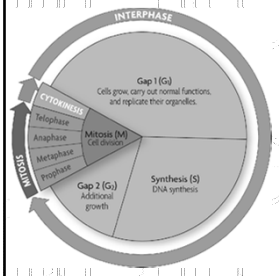


Cell Cycle

Chapter 8

Prokaryotes

- Lack a nucleus
- Have a single chromosome
- Reproduce by binary fission
- Include bacteria

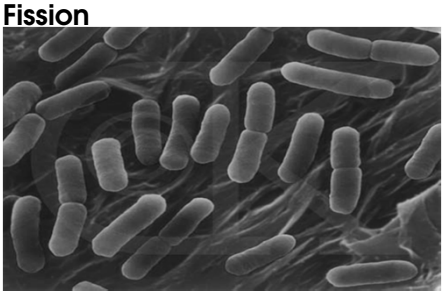
Steps in Binary Fission

- Used by bacteria
- Cells increase their cell mass slightly
- DNA & cell components are replicated
- Each cell divides into 2 daughter cells

* DNA attaches to cell membrane.

Binary Fission of Bacterial Cell

E. Coli Dividing by Binary Fission



Eukaryotes

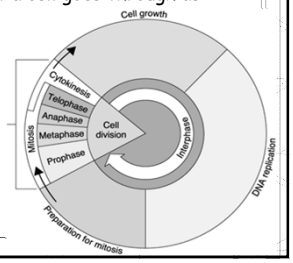
- Contain a nucleus & membrane bound organelles
- Asexually reproduce cells by mitosis

Why must cells divide?

- So an organism can grow
- So an organism can heal itself
- So an organism can maintain cell structure
  - If too small, they cannot contain necessary organelles.
  - If too large they cannot take in enough materials (oxygen, nutrients) or get rid of waste adequately. Large cells do not have adequate surface area for exchange of materials.

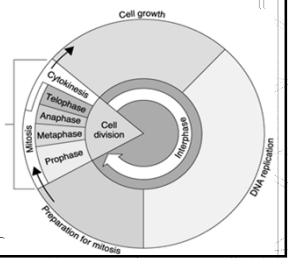
The Cell Cycle

- Series of events that a cell goes through as it grows and divides.



3 main phases of Cell Cycle

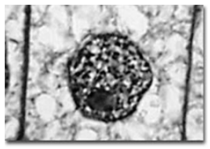
- Interphase
- Mitosis
- Cytokinesis



INTERPHASE

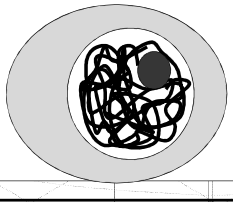
- "in-between" period of cell growth
- Longest phase
- Includes G_1, S, and G_2 phases
  - G_1– cell is growing
  - S – DNA is replicating (copying itself)
  - G_2– cell is growing & organelles are doubling; cell is ready to divide

INTERPHASE



Chromosomes are not visible.

DNA is in the form of chromatiN.

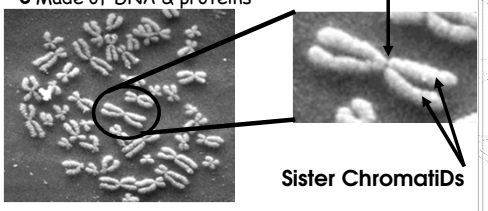


MITOSIS (M-phase)

- Division of the nucleus
- One cell divides and forms 2 genetically IDENTICAL daughter cells
- Each cell must have the same DNA in it.
- 4 phases:
  - Prophase
  - Metaphase
  - Anaphase
  - Telophase

PROPHASE

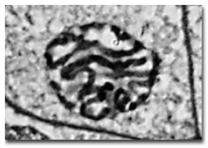
- Chromosomes become visible
- What is a chromosome?
- Made of DNA & proteins



PROPHASE

- Chromatin coils, shortens, and forms a chromatid.
- Two chromatids join at the centromere and form a chromosome. Chromosomes are now visible.
- Paired centrioles separate & move to poles of the cell.
- Spindle fibers form.
- Nucleus and nucleolus disappear.

