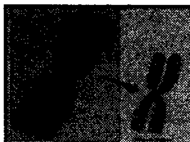
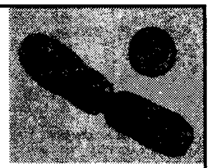
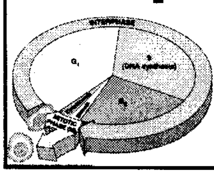
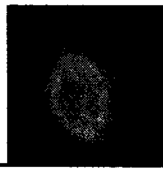
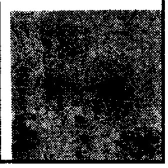
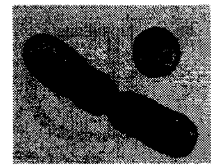



Cell Reproduction

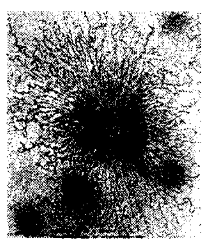
I. Functions of Cell Division

A. Unicellular- Reproduction
B. Multicellular
1. Growth and development from egg.
2. Replacement of dead or damaged cells.
3. Passes along the **genome** (total DNA per species)
    a) Precisely replicates its DNA
    b) Equally distributes DNA to opposite ends of the cell.
    c) Separates into two identical daughter cells.



II. How Prokaryotic Cells Divide

A. Prokaryotic Chromosome
1. Is Singular
2. Contains mostly DNA and some associated proteins
3. Less DNA than eukaryotic chromosomes(1/1000).
4. Highly packed and tightly coiled inside the cell.
5. A circular loop attached to plasma membrane.



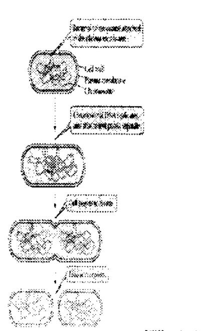
Nuclear Zone

II. How Prokaryotic Cells Divide

B. Division is by Fission
1. Asexual reproduction requires a single parent
2. Binary fission produces two genetically identical daughter cells.
3. Generation times of Escherichia coli is 20 minutes; most bacteria need one hour to a day.

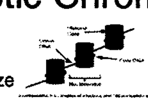

II. How Prokaryotic Cells Divide

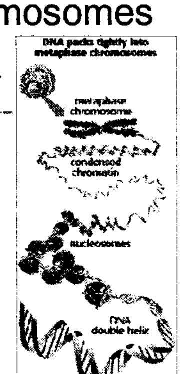
C. Binary Fission
1. DNA is replicated so two chromosomes are attached inside the plasma membrane.
2. The two chromosomes separate when cell lengthens and pulls them apart.
3. When cell is approximately twice its original length:
    a) the plasma membrane grows inward
    b) a new cell wall forms
    c) the cell divides into two approximately equal daughter cells.



III. Eukaryotic Chromosomes

A. DNA is associated with **histones** (proteins)
B. Histone proteins organize chromosomes.
C. When not undergoing division, DNA is a tangled mass of threads called **chromatin**.
D. At cell division, chromatin becomes highly coiled and condensed and visible as **chromosomes**.
E. Each species has a characteristic number of chromosomes.





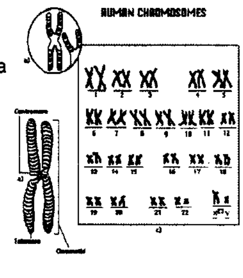
III. Eukaryotic Chromosomes

F. **Diploid** (2n) number includes two sets of chromosomes of each type.
   1. Found in all the nonsex cells of an organism's body (with a few exceptions).
   2. Examples include humans (46), crayfish (200), etc.

G. **Haploid** (n) number contains one of each kind of chromosome.

H. In many animals, only sperm and egg cells have the haploid number.

I. Examples include humans (23), crayfish (100), etc



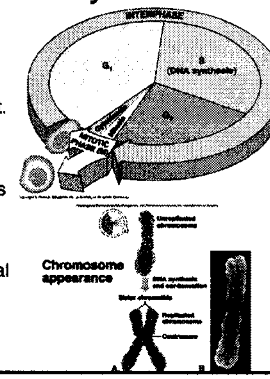
IV. The Cell Cycle

A. Involves nuclear division and cytokinesis (division of the cytoplasm).

B. Nuclear division keeps the chromosome number constant.

C. A chromosome begins cell division with two sister chromatids.

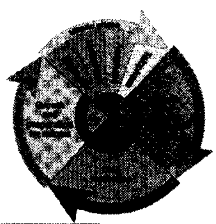
D. Sister chromatids are two parts of a chromosome.
   1. They are attached at a centromere.
   2. Each consists of an identical DNA molecule.

