## Eukaryotic cell

**Review of haploid, diploid, mitosis and meiosis**

## Fundamentals

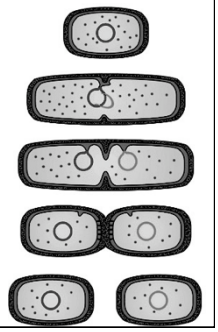
- Genes are DNA sequences that code for proteins
- Proteins catalyze reactions and make up structures
  - Thus genes indirectly control every reaction and structure making up a cell
- Genes are carried together on chromosomes

## Other big difference between prokaryotic and eukaryotic DNA

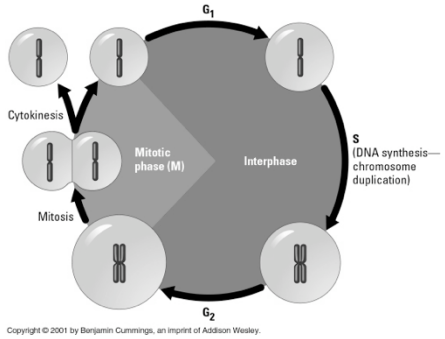
- Eukaryotic genes are spread among multiple chromosomes.
- Almost all eukaryotic organisms are diploid at some stage in their life cycle.
  - This means that they have two copies of each chromosome - one from mom and one from dad.
- Thus they also have two copies of each gene.

## Prokaryotic Chromosomes and Cell Division

- Prokaryotic Genomes
  - Bacterial Chromosomes- Single strands of DNA
  - Reproduction- Binary Fission (asexual)



## The Cell Cycle






## Cellular Division

- Three main functions of cell divisions
  - Reproduction
  - Growth and development
  - Tissue renewal

- **Mitosis** is a process of cell division that preserves chromosome number (e.g., diploid to diploid, haploid to haploid, or dikaryotic to dikaryotic) and results in genetically identical cells
  - Happens during a variety of processes, including simple growth, asexual reproduction, repair
- **Meiosis** is the process of cell division whereby chromosome number is reduced by half (e.g. diploid to haploid)
  - Happens during sexual reproduction
  - Results in genetically variable haploid cells (usually spores or gametes)

## Mitosis

- The Process of cell division that results in the production of 2 daughter cells that are genetically identical to each other and to the parent cell from which they arose.
- Mitosis is for cell growth, development and repair (also asexual reproduction)
- Occurs in Somatic Tissues

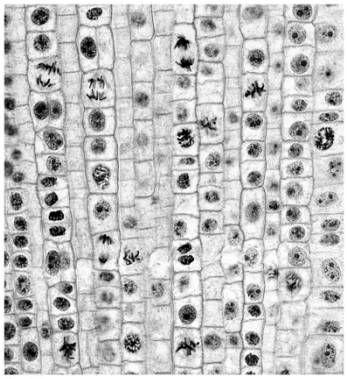


Figure 3-40
*Biology of Plants, Seventh Edition*
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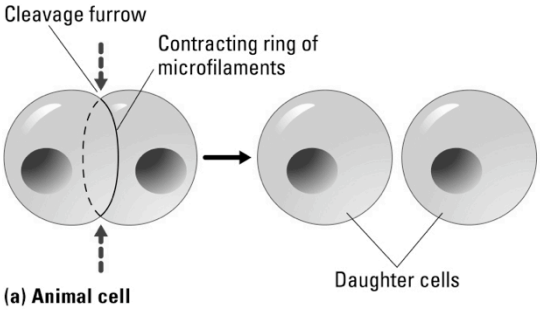
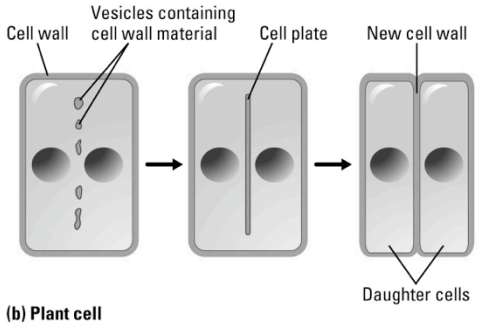
## Cytokinesis- Animals




**(a) Animal cell**



## Cytokinesis- Plants




**(b) Plant cell**



## Genetic Variation

- Lets look around the class at our variation in Phenotype (how our genes are expressed on the outside)
- Lots of variation exists…why?
  - Helps with survival

## Genetic Variation

- So variation is good for a population, how do we get it?
- Genetic Variation in Bacteria
  - Antibiotic resistance from random mutations

## Genetic Variation

- Antibiotic Resistance
  - 1 in a million genes per generation will mutate
  - *E. coli* reproduces in 20 minutes (Generation Time)
  - 1…2…4…8…16…32…64…… **7 hours = 1,000,000 cells!!!**
  - If one of these cells mutated so it was resistant, how many resistant cells in 7 more hours?