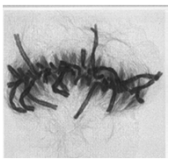
PROPHASE

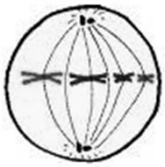


METAPHASE

- Spindle fibers move chromosomes to the middle (or equator) of the cell
- Centrioles are at opposite ends of the cell.

METAPHASE

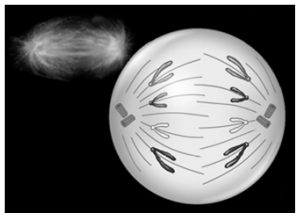




ANAPHASE

- Spindle fibers shorten and pull chromosomes apart to the poles of the cell.

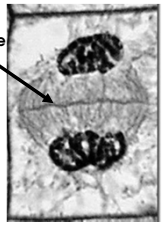
ANAPHASE

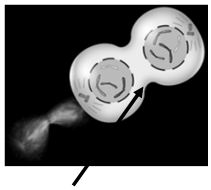


TELOPHASE

- Opposite of prophase
- Nucleus reappears around the chromosomes.
- Nucleolus reappears.
- Chromosomes uncoil and become chromatin once again.

TELOPHASE

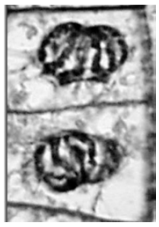




CYTOKINESIS

- Division of cytoplasm
- ANIMAL CELLS….the cell membrane pinches in and forms a cleavage furrow.
- PLANT CELLS…..a cell plate forms in the middle of the cell. This will eventually become the cell wall.

CYTOKINESIS



RESULT OF CELL CYCLE?

- Two daughter cells that are genetically identical to the parent cell (but smaller)
- Same number of chromosomes as the parent cell
- Daughter cells are now in G_1 phase of Interphase and they begin the cycle again.

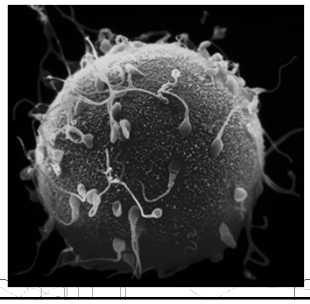
What happens if cell division is out of control?

Cancer cells do not respond to the signals that regulate cell division

- Cancer cells form disorganized clumps called tumors.
  - Benign tumors remain clustered in one location and can be removed.
  - Malignant tumors metastasize, or break away/spread, and can form more tumors.
- Carcinogens are substances known to promote cancer.

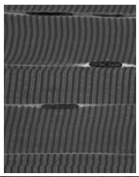
KEY CONCEPT

Gametes have half the number of chromosomes that body cells have.

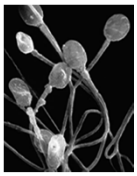


You have body cells and gametes.

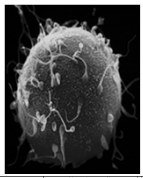
- Body cells are also called somatic cells.
- Germ cells develop into gametes.
  - Germ cells are located in the ovaries and testes.
  - Gametes are sex cells: egg and sperm.
  - Gametes have DNA that can be passed to offspring.



body cells



sex cells (sperm)



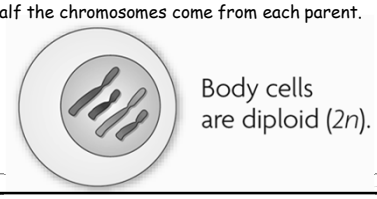
sex cells (egg)

Your cells have autosomes and sex chromosomes.

- Your body cells have 23 pairs of chromosomes.
  - Homologous pairs of chromosomes have the same structure.
  - For each homologous pair, one chromosome comes from each parent.
- Chromosome pairs 1-22 are autosomes.
- Sex chromosomes, X and Y, determine gender in mammals.

