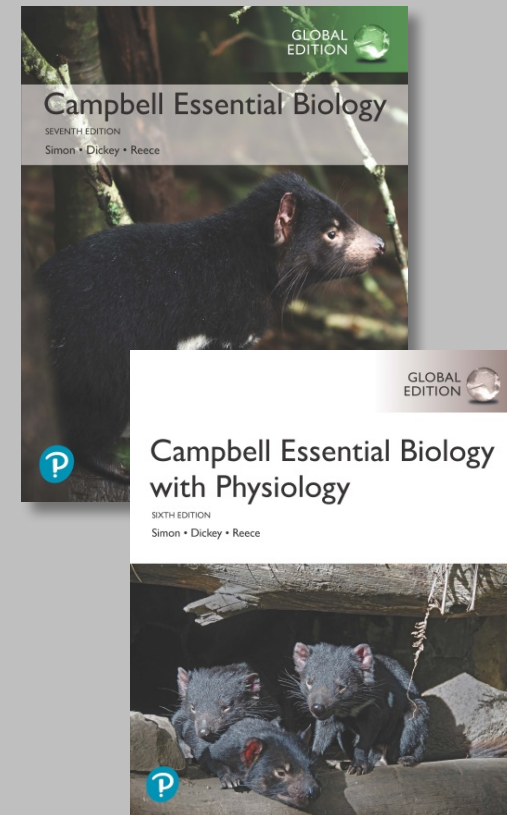


# Campbell Essential Biology, Seventh Edition, Global Edition and Campbell Essential Biology with Physiology, Sixth Edition, Global Edition

## Chapter 09 Patterns of Inheritance



PowerPoint® Lectures created by Edward J. Zalisko, Eric J. Simon, Jean L. Dickey, and Jane B. Reece



