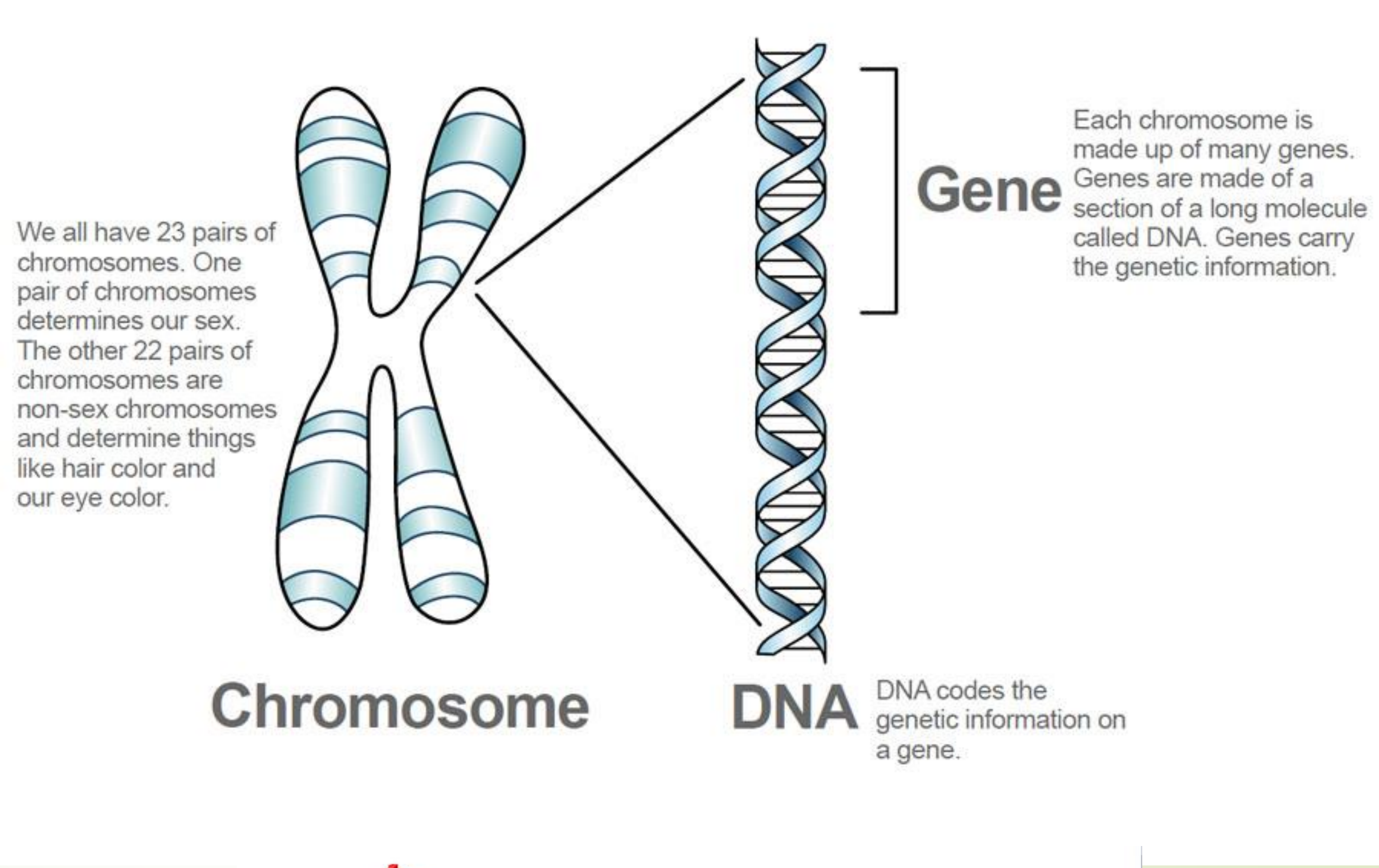
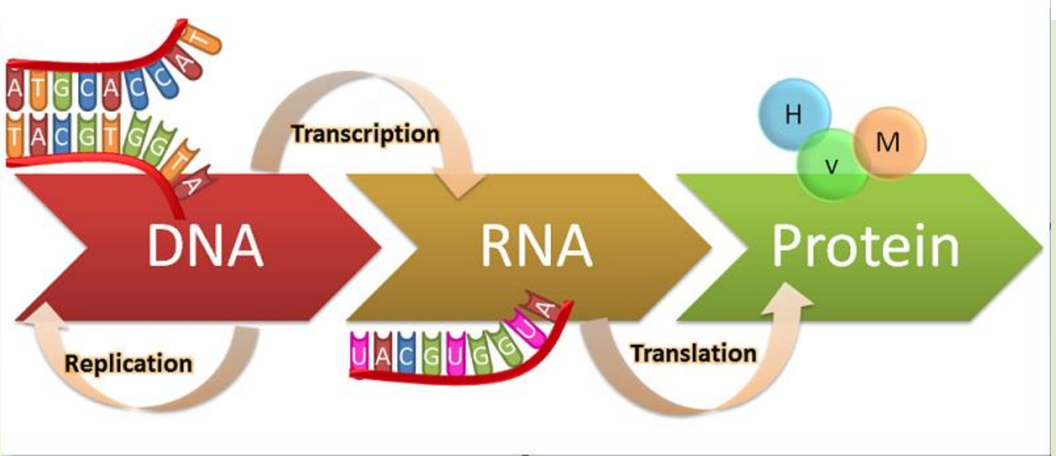
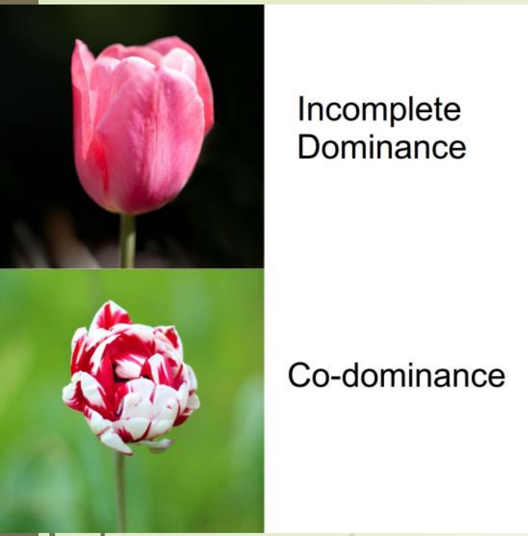
Unit 7

