TOPIC 2: VARIATIONS OF DOMINANCE

TOPIC 2 LEARNING TARGETS

- Use Punnett squares for unusual monohybrid crosses – incomplete dominance, codominance, blood types, sex-linkage

- Use Punnett square for dihybrid crosses

NEW GENETICS VOCABULARY

- Incomplete dominance
- Codominance
- Polygenic trait
- Epistasis
- Multiple alleles
- Pleiotropy
- Sex-linked trait
- Barr body
- Gene mapping
- Gene linkage

WHAT IS A TRAIT?

- Ways of looking, thinking, or being

- Types of traits
  - Dominant (Topic 1)
  - Recessive (Topic 1)
  - Polygenic (Topic 2)
  - Sex-linked (Topic 2)
  - Autosomal (Topic 3)

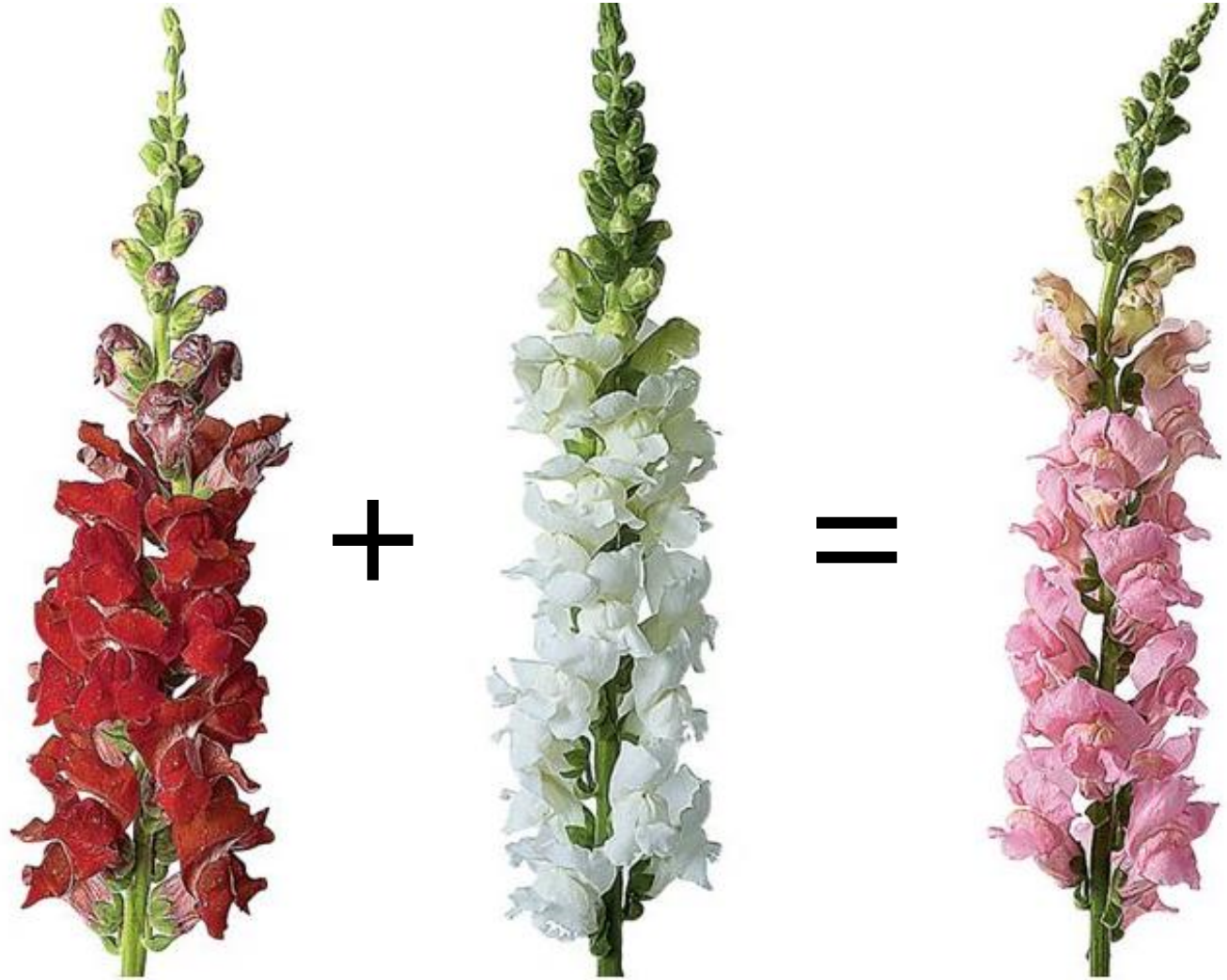
WHAT IS COMPLETE DOMINANCE?

- In Mendel's classic pea crosses, the F_1 offspring always looked like one of the two parental varieties because one allele in a pair showed complete dominance

- Phenotypes of heterozygote and dominant homozygote are indistinguishable



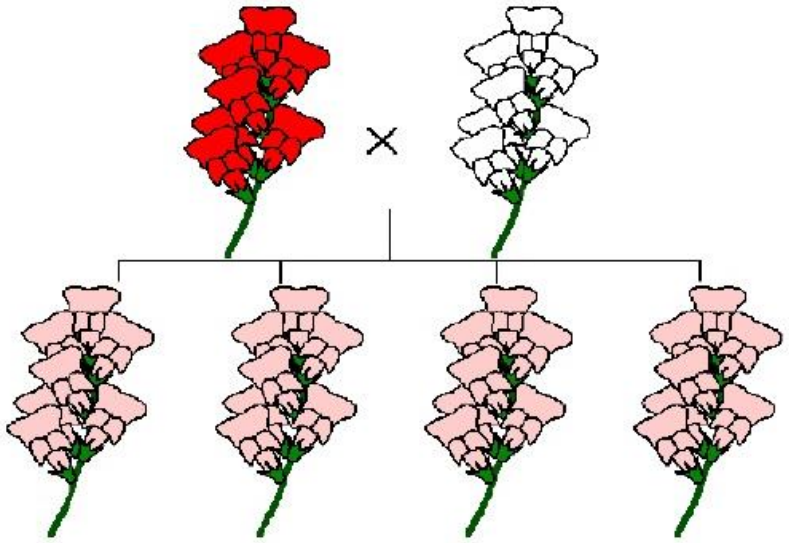
Phenotype	Black	Black	Brown
Genotype	BB	Bb	bb



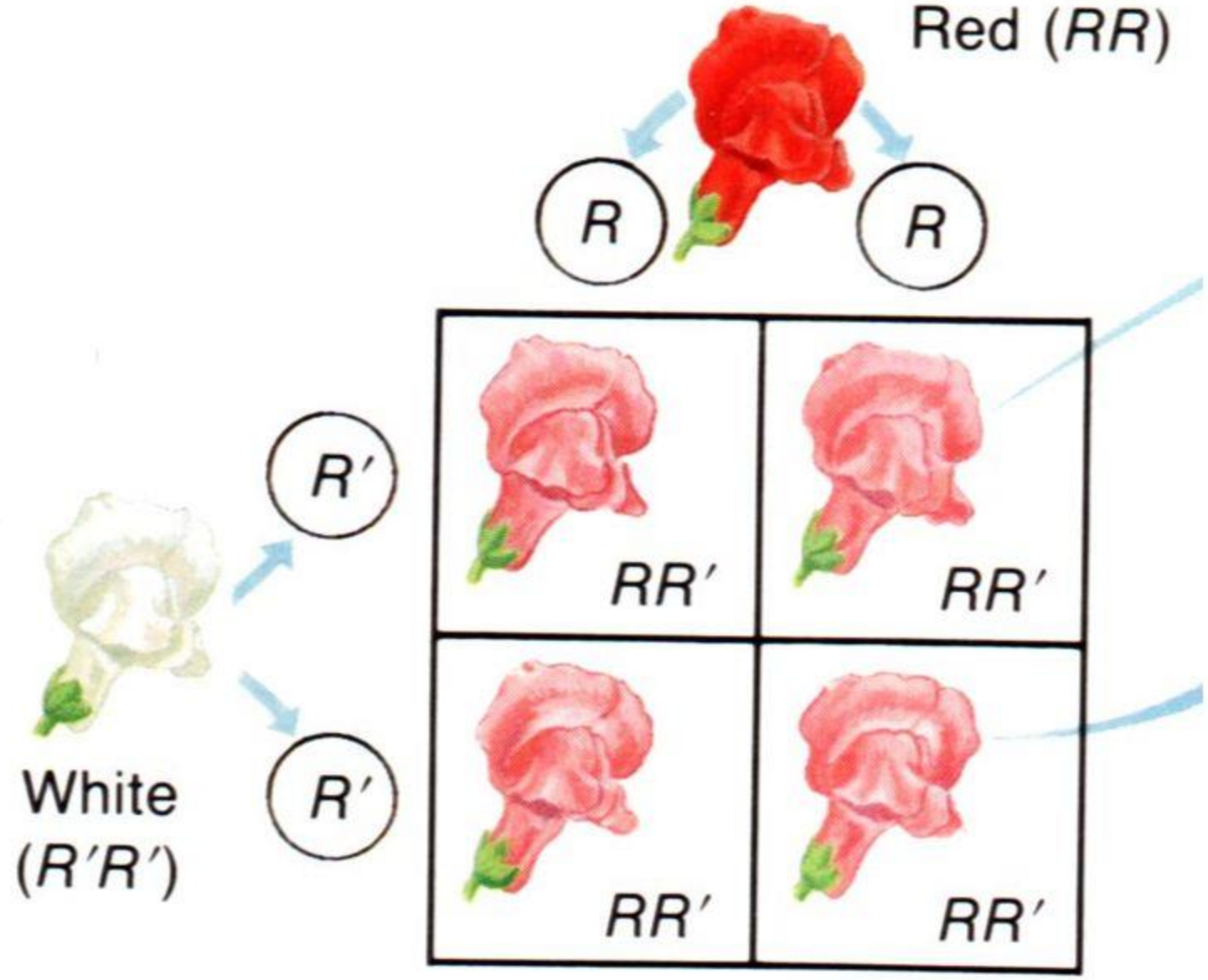
WHAT IS INCOMPLETE DOMINANCE?

- There is no dominant allele or recessive allele

- Example: Red (RR) x White (rr) = Pink (Rr)



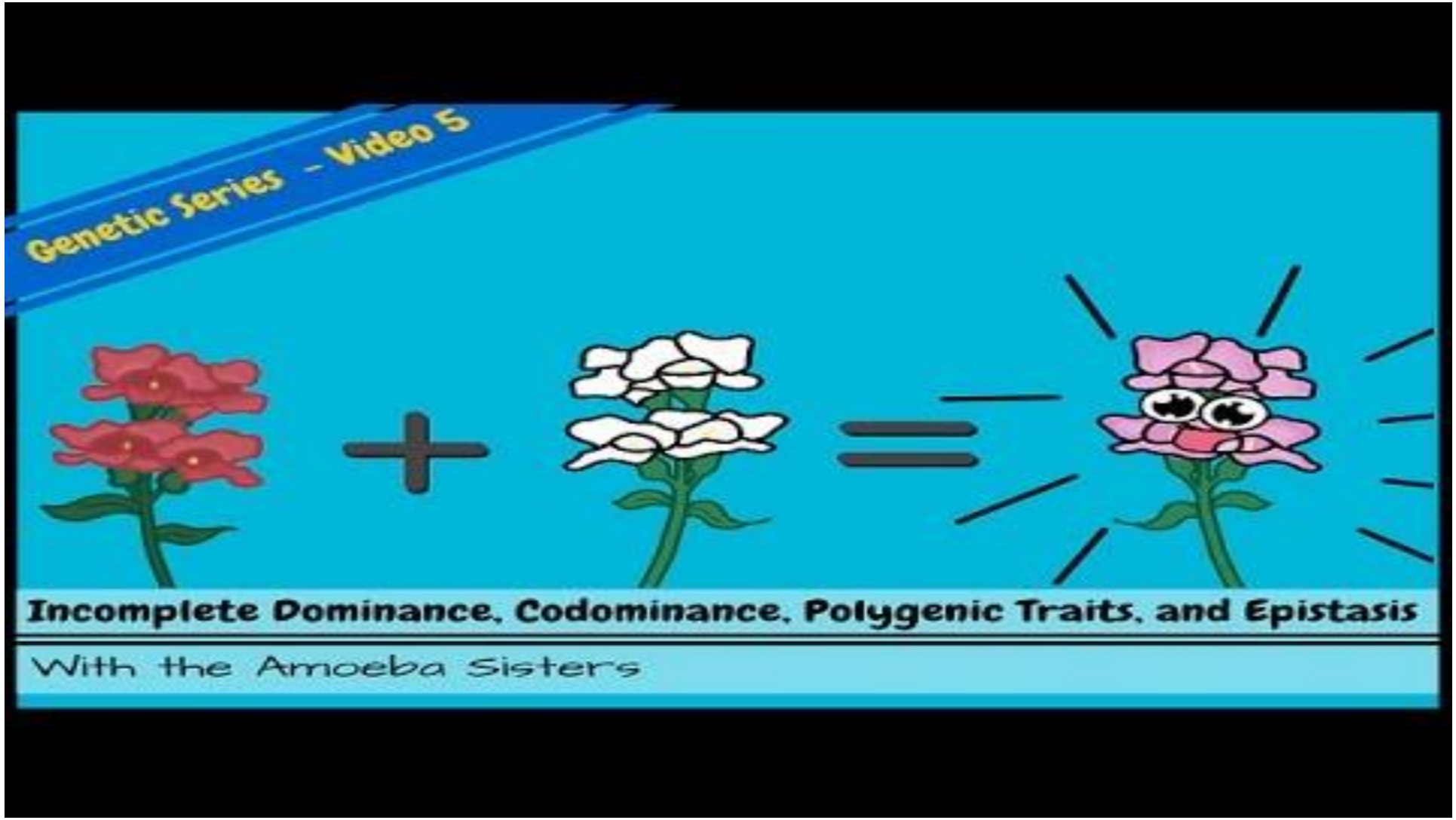
Incomplete Dominance- F_1 generation



WHAT IS CODOMINANCE?