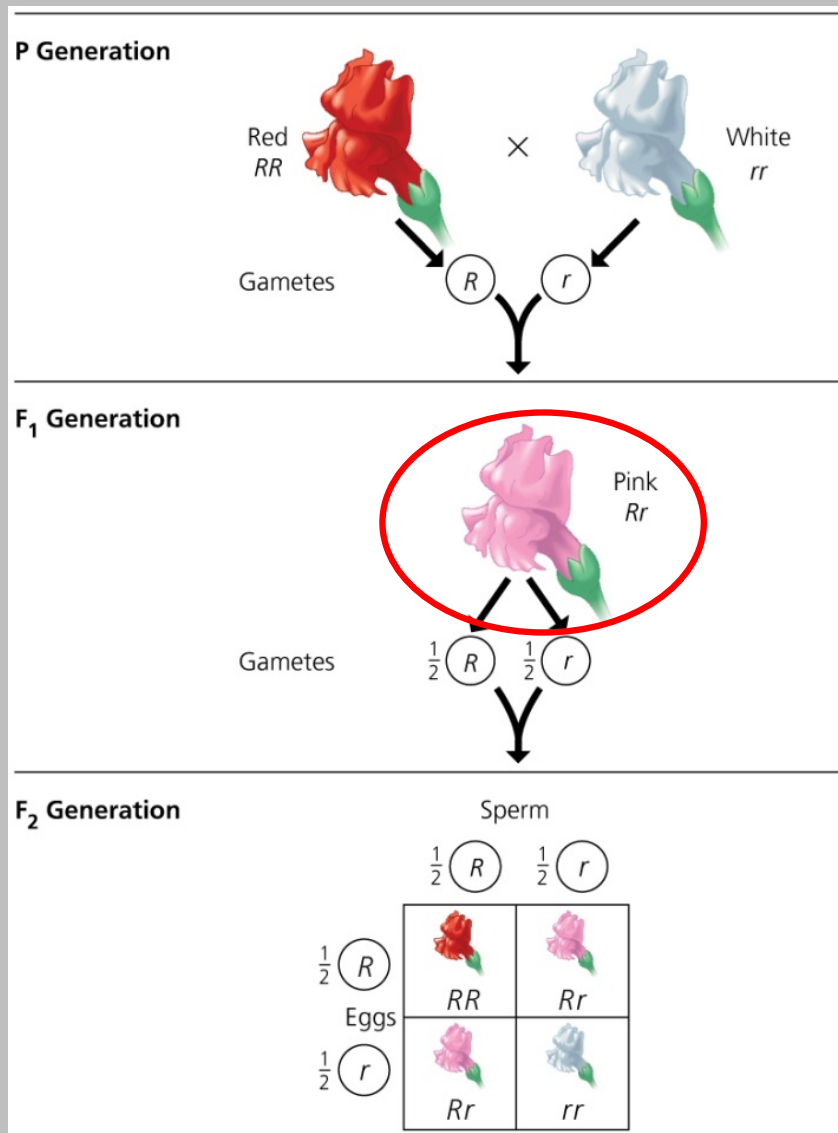
# Variations on Mendel's Laws

- Mendel's two laws explain inheritance in terms of genes that are passed along from generation to generation according to simple rules of probability. These laws are valid for all sexually reproducing organisms.
- But Mendel's laws stop short of explaining some patterns of genetic inheritance.
  - In fact, for most sexually reproducing organisms, cases in which Mendel's rules can strictly account for the patterns of inheritance are relatively rare.
  - More often, the observed inheritance patterns are more complex.



# Variations on Mendel's Laws

## 1) Incomplete Dominance in Snapdragons



- In **incomplete dominance**,  $\rightarrow F_1$  hybrids have an appearance between the parent phenotypes.





