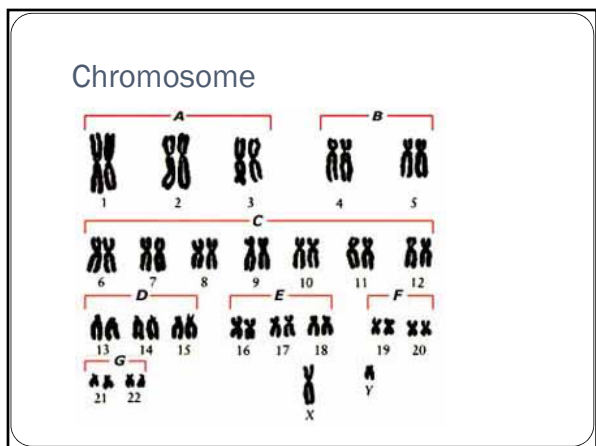
- Offspring acquire genes from parents by inheriting chromosomes.
 - DNA- Nucleic acid that codes for the formation of proteins. Made of four different nucleotides.
 - Genes- The length of DNA that codes for a protein.
 - Chromosomes- Sections of DNA that contain Genes and other Associated DNA.

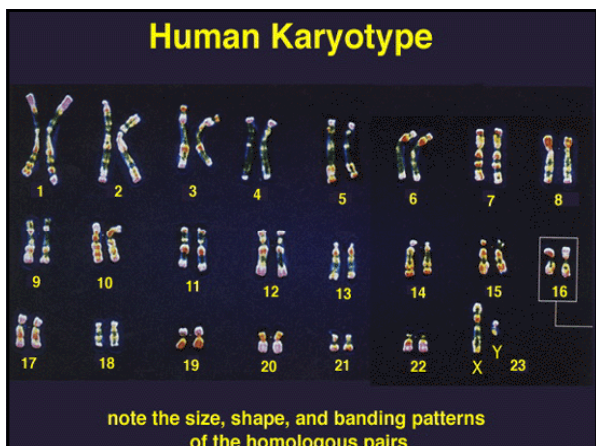
Chromosome

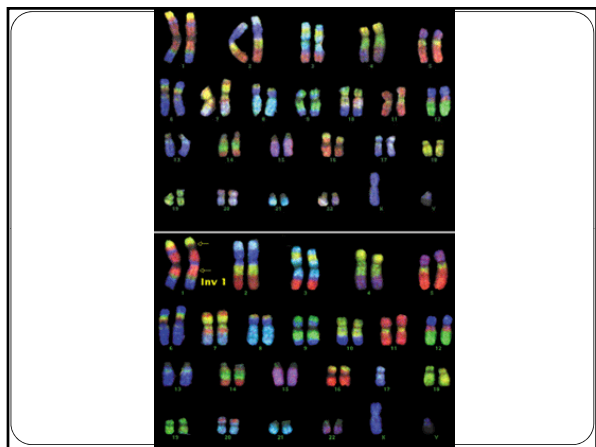








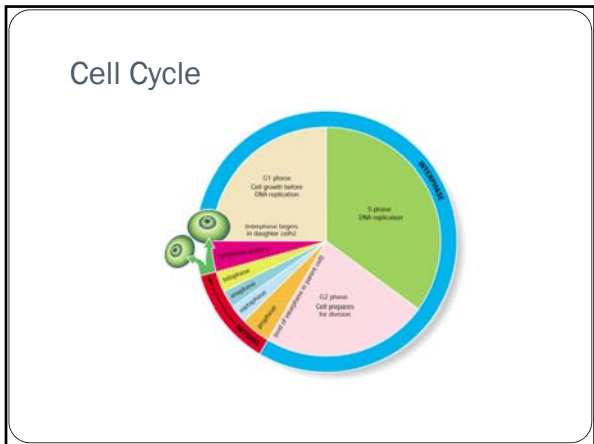




Human Life Cycle

- Where does Mitosis play a role in human development?