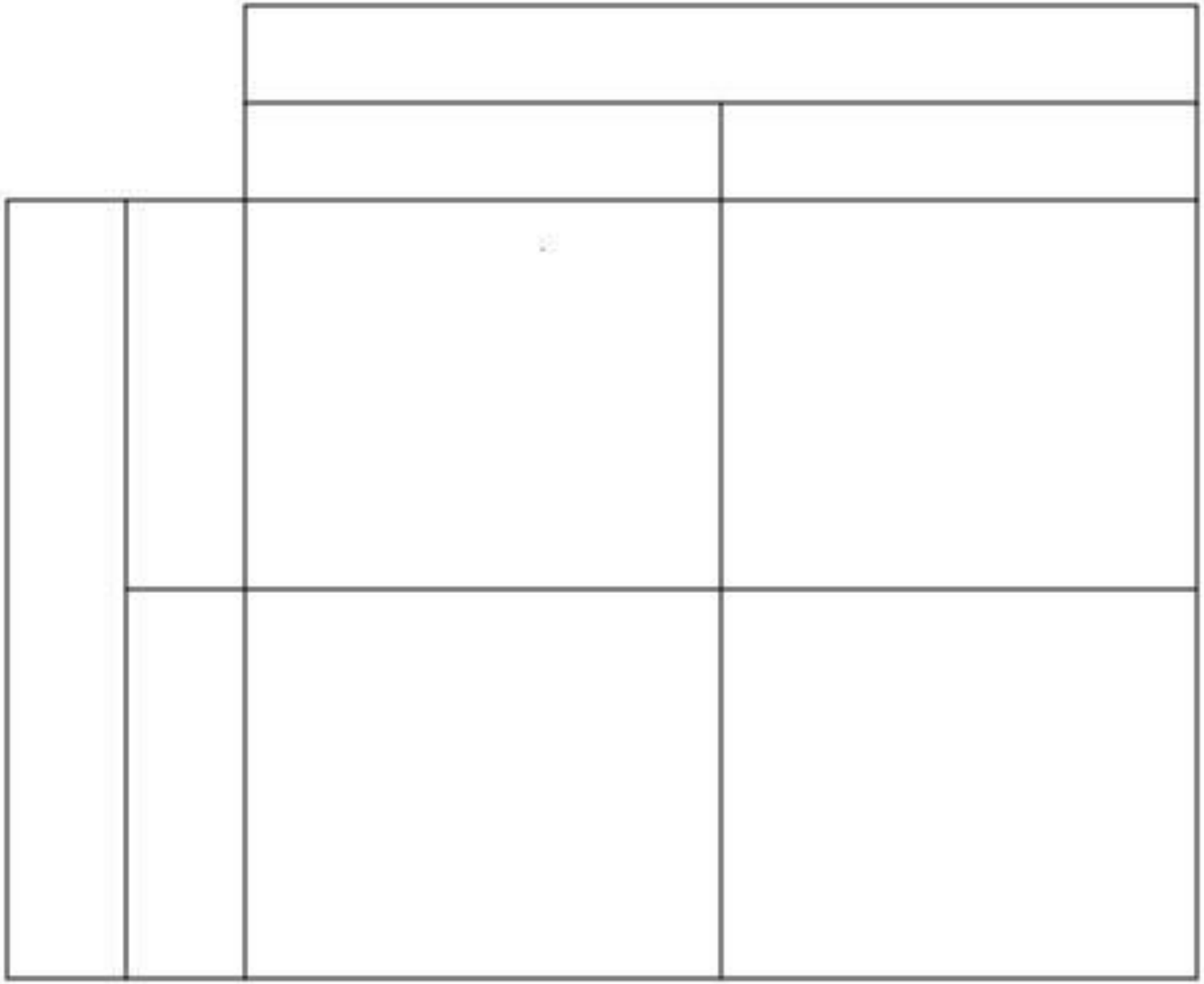
- There is no dominant allele or recessive allele but both are expressed

Phenotype	Black	Speckled	White
Genotype	C^BC^B	C^BC^W	C^WC^W


Genetic Series - Video 5
Incomplete Dominance, Codominance, Polygenic Traits, and Epistasis
With the Amoeba Sisters

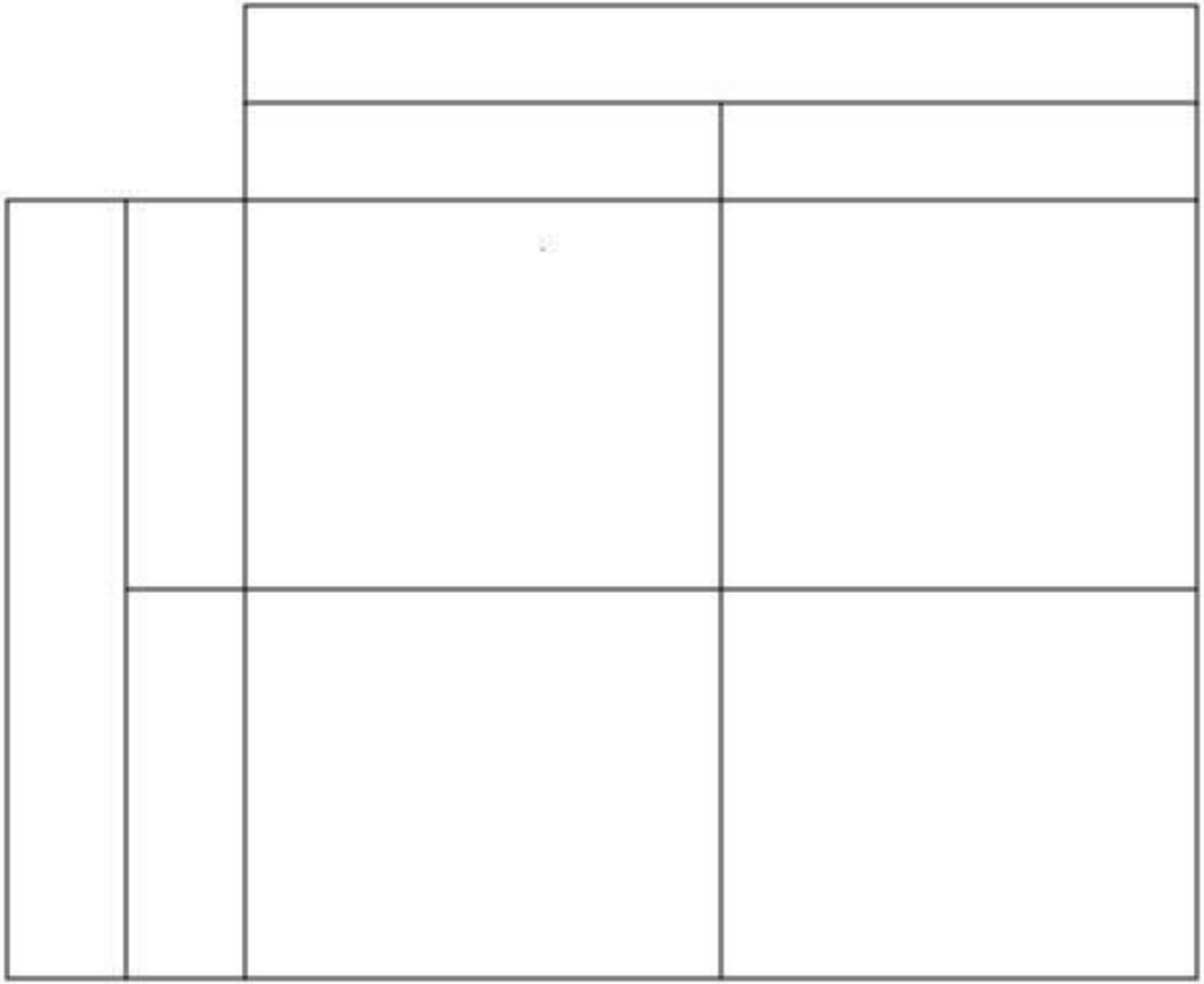
PRACTICE PROBLEM #1

If brown hair and white hair horse alleles show incomplete dominance, what offspring ratios will you see if you cross a brown horse with a white horse?



PRACTICE PROBLEM #2

If red and white flower alleles show codominance, what offspring ratios will you see if you cross a red flower with a white flower?



TOPIC 2 LEARNING TARGETS

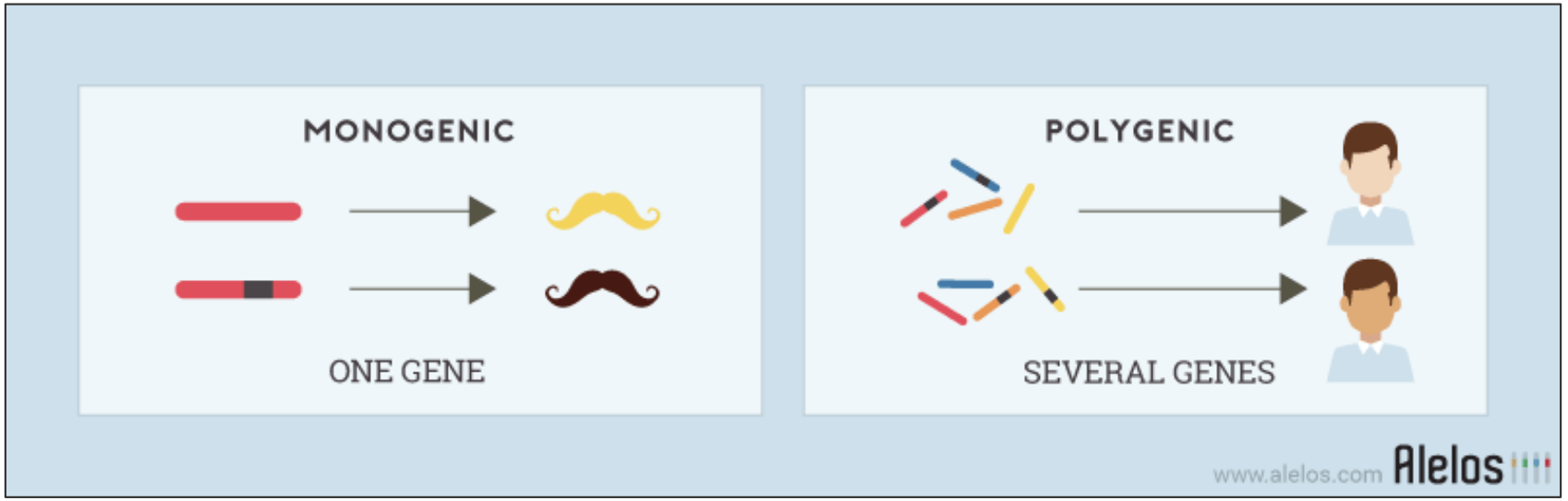
- Use Punnett squares for unusual monohybrid crosses – incomplete dominance ✔, codominance ✔, blood types, sex-linkage

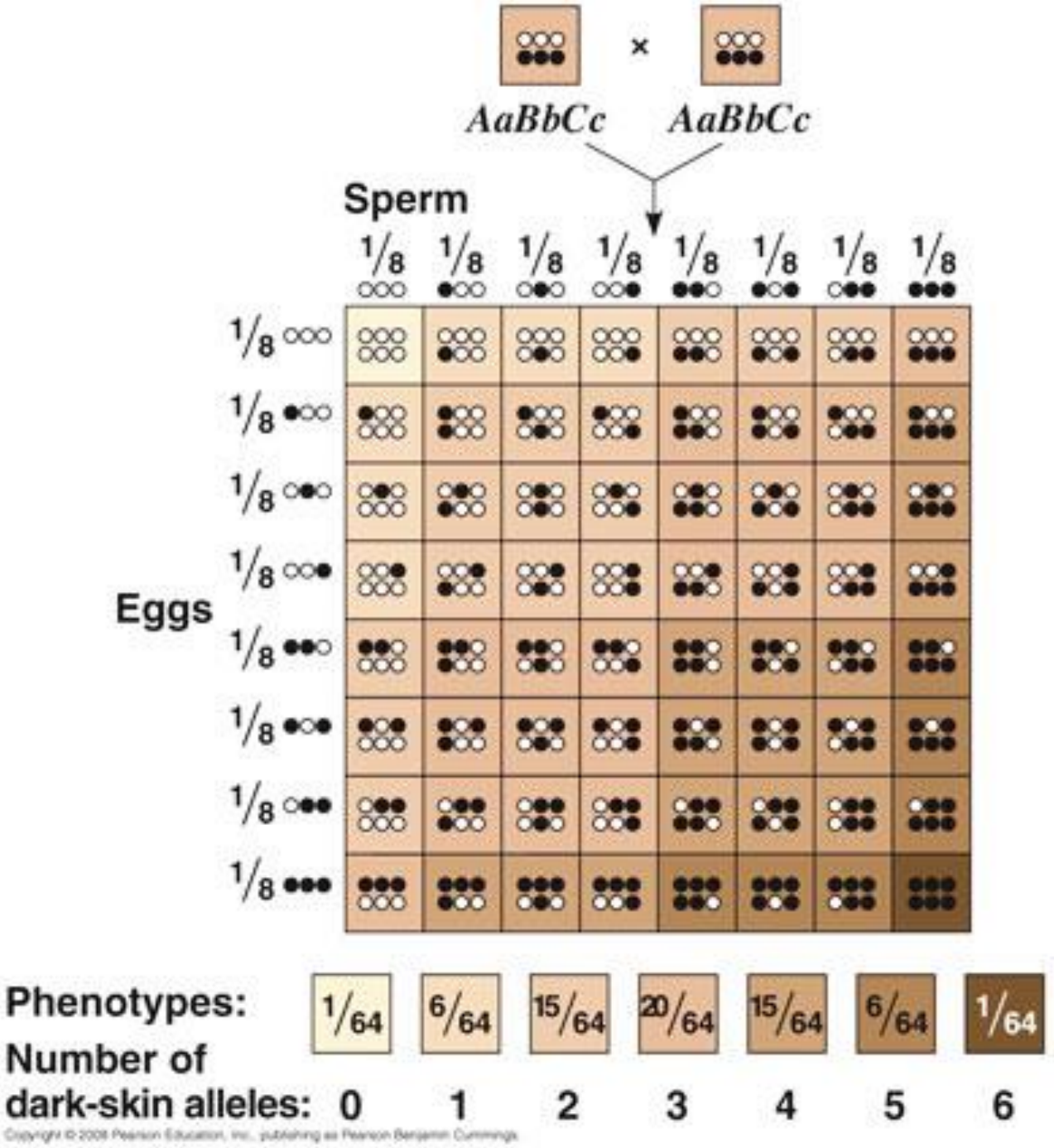
- Use Punnett square for dihybrid crosses

WHAT IS A POLYGENIC TRAIT?