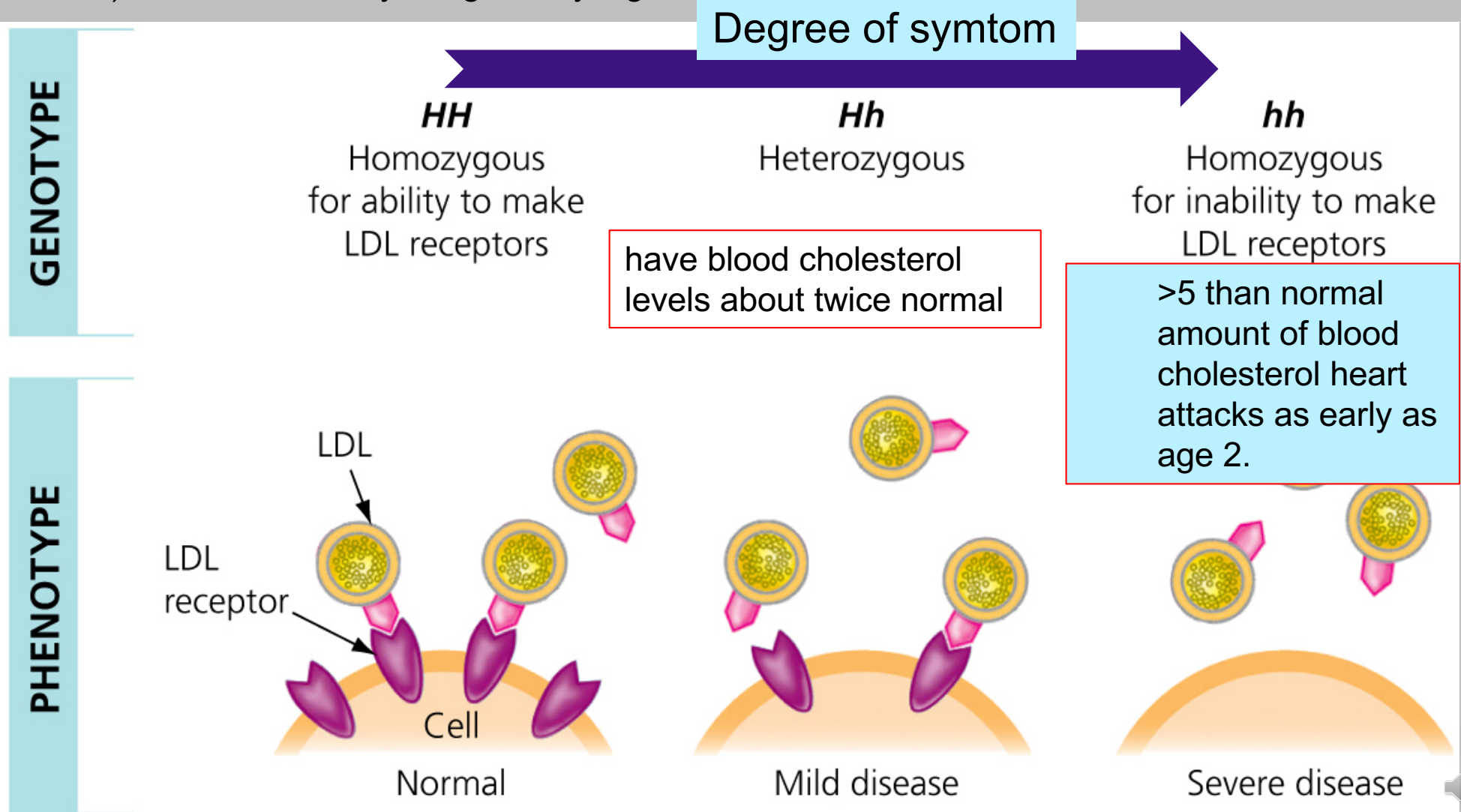


# Variations on Mendel's Laws

## 1) Incomplete Dominance

Hypercholesterolemia

- 1) example of incomplete dominance
- 2) characterized by dangerously high levels of cholesterol in the blood.



# Variations on Mendel's Laws


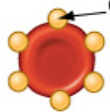


## 2) Multiple Alleles and Codominance

- Multiple alleles
  - 3 or more alleles in a population
  - Phenotype depends on which 2 alleles are inherited

- ABO blood types in humans

-4 blood types (A,B, AB,O)

-Three alleles affecting blood type  $I^A$ ,  $I^B$ ,  $i$

Blood Group (Phenotype)	Genotypes	Red Blood Cells
A	$I^A I^A$ or $I^A i$	
B	$I^B I^B$ or $I^B i$	
AB	$I^A I^B$	
O	$ii$	

Based on which combinations of alleles you have,

**RBC express different types of Carbohydrates called “Surface antigen”**

$I^A$  or  $I^B$  is dominant over  $i$  allele

$I^A$  and  $I^B$  are codominant

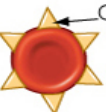
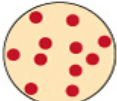
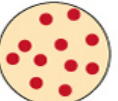


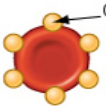
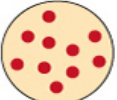

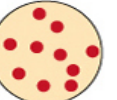


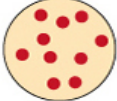
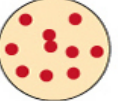
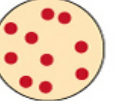
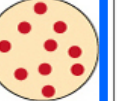

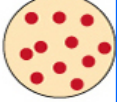





# Variations on Mendel's Laws

## 2) Multiple Alleles and Codominance

### □ ABO blood types and transfusion

- Matching compatible blood groups is critical for safe blood transfusions.
  - If a donor's blood cells have a carbohydrate (A or B) that is foreign to the recipient, then the recipient's immune system produces blood proteins called antibodies that bind to the foreign carbohydrates.
  - These antibodies cause the donor blood cells to clump together, potentially killing the recipient.

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	$I^A I^A$ or $I^A i$		Anti-B				
B	$I^B I^B$ or $I^B i$		Anti-A				
AB	$I^A I^B$		—				
O	$ii$		Anti-A Anti-B				

