Objectives

- Review ER & Golgi Complex
- DNA replication
- Mitosis
- Meiosis

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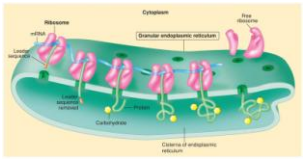
Functions of ER

- Proteins to be secreted are made by ribosomes of rough ER
  - Contain a leader sequence of 30+ hydrophobic amino acids that directs proteins to enter ER
    - Inside ER leader sequence is removed; protein is modified



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Functions of Golgi Complex

- Secretory proteins leave ER in vesicles and go to Golgi Complex
  - In Golgi complex carbohydrates are added to make glycoproteins
    - Vesicles leave Golgi for lysosomes or exocytosis

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Protein Degradation

- Enzyme activity (& regulatory proteins) is controlled by degrading them:
  - By proteases in lysosomes
  - By proteasomes in cytoplasm
    - Proteasomes (large enzyme complexes)
    - ubiquitin tags mark proteins to be degraded

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DNA Replication

- Prior to cells dividing, DNA replicates itself and identical copies go to 2 daughter cells

The Process of DNA replication:

- Helicase: breaks hydrogen bonds to produce 2 free strands of DNA
- Primase: established an RNA primer of RNA nucleotides
- DNA polymerase : binds to each strand and makes new complementary copy of old strand
  - Using A-T, C-G pairing rules
  - Thus each copy is composed of 1 new strand and 1 old strand (called semi-conservative replication)
  - Original DNA sequence is preserved

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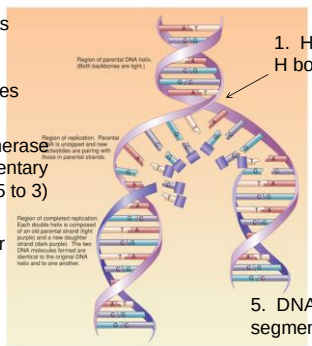
DNA Replication

2. Primase sets up short sequence of RNA nucleotides



1. Helicase breaks H bonds

3. DNA Polymerase adds complimentary Nucleotides (5 to 3)

4. RNA Primer is replaced with DNA nucleotides

5. DNA ligase joins segments together

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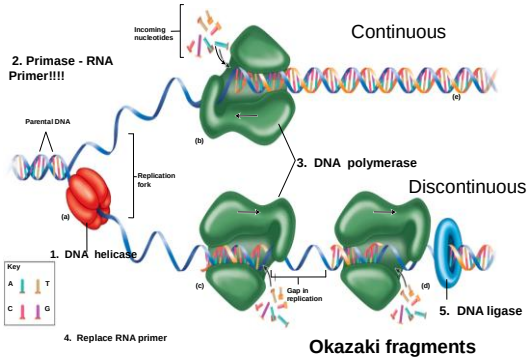
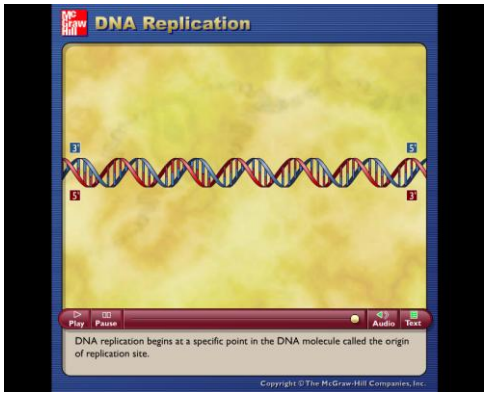
DNA Replication

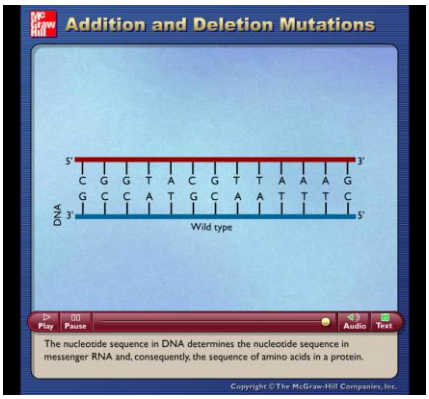




Errors and Mutations

- **DNA polymerase does make mistakes**
  - **But:**
  - ***tends* to replace incorrect, biochemically unstable pairs**