- Two or more genes affect a single phenotype

- Example: Eye color, skin color, height





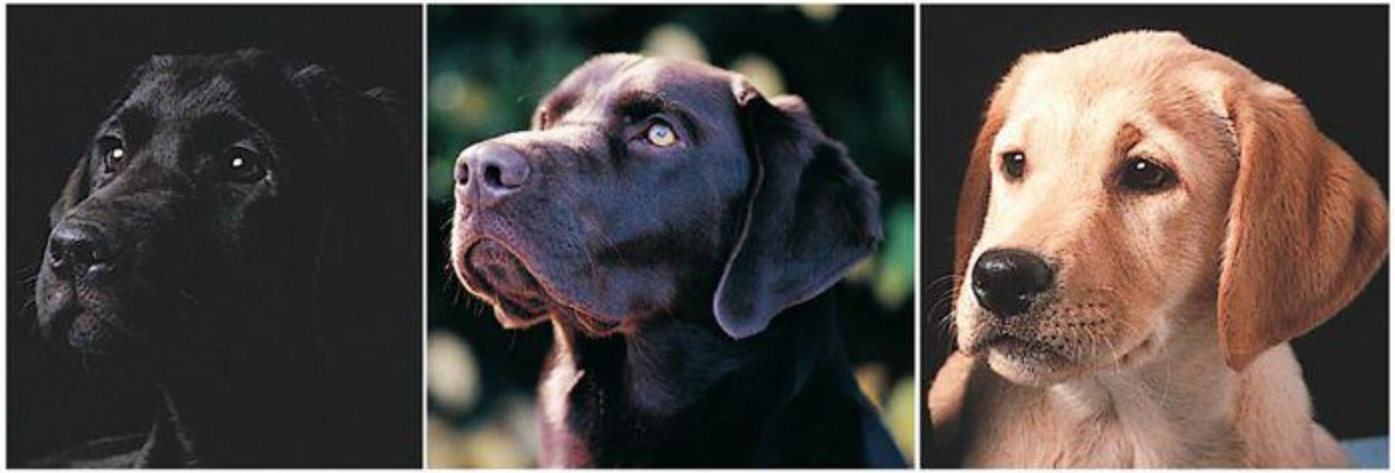
WHAT DOES EPISTASIS MEAN?

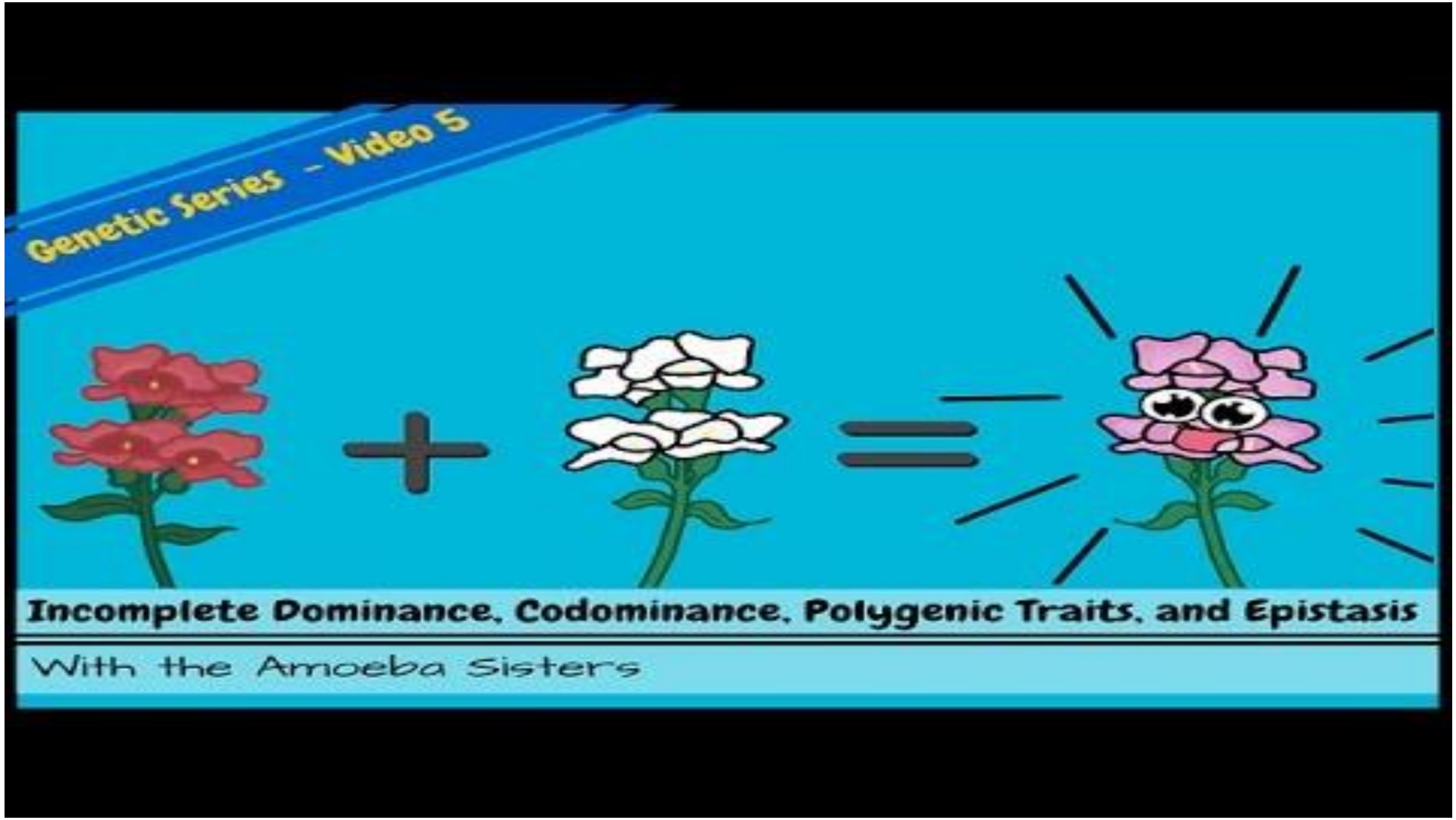
- The phenotypic expression of one gene alters that of another independently inherited gene

- Example: Coat color in Labrador retrievers

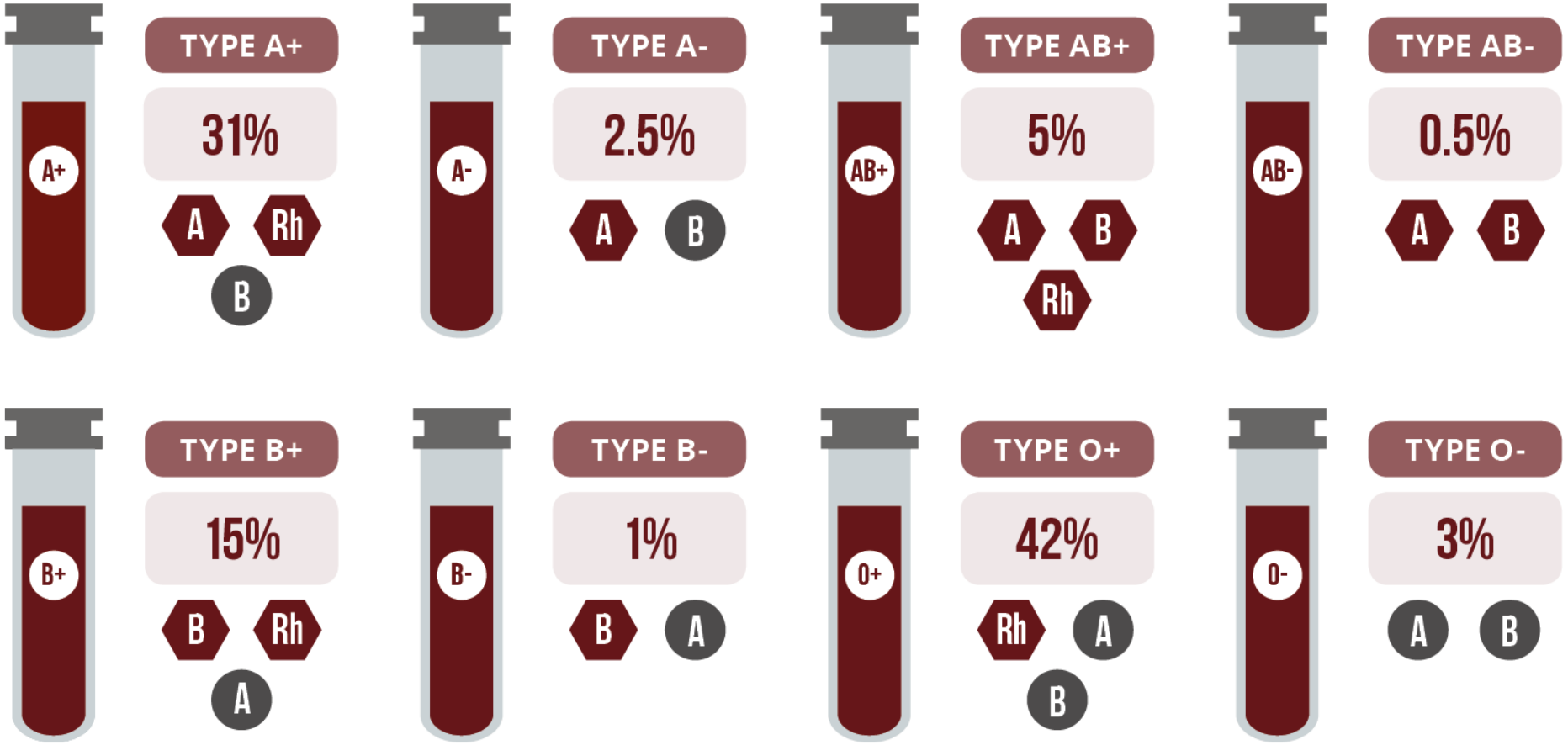
Epistasis in Coat Colors

	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




Genetic Series - Video 5
Incomplete Dominance, Codominance, Polygenic Traits, and Epistasis
With the Amoeba Sisters

BLOOD TYPE DISTRIBUTIONS



KEY
- ANTIGEN
- ANTIBODY

This graphic shows approximate worldwide distributions of different blood types. Note that for different locations and ethnicities figures vary from those shown in this distribution.

The ABO blood system

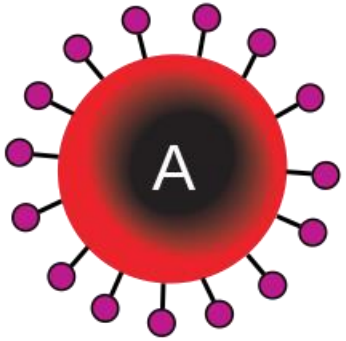
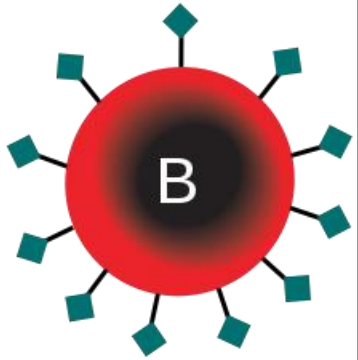
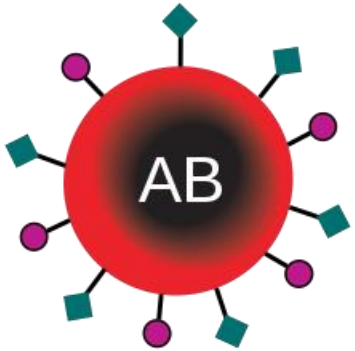
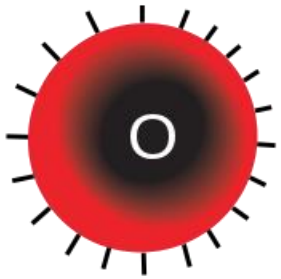
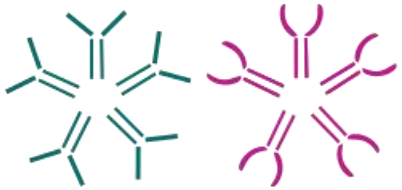
Genotypes	Phenotypes (Blood types)
$I^A I^A$	A
$I^A I^B$	AB
$I^A i$	A
$I^B I^B$	B
$I^B i$	B
ii	O

