Non-Mendelian Inheritance

Blood Types Video (Bozeman Science Lecture)
http://www.youtube.com/watch?v=KXTF7WehgM8

Mendelian Inheritance

- Term used to describe the basic principles of inheritance for traits that are not inherited in complicated ways.
  - Ex. Traits that are either dominant or recessive

	Height	Seed Shape	Seed Color	Seed Coat Color	Pod Shape	Pod Color	Flower Position
Dominant	 Tall	 Round	 Yellow	 Green	 Inflated (full)	 Green	 Axial
Recessive Trait	 Short	 Wrinkled	 Green	 White	 Constricted (flat)	 Yellow	 Terminal

3 Basic Mendelian Principles / Laws

1. Law of Dominance
   - One factor in a pair of a trait dominates over the other unless both are recessive
2. Law of Segregation
   - During gamete production the 2 copies of “hereditary factors” segregate so offspring acquire 1 from each parent
3. Law of Independent Assortment
   - Each pair of “hereditary factors” separates independently of the others

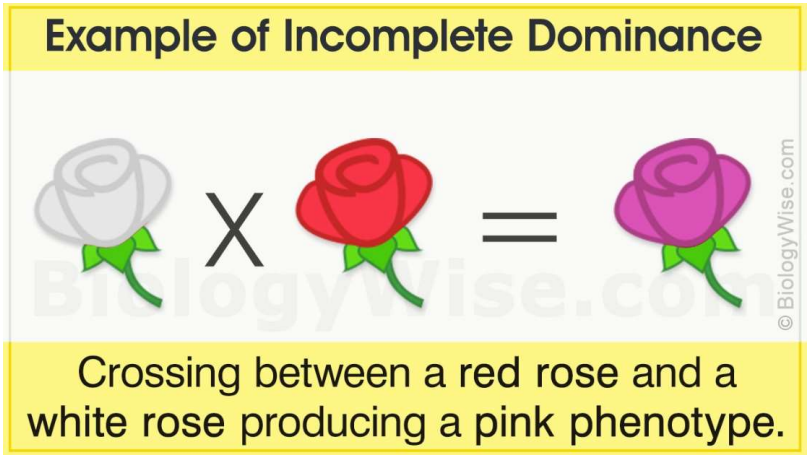
Non-Mendelian Inheritance

- There are many exceptions to the principles we have learned with basic Mendelian genetics.
  - Incomplete Dominance
  - Codominance
  - Multiple Alleles
  - Polygenic Inheritance

Video - Incomplete Dominance vs Codominance

Incomplete Dominance

- Heterozygous genotype results in blending
- Neither trait is dominant
- Represented by 2 different capital letters
- Ex- Japanese four o'clock flowers



Practice Incomplete Dominance:

- A red Japanese four o'clock is crossed with a white Japanese four o'clock:

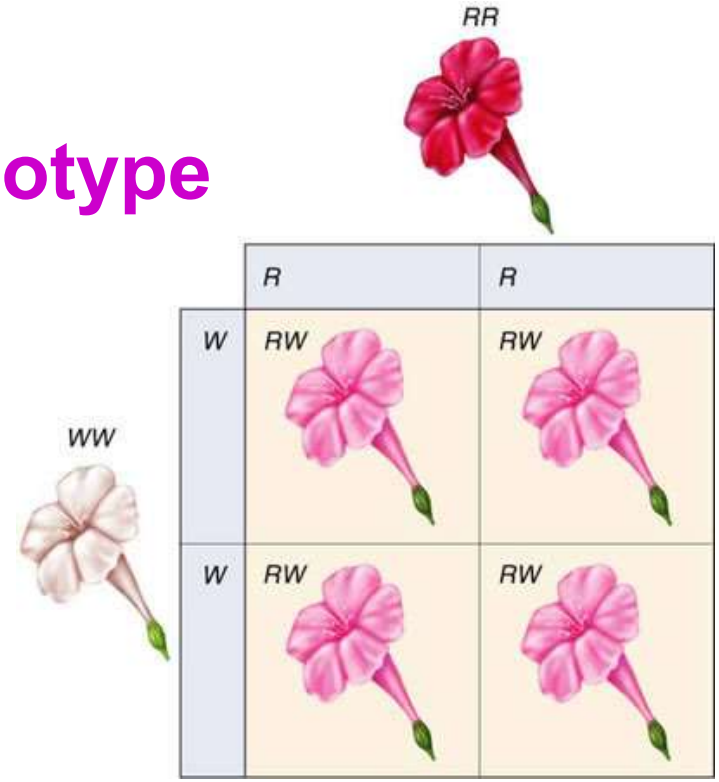
Key: R = red W = white

	R	R
W	RW	RW
W	RW	RW

Genotype / phenotype

100% RW

100% pink



Practice Incomplete Dominance:

- Cross two pink four o'clocks:

	R	W
R	RR	RW
W	RW	WW

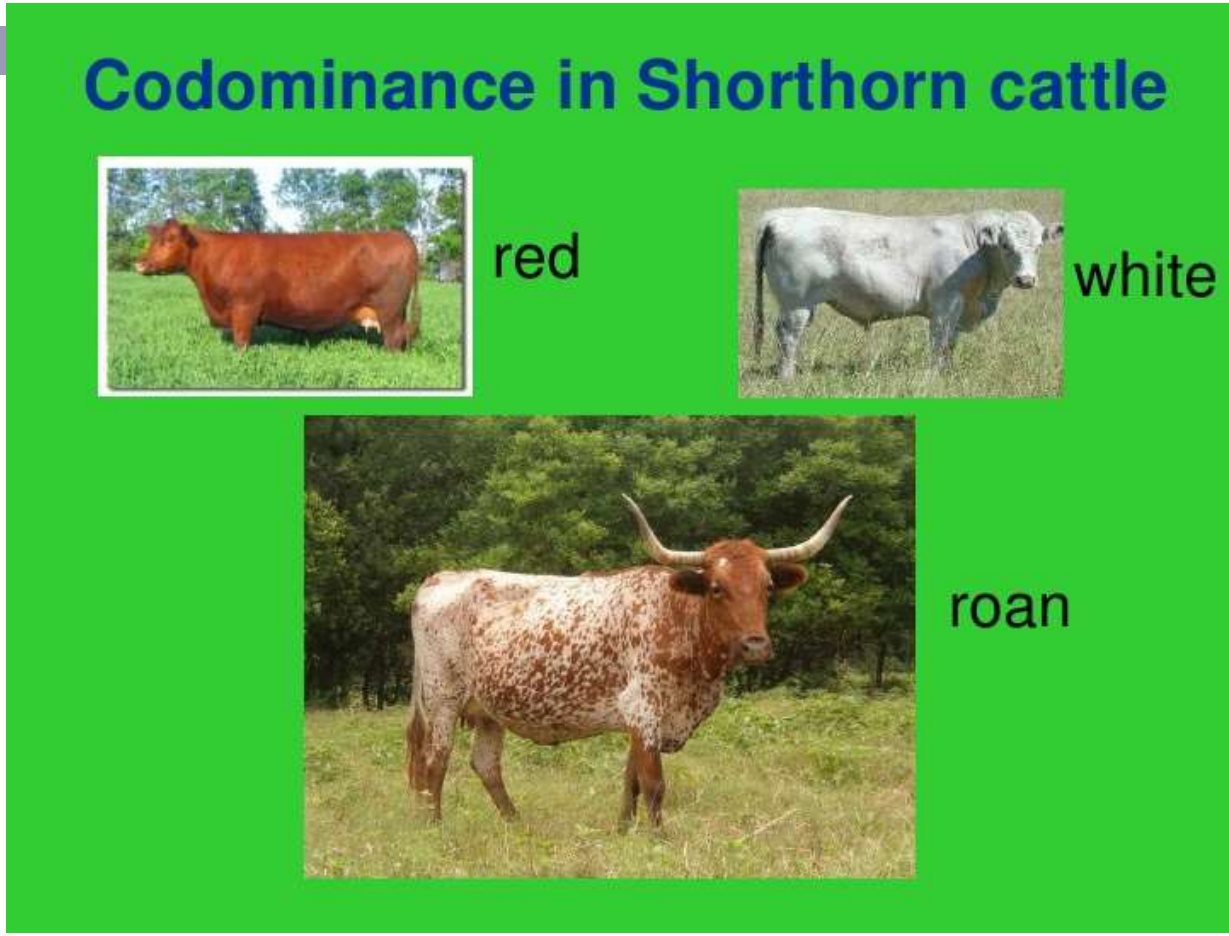
genotypes / phenotypes

25% RR = red
50% RW = pink
25% WW = white

Ratio = 1:2:1

Codominance

- Both traits are expressed because both are dominant.
- Ex- Roan coat color in cattle
  - Express both white and red hairs
- Use “C” in genotypes



Practice Codominance:

- Cross a red cow with a white cow:

Key: C^R = red C^W = white

	C^W	C^W
C^R	C^RC^W	C^RC^W
C^R	C^RC^W	C^RC^W

Offspring genotypes / phenotypes

100% Roan coats

Practice Codominance:

- Cross two roan cattle:

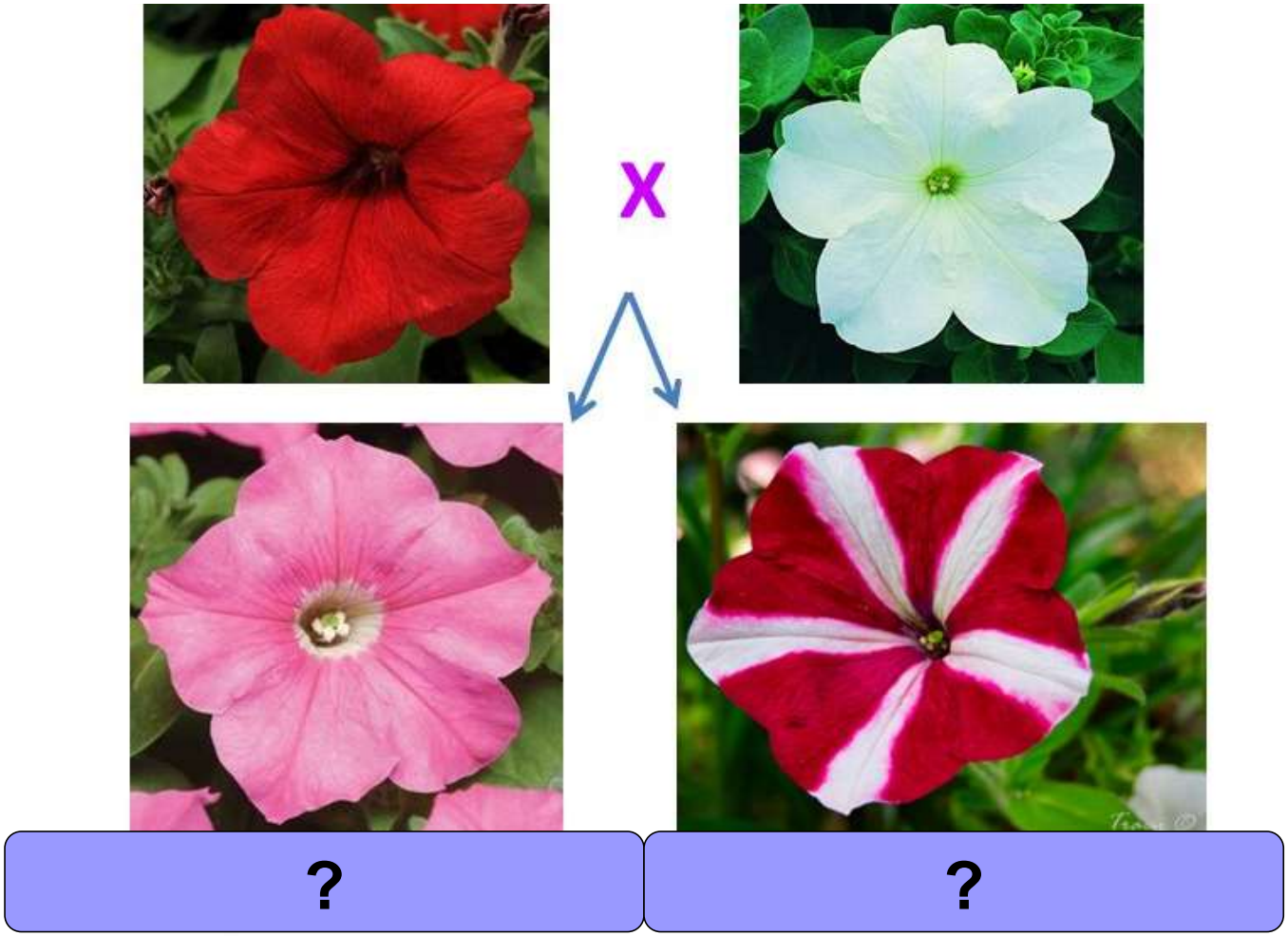
	C^R	C^W
C^R	C^RC^R	C^RC^W
C^W	C^RC^W	C^WC^W