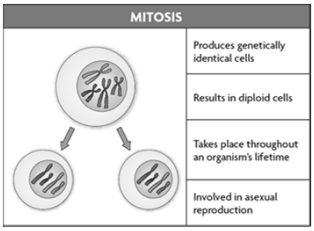
Body cells are diploid; gametes are haploid.

- Fertilization between egg and sperm occurs in sexual reproduction.
- Diploid ($2n$) cells have two copies of every chromosome.
  - Body cells are diploid.
  - Half the chromosomes come from each parent.

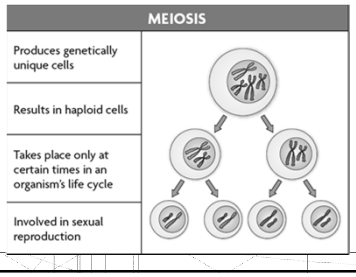


- Haploid (*n*) cells have one copy of every chromosome.
  - Gametes are haploid.
  - Gametes have 22 autosomes and 1 sex chromosome.

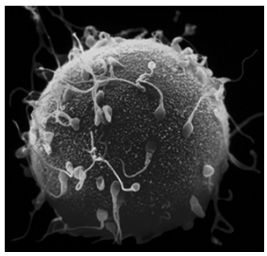
- Chromosome number must be maintained in animals.
- Mitosis and meiosis are types of nuclear division that make different types of cells.
- Mitosis makes more diploid cells.



- Meiosis makes haploid cells from diploid cells.
  - Meiosis occurs in ovaries & testes.
  - Meiosis produces gametes.



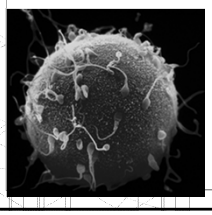
KEY CONCEPT
During meiosis, sex cells are produced.

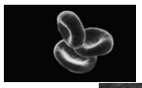


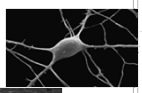
Important Vocabulary:

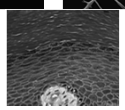
Gametes -
sex cells (egg & sperm)

Somatic Cells –
body cells (*not* sex cells)





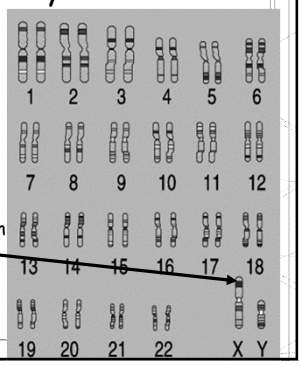




Important Vocabulary:

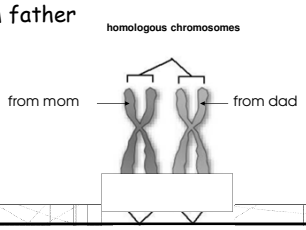
Autosomes
chromosomes that do ***not*** contain genes related to gender

Sex Chromosomes
chromosomes that **do** contain genes related to gender
(X or Y)

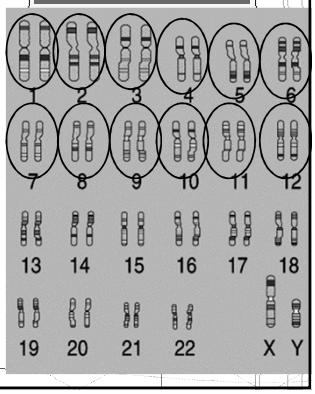


Important Vocabulary:

Homologous Chromosomes – two chromosomes that contain the same types of genes; one comes from mother, one comes from father



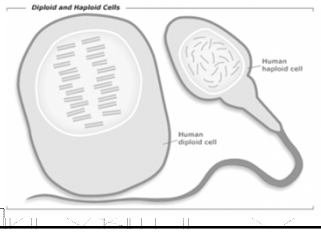
homologous chromosomes

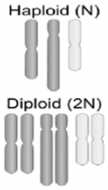


Important Vocabulary:

Diploid (2n) – the cell has 2 copies of each chromosome

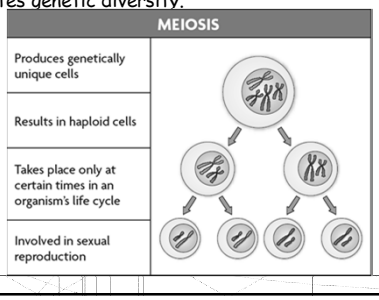
Haploid (n) – **(half)** the cell has only 1 copy of each chromosome