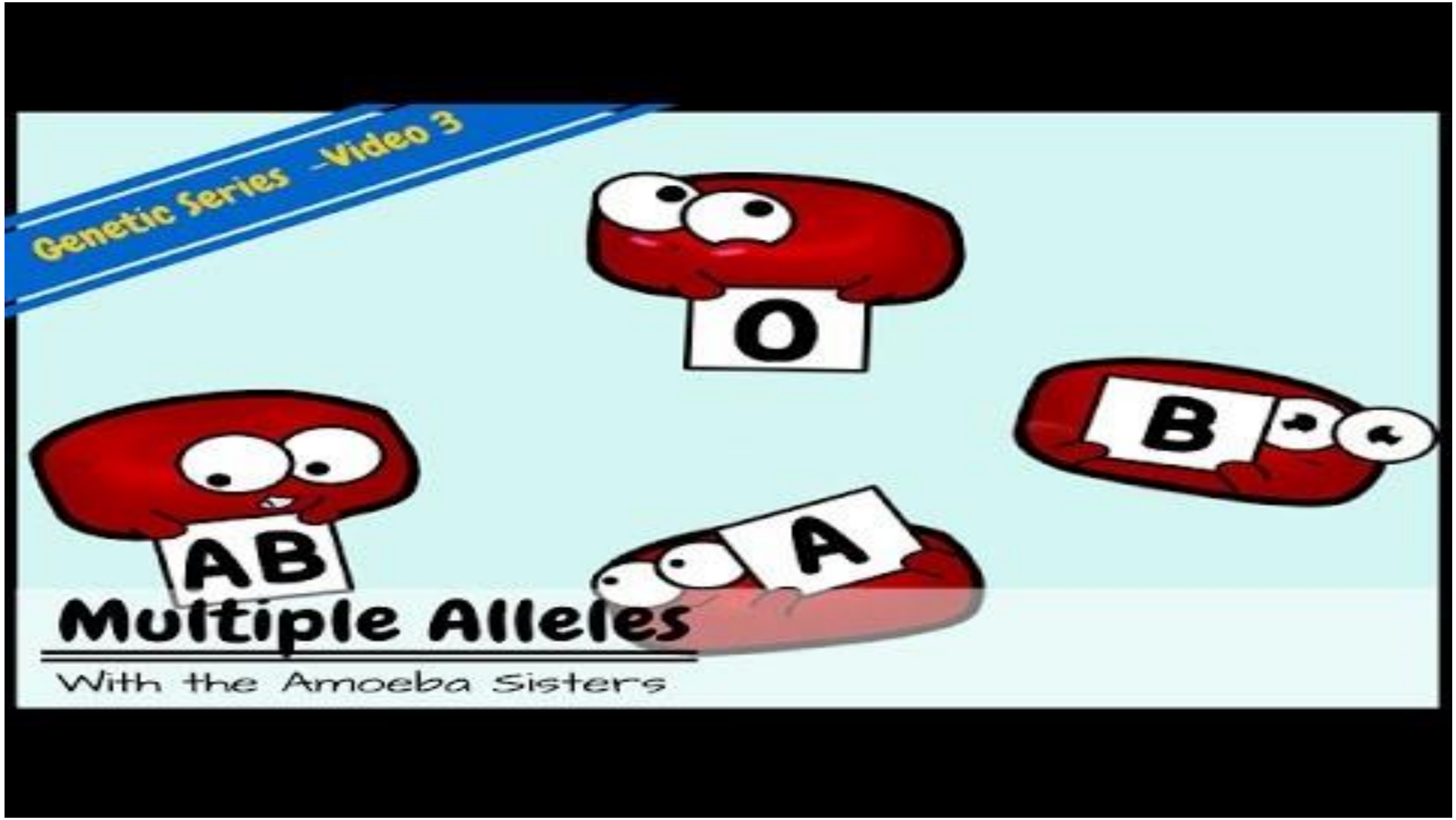
Note:

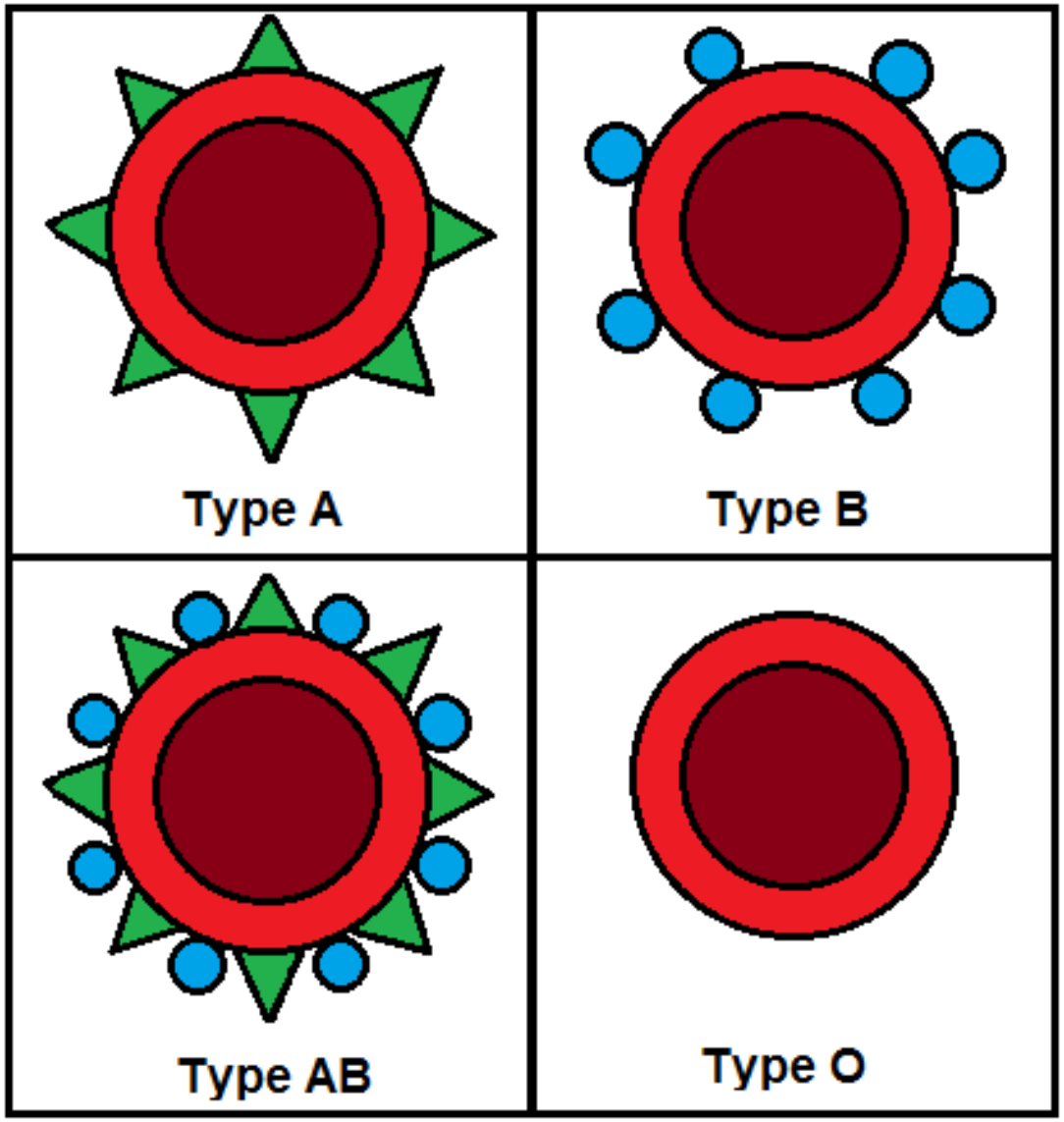
- Blood types A and B have two possible genotypes – homozygous and heterozygous.
- Blood types AB and O only have one genotype each.

WHAT DOES MULTIPLE ALLELES MEAN?

- Two or more alleles affect a single gene
- Example: Blood type (A, B, O)

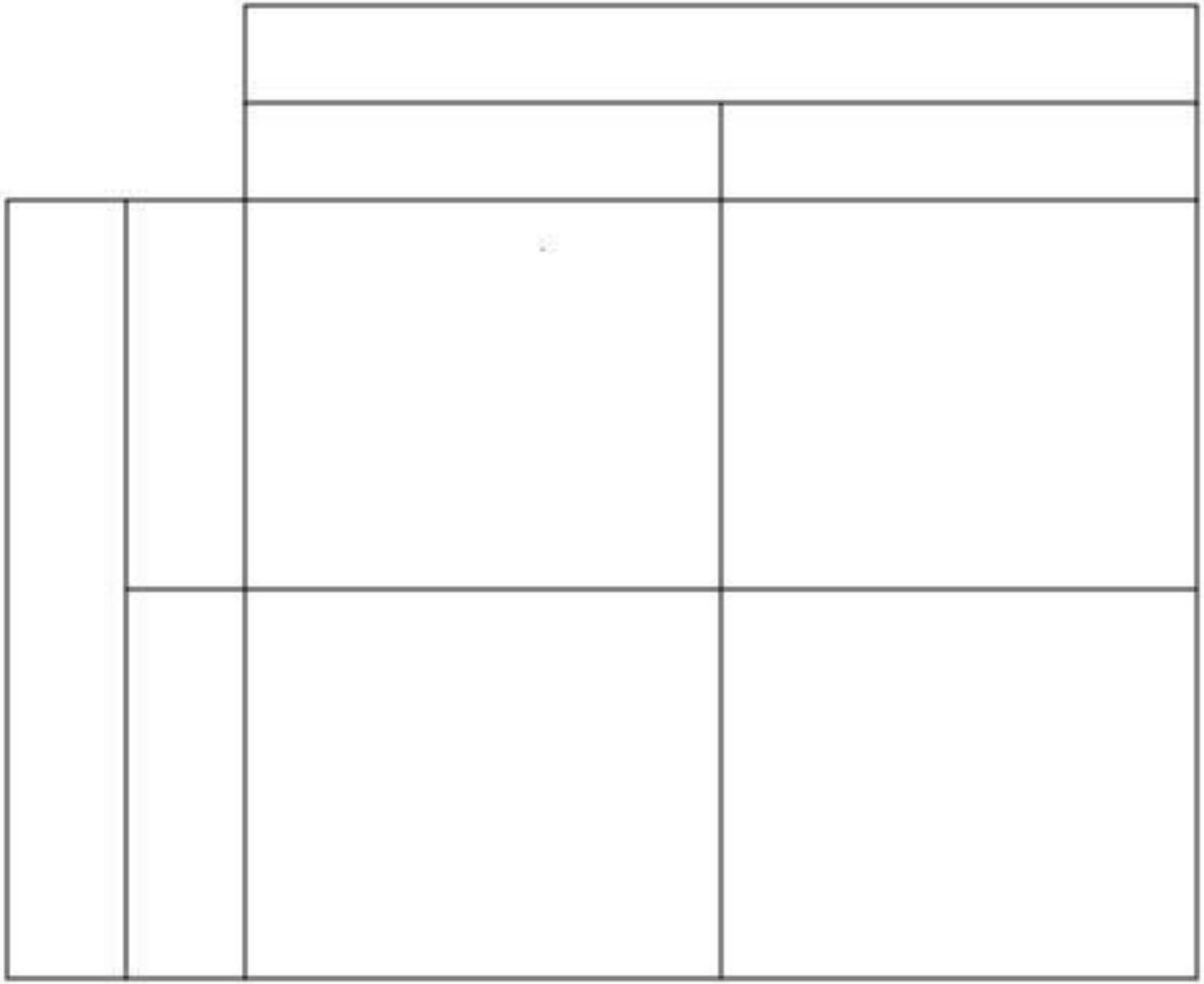
	Group A	Group B	Group AB	Group O
Red blood cell type				
Antibodies in Plasma	 Anti-B	 Anti-A	None	 Anti-A and Anti-B
Antigens in Red Blood Cell	 A antigen	 B antigen	 A and B antigens	None


Genetic Series - Video 3
O
B
AB
A
Multiple Alleles
With the Amoeba Sisters



PRACTICE PROBLEM #3

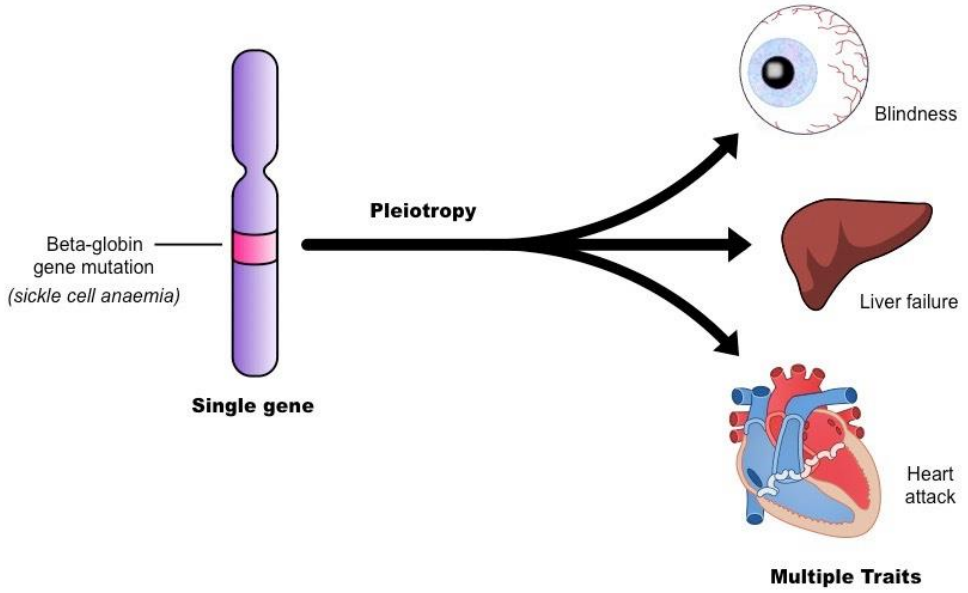
If a father with blood type A (I^Ai) and mother with blood type B (I^Bi) have a child together, what offspring ratios will you see?



WHAT IS PLEIOTROPY?

