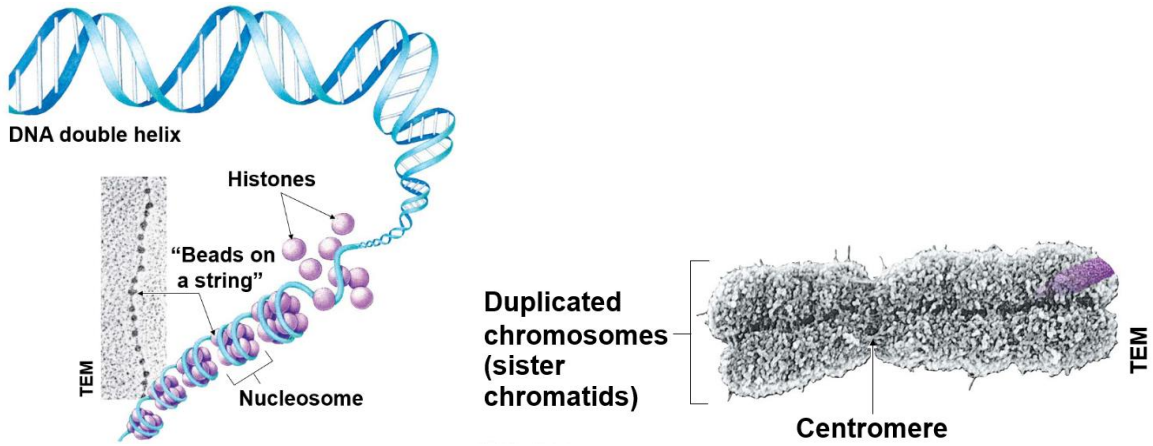
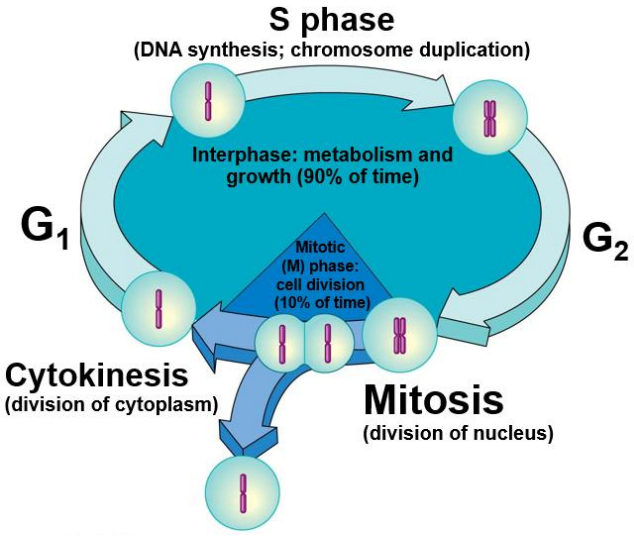
Review