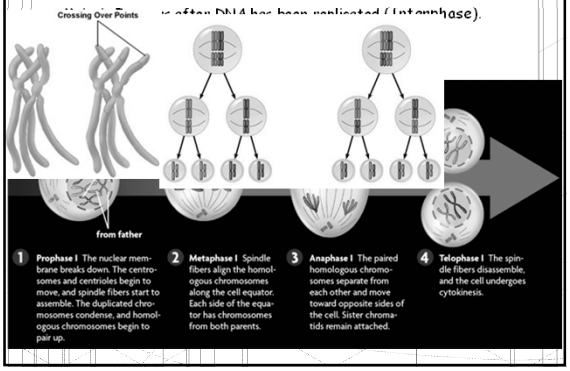
Cells go through two rounds of division in meiosis – MEIOSIS I and MEIOSIS II

- Meiosis reduces chromosome number by HALF and creates genetic diversity.



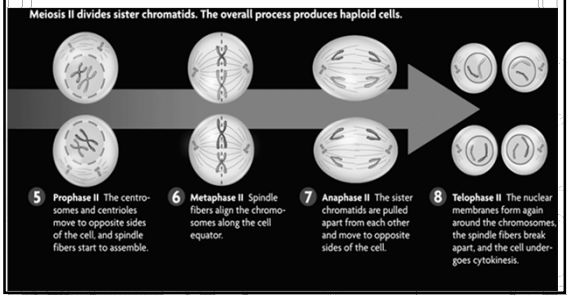
- Meiosis I and Meiosis II each have four phases, similar to those in mitosis.
  - Meiosis I: Pairs of **homologous chromosomes** separate

  - Meiosis II: **Sister chromatids** separate

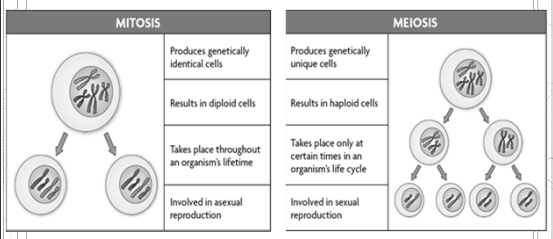


- Meiosis II divides sister chromatids in four phases.

  (DNA is not replicated again between meiosis I and meiosis II.)

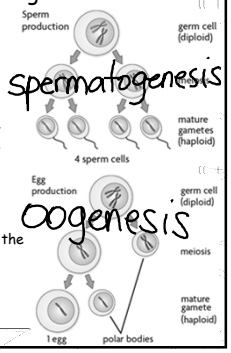


- Meiosis differs from mitosis in significant ways.
  - Meiosis has two cell divisions while mitosis has one.
  - In mitosis, homologous chromosomes never pair up.
  - Meiosis results in haploid cells; mitosis results in diploid cells.



Haploid cells develop into mature gametes.

- Gametogenesis is the production of gametes.
- Gametogenesis differs between females and males.
  - Sperm become streamlined and motile.
  - Sperm primarily contribute DNA to an embryo.
  - Eggs contribute DNA, cytoplasm, and organelles to an embryo.
  - During meiosis, ONE egg gets most of the contents; the other 3 cells form polar bodies and become waste.



Genetic Variation

- Important to increase an organism's chances of survival
- Some unfavorable traits from parents may not be passed on to offspring, while favorable ones are
- Sources of genetic variation:
  - Crossing over (during Prophase I)
  - Independent Assortment (during Metaphase I)
  - Fertilization (random)

Asexual Reproduction

- Asexual reproduction is the creation of offspring from a single parent. Several types: binary fission, budding, etc.
- Binary fission is similar in function to mitosis.
  - Binary fission produces two daughter cells genetically identical to the parent cell.
  - Binary fission occurs in prokaryotes (bacteria)