- A single gene has multiple effects on unrelated traits

- Example: Sickle cell anemia



COMPARE AND CONTRAST

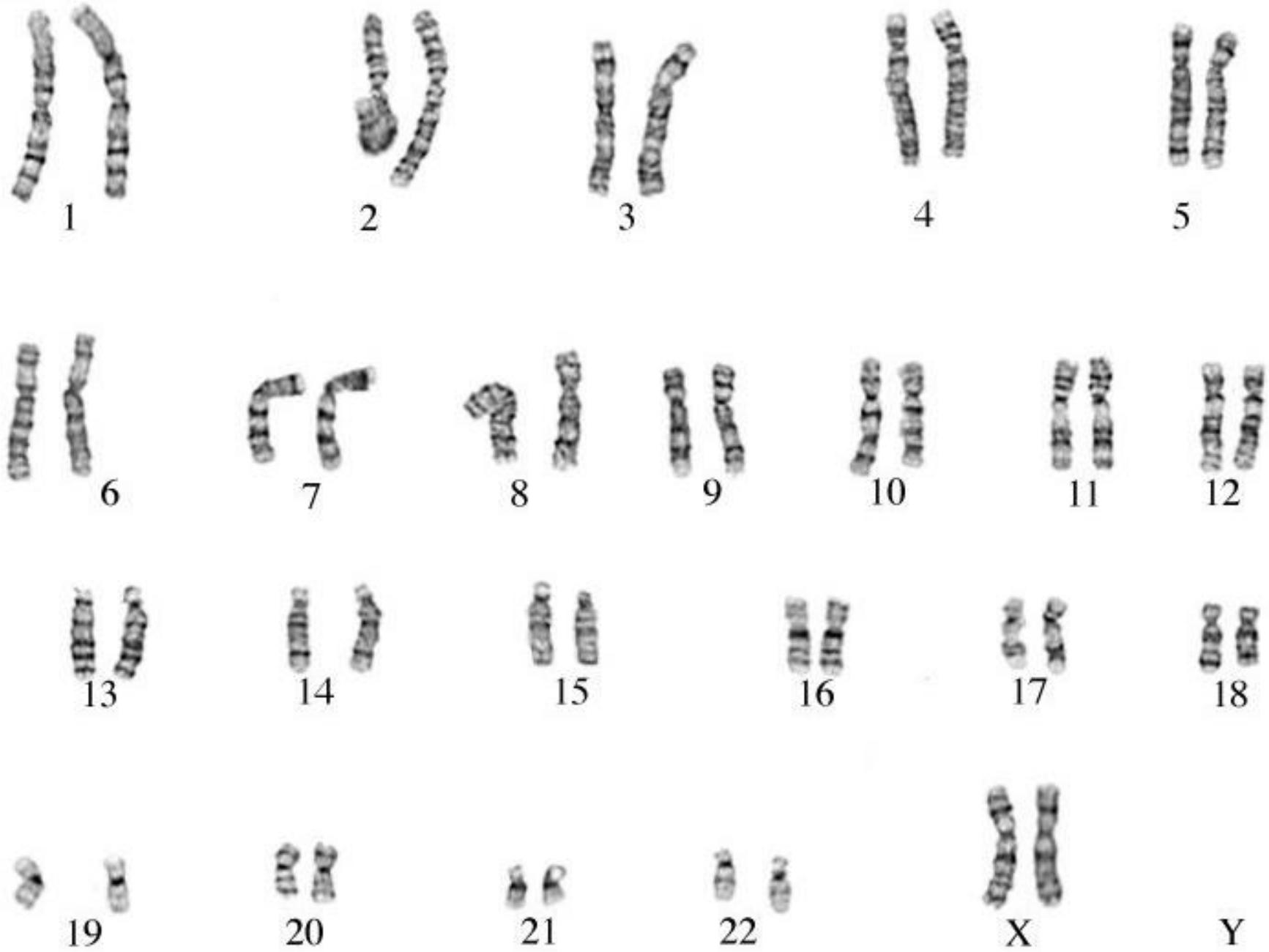
Polygenic trait

Multiple alleles

Pleiotropy

WHAT IS A SEX-LINKED TRAIT?

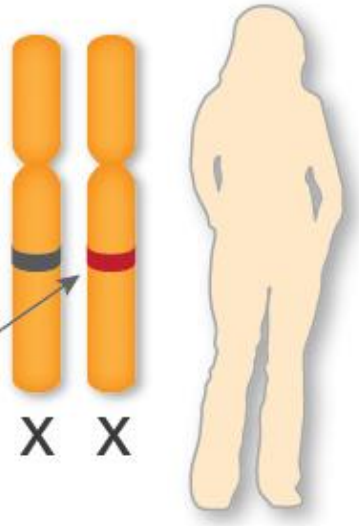
- A gene is located on either sex chromosome
- Most are found on the X chromosome
- Example: Hemophilia (x-linked) causes blood not to clot, Auricular hypertrichosis (y-linked) which causes excessive hair in the ear


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
X
Y

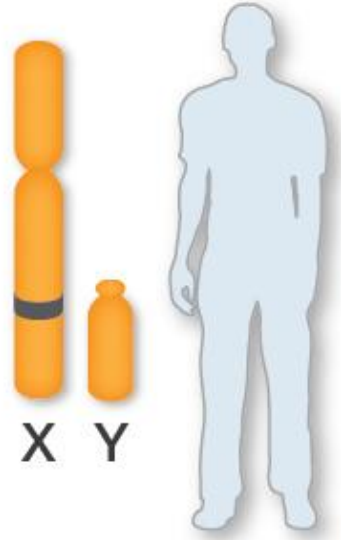
Parents:

Color vision gene

- *Normal allele*
- *Defective allele*

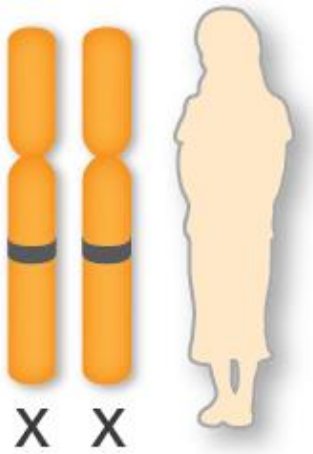


Normal vision
(Corblindness carrier)

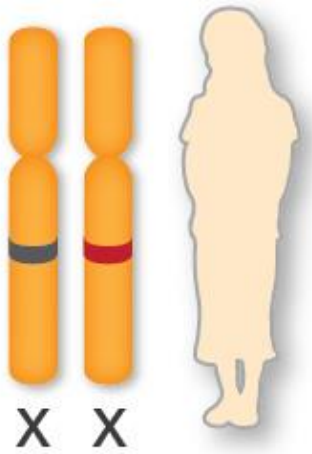


Normal vision

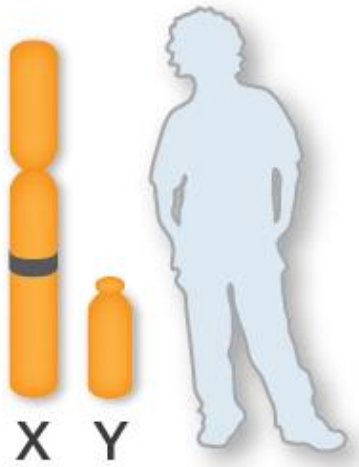
Possible offspring:



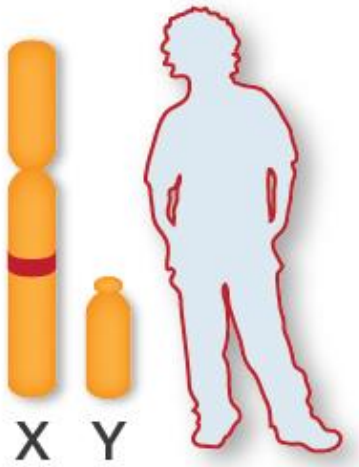
Normal vision



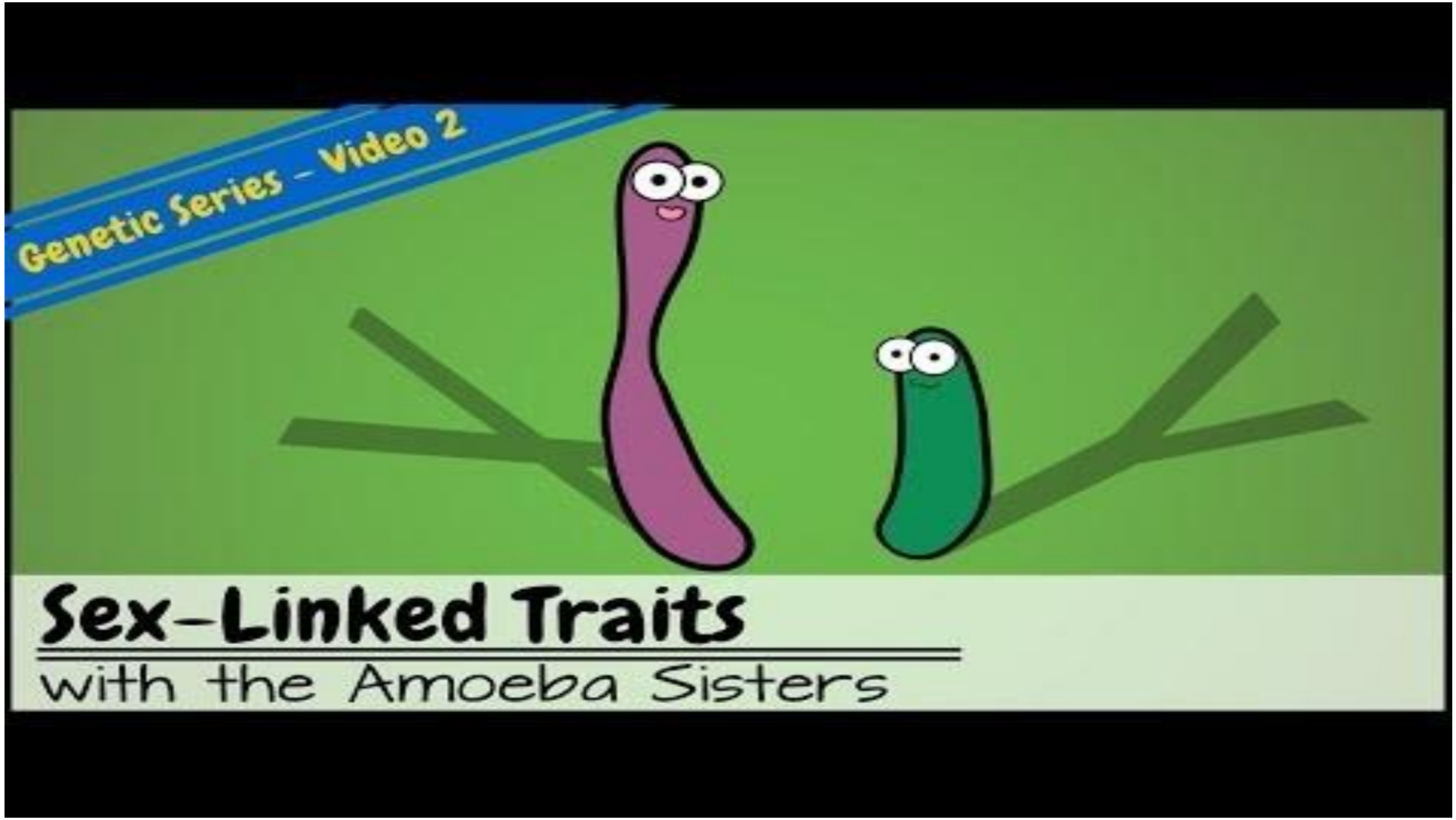
Normal vision
(Corblindness carrier)



Normal vision



Colorblind


Genetic Series - Video 2
Sex-Linked Traits
with the Amoeba Sisters

WHO WAS THOMAS MORGAN?

- Early 1900s, he and his students studied a species of fruit flies, *Drosophila melanogaster*

- Discovered sex-linked traits by choosing the right experimental organism for his research

WHO WAS THOMAS MORGAN? (CONT'D)

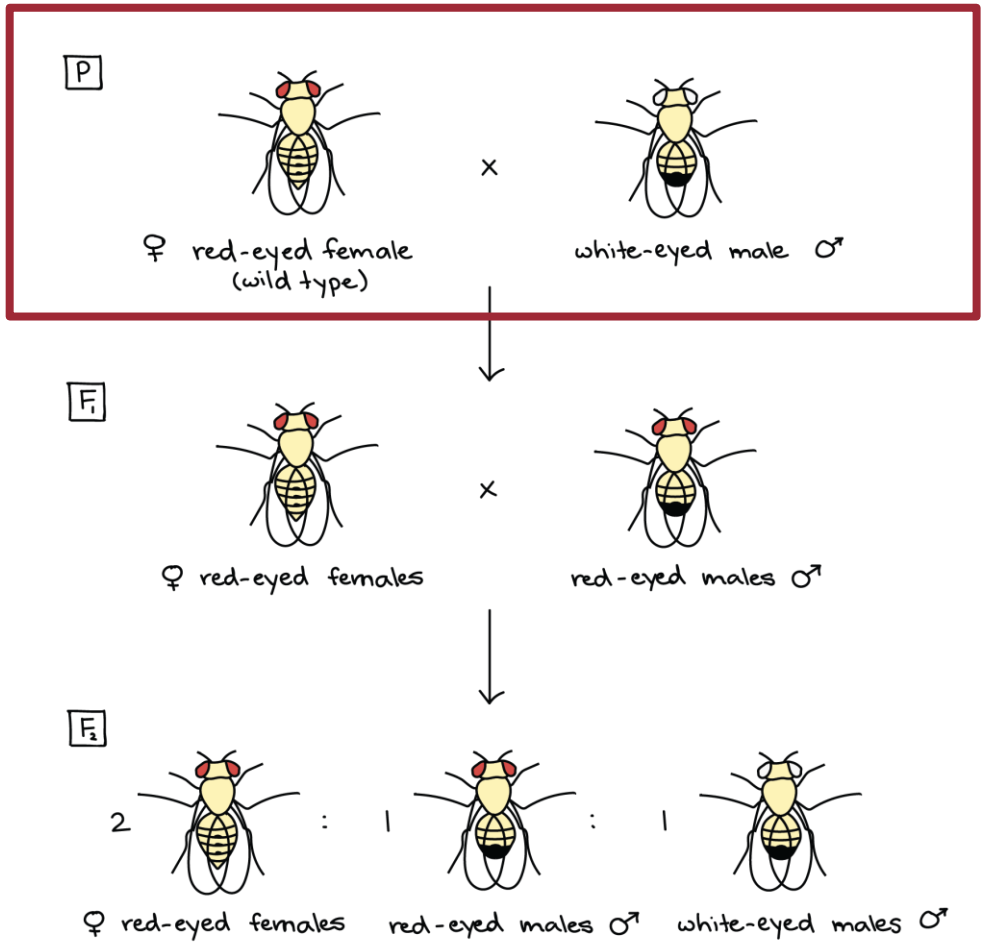
- "Two years' work wasted. I have been breeding those flies for all that time and I've got nothing out of it."