Chapter 8. Cellular Reproduction: cells from cells

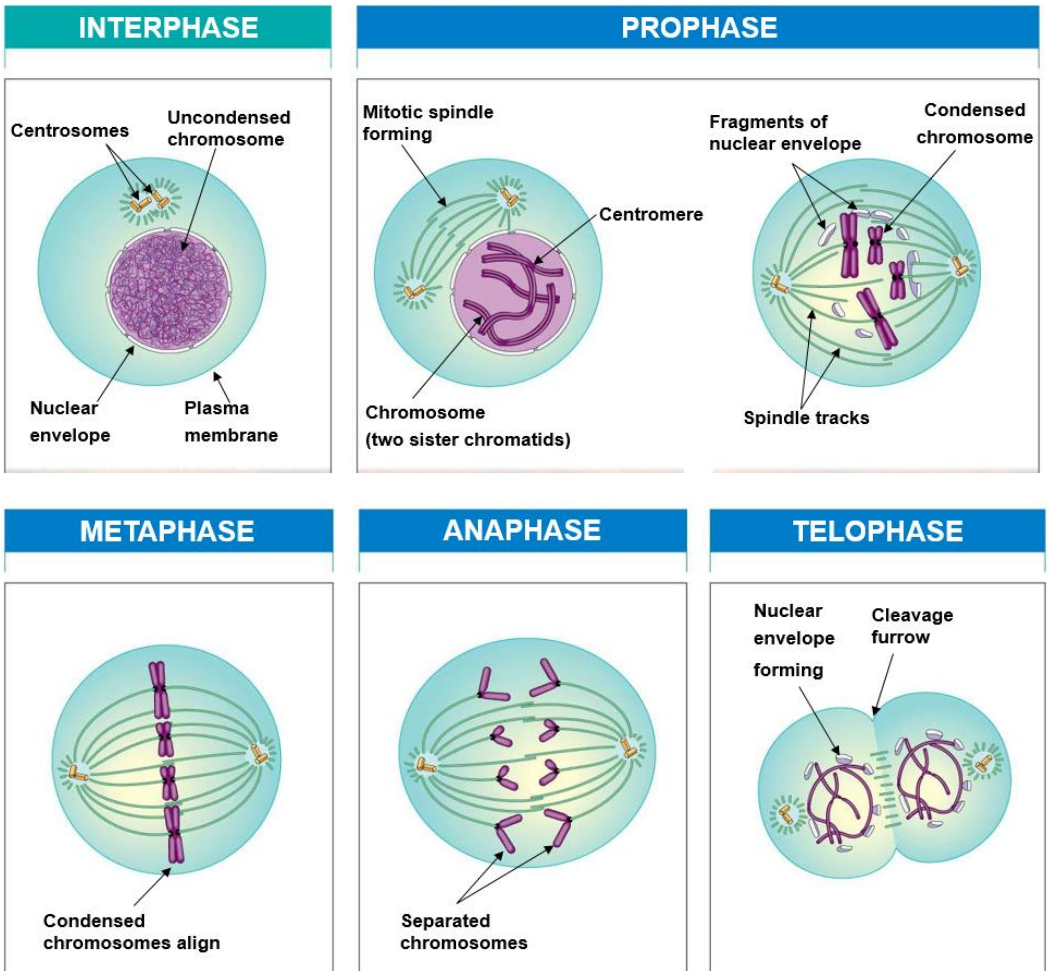
- **Cell division:** The two "daughter" cells that result are genetically identical to each other and to the original "parent" cell.
- **Functions of cell division:**
  1) Cell replacement
  2) Growth
  3) Reproduction
  - ✧ **Asexual reproduction → mitosis (有丝分裂) → growth and maintenance**
  - ✧ **Sexual reproduction → meiosis (减数分裂) → gametes (配子) → reproduction**
- **Chromosome (染色体):** The structure that contain most of the cell's DNA.
- **Chromatin (染色质):** Fibers composed of roughly equal amounts of DNA and protein molecules. The protein molecules help organize the chromatin and help control the activity of its genes.
- **Histones (组蛋白)→Nucleosome (核小体):** Consists of DNA wound around several histone molecules. **→Sister chromatids (姐妹染色单体) →Centromere (着丝点)**



- **Cell cycle:** The ordered sequence of events that extends from the time a cell is first formed from a dividing parent cell until its own division into two cells.



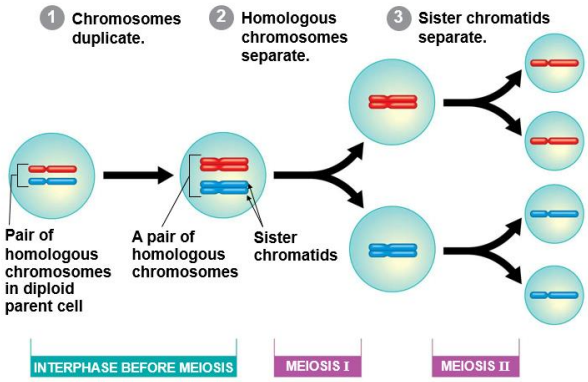
- **Interphase (间期):** A time when a cell goes about its usual business, performing its normal functions within the organism. Interphase lasts for at least 90% of the cell cycle.
  - ✧ G_1 phase:
  - ✧ S phase:
  - ✧ G_2 phase:
- **Four main stages of mitosis (有丝分裂):**
  prophase (前期); metaphase (中期); anaphase (后期); telophase (末期)
  At the start of mitosis, the chromosomes coil up and the nuclear envelope breaks down (prophase). Next, a mitotic spindle made of microtubule tracks moves the chromosomes to the middle of the cell (metaphase). The sister chromatids then separate and are moved to opposite poles of the cell (anaphase), where two new nuclei form (telophase). Cytokinesis overlaps the end of mitosis. In animals, cytokinesis occurs by cleavage, which pinches the cell in two. In plants, a membranous cell plate divides the cell in two. Mitosis and cytokinesis produce genetically identical cells.
- **Mitotic spindle (有丝分裂纺锤体):** A football-shaped structure of microtubule tracks that guides the separation of the two sets of daughter chromosomes.



