### Key Terms and Definitions 1

- **Genome**
- **Chromosome**
- **Gene**
- **Locus**
- **Genotype**
- **Phenotype**
- **Genetics**
- **Heredity**
- **Variation**

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![Figure 16-21b](image)

- Chromatin (700 nm)
- Chromosome
- Metaphase chromosome
- Looped domains (300-nm fiber)
- Metaphase chromosome
- Looped domains (300-nm fiber)
- Metaphase chromosome
Slide 4

DNA double helix (2 nm in diameter)

Nucleosome (10 nm in diameter)

Histones Histone tail H1

DNA, the double helix Histones Nucleosomes, or “beads on a string” (10-nm fiber)

Slide 5

Fig. 5-28

Two polynucleotides spiraling around an imaginary axis form a Double Helix

What is meant by Antiparallel?

Slide 6

- Human somatic cells – ___ pairs of chromosomes
- The two chromosomes in each pair =
- Are these chromosomes identical?
- A karyotype – an ordered display of the pairs of chromosomes from a cell
- What information can you get from a karyotype?
Slide 7

DNA inherited by organisms lead to specific traits

Which of the following illustrate genotype? Phenotype?

Nucleotide #17 - Adenine (A) is replaced by Thymine (T), resulting in a Val for Glu substitution at amino acid #6.

A BRCA1 mutation

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Key Terms and Definitions 2

- Life cycle
- Genetic inheritance
- Asexual reproduction
- Clone
- Sexual reproduction
- Gametes
- Fertilization
- Somatic cells
- Allele

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Fig. 13-2

(a) Hydra
(b) Redwoods
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Sexual Life Cycles

Animals  Plants and some algae  Most fungi and some protists

Haploid (n)  Diploid (2n)

Gametes  

Mitosis  

MEIOSIS FERTILIZATION

Zygote  

Mitosis  

Diploid multicellular organism

Animals

Spores  

Diploid multicellular organism (sporophyte)

Plants and some algae

Most fungi and some protists

MEIOSIS FERTILIZATION

Zygote  

Mitosis  

Haploid multicellular organism (gametophyte)

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The Animal Life Cycle

- The sex chromosomes are called X and Y
- Human females have a homologous pair of X chromosomes (XX)
- Human males have one X and one Y chromosome
- The 22 pairs of chromosomes that do not determine sex are called autosomes

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Slide 13

The Animal Life Cycle

- A diploid cell (2n) has two sets of chromosomes
- n = # of chromosomes in a gametes
- For humans, the diploid number is 46 (2n = 46)
  (Fruit flies 2n = 8, Dogs 2n = 78)

Polyploidy = more than 2 sets of chromosomes
(common in plants)

Are humans ever polyploids?

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Fig. 13-4

Key
- Maternal set of chromosomes (n = 3)
- Paternal set of chromosomes (n = 3)

Label the following diagram

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The Animal Life Cycle

- A gamete (sperm or egg) contains a single set of chromosomes, and is haploid (n)
- For humans, the haploid number is 23 (n = 23)
- Each set of 23 consists of 22 autosomes and a single sex chromosome
- In an unfertilized egg (ovum), the sex chromosome is X
- In a sperm cell, the sex chromosome may be either X or Y

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Slide 16

The Animal Life Cycle

- **Fertilization** is the union of gametes (the sperm and the egg)
- The fertilized egg is called a zygote and has one set of chromosomes from each parent
- The zygote produces somatic cells by _______ and develops into an adult

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Key Concept: Much of our inheritable variation results from changes to the parent’s DNA that occur during meiosis

Individual eggs and sperm are different from each other and from the parent – therefore, so are siblings

What's the difference between fraternal and identical twins?

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The BIG PICTURE of Meiosis

- One Interphase just like Mitosis
  - G1, S-Phase, G2
  - diploid 46 chromosomes replicate to form 92 sisters joined in pairs
- Followed by Two Cell Divisions instead of One
  - In meiosis I, homologous chromosomes separate resulting in two haploid daughters with 46 sisters joined in 23 pairs
  - It is called the reductional division
  - In meiosis II, sister chromatids separate resulting in four haploid daughters with 23 unjoined chromosomes (much like mitosis)
  - It is called the equational division
Interphase

Homologous pair of chromosomes in diploid parent cell

Chromosomes replicate

Homologous pair of replicated chromosomes

Sister chromatids

Diploid cell with replicated chromosomes

Meiosis I

Homologous chromosomes separate

1 Haploid cells with replicated chromosomes

Meiosis II

2 Sister chromatids separate

Haploid cells with unreplicated chromosomes

Reductional division

Equational division

Slide 20

Remind me what prophase is again........