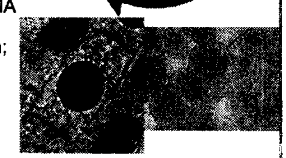


V. Interphase

A. Considered a "resting state" until DNA replication was detected in the 1950s.

B. Consists of G1, S, and G2 stages.
   1. G1 - just prior to DNA replication, when cell grows in size and organelles increase in number.
   2. S - DNA replication occurs; proteins associated with DNA are also synthesized.
   3. G2 - just prior to cell division; preparation for mitotic cell division (grows).

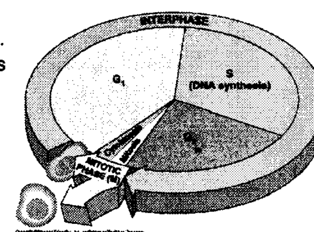




VI. Mitosis

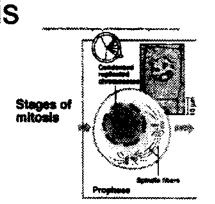
A. M stage (M = mitosis) is the entire cell division state, including both mitosis and cytokinesis.

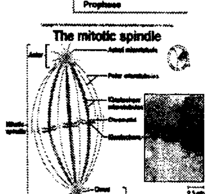
B. Mitosis (karyokinesis) is divided into phases.



VI. Mitosis

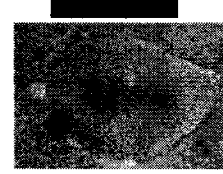
C. Phases of Mitosis
   1. **Prophase**
      a) **Chromatin** condenses forming visible **chromosomes** (held together by a **centromere**).
      b) The nucleolus disappears.
      c) Chromosomes have no particular orientation.
      d) Protein complexes (**kinetochores**) develop on each side of centromere.
      e) **Spindle** begins to assemble as pairs of **centrosomes** migrate away from each other.
      f) Short microtubules radiate out from the pair of centrioles located in each centrosome; form starlike **asters**.





VI. Mitosis

2. **Prometaphase**
   a) The spindle consists of poles, asters, and fibers that are bundles of microtubules.
   b) Chromosomes attach to the spindle (kinetochore fibers).
   c) Nuclear envelope fragments
   d) Polar fibers (nonkinetochore fibers) span from centrosome to centrosome.
   e) The chromosomes move towards the equator.

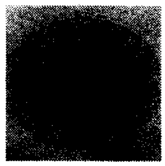


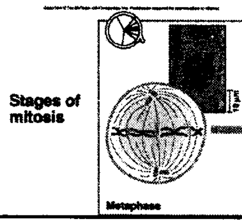
VI. Mitosis

3. Metaphase

a) Chromosomes, attached to kinetochore fibers, are aligned at the metaphase plate.

b) Nonattached spindle fibers (polar, nonkinetochore) fibers, overlap.





VI. Mitosis

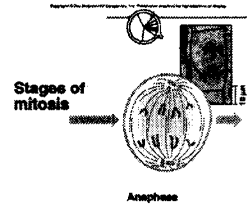
4. Anaphase

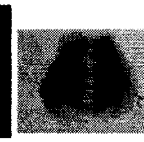
a) Sister chromatids separate at centromere.

b) Daughter chromatids, each with a centromere, move to opposite poles.

c) Polar spindle fibers lengthen as they slide past each other.

d) Kinetochore spindle fibers disassemble at the kinetochores; this pulls daughter chromatids to poles.





VI. Mitosis

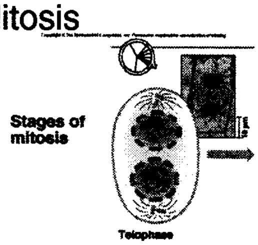
5. Telophase

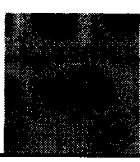
a) Spindle disappears.

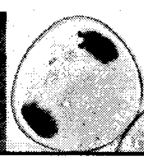
b) Chromotids decondense and return to chromatin.

c) Nuclear envelope reforms.

d) Nucleoli reappear



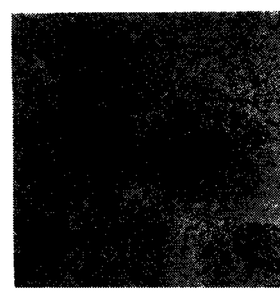




VII. Cytokinesis

A. In Animal Cells

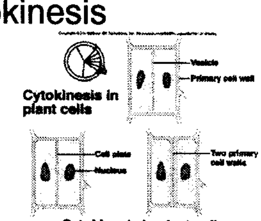
1. Cleavage furrow forms between the two daughter nuclei.
2. Cytoplasmic cleavage begins as anaphase draws to a close.
3. Cleavage furrow deepens as band of actin filaments slowly constricts between the two daughter cells.
4. Narrow bridge exists between daughter cells during telophase; then constriction separates the cytoplasm.