Genotypes / phenotypes

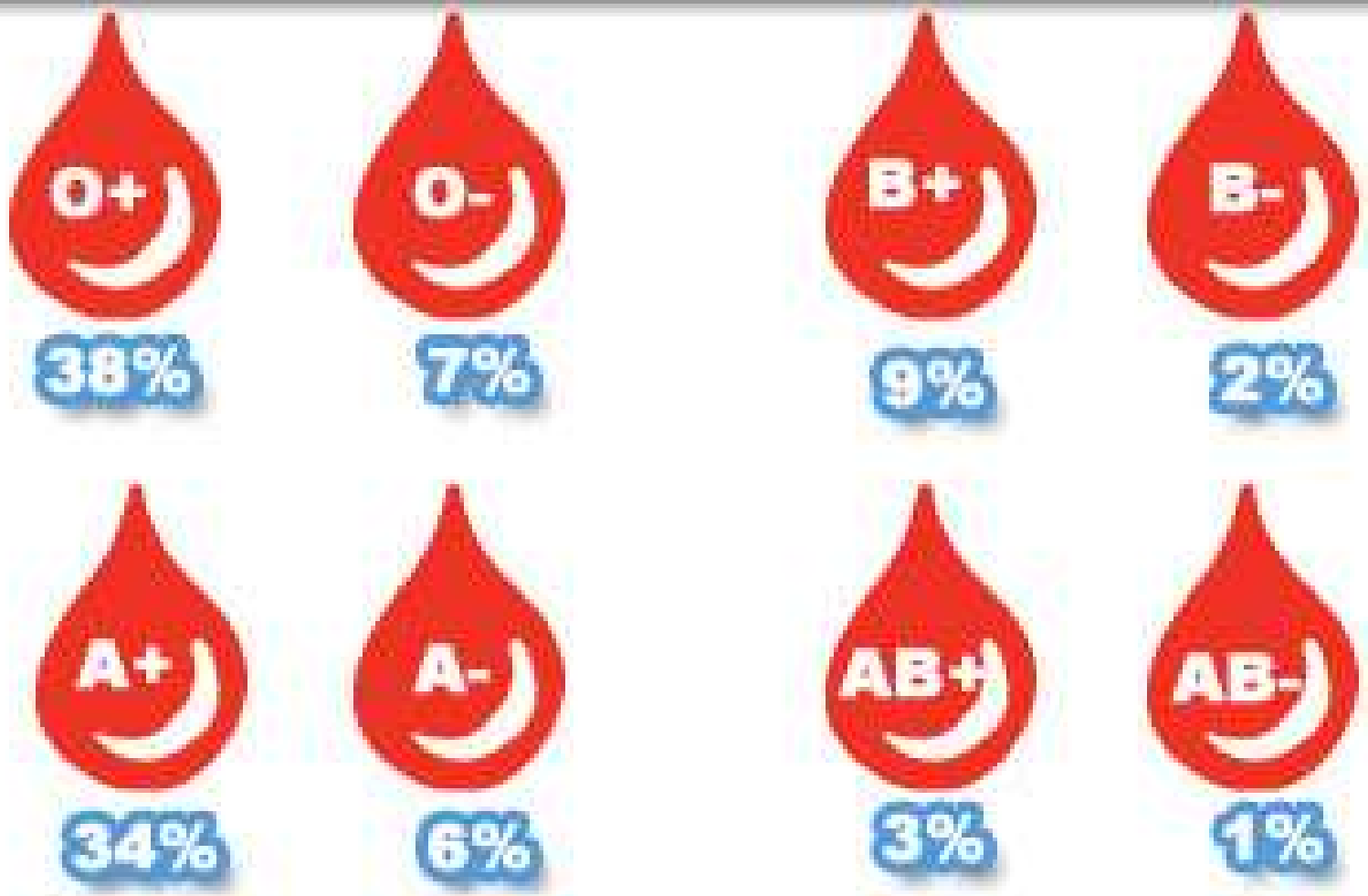
25% C^RC^R **= red coats**
50% C^RC^W **= roan coats**
25% C^WC^W **= white coats**

Ratio = 1:2:1

Is it Incomplete dominance or Codominance?



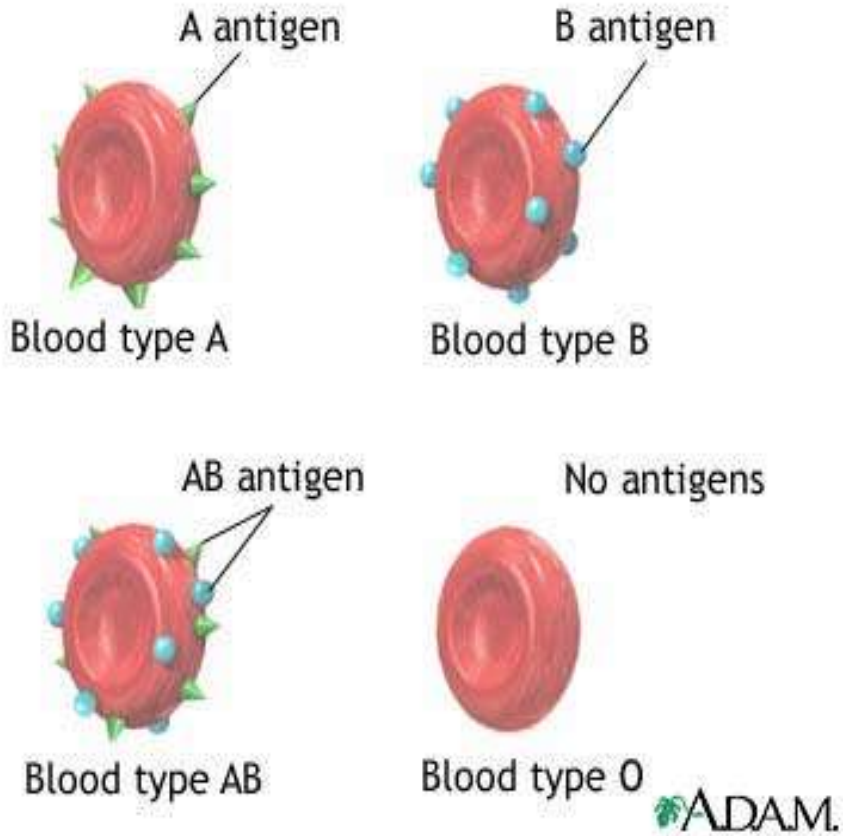
What's Your Blood Type?