Slide 21

Metaphase I

Fig. 13-8a

Anaphase I

Telophase I and Cytokinesis

Centrosome (with centriole pair)

Sister chromatids

Chiasmata

Spindle

Homologous chromosomes

Fragments of nuclear envelope

Centromere (with kinetochore)

Metaphase plate

Microtubule attached to kinetochore

Sister chromatids remain attached

Homologous chromosomes separate

Cleavage furrow

What are chiasmata?
Slide 22

Remind me what telophase is again.......
A Comparison of Mitosis and Meiosis

- Mitosis conserves the number of chromosome sets, producing cells that are genetically identical to the parent cell.
- Meiosis reduces the number of chromosome sets from two (diploid) to one (haploid), producing cells that differ genetically from each other and from the parent cell.
- The mechanism for separating sister chromatids is virtually identical in meiosis II and mitosis.

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Fig. 13-9a

MITOSIS MEIOSIS

MEIOSIS

I Prophase

Chiasma

Chromosome replication

Homologous chromosome pair

Chromosome replication

2n = 6

Parent cell

Prophase

Replicated chromosome

Metaphase Metaphase I

Anaphase Anaphase I

Telophase Telophase I

Haploid n = 3

Daughter cells of meiosis

MEIOSIS II

Daughter cells of meiosis

2n

2n

Daughter cells of mitosis

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- Three events are unique to meiosis, and all three occur in meiosis I:
  - Formation of tetrads at the metaphase plate
  - Synapsis (cohesion) and crossing over amongst 4 sisters
  - Separation of homologous chromosomes.
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Remember Our Key Concept:

• Much of our inheritable variation results from changes to the parent’s DNA that occur during meiosis
• These changes occur in both parents and are then combined at fertilization to create most of the variation that arises in each generation

Concept 13.4: Genetic variation produced in sexual life cycles contributes to evolution

• Mutations (changes in an organism’s DNA) are the primary source of genetic diversity
• Mutations create different versions of genes called alleles (which reside on homologous chromosomes)
• Reshuffling of alleles during sexual reproduction produces genetic variation
Origins of Genetic Variation Among Offspring

Three mechanisms contribute to genetic variation:
- Independent assortment of chromosomes
- Crossing over
- Random fertilization

Independent Assortment of Chromosomes

- Homologous pairs of chromosomes orient randomly at metaphase I of meiosis
- In independent assortment, each pair of chromosomes sorts maternal and paternal homologues into daughter cells independently of the other pairs
- The number of combinations possible when chromosomes assort independently into gametes is \(2^n\), where \(n\) is the haploid number
- For humans \((n = 23)\), there are more than 8 million \((2^{23})\) possible combinations of chromosomes
**Prophase I of meiosis**
- Pair of homologs nonsister chromatids held together during synapsis
- Chiasma

**Anaphase I**
- Daughter cells
- Recombinant chromosomes

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**Crossing Over**
- Crossing over produces **recombinant chromosomes**, which combine genes inherited from each parent
- Crossing over begins very early in prophase I, as homologous chromosomes pair up gene by gene
- In crossing over, homologous portions of two nonsister chromatids trade places
- Crossing over contributes to genetic variation by combining DNA from two parents into a single chromosome

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**Random Fertilization**
- Random fertilization adds to genetic variation because any sperm can fuse with any ovum (unfertilized egg)
- The fusion of two gametes (each with 8.4 million possible chromosome combinations from independent assortment) produces a zygote with any of about 70 trillion diploid combinations
The Evolutionary Significance of Genetic Variation Within Populations

- Natural selection results in the accumulation of genetic variations favored by the environment
- Sexual reproduction contributes to the genetic variation in a population, which originates from mutations