Figure 13.3 The human life cycle



Cell Cycle

- Rates
 - Some continuous
 - RBC
 - Some never or rarely
 - Muscle and Nerve
- Alternates from Interphase and M phase

Cell Cycle

- Interphase
 - 90% of cell cycle
 - lots of activity
 - Metabolism, Protein synthesis, DNA Replication and increase in number of mitochondria and chloroplasts.
 - Three phases
 - G1- First growth phase (G = gap)
 - S- Synthesis
 - G2- Second growth phase

Interphase



Mitosis

- Very reliable (one error in 100,000 divisions)
- Stages
 - Prophase
 - Metaphase
 - Anaphase
 - Telophase (happens with Cytokinesis)

Stages of Mitosis

- Prophase
 - Nucleoli disappear
 - Chromatin condense
 - Spindle forms and attaches to Chromosomes
 - Centrosomes move apart

Prophase



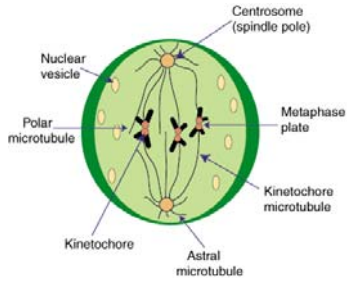
Metaphase

- The centrosomes are at opposite ends
- Chromosomes are at metaphase plate
- Centromeres are all lined up
- Spindle fully formed.

Metaphase



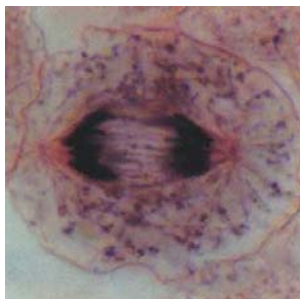
Spindle



Anaphase

- Sister chromatids split
- Kinetochore fibers shorten
- Nonkinetochore fibers lengthen and motor proteins “walk” past

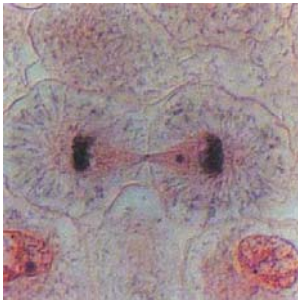
Anaphase



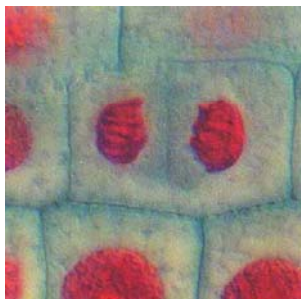
Telophase

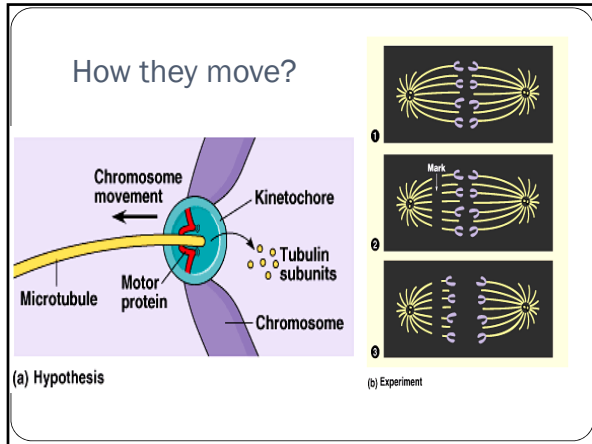
- Nonkinetochore further elongate
- daughter nuclei begin to form
- by the end two nuclei are clearly visible in their interphase appearance.

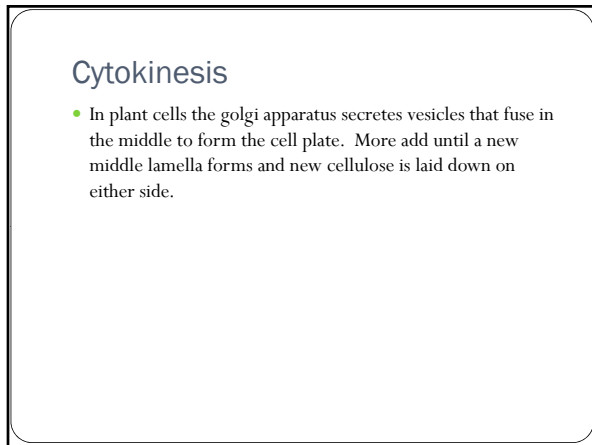
Animal Telophase

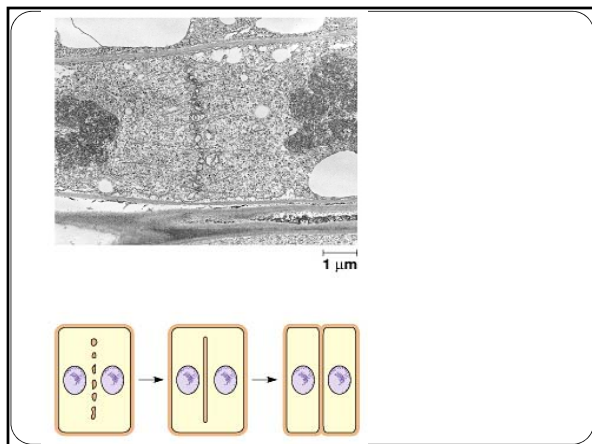


Plant Telophase



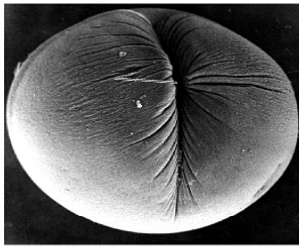




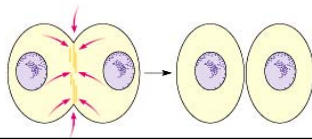


Cytokinesis

- In Animal cells
 - Pinching forms a cleavage furrow.
 - Contractile ring of actin fibers pinch the cells in two.



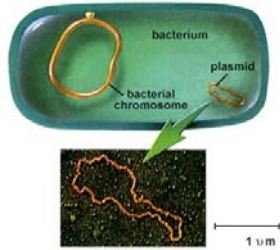
100 μm



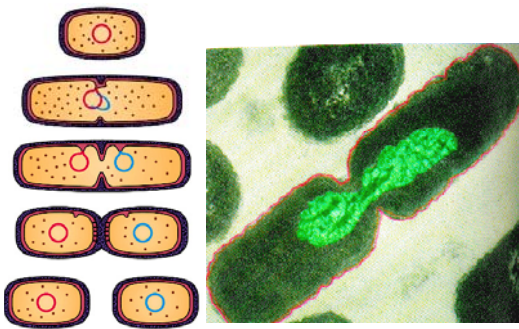
Binary Fission in Bacteria

- Bacteria just have a single large loop of DNA as their genomic DNA.
 - Some have extra genomic pieces called plasmids.
 - Can be antibiotic resistant
 - or F factors (fertility factors)
- Fission happens when the chromosome duplicates itself, attaches to the inner cell and then grows and pulls the two copies apart.

Bacterial Fission



Bacterial Fission



Fission Animation



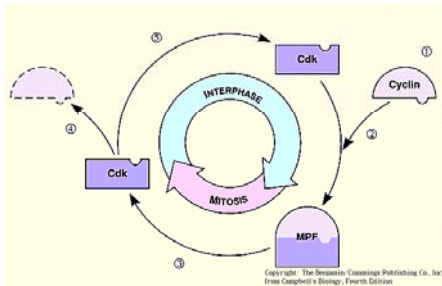
Regulation of Cell Cycle

- Check points or switches control the rate of the cell cycle
- Intracellular and extracellular control
- G1 checkpoint or the Restriction point is said to be the beginning of the cell cycle.
 - G₀ state is the resting state

Cell Cycle Regulation

- Protein Kinases are enzymes that transfer a phosphate group from ATP to a target protein
- This activates these proteins
- Move into cell cycle
- These Kinases are regulated by cyclins

Regulation



Cyclin

- Cyclin binds to CdK to produce MPF
 - in the beginning the MPF phosphorylates proteins and make the chromatin condense
 - Nuclear membrane dispersion
 - In the second half it activates proteolytic enzymes that break down cyclin.

External Cues

- Chemical Factors
 - All Kinetochores need to be attached to Chromosomes or Anaphase won't begin.
 - Growth factors
- Physical factors
 - Density Dependent Inhibition

Cancer

- No response to DDI
- May make excess growth factors
- May have different signaling systems.
- Normal checkpoints are not working
 - Are considered transformed cells (neoplastic transformation)

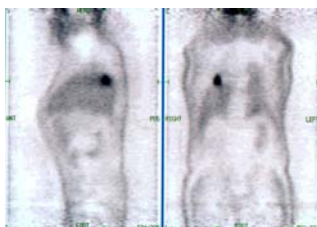
Cancer

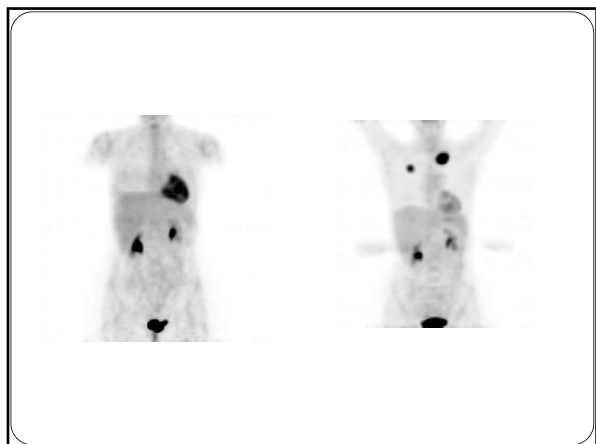
- Tumor is a mass of cells that have lost their ability to stop dividing.
 - Malignant
 - can impair normal function of tissue, organ.
 - Altered cell cycle, excessive divisions.
 - May have different # of chromosomes
 - altered metabolism
 - no DDI
 - Benign- stay at original site. Don't impair normal function usually.

Cancer

- Metastasis- cells move from original location
 - move in blood, lymph
 - can be treated with radiation, chemotherapy.

Pet Scan

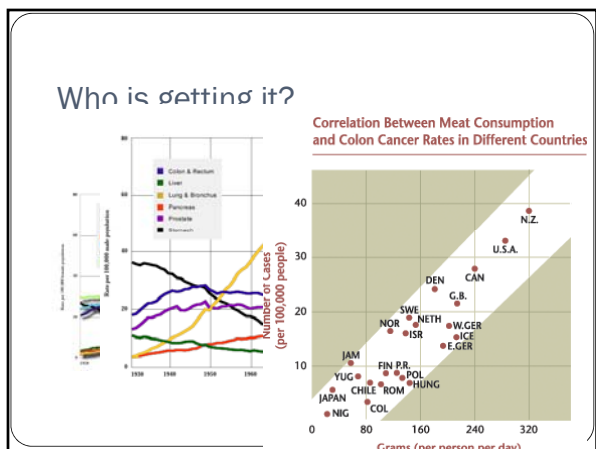




Looks like

A tumour
Cancer cells dividing.

the molecules keep normal cells they become neighbours



Monitor

Testicular Cancer Cases
Per 100,000 men

Year	Cases per 100,000 men
1964	4.01
1996	6.39

Canada
Up 59.4%

The Evolution of Colon Cancer

Normal Epithelium Early Adenoma Intermediate Adenoma Late Adenoma Carcinoma

Normal Cells Neoplastic Cells Phase 1