Multiple Alleles

- When there are more than 2 allelic pairs for a gene.

- Ex-blood groups in humans
  - 4 different blood types:
  - A, B, AB, O
  - Determined by specific antigens on the surface of the red blood cell



- Blood type is determined by 3 different alleles: A, B, & O
  - A & B are codominant, O is recessive

Phenotype / Genotype(s)

- Type A: I^AI^A, I^Ai or AA, AO
- Type B: I^BI^B, I^Bi or BB, BO
- Type AB: I^AI^B or AB
- Type O: ii or OO

Video - Multiple Alleles (Amoeba Sisters)

Practice: I^AI^B or AB ii or OO

- Cross a woman with type AB blood with a man with type O:

	I^A	I^B
i	$I^A i$	$I^B i$
i	$I^A i$	$I^B i$

	A	B
O	AO	BO
O	AO	BO

Results: 50% Type A, 50% Type B (all heterozygous)

Practice:

- Cross a man with type A (homozygous) blood with a female who is type B (homozygous):

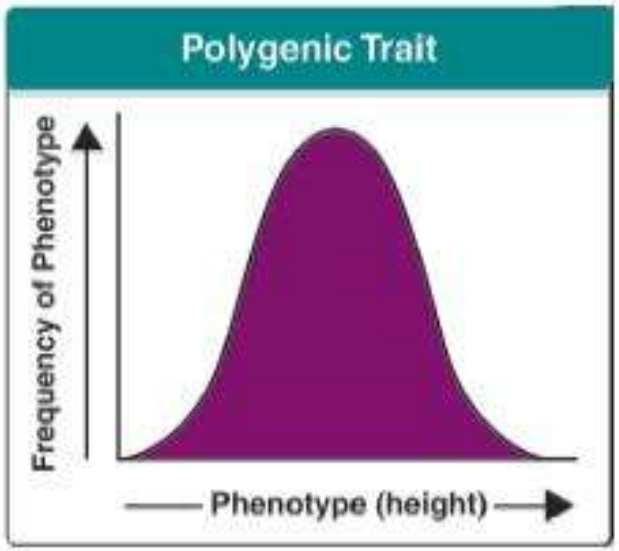
	I^A	I^A
I^B	I^AI^B	I^AI^B
I^B	I^AI^B	I^AI^B