Genetics

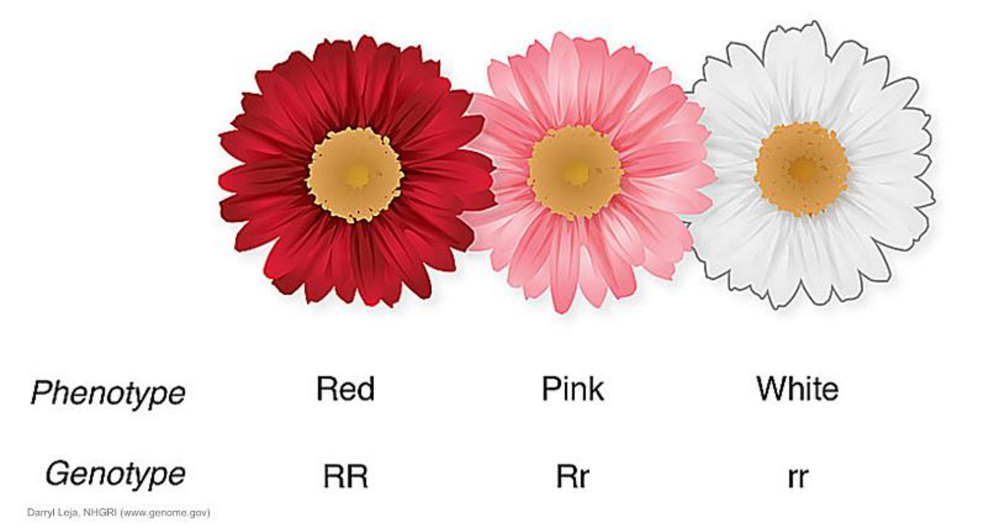


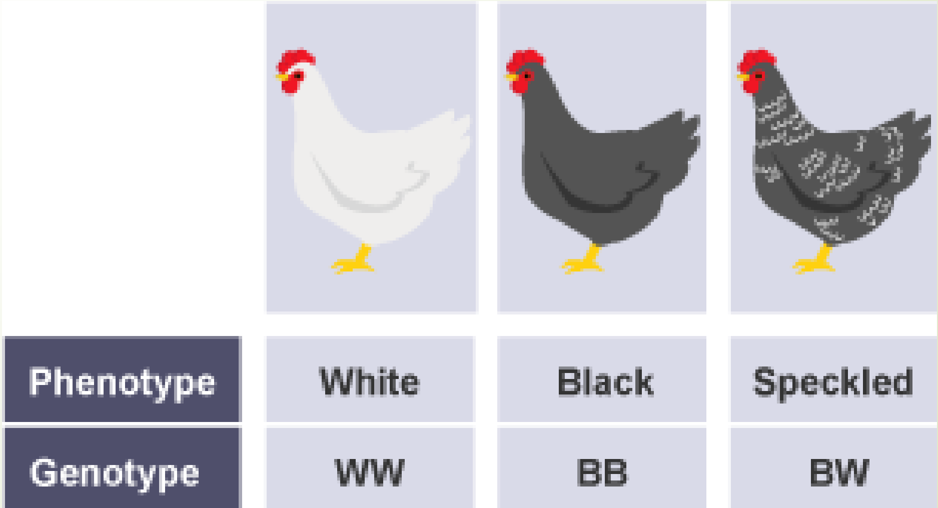




Topic 2: Variations of Dominance

- By the end of this topic, I should be able to:
  - Use Punnett squares for exceptions to Mendelian Genetics (incomplete dominance, codominance, blood types, and sex-linkage)
  - Use Punnett squares for dihybrid crosses





Exceptions to Simple Dominance

- Incomplete Dominance: alleles "**blend**" (ex: pink flowers)

- Codominance: both alleles show up in their "**pure form**" (ex: red and white splotchy flowers)

Incomplete Dominance

- There is no dominant allele or recessive allele
- Blending: Red and White flowers
- R=Red
- W=White
- RW=Pink

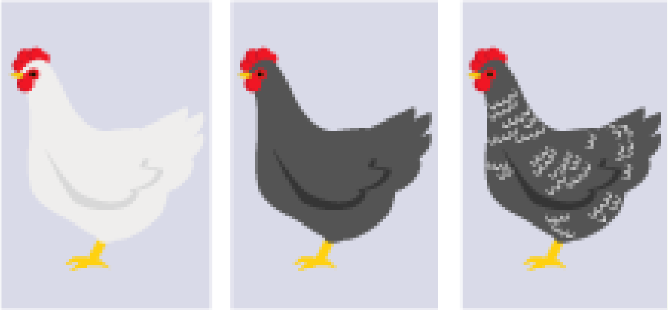
Situation: *If red and white flower alleles show* ***incomplete dominance,*** *what offspring ratios will you see if you cross a Red-flowered plant with a white-flowered plant?*

Parent Genotypes: ___________________________

Offspring Ratios:
Genotype: ______________
Phenotype: _____________

Codominance

- There is no dominant or recessive allele but both are expressed
- Ex: a chicken with white & black feathers



Phenotype	White	Black	Speckled
Genotype	WW	BB	BW

Situation: *If black and white chicken alleles show* ***codominance,*** *what offspring ratios will you see if you cross a black chicken with a white chicken? Hybrids display speckled coloration.*

Parent Genotypes: ___________________________

Offspring Ratios:
Genotype: ______________
Phenotype: _____________

Multiple Alleles

Sometimes there are more than two alleles for a particular gene. We call this inheritance pattern multiple alleles. For example, there are three alleles controlling human blood type—A, B, and O. A and B are both dominant (express codominance) over O.

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.

Blood Type:

- Type A=AA, AO
- Type B=BB, BO
- Type O=OO
- Type AB = AB

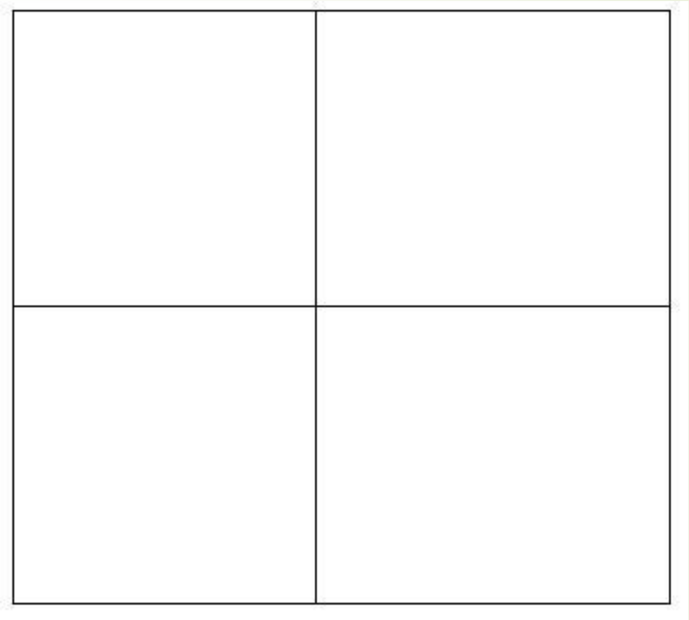
Situation: If two parents with blood type AB have children, what offspring ratios will you see?

Parent Genotypes:

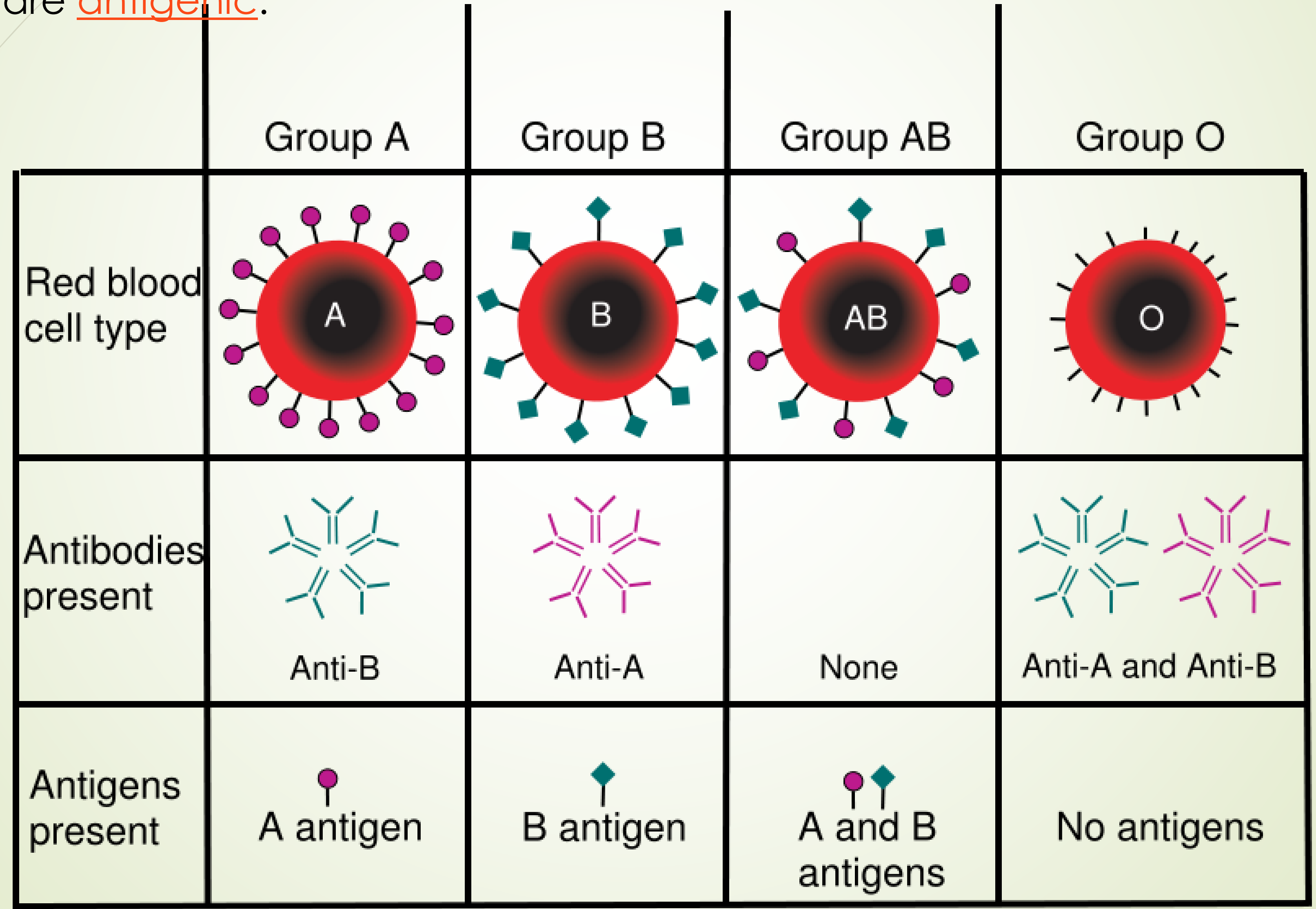
Offspring Ratios

-Genotype:

-Phenotype



Each **blood group** is represented by a substance on the surface of red blood cells (RBCs). These substances are important because they contain specific sequences of amino acid and carbohydrate which are antigenic.



More Info…

- Since there are three different alleles, there are a total of six different genotypes at the human ABO genetic locus.

Allele from Parent 1	Allele from Parent 2	Geno-type	Blood Type
A	A	AA	A
A	B	AB	AB
A	O	AO	A
B	A	AB	AB
B	B	BB	B
B	O	BO	B
O	O	OO	O

Blood Types A & B

- If someone has blood type A, they must have at least one copy of the A allele, but they could have two copies. Their genotype is either AA or AO. Similarly, someone who is blood type B could have a genotype of either BB or BO.

Blood Types	Possible Genotypes
A	AA AO
B	BB BO

Blood Type AB & O

- A blood test of either type AB or type O is more informative. Someone with blood type AB must have both the A and B alleles. The genotype must be AB. Someone with blood type O has neither the A nor the B allele. The genotype must be OO.