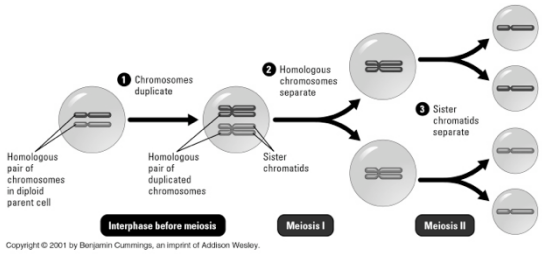
## Genetic Variation

- So, for organisms with very short generation times, depending on mutations for genetic variation can be OK
- What is **your** generation time?
- Can't depend on mutations for variation…too slow
- **Why is there Sex?**
  - Provides a way to mix genes and get variation

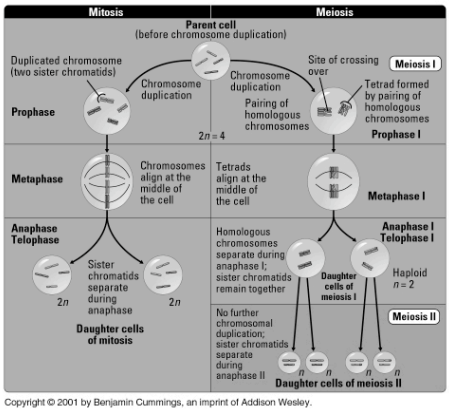
## Meiosis

- The process of cell division that results in the production of 4 haploid gametes that are genetically different from one another and from the parents.
- In Mitosis we made exact copies of the parent cells, with two sets of chromosomes
- In Meiosis the result is different cells with only one set of chromosomes

## Meiosis- Overview



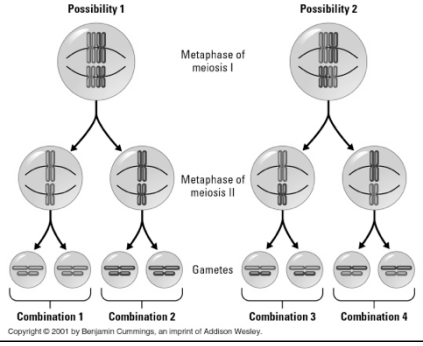




## How do we get our Genetic Variation?

- Random Assortment
  - We have a set of chromosomes from mom and a set from dad, which of these gets into the gametes is random
  - Four chromosome example- $2^2$=4 combos
  - Humans have 23 chromosomes- $2^{23}$= over 8 million different combos from each parent. $2^{23} \times 2^{23}$ =?
  - Over **64 trillion** different combinations of your parents genes!!

## Random Assortment

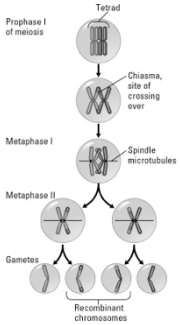




## How do we get our Genetic Variation?

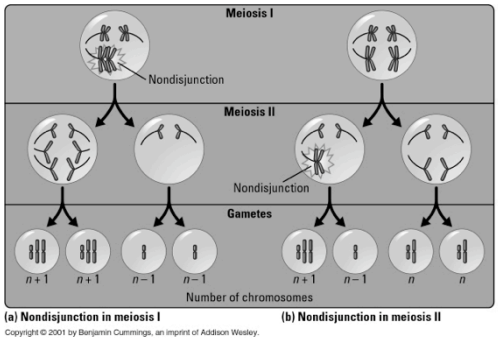
- Crossing Over
  - The exchange of corresponding segments between two homologous chromosomes.
  - Scrambles up the genes
  - Happens in Prophase I of Meiosis
  - Figure 7.18- example with one chromosome

## Crossing Over





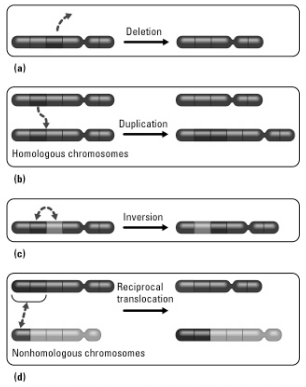
## Extra Chromosomes



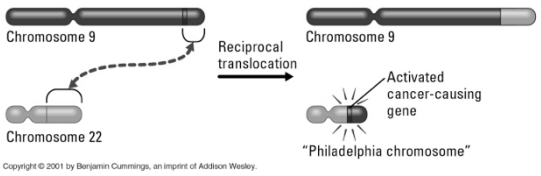


## When Meiosis Has Errors

- Alteration of Chromosome Structure
  - Four main types of structural changes
  - Deletion, Duplication, Inversion, and Translocation









## Errors are a source of Variation

- Most errors are "bad", but some can be good.
- New species can be developed from extra chromosome numbers (polyploid)
- Beneficial changes will persist, damaging ones will disappear

## Polyploidy

- More than 2 sets of chromosomes (diploid)
- Very common in plants (50-60% of flowering plants!)
- Can occur as a result of non-disjunction during meiosis
- Can occur when cytokinesis fails
- Can occur between two species-interspecific hybrid
- Leads to reproductive failure (eg. With diploids)
- Can lead to new species - especially sympatric speciation

## Key points

- Mitosis results in production of genetically identical cells
  - Involved in growth, asexual reproduction
- Meiosis results in halving chromosome number, results in genetic variabilty
  - A key step in sexual reproduction