	A	A
B	AB	AB
B	AB	AB

Results: 100% Type AB

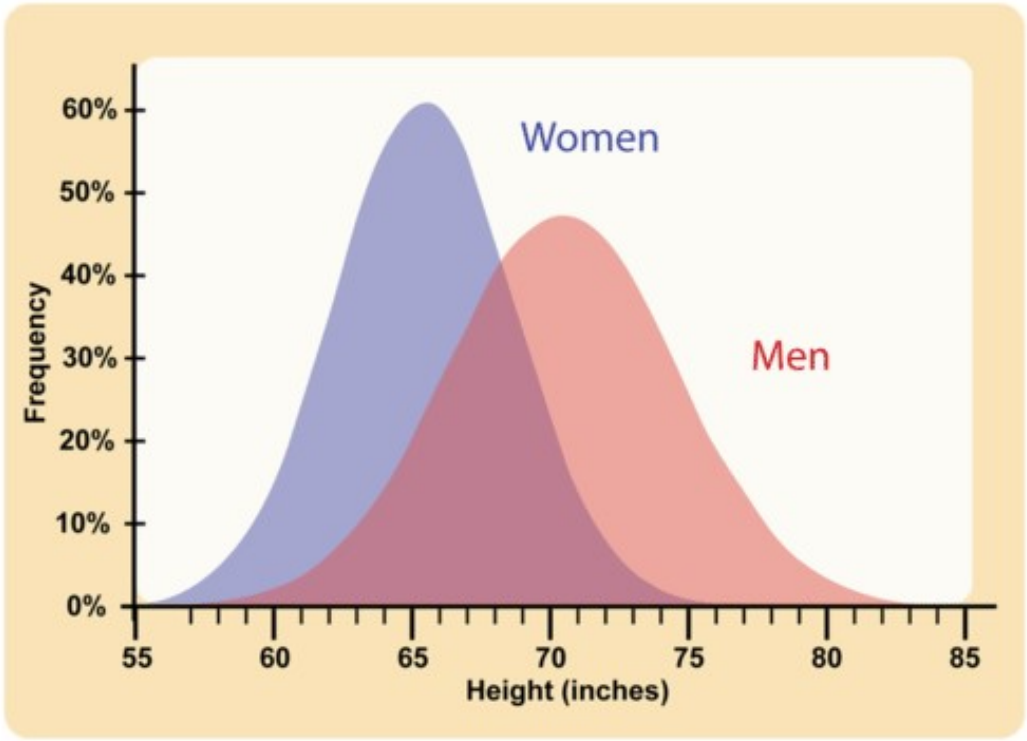
Polygenic Inheritance

- Characteristics that vary along a continuum, resulting from a blending of several separate genes
  - Ex: skin color, eye color, height

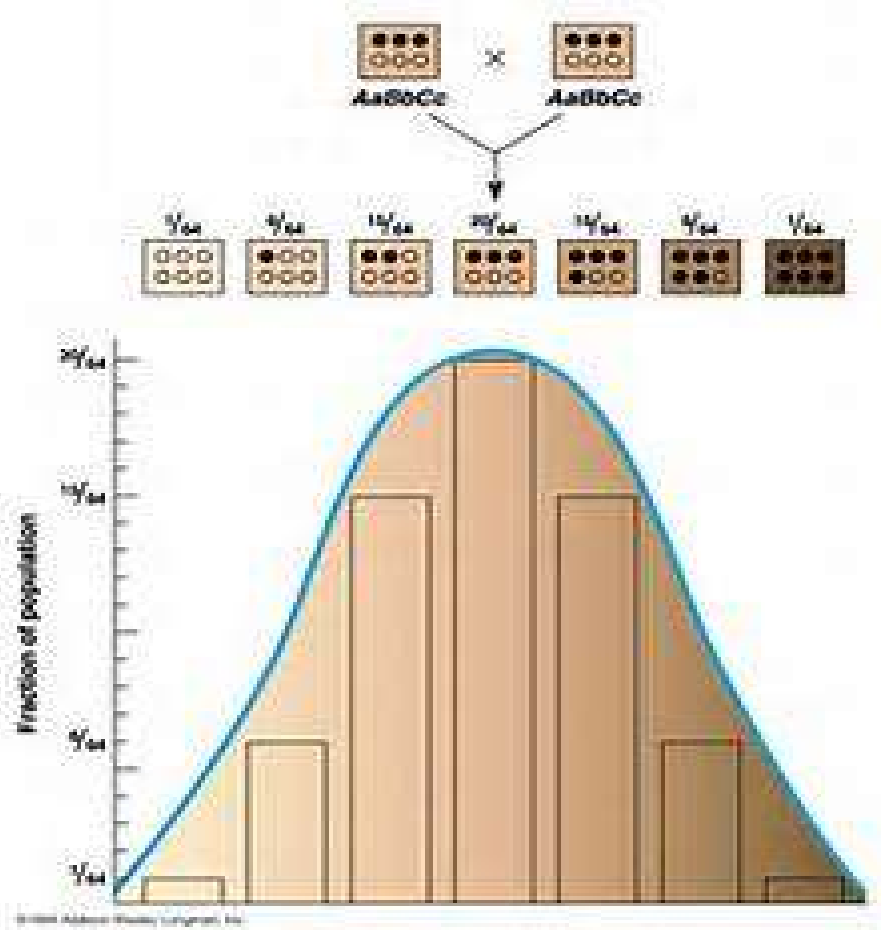


Amoeba Sisters Polygenic Traits (start at 3:20)