Blood Type	Genotype
AB	AB
O	OO

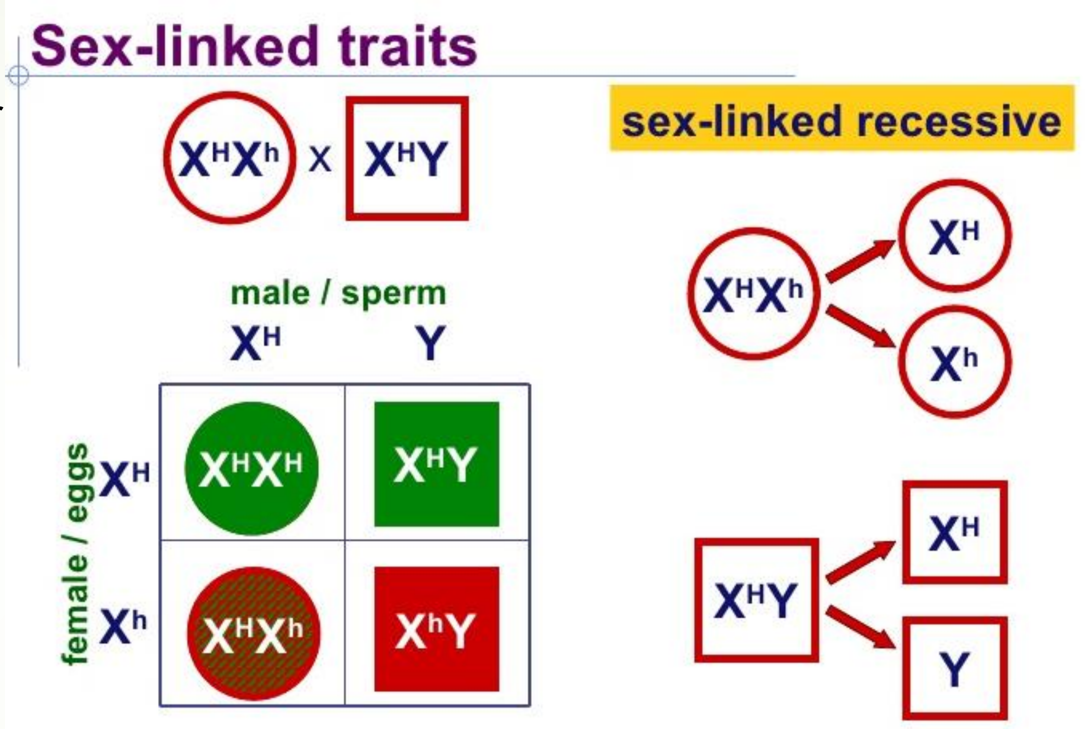
Sex linked inheritance

- Sex linkage = the presence of genes on a sex chromosome (X or Y)
  - X-linked Genes = genes found on the X chromosome
  - Y-linked Genes = genes found on the Y chromosome

- Sex linkage was discovered by Thomas Morgan while working with fruit flies…tiny and easy to mate!

- Fruit flies can have red or white eyes

- Morgan noticed that there were a few white eyed males, but almost no white-eyed females…