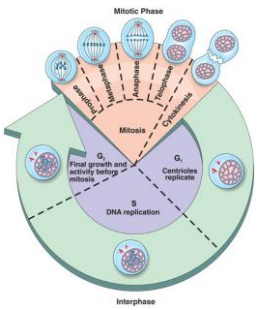
    thus, only 1 real error per 1 billion bases replicated
- **DNA mutations: because of replicationn errors or environmental factors**
  - **some mutations = no problem/some big problem**

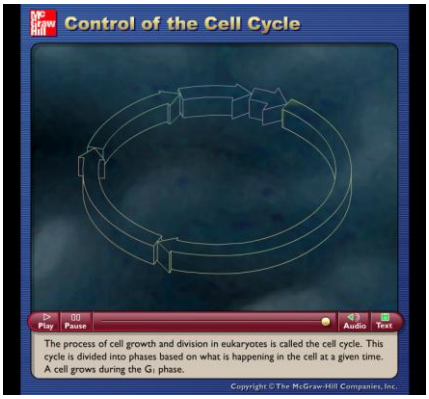


Cell Cycle

Most cells of body are in interphase, the non-dividing stage of life cycle

- Interphase is subdivided into:
  - G_1 - cell performs normal physiological roles
  - S - DNA is replicated in preparation for division
  - G_2 - chromatin condenses prior to division





Mitosis

- **Cell division occurs in all body cells (except eggs and sperm)**
- **Functions of mitosis:**
  - **growth of tissues**
  - **replacement of cells that die**
  - **repair of damaged tissues**
- **4 phases of mitosis**
  - **prophase, metaphase, anaphase, telophase**

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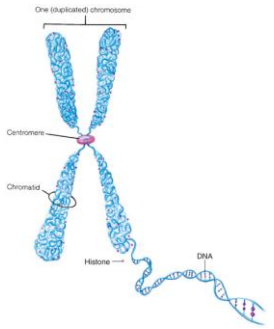
Mitosis (M phase)

- When the cell divides
- Chromosome condense and duplicate
  - Consist of 2 duplicate strands called chromatids
    - connected by a centromere



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Mitosis (M phase)

- **In prophase chromosomes become visible distinct structures**
- **In metaphase chromosomes line up single file along equator**
  - **Positioned by spindle fibers**
- **In anaphase centromeres split**
  - **Spindle fibers pull each chromatid to opposite poles**
- **In telophase cytoplasm is divided (= cytokinesis), producing 2 daughter cells**

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Role of Centrosome

- Animal cells have a centrosome located near nucleus in interphase
  - Contains 2 centrioles

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Role of Centrosome

- **Centrosome is duplicated in G_1 if cell is going to divide**
  - **Replicates move to opposite poles by metaphase**
  - **Microtubules grow from centrosomes to form spindle fibers**
    - **attach to centromeres of chromosomes**
  - **Spindle fibers pull chromosomes to opposite poles during anaphase**

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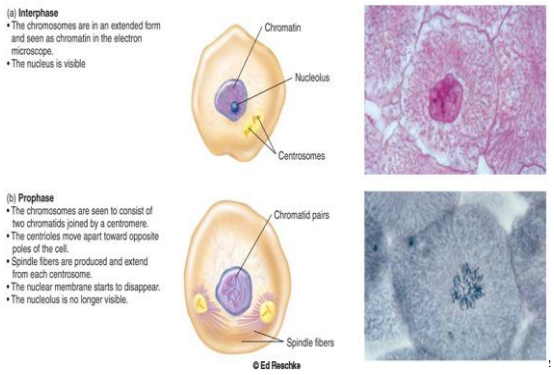
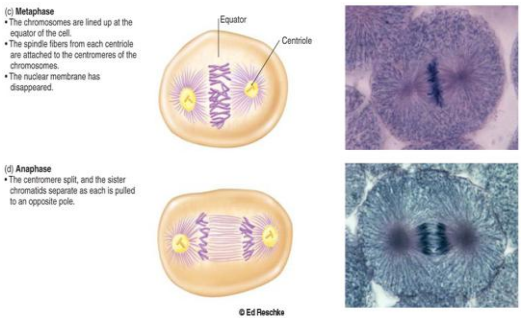
Mitosis (M phase)