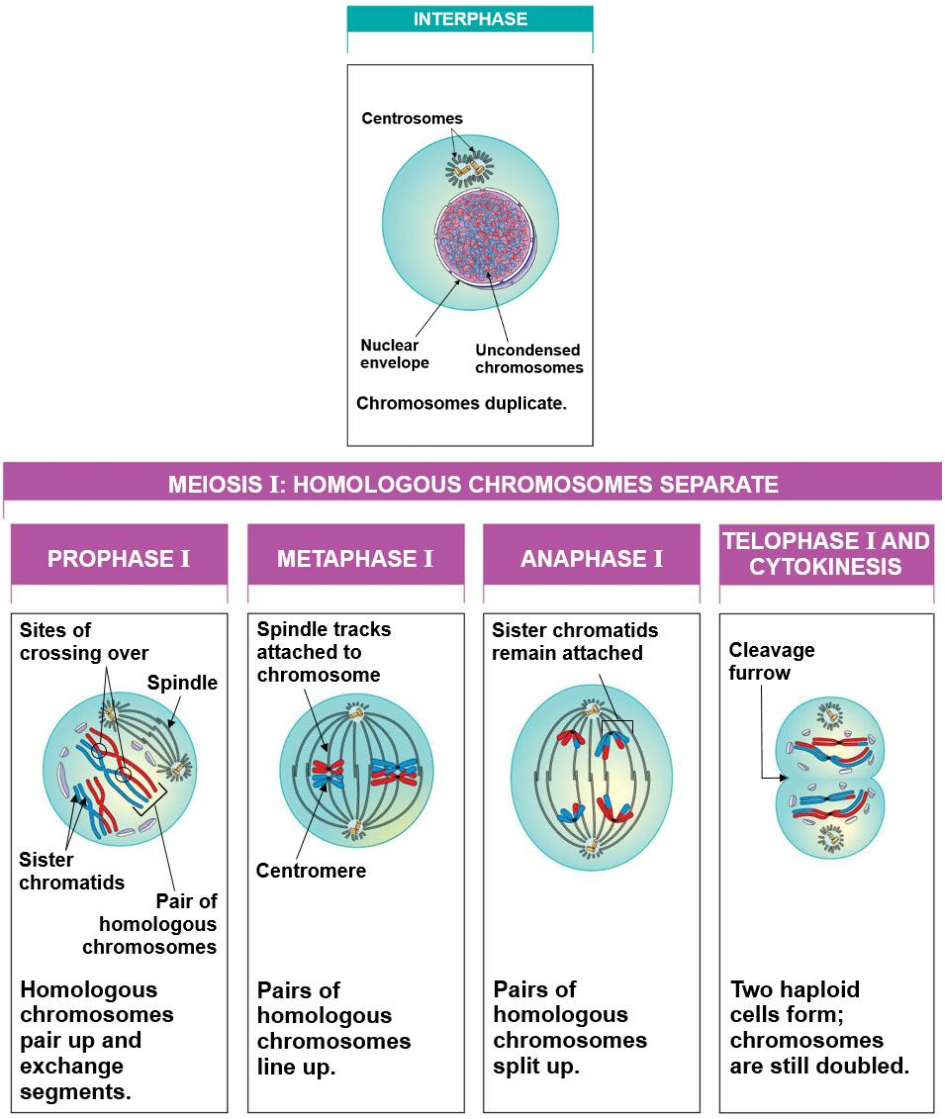
- **Cytokinesis (胞质分裂):** The division of the cytoplasm into two cells, usually begins during telophase, overlapping the end of mitosis.
  - ✧ **Animal cell:** Cleavage