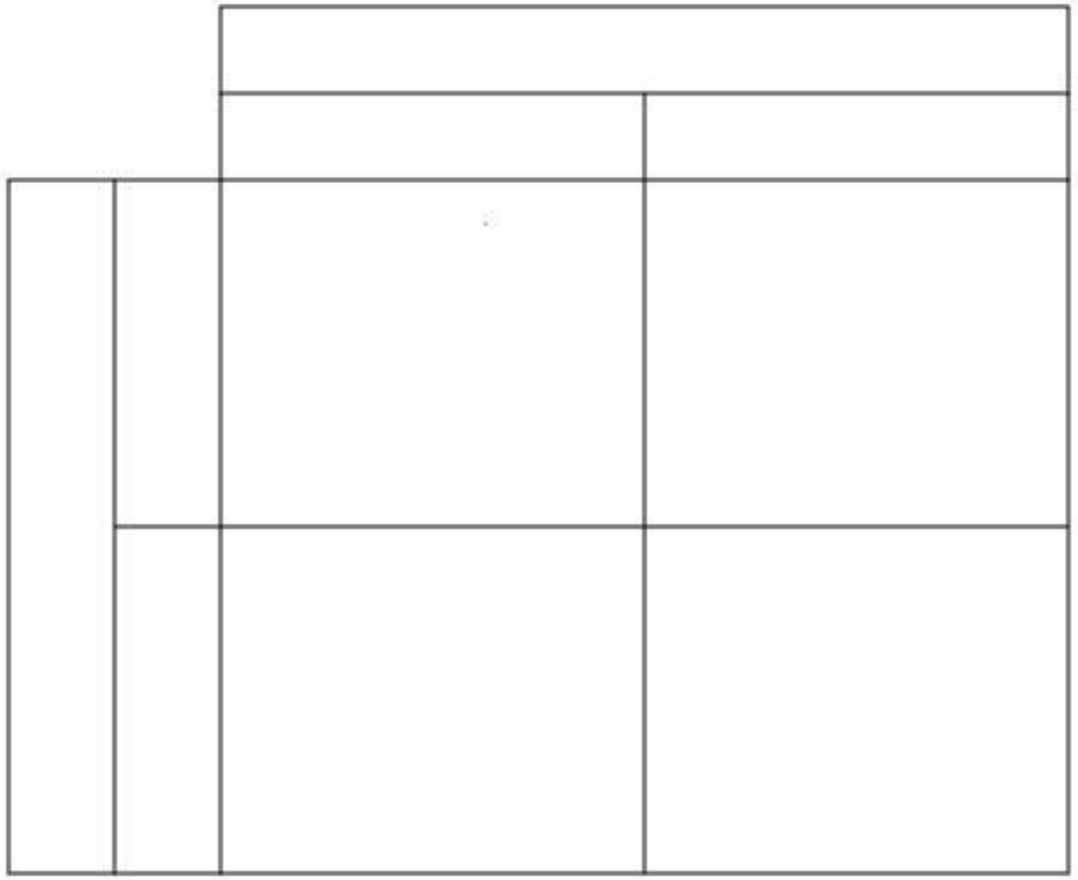
- Eventually, he and his team discovered a mutant male with white eyes (X^r)

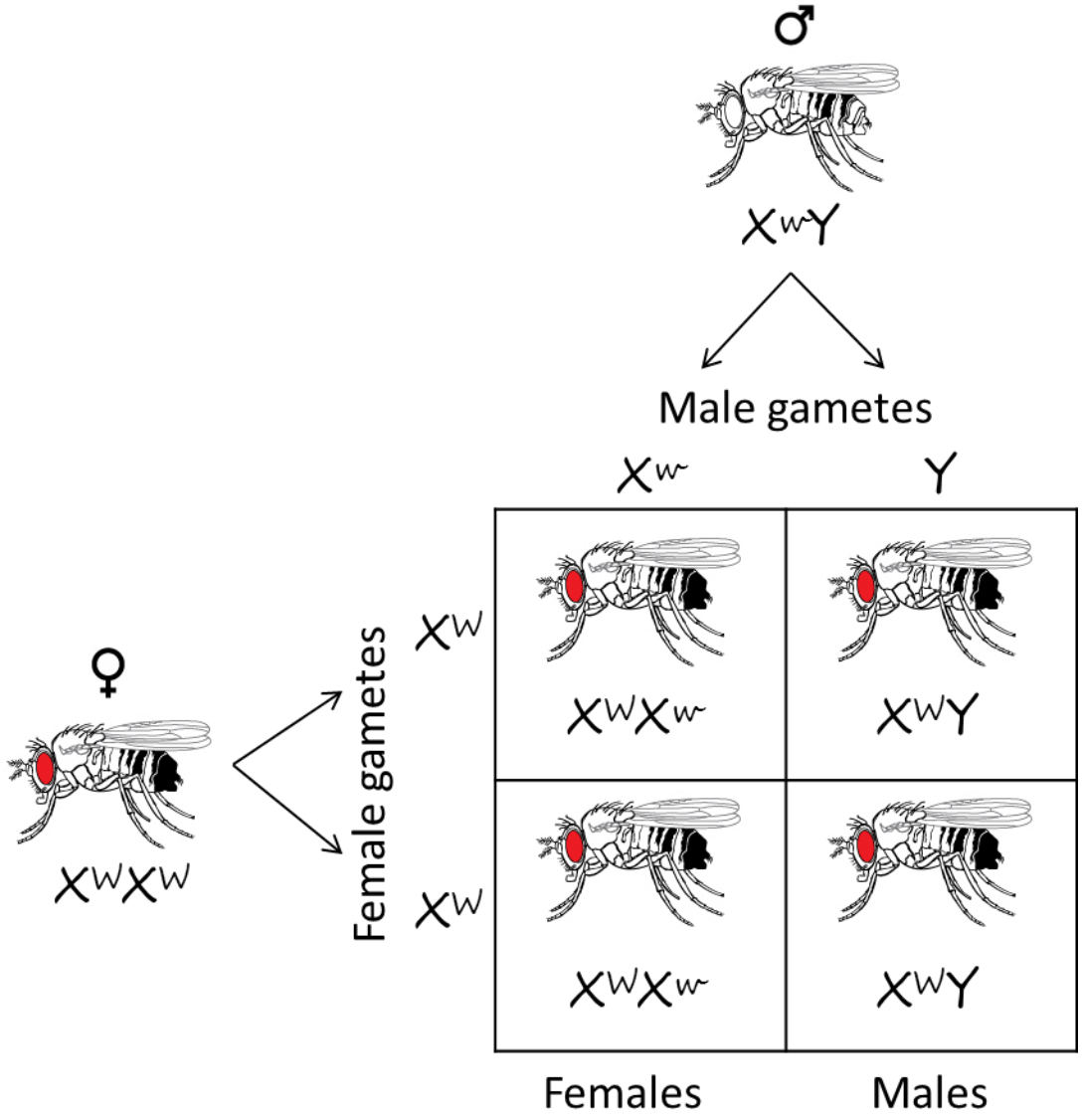
WHY FRUIT FLIES?

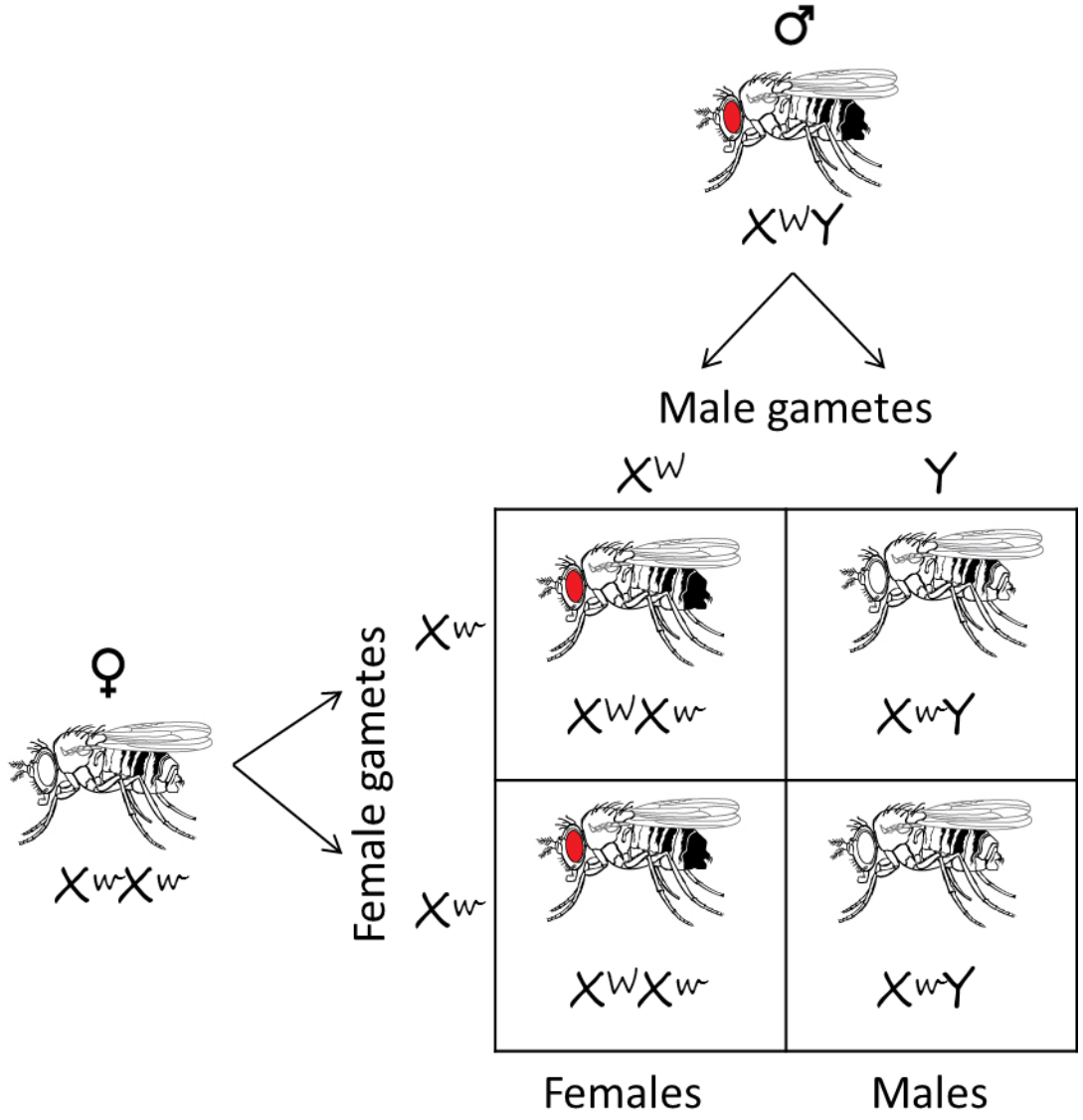
- Fruit flies have only four pairs of chromosomes (three pairs of autosomes, one pair of sex chromosomes)
- Prolific breeders with hundreds of offspring from each mating
- New generation every two weeks