Mitosis



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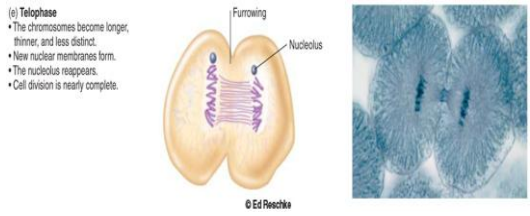
Mitosis



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Telomeres

- Non-coding regions of DNA at ends of chromosomes
- Each time cell divides, a length of telomere is lost
  - Because DNA polymerase can't copy the very end of DNA strand
- When telomere is used up, cell becomes senescent
- Believed to represent a molecular clock for aging
  - That ticks down with each division
  - Trigger for apoptosis??

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Telomeres

- Germinal and cancer cells can divide indefinitely and do not age
  - Have the enzyme telomerase which replaces telomere nucleotides not duplicated during DNA replication

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Cyclins

- **Cyclins: Proteins that promote different phases of cell cycle**
  - **Accumulate prior to mitosis**
  - **Destroyed during cell division**
  - **Promotes phases to occur and continue**
- **Oncogenes: genes whose mutations are associated with cancer**
- **Tumor suppressor genes inhibit cancer development**
  - **Tumor suppressor gene p53 (transcription factor)**
    - **It halts cell division when DNA is damaged**
      - **Then either promotes repair of the DNA; or apoptosis (cell death)**
    - **Mutations in p53 are found in 50% of all cancers**

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Cell Death

- Occurs in 2 ways:
  - Necrosis: pathological changes kill a cell
  - Apoptosis: normal physiological response
    - Extrinsic pathway – ligands bind to "death receptor proteins"
    - Intrinsic pathway – intracellular signals
    - Both pathways activate cytoplasmic caspases, which lead to cell death

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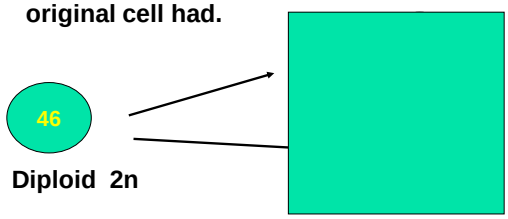
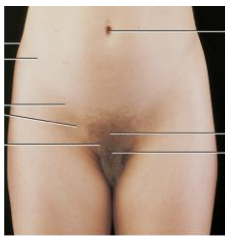
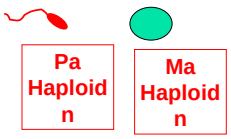
Meiosis

Meiosis: division of cells that results in daughter cells with one-half of the genetic information that the original cell had.



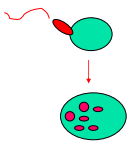
Diploid 2n





Meiosis

- **Cell division occurring in ovaries and testes to produce gametes (ova and sperm)**
- **Two divisional sequences**
- **Daughter cells have ½ the chromosomes the original cell had**



Junior = Zygote = diploid organism= 2n

3-69

Meiosis

- **In 1st division:**
  - homologous chromosomes pair along equator of cell rather than singly as in mitosis
  - 1 member of homolog pair is pulled to each pole
  - gives each daughter cell 23 different chromosomes, consisting of 2 chromatids
- **In 2nd division:**
  - each daughter divides; chromosomes split into 2 chromatids
  - 1 goes to each new daughter cell
    - Each daughter cell contains 23 chromosomes
      - Orginal mother cell had 46
      - Aka reduction division