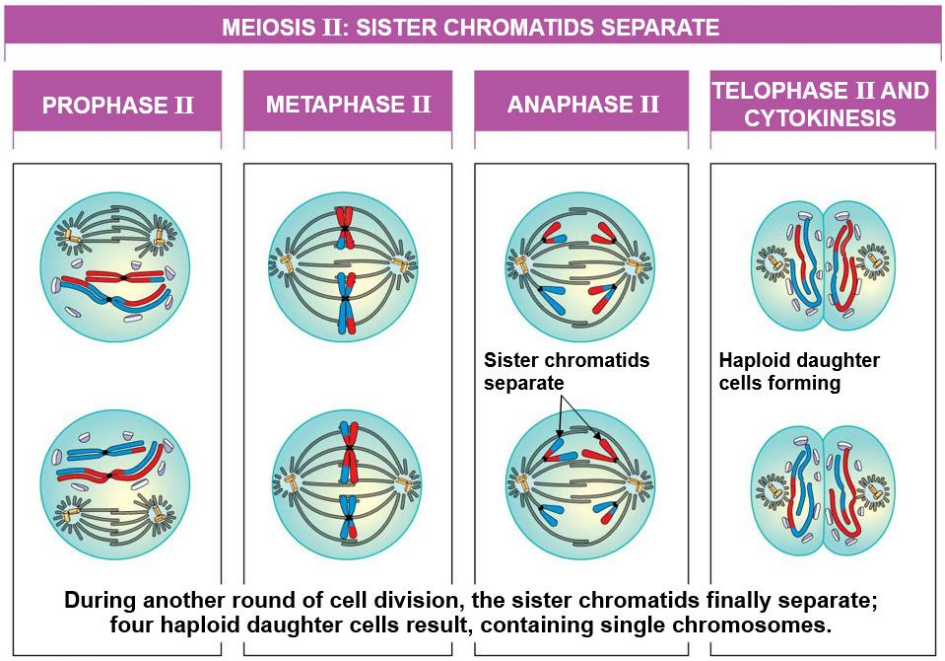
- ✧ **Plant cell:** Vesicles containing cell wall material collect at the middle of the cell. The vesicles fuse, forming a membranous disk called the **cell plate (细胞板)**. The cell plate grows outward, accumulating more cell wall material as more vesicles join it. Eventually, the membrane of the cell plate fuses with the plasma membrane, and the cell plate's contents join the parental cell wall.

- **Cell cycle control system:** Consists of specialized proteins within the cell. These proteins integrate information from the environment and from other body cells and send "stop" and "ho ahead" signals at certain key points during the cell cycle.
- **Tumor:** An abnormally growing mass of body cells.
  - ✧ **Benign tumor (良性肿瘤):** The abnormal cells remain at the original site.
  - ✧ **Malignant tumor (恶性肿瘤):** One that has the potential to spread into neighboring tissues and other parts of the body, forming new tumors.
- **Metastasis (转移):** The spread of cancer cells beyond their original site.
- **Cancer treatment:**
  - ✧ **Surgery:** The first step to remove a tumor, usually for many benign tumors.
  - ✧ **Radiation therapy:** Usually for malignant tumors that have not yet spread.
  - ✧ **Chemotherapy:** The use of drugs to disrupt cell division, is used to treat widespread or metastatic tumors.
- **Somatic cell (体细胞):** body cell
- **Karyotype (核型):** arrangement of the chromosomes in matching pairs by size
- **Homologous chromosomes (同源染色体):** Carry genes controlling the same inherited characteristics.
  - ✧ **Sex chromosomes (性染色体):** Determine a person's sex (male versus female). Males have one X chromosome and one Y chromosome; females have two X chromosomes.
  - ✧ **Autosomes (常染色体):** The chromosomes except sex chromosomes that found in both males and females.
- **Life cycle (multicellular organism):** The sequence of stages leading from the adults of one generation to the adults of the next.
- **Diploid organisms (二倍体):** All body cells contain pairs of homologous chromosomes.
- **Haploid cell (单倍体):** It has only one member of each pair of homologous chromosomes.
- **Fertilization (受精):** In the human life cycle, a haploid sperm fuses with a haploid egg.
- **Zygote (受精卵):** The resulting fertilized egg.
- **How meiosis halves chromosome number:**