Blood donation possible from these blood types

Reserved



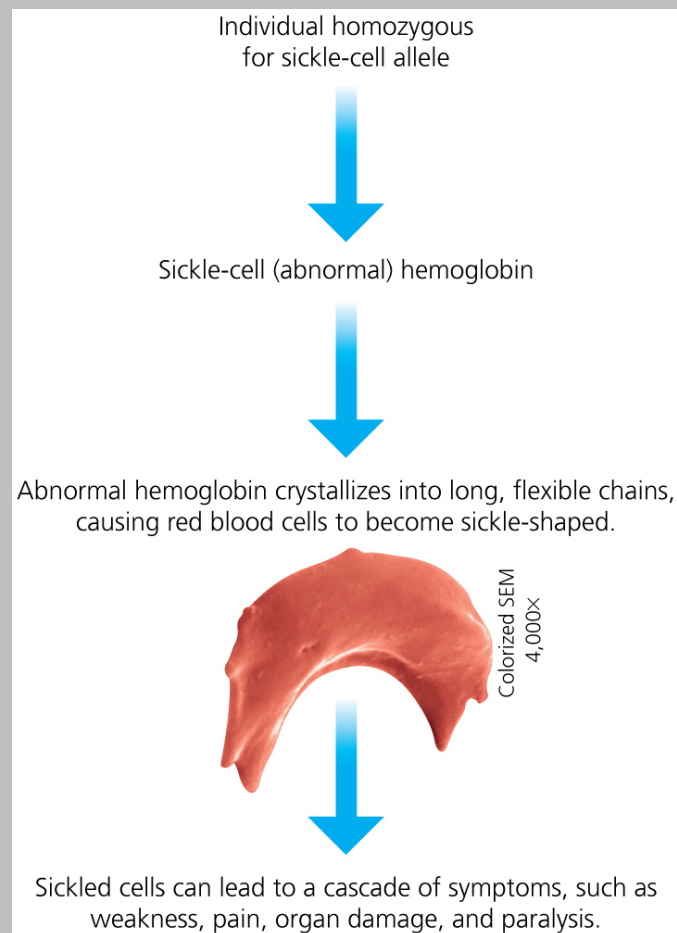
# Variations on Mendel's Laws

- 1) **Incomplete Dominance**
- 2) **Multiple Alleles and Codominance**
- 3) **Pleiotropy**  
→ one gene influences several characters.
- 4) **Polygenic Inheritance**  
→ the additive effects of two or more genes on a single phenotypic character



# Variations on Mendel's Laws

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# Variations on Mendel's Laws

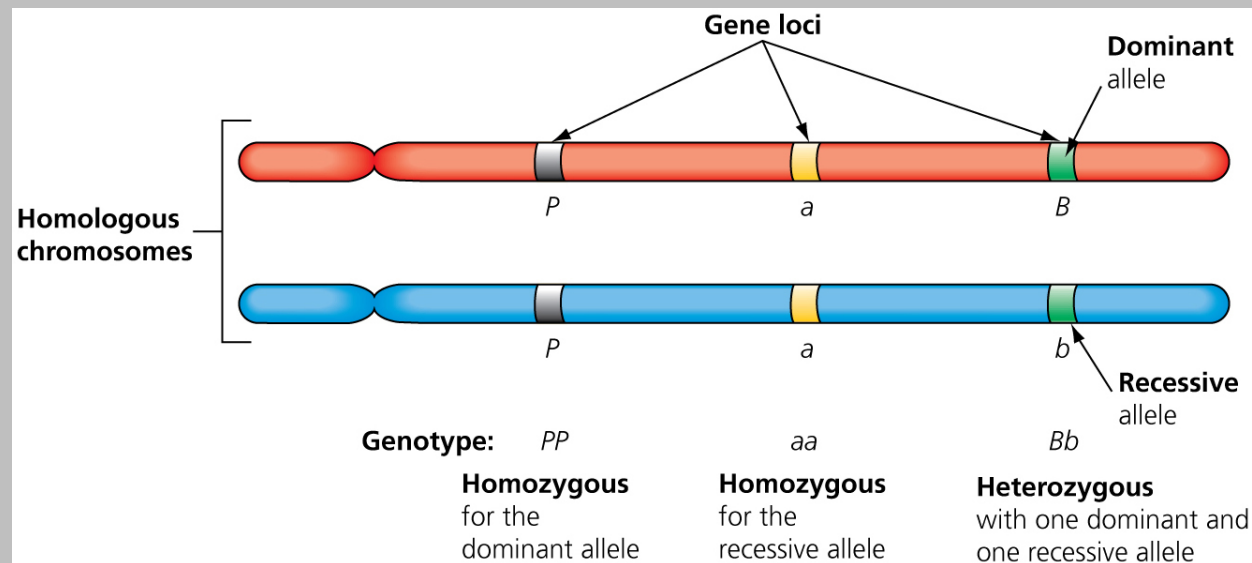
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- 3) **Pleiotropy**  
→ one gene influences several characters.
- 4) **Polygenic Inheritance**  
→ the additive effects of two or more genes on a single phenotypic character
  - Height in people
  - Many diseases, including diabetes, heart disease, and cancer, display polygenic inheritance.