PRACTICE PROBLEM #4

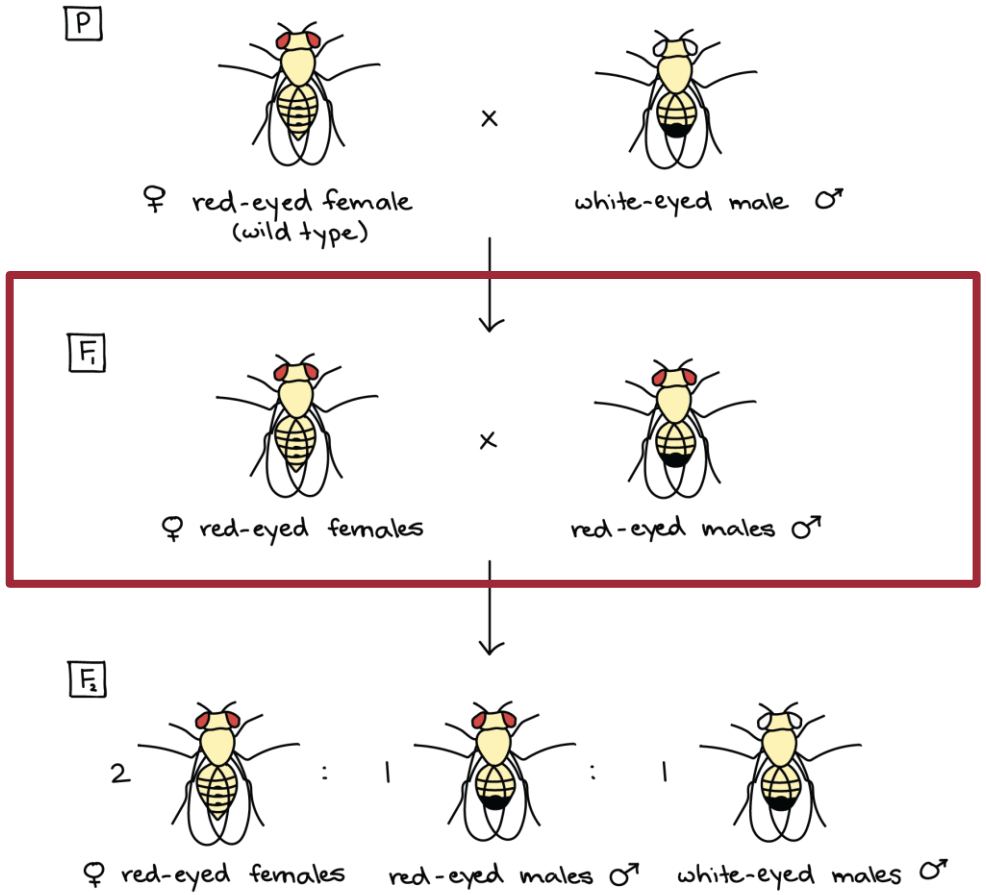


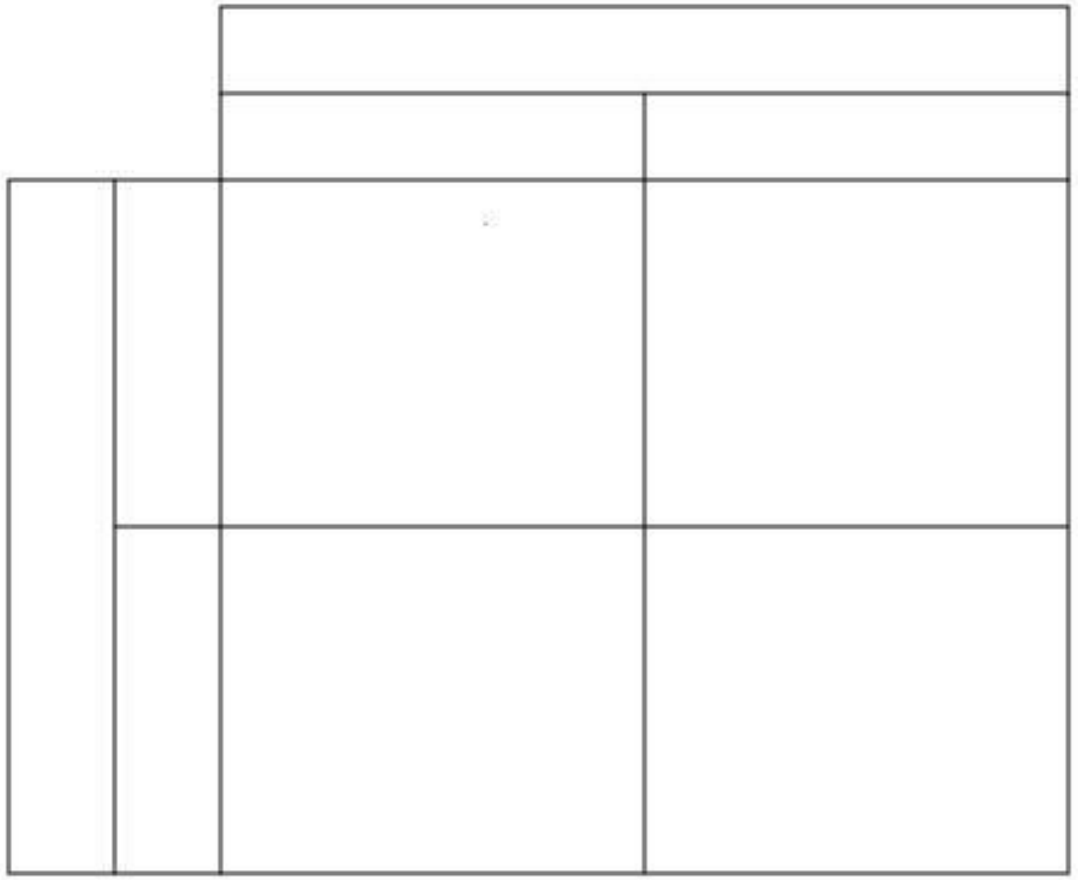


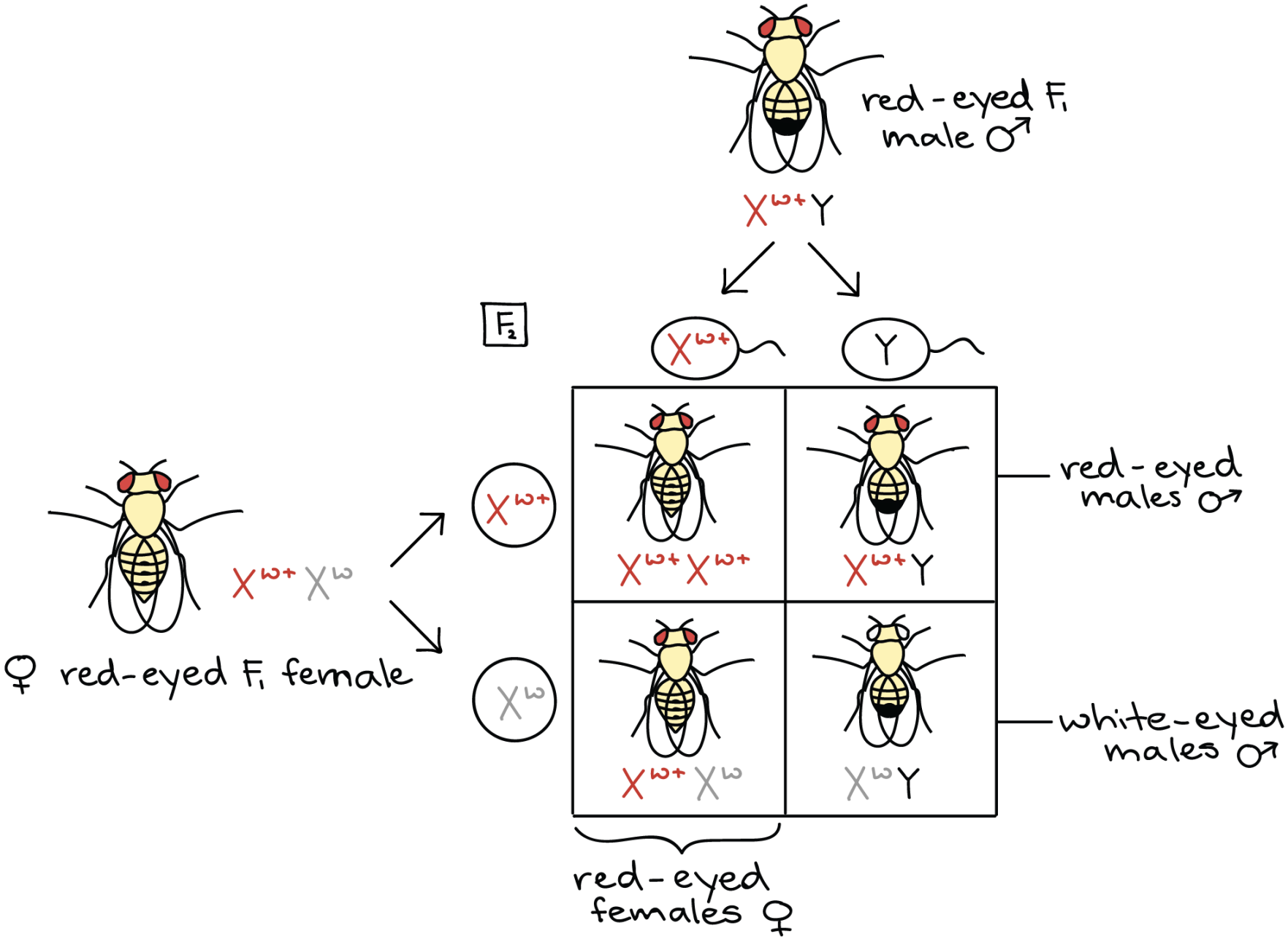

♂
XwY
Male gametes
Xw
Y
♀
XWXW
Female gametes
XW
XW
XWXw
XWY
XWXw
XWY
Females
Males


♂
XWY
Male gametes
XW
Y
♀
XwXw
Female gametes
Xw
Xw
XWXw
XwY
XWXw
XwY
Females
Males

PRACTICE PROBLEM #5






red-eyed F1 male ♂
$X^{w+}Y$
F2
X^{w+}
Y
X^{w+}
X^{w}
$X^{w+}X^{w+}$
$X^{w+}Y$
$X^{w+}X^{w}$
$X^{w}Y$
red-eyed males ♂
white-eyed males ♂
red-eyed females ♀
$X^{w+}X^{w}$
♀ red-eyed F1 female

THINK-PAIR-SHARE

Question: Why are males affected much more often than females by X-linked disorders?

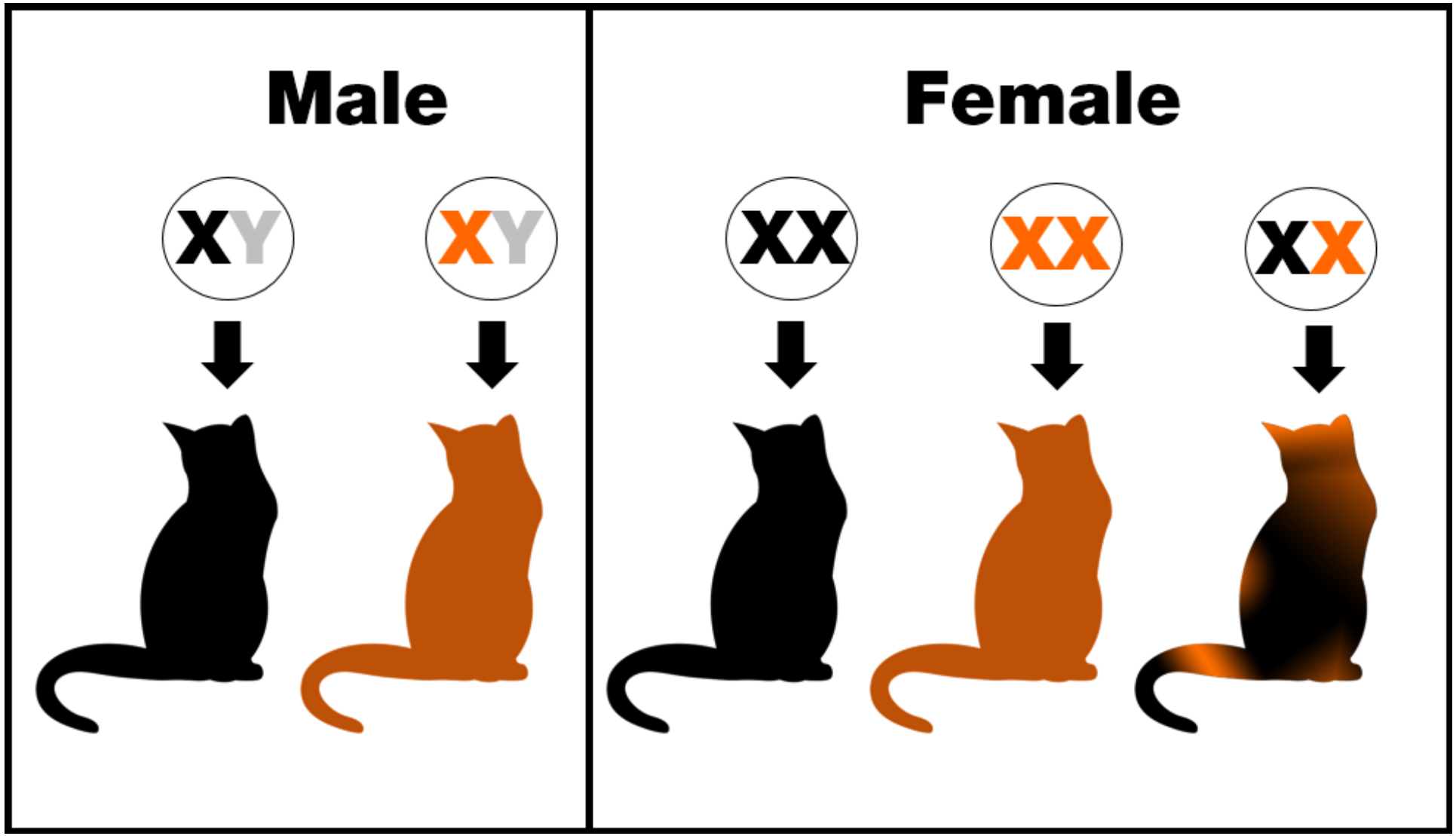
For the next minute, quietly think about the following questions.

For the next minute, with your neighbor, talk about your responses.

WHAT IS A BARR BODY?

- An inactivated X chromosome in each cell of a female mammal

- Example: Tortoiseshell cats have both cells where the X chromosome with orange allele is active and cells where the X chromosome with black allele is active


Male
XY
XY
Female
XX
XX
XX

PICK YOUR PROBLEM

- For the next 15 minutes, quietly work alone or with your neighbor to create a question a genetics problem to be given as an assignment to a classmate.

- The problem must test incomplete dominance, codominance, multiple alleles, polygenic traits, or sex-linked traits.

- Your problem must have an answer key that includes all of your work.

TOPIC 2 LEARNING TARGETS

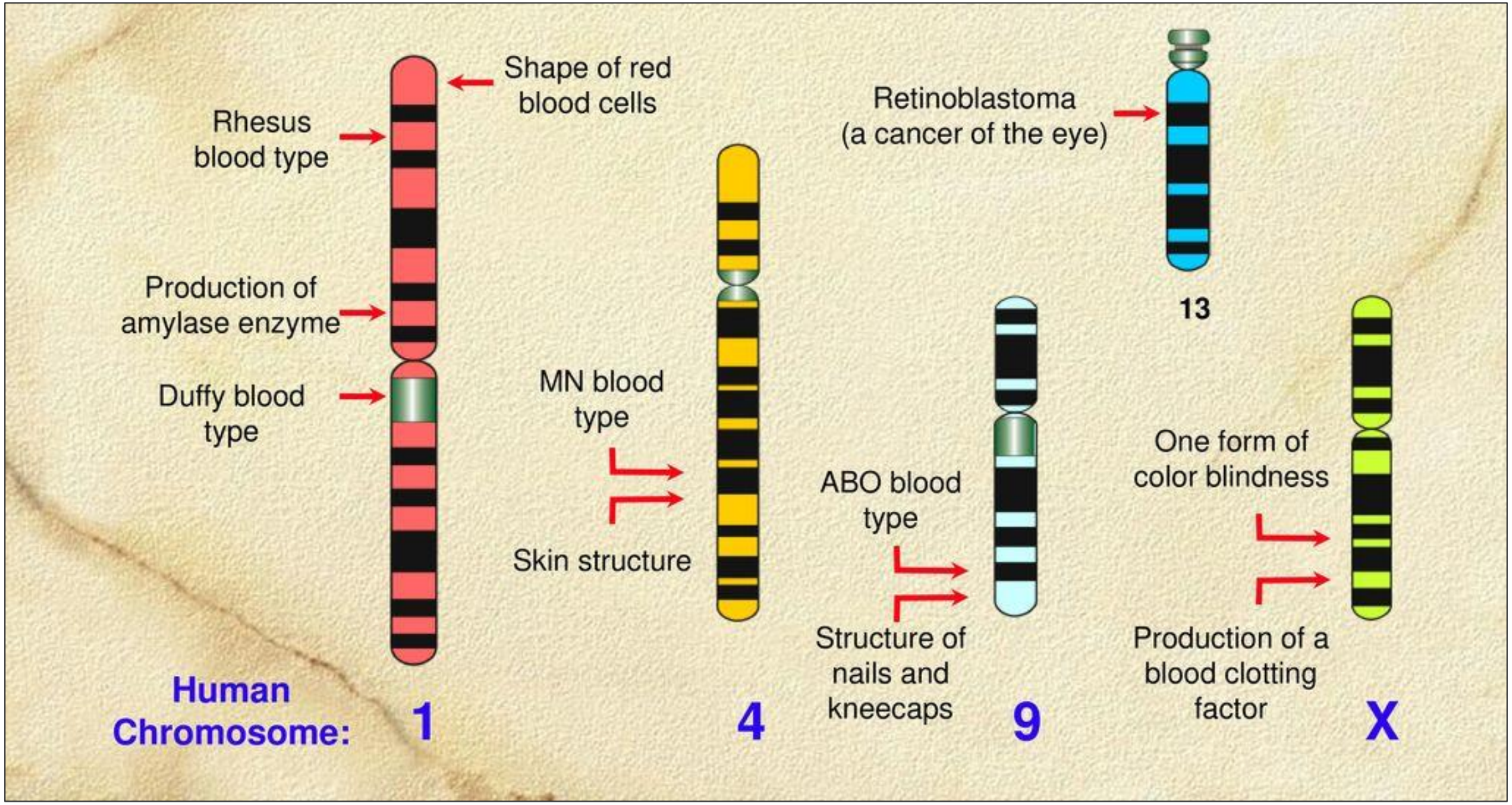
- ✓Use Punnett squares for unusual monohybrid crosses – incomplete dominance, codominance, blood types, sex-linkage

- Use Punnett square for dihybrid crosses

WHAT IS GENE MAPPING?