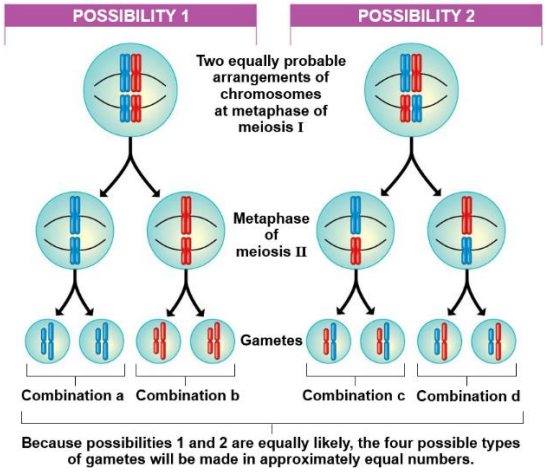


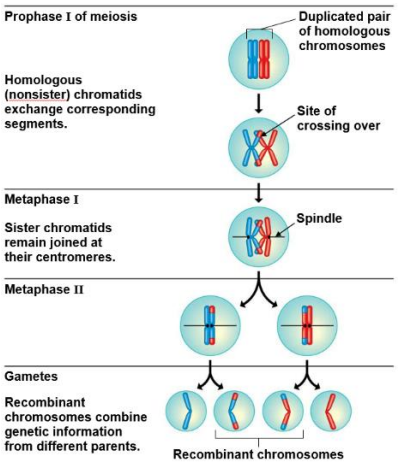
- **Meiosis:** The process of cell division that produces haploid gametes in diploid organisms.
- Meiosis, like mitosis, is preceded by chromosome duplication. But in meiosis, the cell divides twice to form four daughter cells. The first division, meiosis I, starts with the pairing of homologous chromosomes. In crossing over, homologous chromosomes exchange corresponding segments. Meiosis I separates the members of the homologous pairs and produces two daughter cells, each with one set of (duplicated) chromosomes. Meiosis II is essentially the same as mitosis; in each of the cells, the sister chromatids of each chromosome separate.



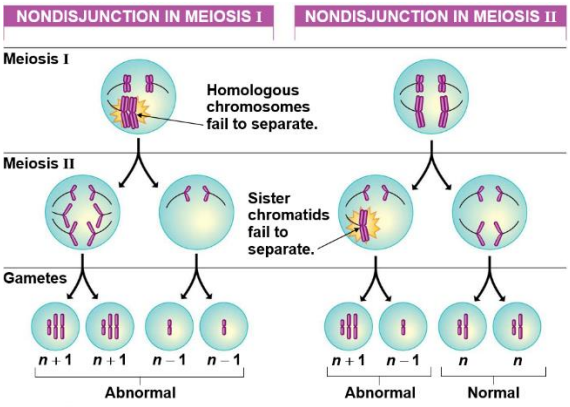


- **The difference between meiosis and mitosis:**
  1. During meiosis, the number of chromosomes is cut in half. A cell that duplicated its chromosomes undergoes two consecutive divisions, called meiosis I and meiosis II.
  2. **Crossing over**: the exchange of corresponding segments between nonsister chromatids of homologous chromosomes, which occurs during *prophase I* of meiosis.
- **The total number of chromosome combinations (in gamete):** 2^n, n represents the haploid number.
- **Genetic variation (遗传变异):**
  - ✧ Independent assortment of chromosomes;
  - ✧ Crossing over.





- **When Meiosis goes awry:**
  - ✧ **Nondisjunction:** The members of a chromosome pair fail to separate at anaphase. Nondisjunction can occur during meiosis I or II.



- Down syndrome (唐氏综合症): trisomy 21 (21 三体综合症), an autosomal nondisjunction.
- The most common human sex chromosome abnormalities:

Table 8.1 Abnormalities of Sex Chromosome Number in Humans

Sex Chromosomes	Syndrome	Origins of Nondisjunction	Frequency in Population
XXY	Klinefelter syndrome (male)	Meiosis in egg or sperm formation	$\frac{1}{2,000}$
XYY	None (normal male)	Meiosis in sperm formation	$\frac{1}{2,000}$
XXX	None (normal female)	Meiosis in egg or sperm formation	$\frac{1}{1,000}$
XO	Turner syndrome (female)	Meiosis in egg or sperm formation	$\frac{1}{5,000}$

Chapter 9. Patterns of Inheritance

- **Heredity (遗传性):** The transmission of traits from one generation to the next.
- **Character:** A heritable feature that varies among individuals.
- **Trait:** Each variant of a character.
- **Hybrids:** The offspring of two different purebred varieties**.**
- **Monohybrid cross:** A cross between the purebreds of one character.
- **Mendel's four hypotheses:**

  1) There are alternative versions of genes—**alleles (等位基因)** that account for variations in inherited characters;

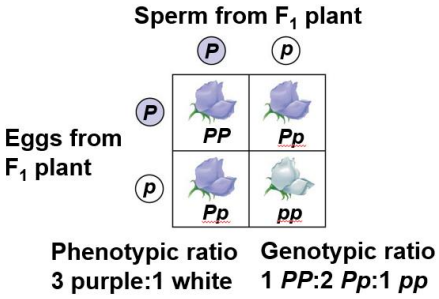
  2) For each inherited character, an organism inherits two alleles, one from each parent.