# The Chromosomal Basis of Mendel's Laws

## The Relationship Between Alleles and Homologous Chromosomes

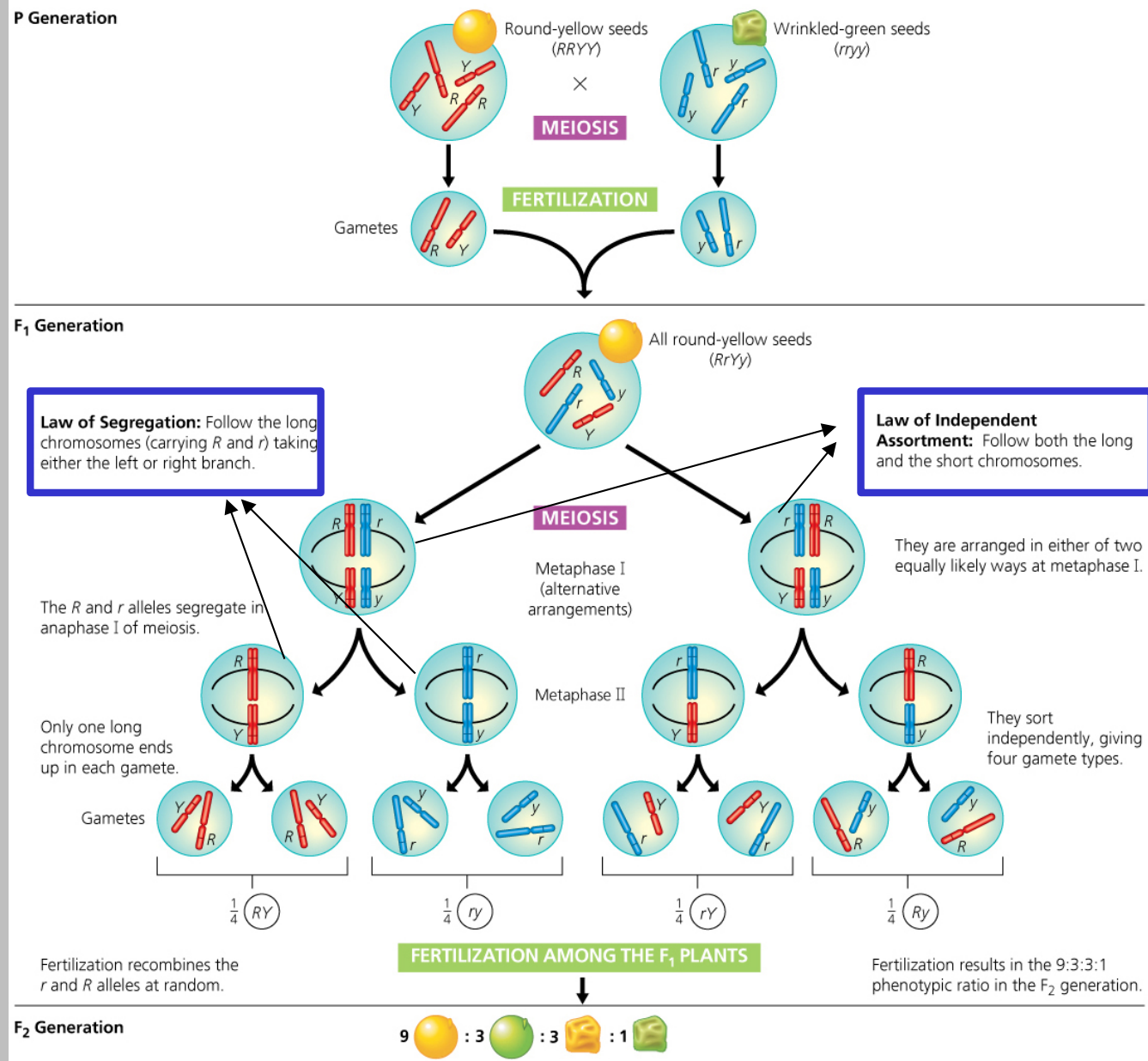
A gene **locus** is a specific location of a gene along a chromosome.



From previous slide



# The Chromosomal Basis of Mendel's Laws (relating to meiotic process)



# Beyond Mendel's law

## Linked Genes

- **Linked genes** are located near each other on the same chromosome and **tend to travel together during meiosis and fertilization**.
  - Linked genes are **often inherited as a set** and therefore often do not follow Mendel's law of independent assortment.
- So far, the patterns of genetic inheritance we've discussed have always involved genes located on autosomes, not on the sex chromosomes.
  - We are now ready to look at the role of sex chromosomes and the inheritance patterns exhibited by the characters they control.

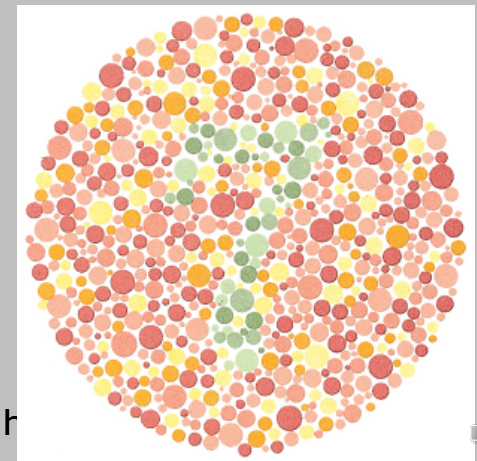


# Beyond Mendel's law

## Linked Genes

### 1) Sex-Linked Genes

- A gene located on a sex chromosome is called a **sex-linked gene**.
- Because they are located on the sex chromosomes, sex-linked genes exhibit unusual inheritance patterns (next slide)
- Most sex-linked genes are found on the **X chromosome**.
  - Examples: red-green colorblindness, hemophilia, and a type of muscular dystrophy, result from sex-linked recessive alleles.
  - Red-green colorblindness is a common sex-linked disorder caused by a malfunction of light-sensitive cells in the eyes. **Mostly males** are affected, but heterozygous females have some defects too.



# Beyond Mendel's law

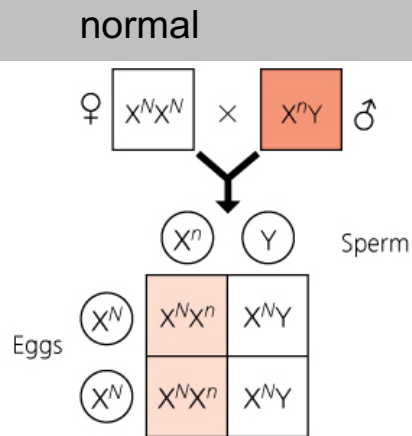
## Linked Genes

### 1) Sex-Linked Genes

#### e.g1) Color blindness, a X -Linked Recessive Trait

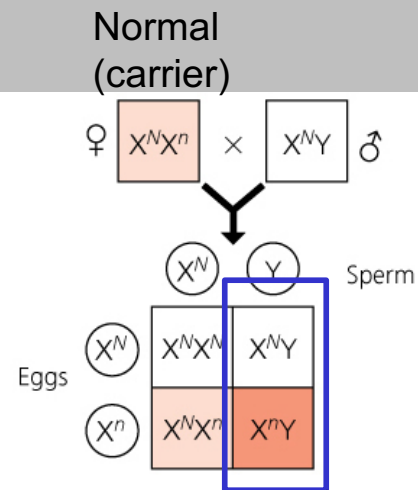
- Colorblindness gene is located only at X and recessive

Case 1



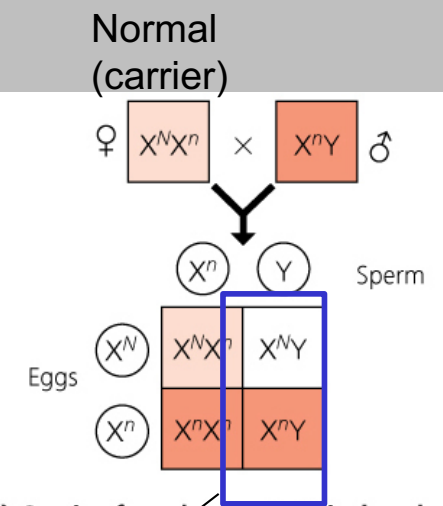
(a) Normal female × colorblind male

Case 2



(b) Carrier female × normal male

Case 3



(c) Carrier female × colorblind male

$\frac{1}{2}$  male CB phenotype



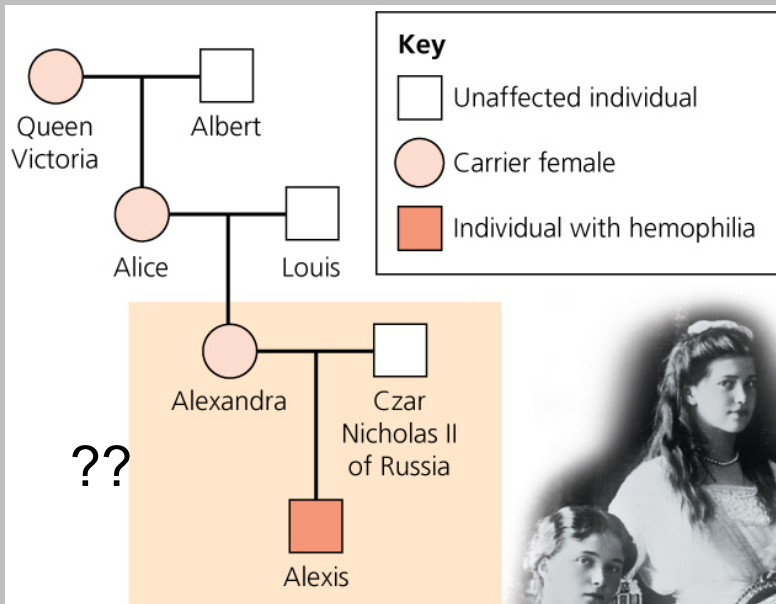
# Beyond Mendel's law

## Linked Genes

### 1) Sex-Linked Genes

e.g2) Hemophilia A , a X -Linked Recessive Trait

- Encodes defective clotting protein => blood does not clot normally



Homework

→ Figure out the genotypes of each individual

H : normal allele

h: recessive allele for hemophilia A



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# Epigenetics and the Role of Environment

- Many phenotypic characters result from a combination of heredity and environment.
  - Whether human characters are more influenced by genes or by the environment—nature or nurture—is a very old and hotly contested issue.
  - Spending time with identical twins will convince anyone that environment, which can include effects of personal choices, affects a person's traits.
- In general, only genetic influences are inherited and any effects of the environment are not usually passed to the next generation.



# Epigenetics and the Role of Environment



## Nature vs Nurture

- In recent years, however, biologists have begun to recognize the importance of **epigenetic inheritance**, the transmission of traits by mechanisms **not directly involving DNA sequence**.
  - For example, components of chromosomes can **be chemically modified** by adding or removing chemical groups on the DNA and/or protein components of chromosomes.
  - Epigenetic modifications—and the changes in gene activity that result—may even be carried on to the next generation. Unlike alterations to the DNA sequence, chemical changes to the chromosomes can be reversed.