height

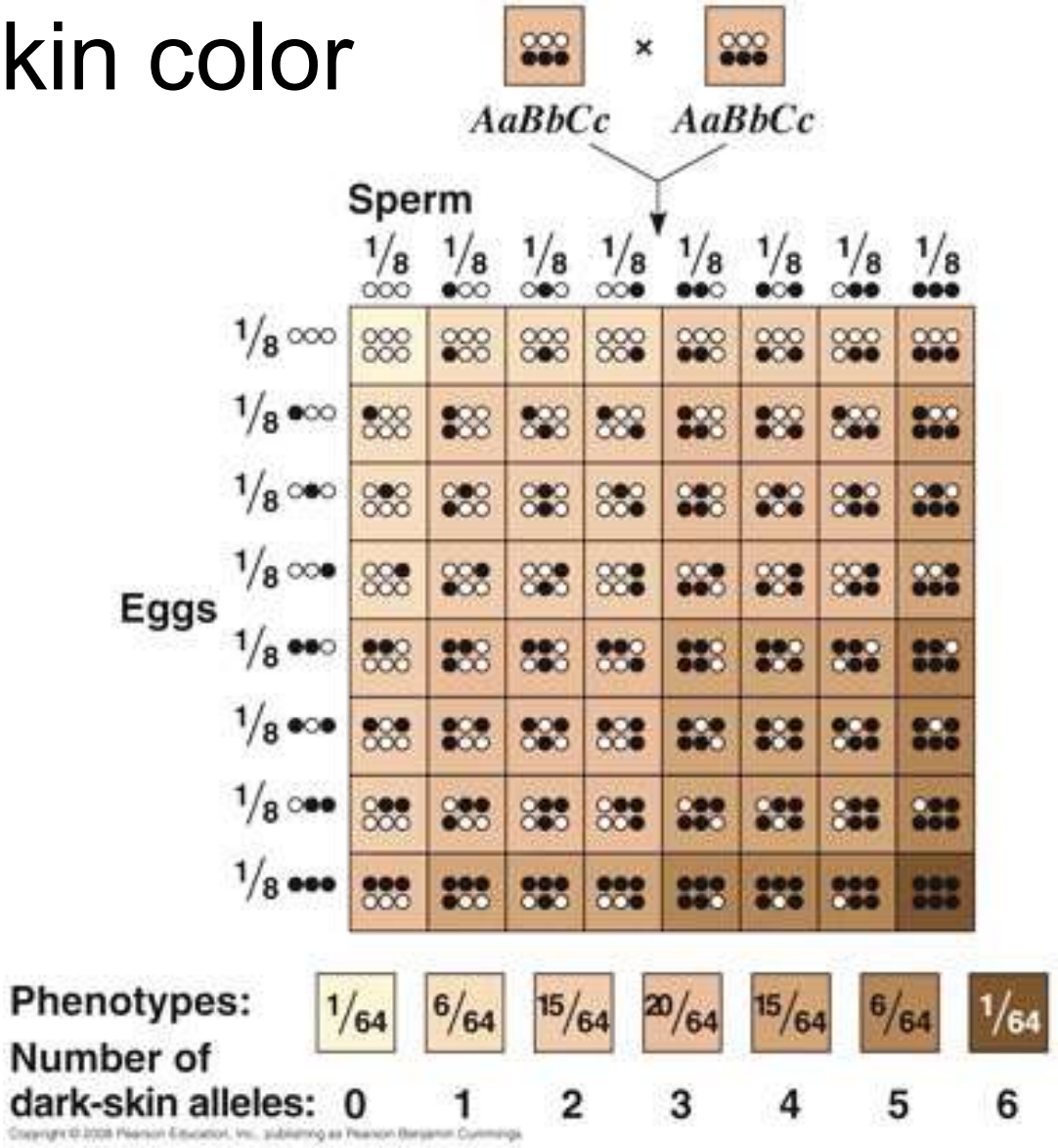


skin color



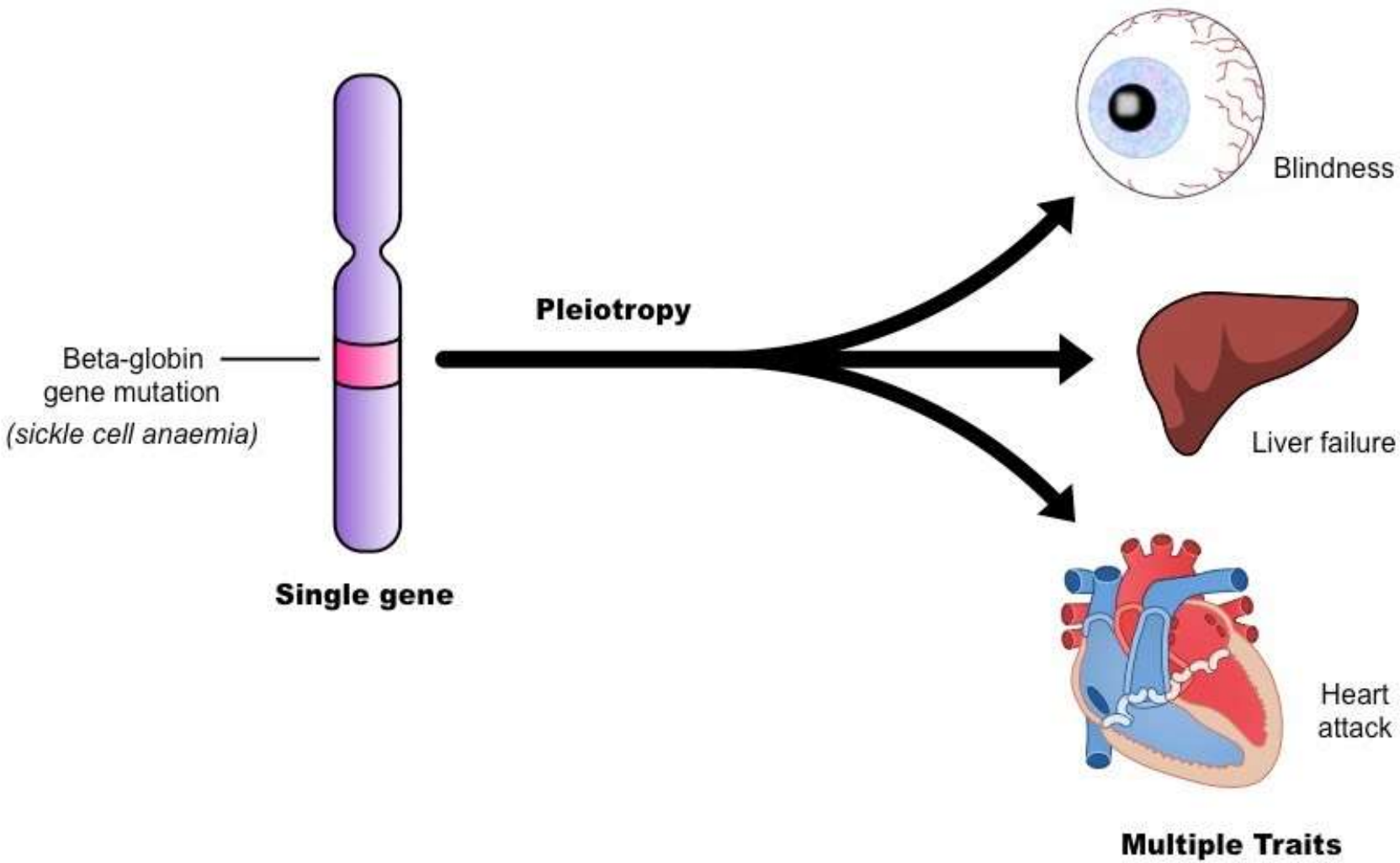
Ex. Skin color

- Non-identical twins



Pleiotropy

- When a gene affects more than one phenotypic trait
- example - gene that codes for the protein in collagen, a substance that helps form bones is also important in the ears and eyes.
  - Mutations in the gene result in problems not only in bones but also in these sensory organs, which is how the gene's pleiotropic effects were discovered.
- Another example of pleiotropy occurs with sickle cell anemia. This recessive genetic disorder occurs when there is a mutation in the gene that normally encodes the red blood cell protein called hemoglobin. People with the disorder have two alleles for sickle-cell hemoglobin, so named for the sickle shape that their red blood cells take on under certain conditions such as physical exertion. The sickle-shaped red blood cells clog small blood vessels, causing multiple phenotypic effects, including stunting of physical growth, certain bone deformities, kidney failure, and strokes.


Beta-globin
gene mutation
(sickle cell anaemia)
Single gene
Pleiotropy
Blindness
Liver failure
Heart
attack
Multiple Traits

Epistasis

- When genes affect the expression of other genes
- similar to dominance, except that it occurs between different genes rather than between different alleles for the same gene

- Example – Albinism
  - A person with albinism has virtually no pigment in the skin. The condition occurs due to an entirely different gene than the genes that encode skin color. Albinism occurs because a protein called tyrosinase, which is needed for the production of normal skin pigment, is not produced due to a gene mutation. If an individual has the albinism mutation, he or she will not have any skin pigment, regardless of the skin color genes that were inherited.

Epistasis in Coat Colors

	EB	Eb	eB	eb
EB	EEBB black	EEBb black	EeBB black	EeBb black
Eb	EEBb black	EEbb chocolate	EeBb black	Eebb chocolate
eB	EeBB black	EeBb black	eeBB yellow	eeBb yellow
eb	EeBb black	Eebb chocolate	eeBb yellow	eebb yellow