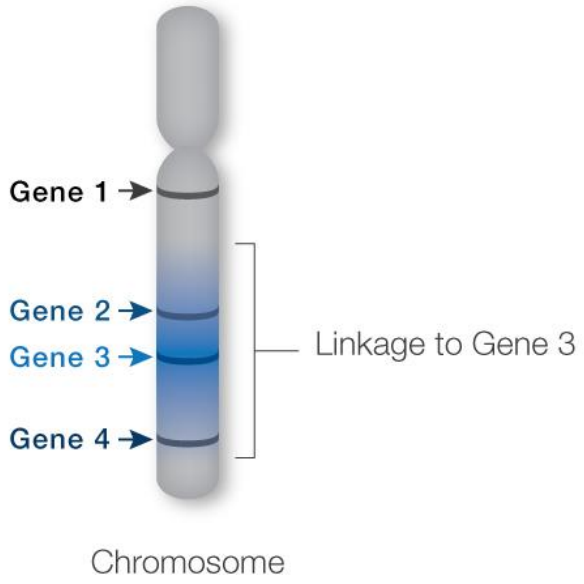
- Determining the precise position of a gene on a chromosome

- Once the position is known, it can be shown on a diagram

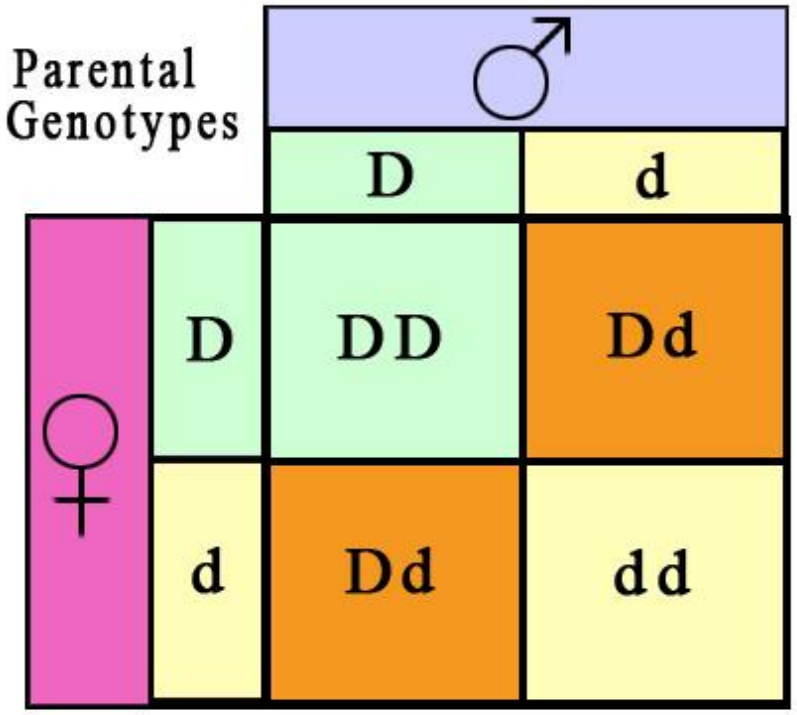

Shape of red blood cells
Rhesus blood type
Production of amylase enzyme
Duffy blood type
Retinoblastoma (a cancer of the eye)
13
MN blood type
Skin structure
ABO blood type
Structure of nails and kneecaps
9
One form of color blindness
Production of a blood clotting factor
X
Human Chromosome:
1
4

WHAT IS GENE LINKAGE?

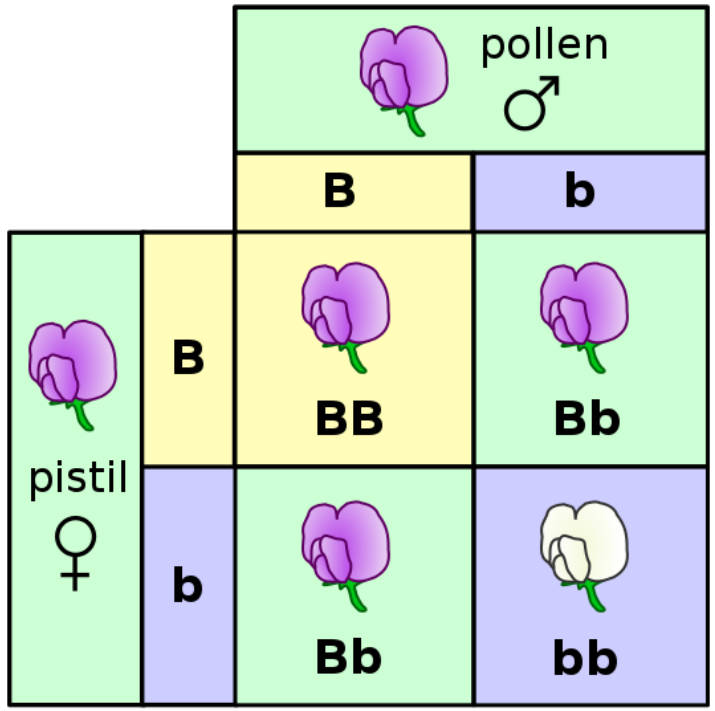
The tendency of DNA sequences that are close together on a chromosome to be inherited together during meiosis



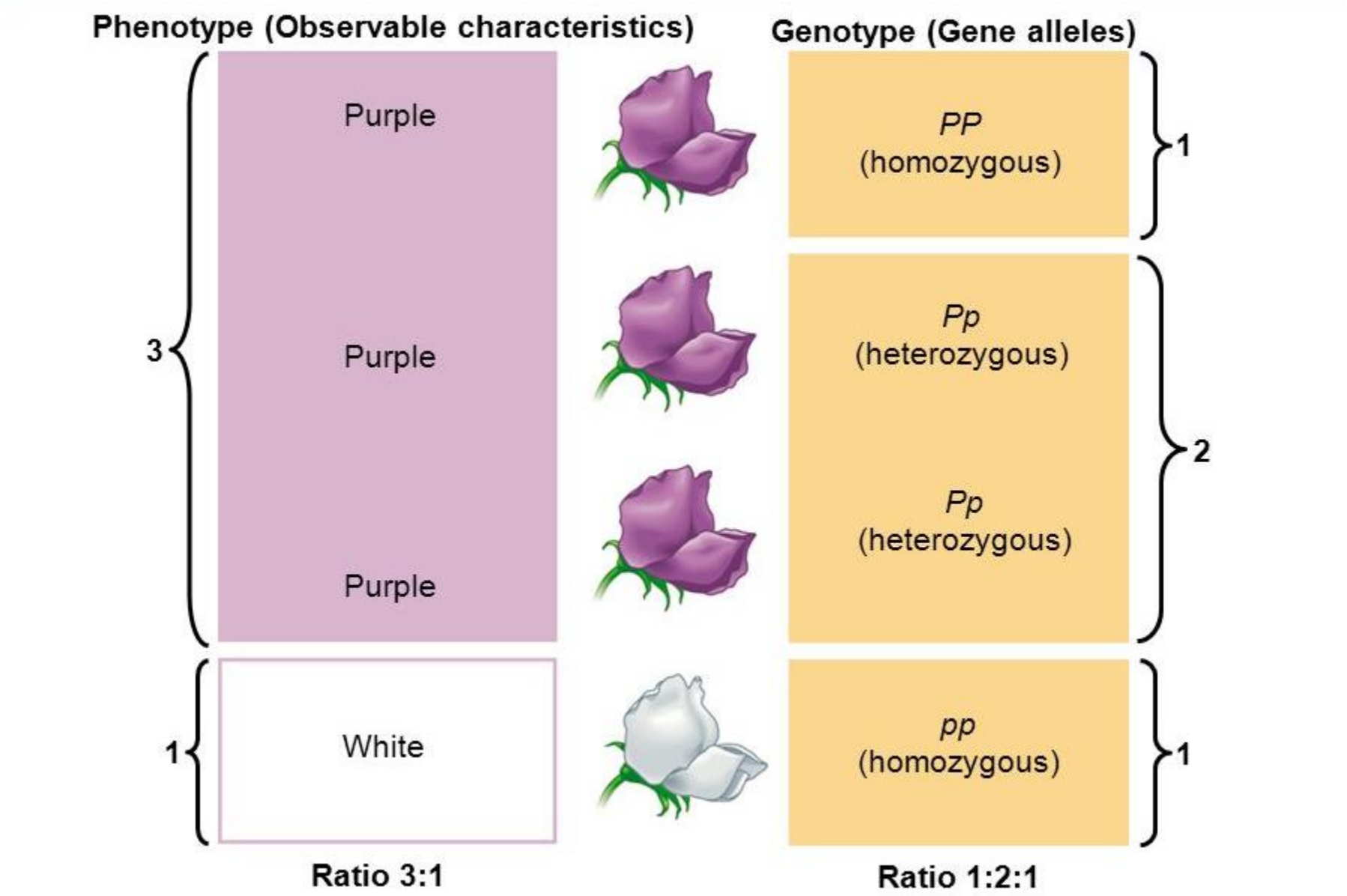
MONOHYBRID CROSS

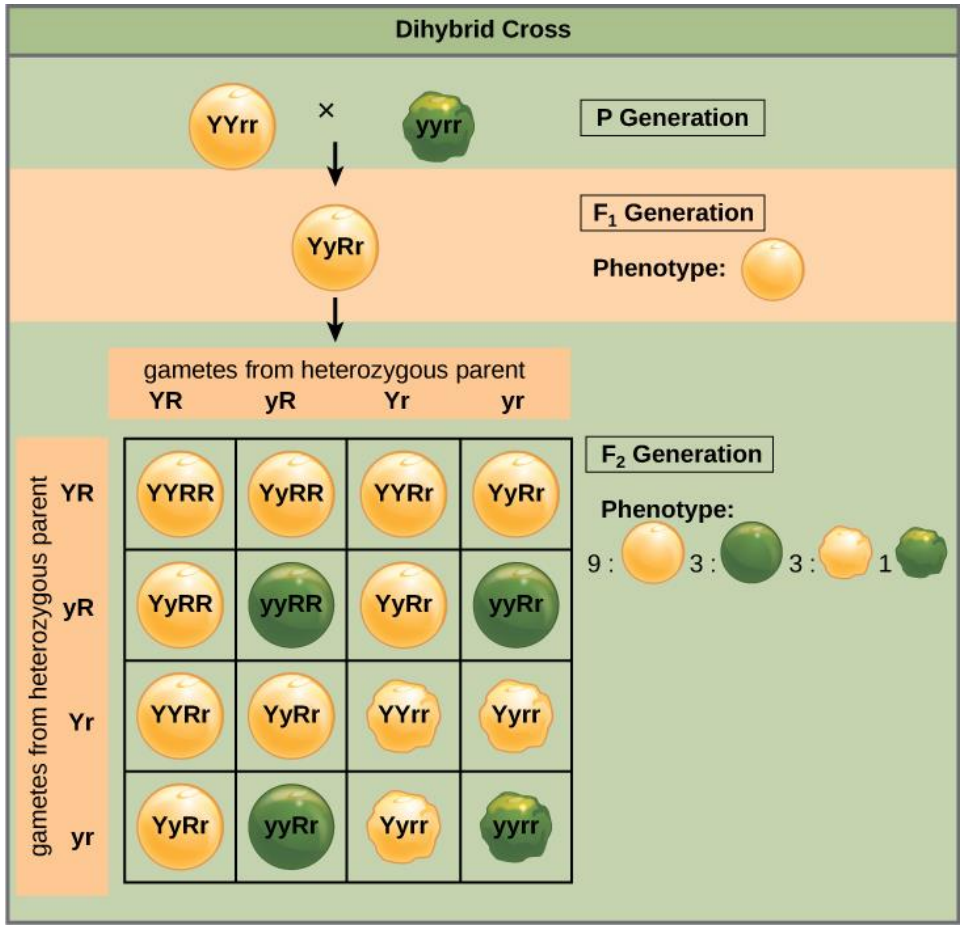


D = Dominant Allele
d = Recessive Allele



Mendel's F_1 Generation
Self- or cross-pollination


Phenotype (Observable characteristics)
Genotype (Gene alleles)
Purple
Purple
Purple
White
3
1
PP
(homozygous)
Pp
(heterozygous)
Pp
(heterozygous)
pp
(homozygous)
1
2
1
Ratio 3:1
Ratio 1:2:1



DIHYBRID CROSS

genotype:
A a B b

foil method:

gametes:

AB Ab aB ab

PRACTICE PROBLEM #6

If you have a grey bodied, striped fish (GgRr) breed with a yellow bodied, unstriped fish (ggrr), how would you write that on a dihybrid cross and what would the phenotype ratios be?

GgRr x ggrr

foil method: