TEAS Science

Heredity

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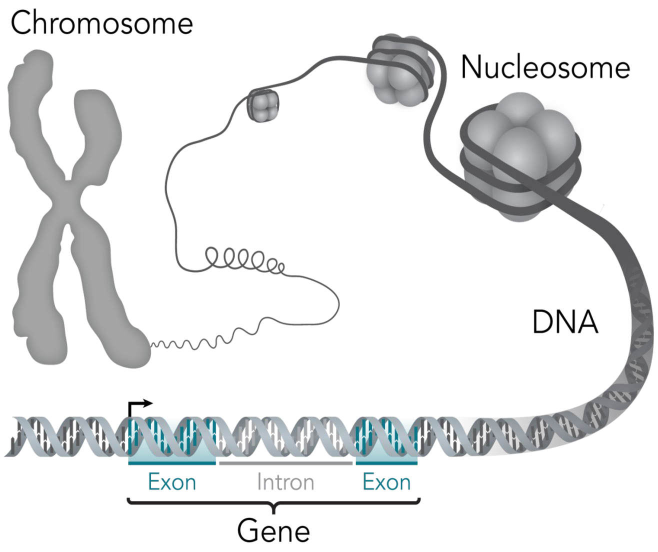
Introduction to Heredity

- Process by which traits and characteristics are passed from parents to offspring through genes.
- Helps explain why offspring often resemble their parents and why offspring may inherit genetic disorders or particular traits.

Term to Know:

➔ **Gene**

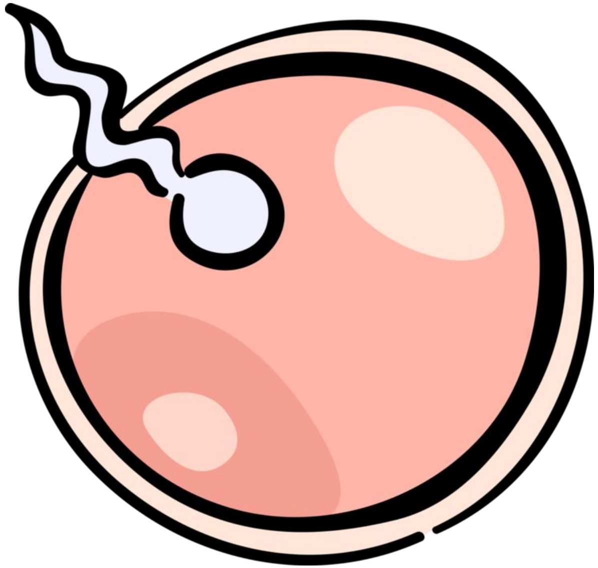
- Segment of DNA
- Contains instructions for building and maintaining an organism's cells
- Passes traits to the next generation



Source

Where does our genetic makeup come from?

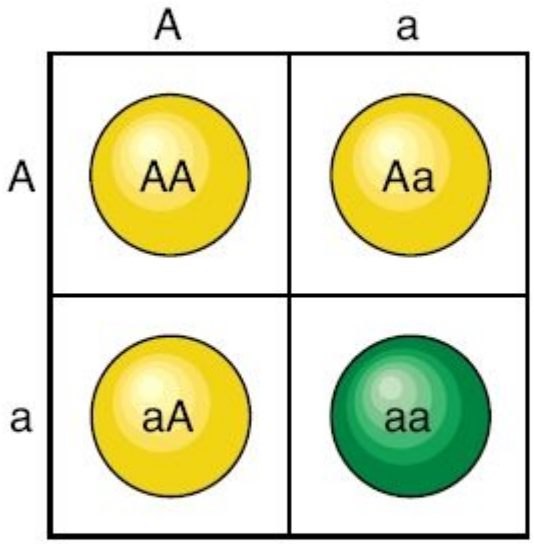
- ➔ **OUR BIOLOGICAL PARENTS**
- ➔ **½ from mom + ½ from dad**
- ➔ **Each parent contributes ONE version of each gene pair.**



Source

Genotype vs. Phenotype

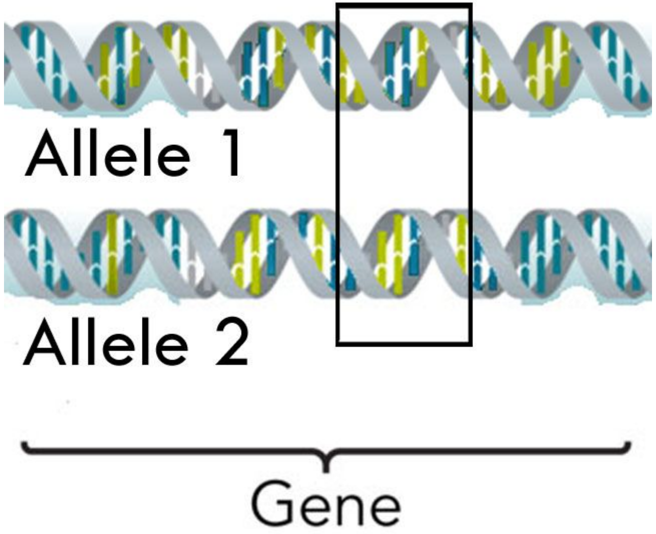
- ➔ **Genotype**
  - ◆ Genetic makeup of an individual; combination of alleles it has for a particular trait
    - Ex: Aa, AA, aa
- ➔ **Phenotype**
  - ◆ Observable physical trait that results from the genotype



Source

Alleles

- ➔ **Different versions of a gene that determine different traits.**
- ➔ **Each gene has TWO alleles, ONE inherited from each parent.**
    - ◆ Example: Gene for flower color might have a “B” allele for purple flowers and a “b” allele for white flowers
- ➔ **Combination of alleles determines the trait expressed in an organism.**



Source

Dominant vs. Recessive Alleles

- **Dominant Alleles:**
  - Versions of a gene that will always be expressed in an organism's appearance.
- **Recessive Alleles:**
  - Only show their effect if both alleles for a trait are recessive. Ex: bb

	B	B
B	BB	BB
b	Bb	Bb

B = Black hair
b = brown hair

Source

Homozygous vs. Heterozygous Alleles

- **Homozygous:**
  - BOTH alleles are either dominant OR recessive.
  - Example: BB or bb
- **Heterozygous:** two different alleles for that trait
  - Example: Bb

Source

Mendelian Genetics

- Gregor Mendel "Father of Genetics"
- Conducted foundational experiments on pea plants
- Discovered the key principles of heredity
- Laws of Inheritance:
  - Law of Segregation
  - Law of Independent Assortment

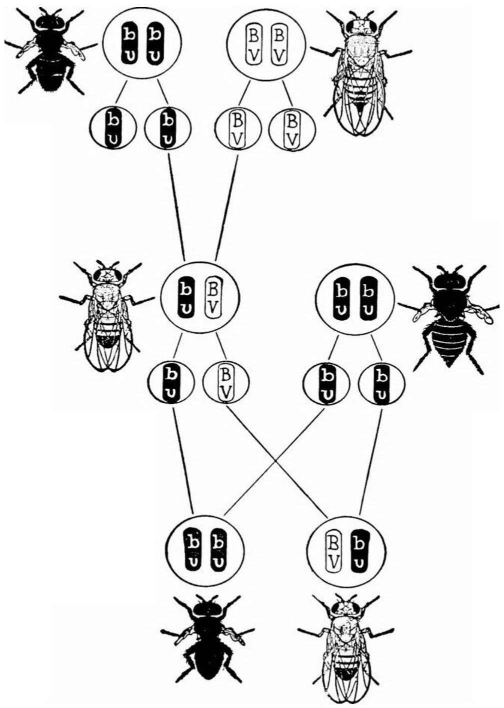
Source

Law of Segregation

➔ Each individual has two alleles for each trait (one from each parent)

➔ Only ONE allele from each parent is passed on to each offspring.

➔ During formation of gametes, only ONE allele is carried in the egg or sperm.



Source

Law of Independent Assortment

SE Nursing

- Alleles for different traits are passed on independently of one another, because chromosomes randomly separate during meiosis.
- One trait does not influence the inheritance of another trait.
- Increases genetic variation
- Ex: plant color and height
  - White flower can be tall or short

Source

Where does genetic variation come from?

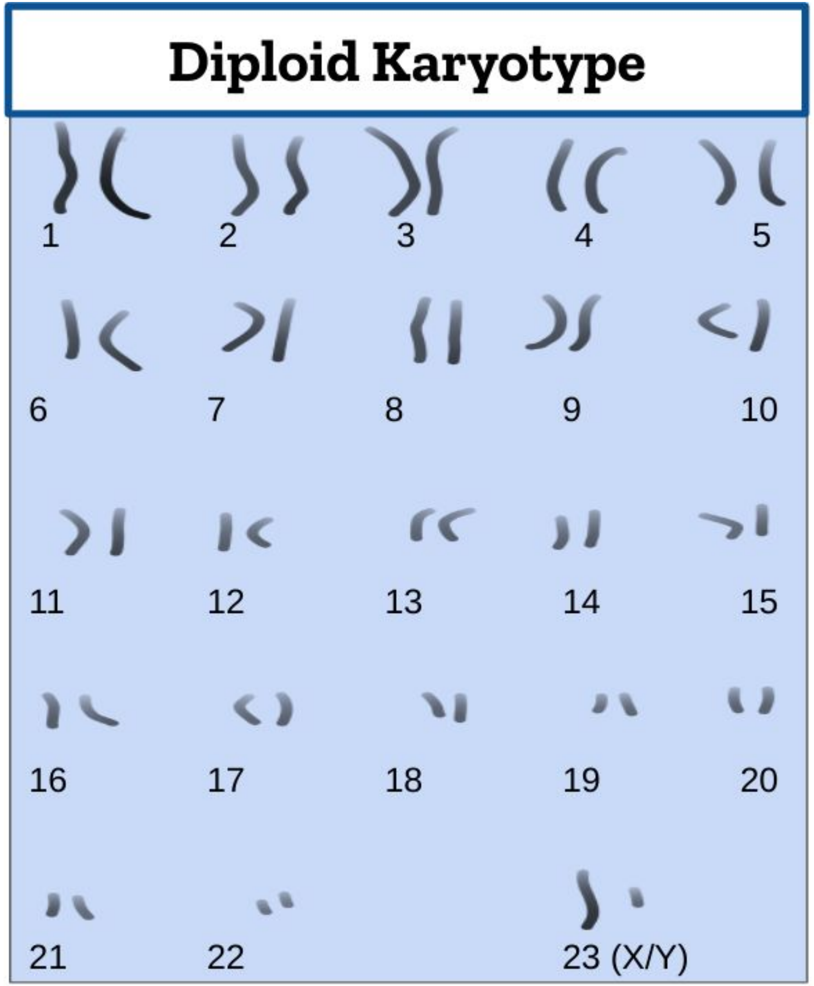
- Formation of Gametes in Meiosis
  - Crossing Over
  - Law of Segregation
  - Law of Independent Assortment (random assortment)
- Sexual Reproduction
  - Random Fertilization
- Mutations

Meiosis

SE
Nursing

- Type of cell division that reduces the number of chromosomes by half (46 -> 23)
- Resulting in gametes that have one set of chromosomes
- Haploid egg cell (n) + haploid sperm cell (n) = diploid zygote (2n)

Source


Diploid Karyotype
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19
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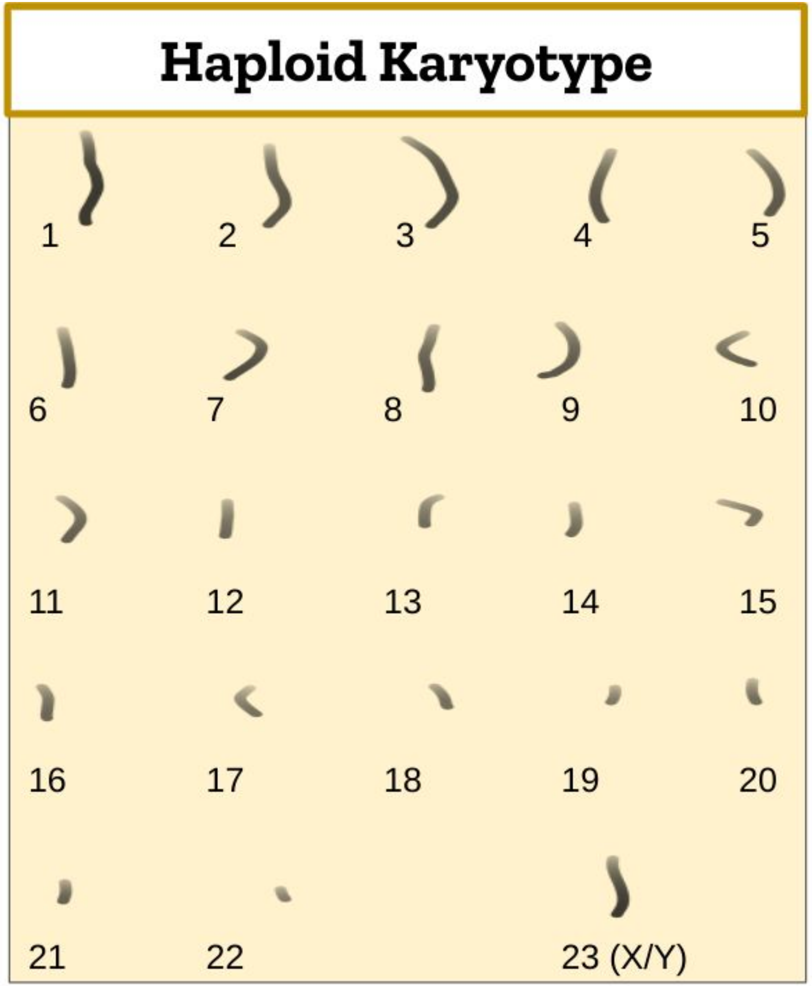
21
22
23 (X/Y)


Haploid Karyotype
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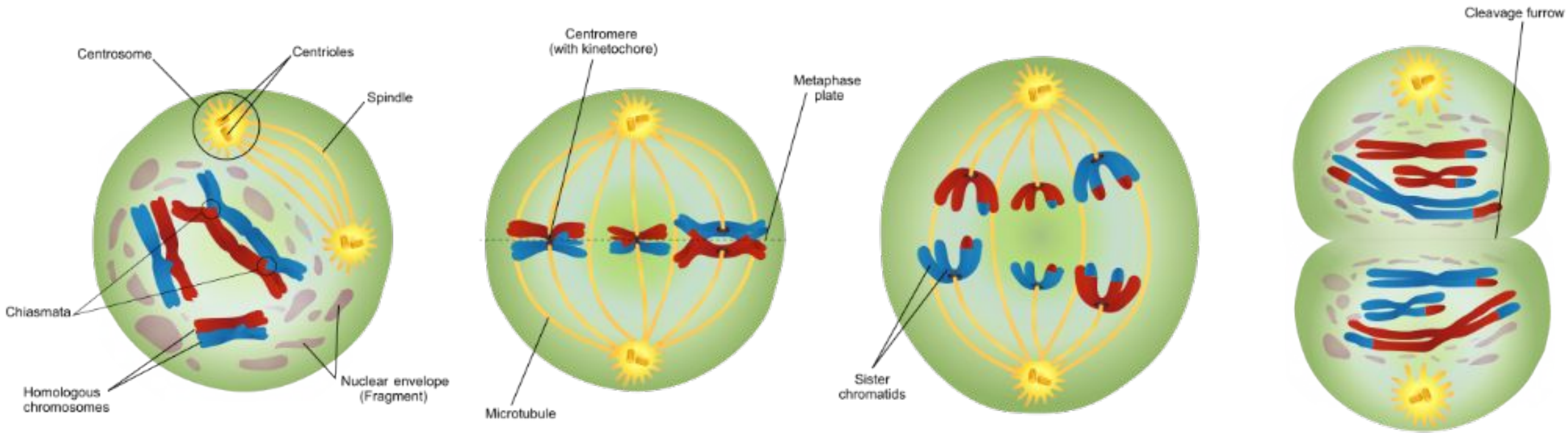
23 (X/Y)

Source

Prophase I | Metaphase I | Anaphase I | Telophase I & cytokinesis



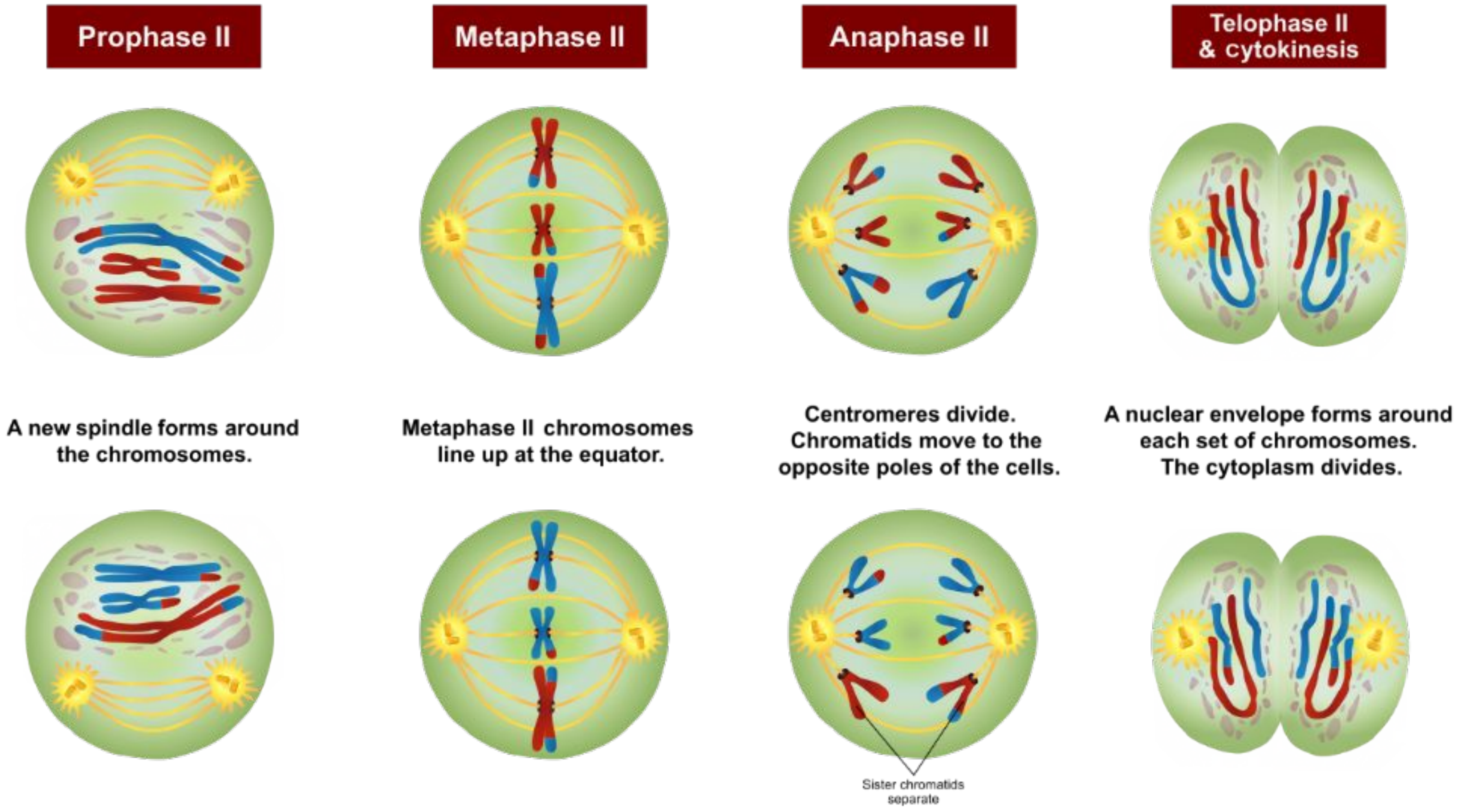
Prophase I: The chromosomes condense, and the nuclear envelope breaks down. Crossing-over occurs.

Metaphase I: Pairs of homologous chromosomes move to the equator of the cell.

Anaphase I: Homologous chromosomes move to the opposite poles of the cell.

Telophase I & cytokinesis: Chromosomes gather at the poles of the cells. The cytoplasm divides.

[Source]


Prophase II
Metaphase II
Anaphase II
Telophase II & cytokinesis
A new spindle forms around the chromosomes.
Metaphase II chromosomes line up at the equator.
Centromeres divide. Chromatids move to the opposite poles of the cells.
A nuclear envelope forms around each set of chromosomes. The cytoplasm divides.
Sister chromatids separate

Source

Gametes

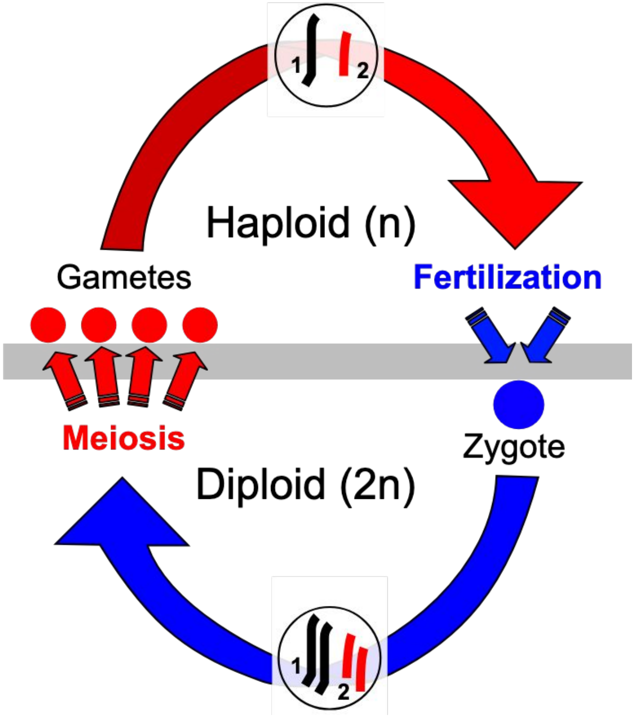
➔ Egg & Sperm

➔ During sexual reproduction, gametes fuse during fertilization.

➔ Contains ½ of parent's chromosomes/genetic make up

➔ Example:

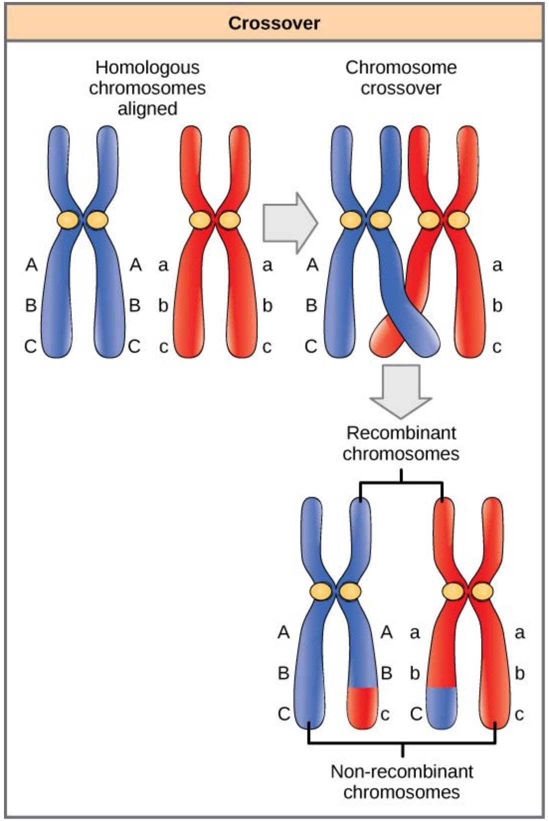
- Egg (23 chromosomes) + Sperm (23 chromosomes)



Source

Crossing Over

- ➔ During Prophase 1, homologous chromosomes exchange segments of DNA.
- ➔ Results in new combinations -> increases genetic diversity -> variation in offspring



Source

Law of Independent Assortment

- Alleles for different traits are passed on independently of one another, because chromosomes randomly separate during meiosis.
- One trait does not influence the inheritance of another trait.
- Increases genetic variation
- Ex: plant color and height
  - White flower can be tall or short

Source

Random Fertilization

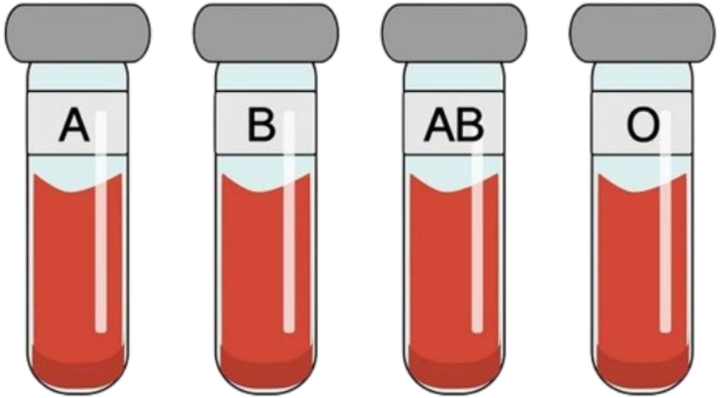
- Combination of 2 random gametes fuse during fertilization
- Each egg and sperm are unique due to crossing over and law of independent assortment that took place during meiosis.

Source

Are there exceptions to “complete dominance” seen in Mendelian Genetics?

Non-Mendelian Genetics

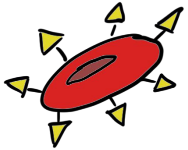
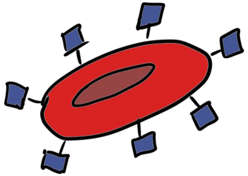
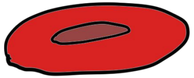
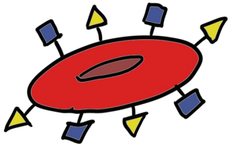
- ➔ Multiple Alleles
- ➔ Incomplete Dominance
- ➔ Codominance
- ➔ Epistasis
- ➔ Polygenic Traits



Source

Multiple Alleles

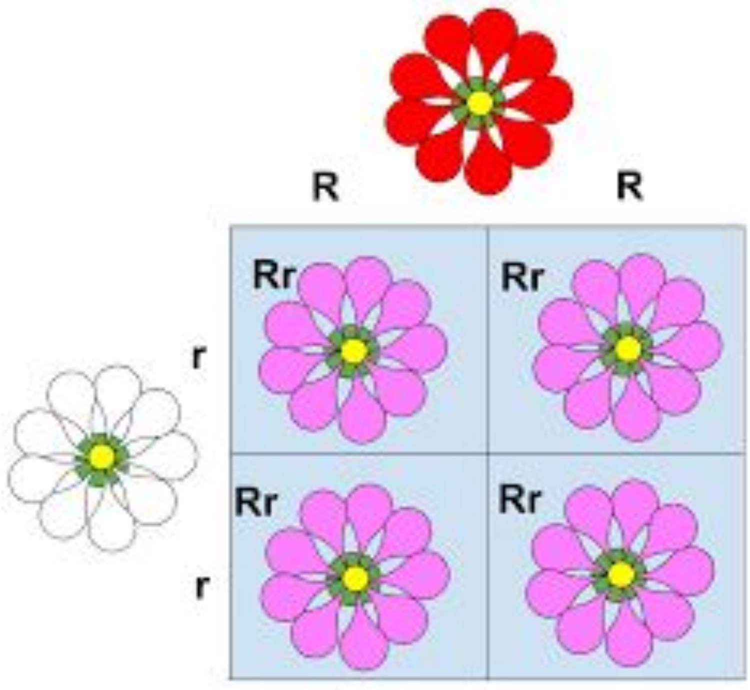
- ➔ **Some genes have more than two allele options**
- ➔ **Example:**
  - ◆ **ABO Blood Types (A, B, and O)**

Genotype	Phenotype	
I^A_ (I^AI^A or I^Ai)		Type A
I^B_ (I^BI^B or I^Bi)		Type B
ii		Type o
I^AI^B		Type AB

Source

Incomplete Dominance

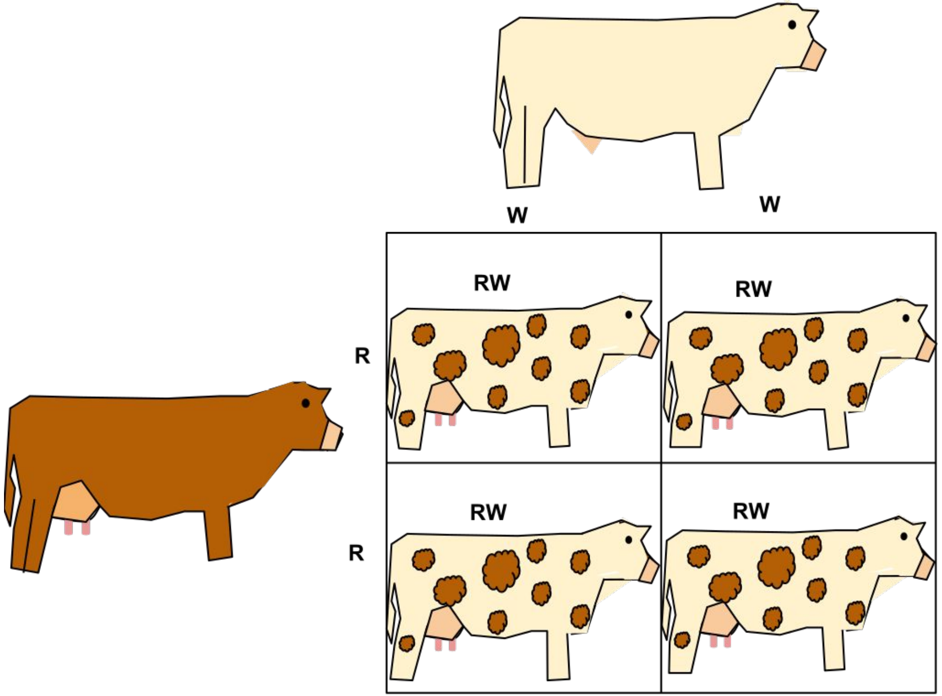
- ➔ Neither allele is completely dominant, resulting in a blended phenotype
- ➔ Example: Pink flowers results from a red and white flower cross



Source

Codominance

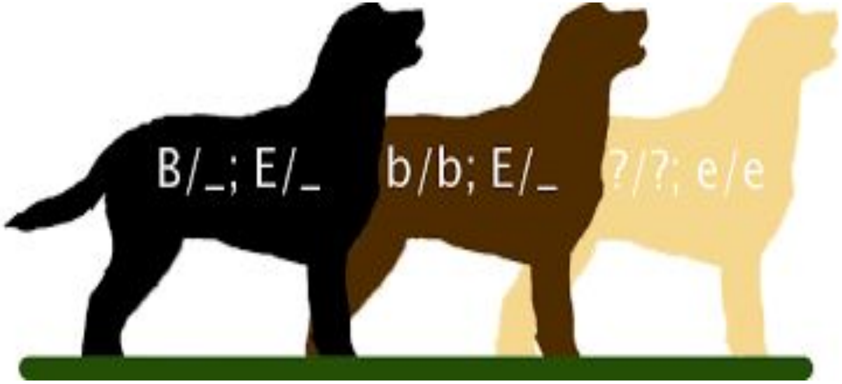
- ➔ Both alleles are fully expressed
- ➔ Example:
  - ◆ Roan Cattle
  - ◆ AB blood type



Source

Epistasis

- One gene can mask or modify the expression of another gene
- Example:
  - Color of Labrador retrievers

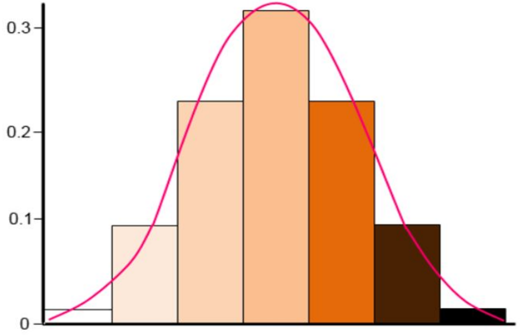


Source

Polygenic Traits

- ➔ Traits often show a continuous range of variation
- ➔ Controlled by multiple genes
- ➔ Examples: height and skin color

	ABC	*ABc*	*AbC*	*aBC*	*Abc*	*aBc*	*abC*	*abc*
ABC	6	5	5	5	4	4	4	3
ABc	5	4	4	4	3	3	3	2
AbC	5	4	4	4	3	3	3	2
aBC	5	4	4	4	3	3	3	2
Abc	4	3	3	3	2	2	2	1
aBc	4	3	3	3	2	2	2	1
abC	4	3	3	3	2	2	2	1
abc	3	2	2	2	1	1	1	0



Source

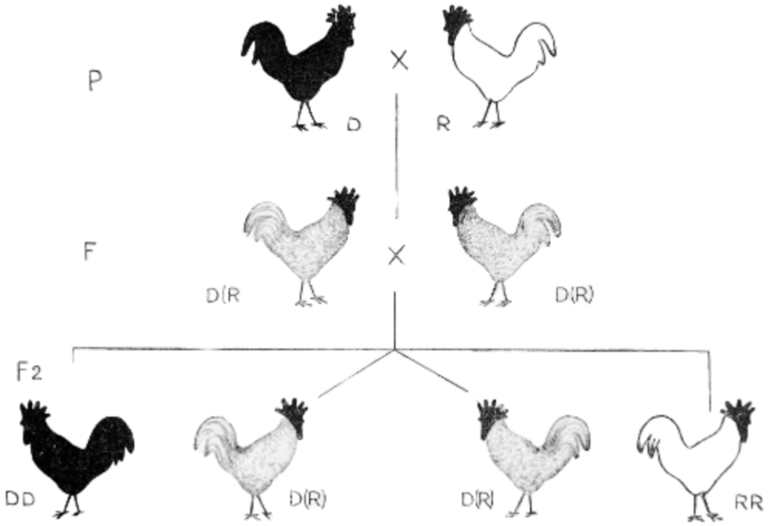
How can we predict what traits offspring may have?

Punnett Squares

- Tool used to predict the genotypes and phenotypes of offspring between two parents.
  - Allows one to see the potential combinations of alleles in offspring
- Monohybrid Cross (1 gene with 1 set of alleles)
- Dihybrid Cross (2 set of alleles)

Generations

- P Generation:
  - Parental Generation
  - Original individuals crossed
- F1 Generation:
  - Offspring produced from the P generation.
- F2 Generation:
  - Offspring produced from the F1 generation



MENDELIAN INHERITANCE IN ANDALUSIAN FOWLS.

P, the parents, black (dominant) and white (recessive).
F1, the hybrid generation, "blue" Andalusians, illustrating imperfect dominance.
F2, the second filial generation: 25 per cent. pure blacks ("extracted pure dominants"), DD; 50 per cent. "blues" (impure dominants) D(R); and 25 per cent. whites (extracted recessives), with occasional black spots (RR).

Source

Monohybrid Cross

- Focuses on ONE trait
- Outside: Alleles
- Inside: Possible genotype combinations
- Can determine phenotype ratios to make predictions