  Homozygous (纯合子): An organism that has two identical alleles for a gene.

  Heterozygous (杂合子): An organism that has two different alleles for a gene.

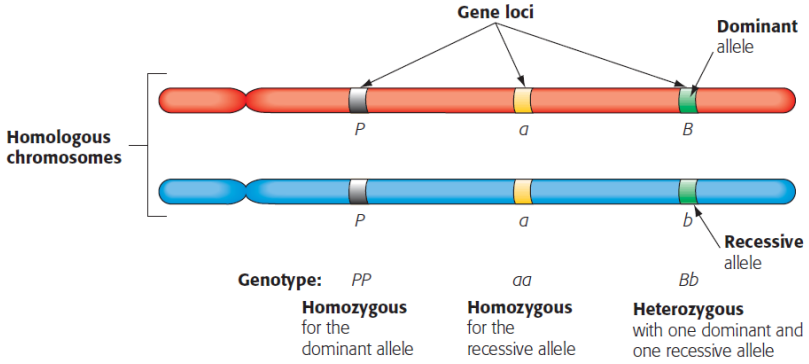
  3) If the two alleles of an inherited pair differ, then one determines the organism's appearance and is called the **dominant allele (显性等位基因)**; the other has no noticeable effect on the organism's appearance and is called the **recessive allele (隐性等位基因)**.

  4) **The law of segregation** (分离定律): A sperm or egg carries only one allele for each inherited character because the two alleles for a character segregate (separate) from each other during the production of gametes.
- Punnett square（庞氏表）



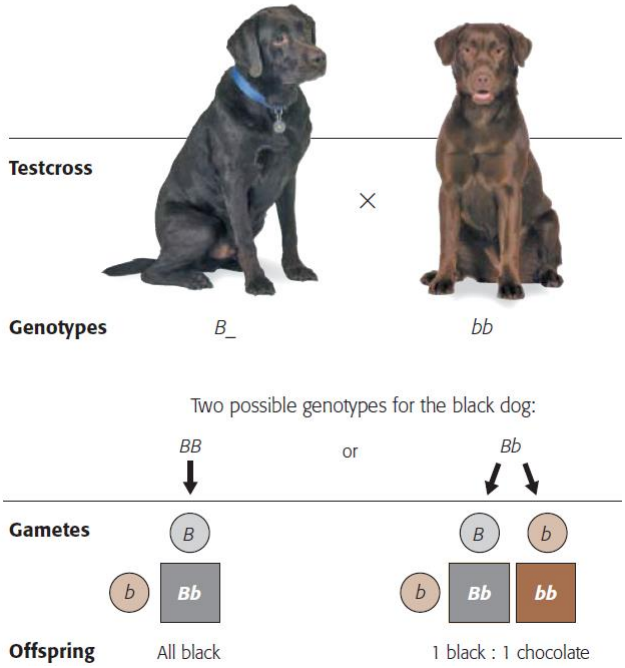
- **Phenotype (表现型):** An organism's physical appearance.
- **Genotype (基因型):** An organism's genetic makeup.
- **Gene locus (基因位点):** A specific location of a gene along the chromosome. Alleles (alternative versions) of a gene reside at the same locus on homologous chromosomes.

Figure 9.7 The relationship between alleles and homologous chromosomes. The matching colors of corresponding loci highlight the fact that homologous chromosomes carry alleles for the same genes at the same positions along their lengths.



- **Mendel's law of independent assortment:** Each pair of alleles segregates independently of the other pairs of alleles during gamete formation.
- **Dihybrid cross (双因子杂种杂交):** The mating of parental varieties differing in two characters.
- **Testcross (侧交):** A mating between an individual of dominant phenotype but unknown genotype and a homozygous recessive individual.

▼ Figure 9.10 A Labrador retriever testcross. To determine the genotype of a black Lab, it can be crossed with a chocolate Lab (homozygous recessive, *bb*). If all the offspring are black, the black parent most likely had genotype *BB*. If any of the offspring are chocolate, the black parent must be heterozygous (*Bb*).