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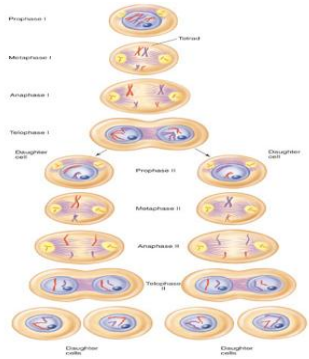
Meiosis



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Genetic diversity & Meiosis

- Genetic recombination occurs in prophase I

1. **Crossing-over:** Parts of one homologous chromosome are exchanged with its partner homolog

2. **Independent assortment:** the way chromosomes line up during metaphase is random

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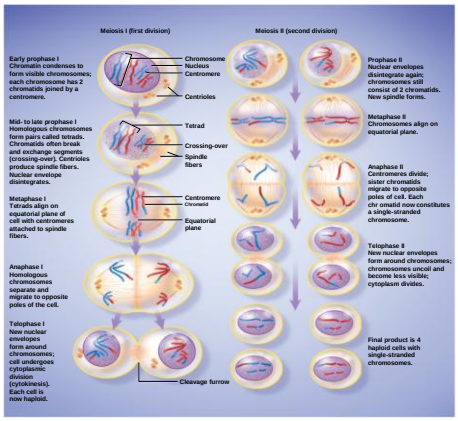
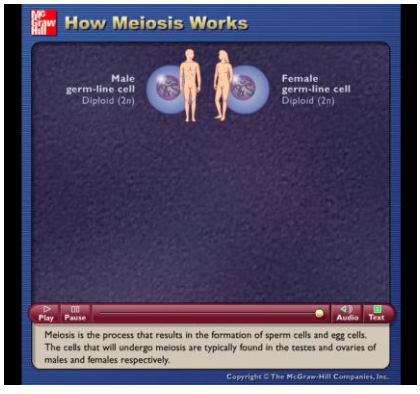
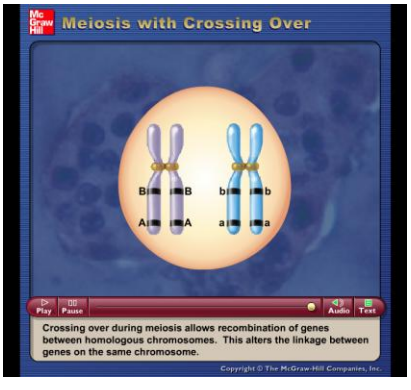
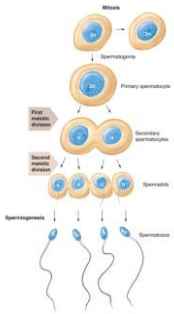






Spermatogenesis

- Germ cells that migrate from yolk sac during development become spermatogonia (stem cells)
  - Spermatogonia replicate selves throughout life by mitosis
  - Give rise to haploid sperm by meiosis



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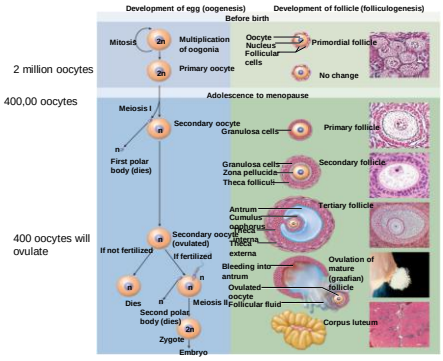
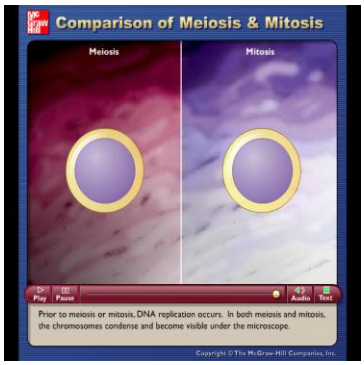
Oogenesis



Epigenetic Inheritance

- **Occurs when gene silencing is passed on to daughter cells**
  - **Gene silencing is enacted by DNA methylation or post-translational modification of histones**
- **Can contribute to diseases**
- **Identical twins can have differences in gene expression**
- **--because of epigenetic changes in response to differences in their environments**



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