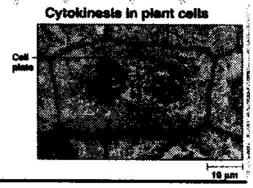
VII. Cytokinesis

B. In Plant Cells

1. The rigid cell wall that surrounds plant cells does not permit cytokinesis by furrowing.
2. Golgi apparatus produces vesicles that move to the midpoint between the daughter cell nuclei.
3. Vesicles fuse, forming a cell plate.
4. Vesicles also release molecules that signal the formation of plant cell walls.
5. Later, walls are strengthened by the addition of cellulose fibrils.



Cytokinesis in plant cells



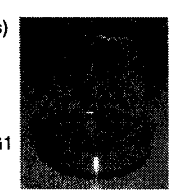
VIII. Control of the Cell Cycle

A. Some cells (e.g., skin cells) divide continuously throughout life.

B. Other cells (e.g., skeletal muscle cells and nerve cells) are arrested in the G1 stage.

C. Still other cells, such as cardiac muscle cells, are arrested in the G2 Stage.

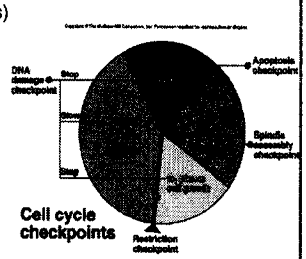
D. Cyclic molecule levels create the **cell cycle control system**



VIII. Control of the Cell Cycle

E. Cell Cycle Checkpoints

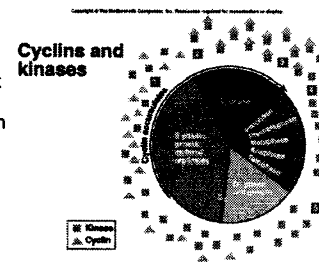
1. Enzymes known as cyclin-dependent kinases (Cdks) regulate passage of cells through checkpoints
2. Three main checkpoints
   1. G1
      a) Restriction point in animals
      b) Three Cdk (cyclin dependent kinase) involved
   2. G2 (MPF- maturation promoting factor)
   3. M (anaphase is checkpoint)



VIII. Control of the Cell Cycle

F. Cyclin-dependent kinases (Cdks)

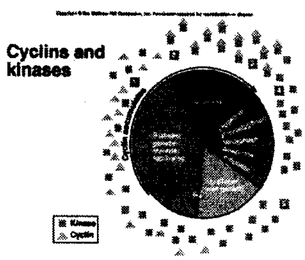
1. Kinases remove a phosphate group from ATP and add it to another protein.
2. The recipient protein (which may be another kinase) becomes activated.
3. Enzymes of cell cycle are cyclin dependent because they activate when they combine with cyclin.



VIII. Control of the Cell Cycle

G. Cyclin proteins

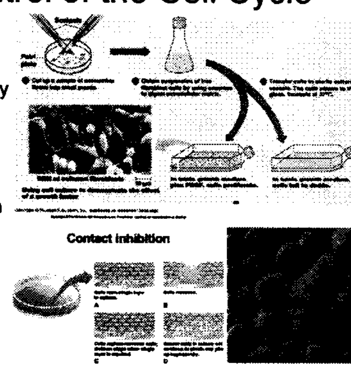
1. Cycle at different concentrations in cell division
2. Activate cyclin-dependent kinases, which in turn activate enzymes; one destroys cyclin (MPF).
3. Kinases that combine with cyclins become activated and regulate the passage of cells through the various stages of the cell cycle.



VIII. Control of the Cell Cycle

H. External Factors

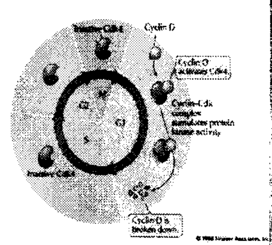
1. Growth factors (regulatory substances) may be necessary.
2. Cell density (density – dependent inhibition)
3. Cell size is main indicator of cell division.



IX. Cancer

A. Oncogenesis (cancer-causing genes) may code for cyclins that no longer function as they should.

1. Growth factors bring about cell growth.
2. Ordinarily a cyclin combines with its kinase only when a growth factor is present.
3. Cyclin that has gone awry combines with its kinase when growth factor is absent, resulting in a tumor.



IX. Cancer

B. Tumor-suppressor genes
   1. Causes production of protein that combines with a cyclin-kinase complex
   2. Stops that kinase from being active.

C. Transformation is when eukaryotic cells go through unregulated growth.

D. Benign tumors stay at original site.

E. Malignant tumors have the ability to spread to other sites.

F. Spreading of cancer cells is called metastasis.