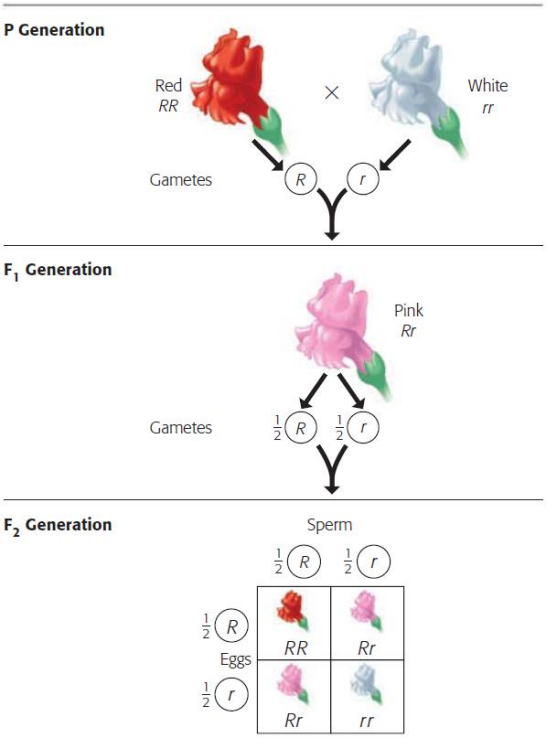


- **Rule of multiplication:** The probability of a dual event is the product of the separate probabilities of the independent events.
- **Human disorders controlled by a single gene:**

Table 9.1	Some Autosomal Disorders in People
Disorder	**Major Symptoms**
Recessive Disorders	
Albinism	Lack of pigment in skin, hair, and eyes
Cystic fibrosis	Excess mucus in lungs, digestive tract, liver; increased susceptibility to infections; death in early childhood unless treated
Phenylketonuria (PKU)	Accumulation of phenylalanine in blood; lack of normal skin pigment; mental retardation unless treated
Sickle-cell disease	Sickled red blood cells; damage to many tissues
Tay-Sachs disease	Lipid accumulation in brain cells; mental deficiency; blindness; death in childhood
Dominant Disorders	
Achondroplasia	Dwarfism
Alzheimer's disease (one type)	Mental deterioration; usually strikes late in life
Huntington's disease	Mental deterioration and uncontrollable movements; strikes in middle age
Hypercholesterolemia	Excess cholesterol in blood; heart disease

- **Incomplete dominance (半显性):** The appearance of F_1 hybrids falls between the phenotypes of the two parents.

▼ Figure 9.18 Incomplete dominance in snapdragons.
Compare this diagram with Figure 9.6, where one of the alleles displays complete dominance.



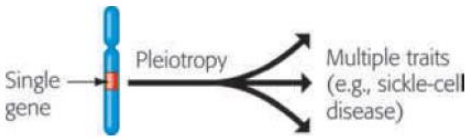
- **Multiple alleles (复等位基因):** The genes that found in populations in more than two forms.

- **Codominant (共显性):** Both alleles are expressed in heterozygous individuals.

Figure 9.20 Multiple alleles for the ABO blood groups. The three versions of the gene responsible for blood type may produce carbohydrate A (allele I^A), carbohydrate B (allele I^B), or neither carbohydrate (allele i). Because each person carries two alleles, six genotypes are possible that result in four different phenotypes. The clumping reaction that occurs between antibodies and foreign blood cells is the basis of blood-typing (shown in the photograph at right) and of the adverse reaction that occurs when someone receives a transfusion of incompatible blood.

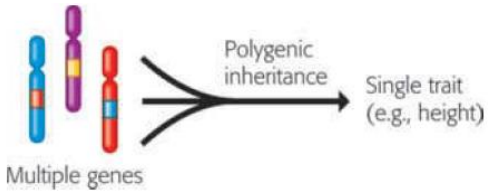
Blood Group (Phenotype)	Genotypes	Red Blood Cells	Antibodies Present in Blood	Reactions When Blood from Groups Below Is Mixed with Antibodies from Groups at Left			
				O	A	B	AB
A	I^AI^A or I^Ai	Carbohydrate A	Anti-B				
B	I^BI^B or I^Bi	Carbohydrate B	Anti-A				
AB	I^AI^B		—				
O	ii		Anti-A Anti-B				

- **Pleiotropy (基因多效性):** A property that one gene influences several characters.