	T	t
T	TT	Tt
t	Tt	tt

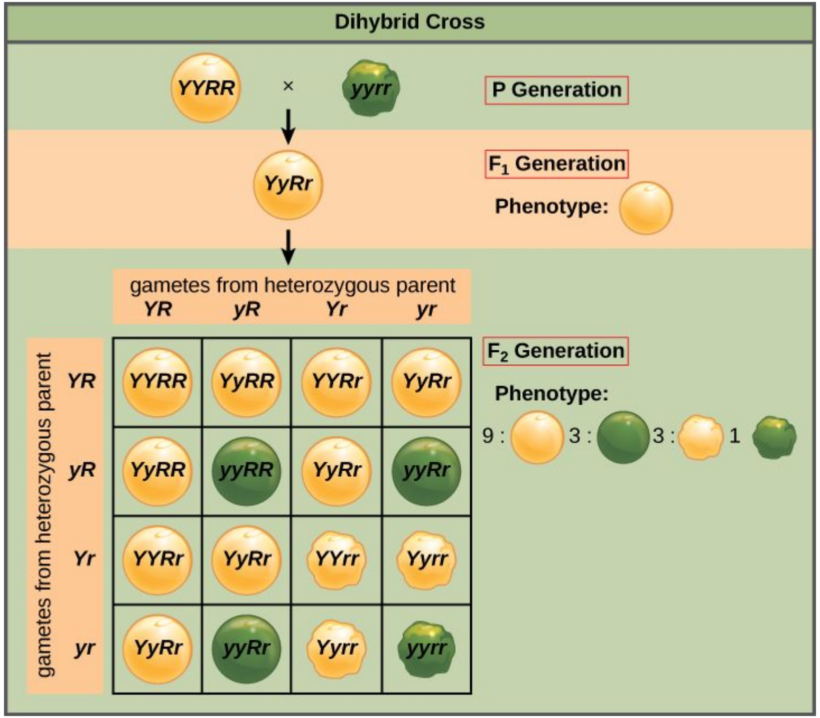
Dihybrid Cross

➔ Tracks TWO different traits

➔ Outside: Alleles

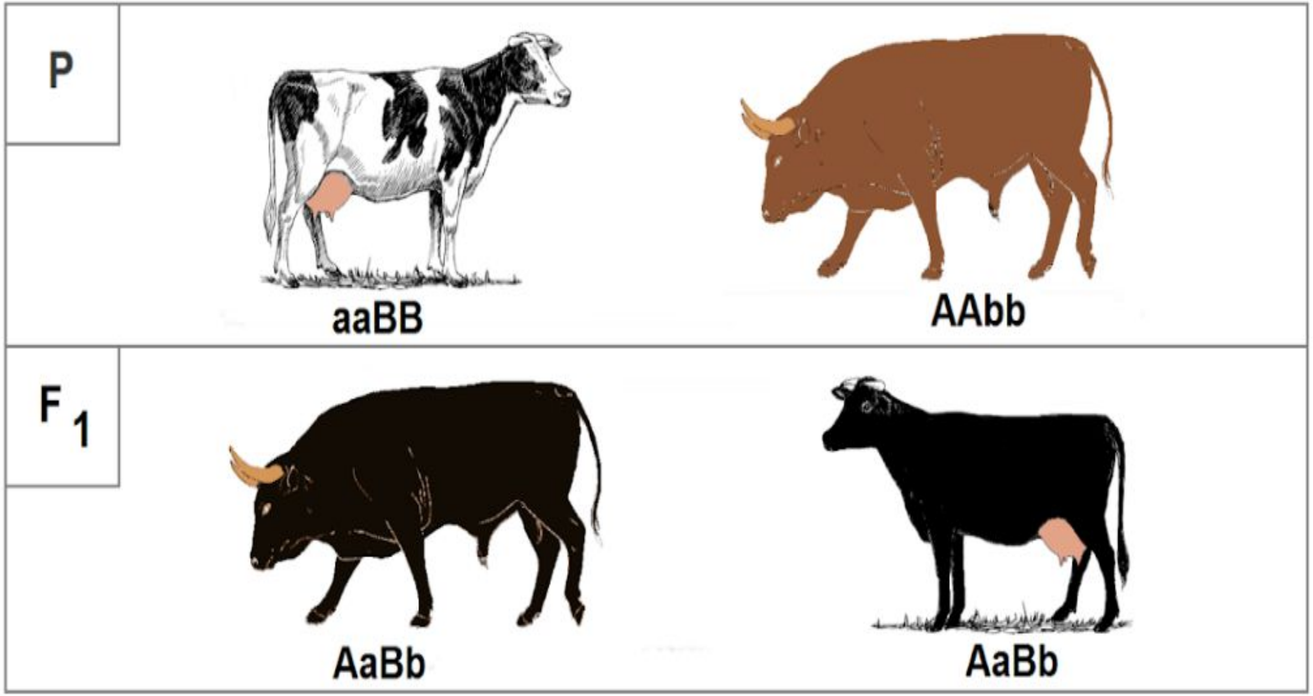
➔ Inside: Possible genotypes

➔ Can be used to determine phenotype ratios



Source

Dihybrid Inheritance



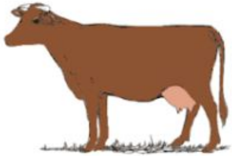
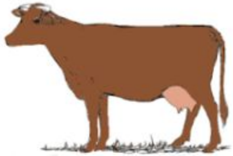
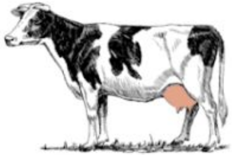
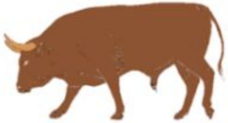
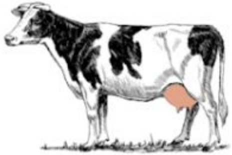
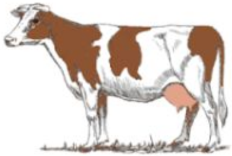
A = allele for solid colour
a = allele for spotting

B = allele for black
b = allele for brown

Capital letter means dominant allele.

Lower case means recessive allele.

Source

F2	AB	Ab	aB	ab
AB	 AABB	 AABb	 AaBB	 AaBb
Ab	 AABb	 AAbb	 AaBb	 Aabb
aB	 AaBB	 AaBb	 aaBB	 aaBb
ab	 AaBb	 Aabb	 aaBb	 aabb

[Source]

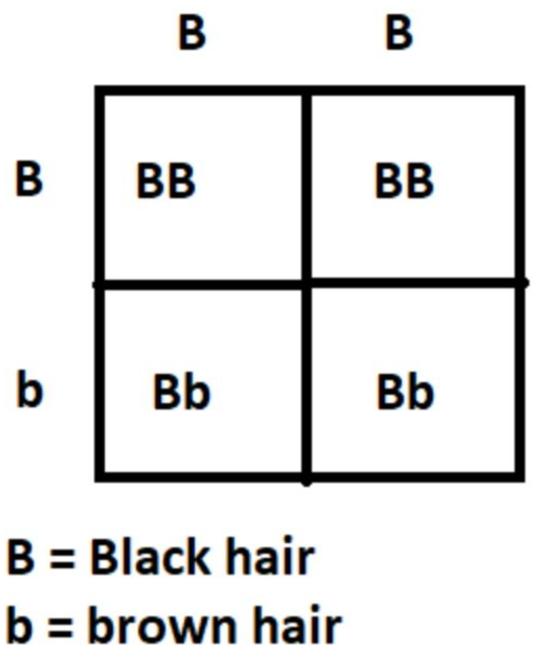
Phenotype Ratios:

9/16: black
3/16: brown
3/16: black spotted
1/16: brown spotted

Note: 9:3:3:1 ratio when crossing heterozygotes

Ratios & Percentages

- Genotype:
  - Ratio: 1:1:0
    - (BB:Bb:bb)
  - Percentage: 50% BB 50% Bb 0% bb
- Phenotype:
  - Ratio: 1:0
    - Black hair: brown hair
  - Percentage: 100% Black hair 0% brown hair



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