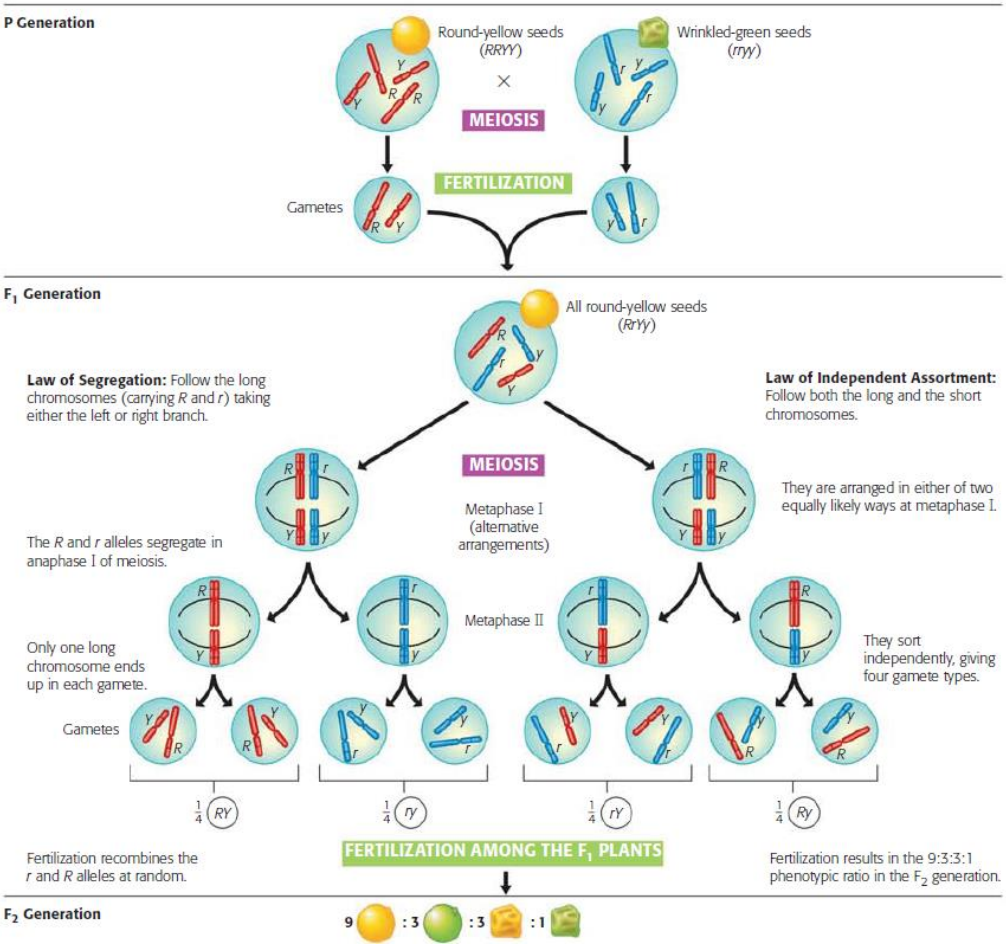


In pleiotropy, one gene (such as the sickle-cell disease gene) can affect many characters (such as the multiple symptoms of the disease).

- **Polygenic inheritance (多基因遗传):** The additive effects of two or more genes on a single phenotypic character.



- **Epigenetic inheritance (表观遗传):** The transmission of traits by mechanisms not directly involving DNA sequence.
- **The chromosome theory of inheritance:** Genes are located at specific positions (loci) on chromosomes and that the behavior of chromosomes during meiosis and fertilization accounts for inheritance patterns.



- **Linked genes (连锁基因):** Genes located near each other on the same chromosome and tend to travel together during meiosis and fertilization. Such genes are often inherited as a set and therefore often do not follow Mendel's law of independent assortment.
  - ✧ **Sex Determination in Humans**
    In humans, sex is determined by whether a Y chromosome is present. A person who inherits two X chromosomes develops as a female. A person who inherits one X and one Y chromosome develops as a male.
  - ✧ **Sex-linked gene (性别连锁基因):** A gene located on a sex chromosome.
    Most sex-linked human disorders, such as red-green colorblindness and hemophilia (血友病), are due to recessive alleles and are seen mostly in males. A male receiving a single sex-linked recessive allele from his mother will have the disorder; a female has to receive the allele from both parents to be affected.

Sex-Linked Traits				
Female: Two alleles	Genotype	X^NX^N	X^NX^n	X^nX^n
	Phenotype	Normal female	Carrier female	Affected female (rare)
Male: One allele	Genotype	X^NY		X^nY
	Phenotype	Normal male		Affected male