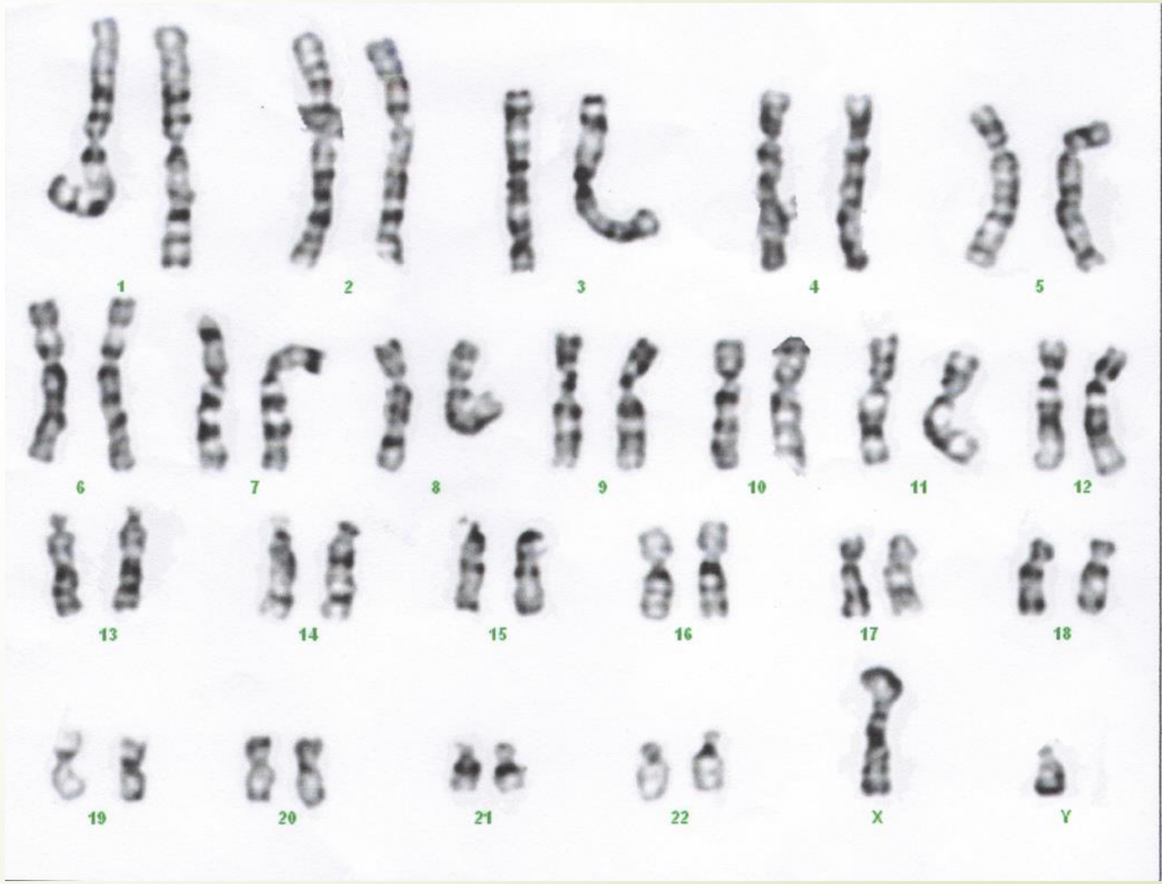


Thomas's Conclusion

- The gene for fruit fly eye color is on the X chromosome
  - Compare the size of the X and Y chromosomes!
  - Remember, males have only 1 X chromosome, while females have 2

Red Eye Allele: X^R

White Eye Allele: X^r



Example 1: X^RX^R x X^rY

- Red eyed female x white-eyed male

Phenotype Ratio:

50% red-eyed females
50% red-eyed males

	X^R	X^R
X^r	X^RX^r	X^RX^r
Y	X^RY	X^RY

Example 2: X^RX^r x X^RY

- Red-Eyed Female (HETEROZYGOTE) x Red-Eyed Male

Phenotype Ratio:

50% Red-eyed females

25% Red-eyed males

25% White-eyed males

	X^R	X^r
X^R	X^RX^R	X^RX^r
Y	X^RY	X^rY

A Human Example of Sex Linkage

- Hemophilia is a human X-linked disorder that causes blood to clot incorrectly → patient "bleeds out" after a minor cut

- Normal Allele: X^H
- Hemophilia Allele: X^h

Common in Anastasia's Family…just the men!

Hemophilia

- **Situation:** Carrier Mother X Normal Father
- Parent Genotypes:

  $X^H X^h$ x $X^H Y$

- Phenotype Ratio:

  50% normal females

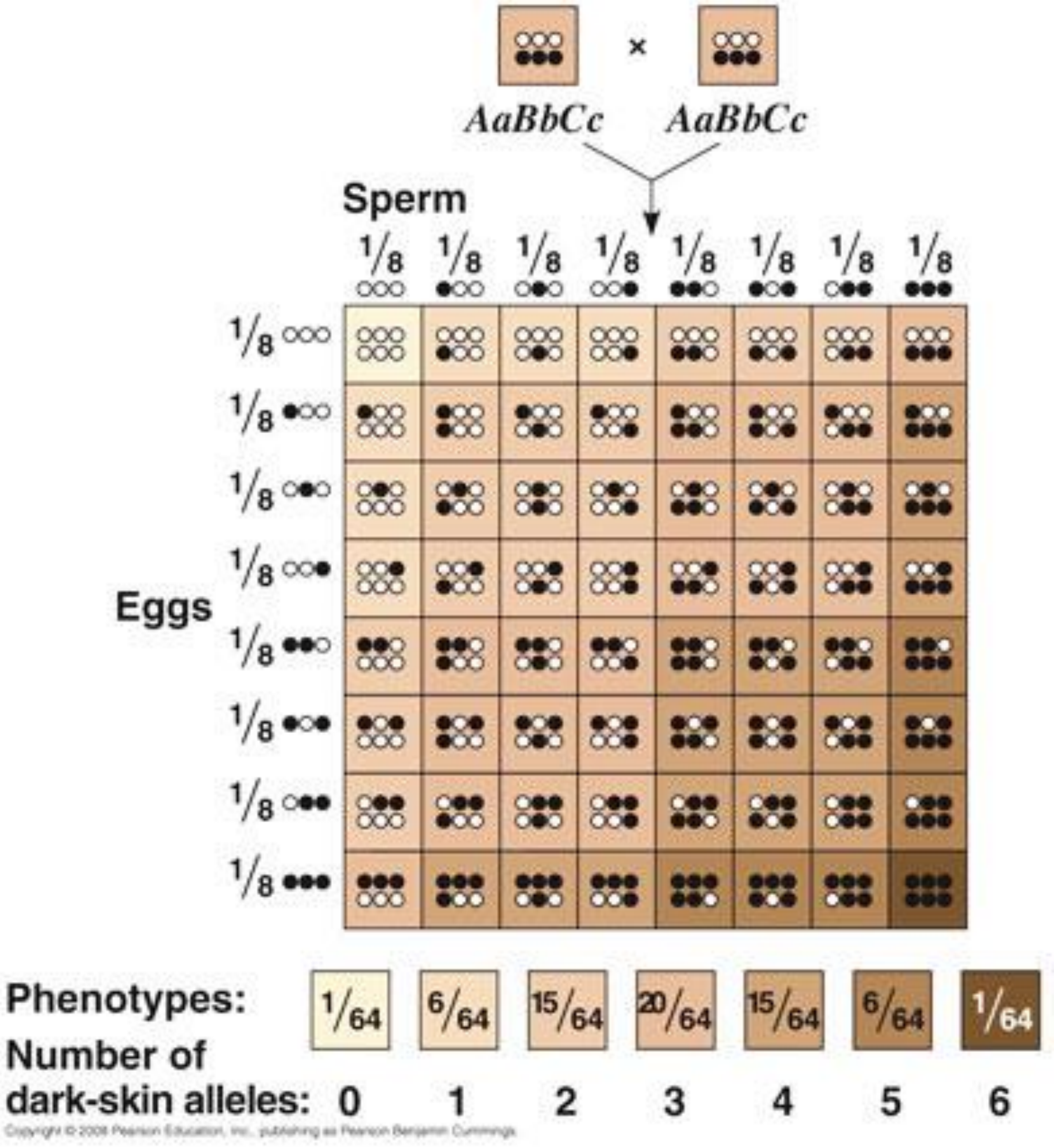
  25% normal males

  25% hemophilic males

	X^H	X^h
X^H	$X^H X^H$	$X^H X^h$
Y	$X^H Y$	$X^h Y$

Polygenic

- Produced by interaction of several genes
- Show wide ranges of phenotypes
- Example: human skin and hair color and other complex traits



Dihybrid Cross

- Involves two characteristics (two pairs of contrasting traits) for each individual.
- Predicting the results of a dihybrid cross is more complicated than predicting the results of a monohybrid cross.
- All possible combinations of the four alleles from each parent must be considered.

Dihybrid Cross (2 factors): *a 16 square grid that is used to predict and compare the genetic variations that will result when crossing* ***2 traits*** *of two organisms.*

RrYy x RrYy

	RY	Ry	rY	ry
RY	RRYY	RRYy	RrYY	RrYy
Ry	RRYy	RRyy	RrYy	Rryy
rY	RrYY	RrYy	rrYY	rrYy
ry	RrYy	Rryy	rrYy	rryy

R = Tall
r = short

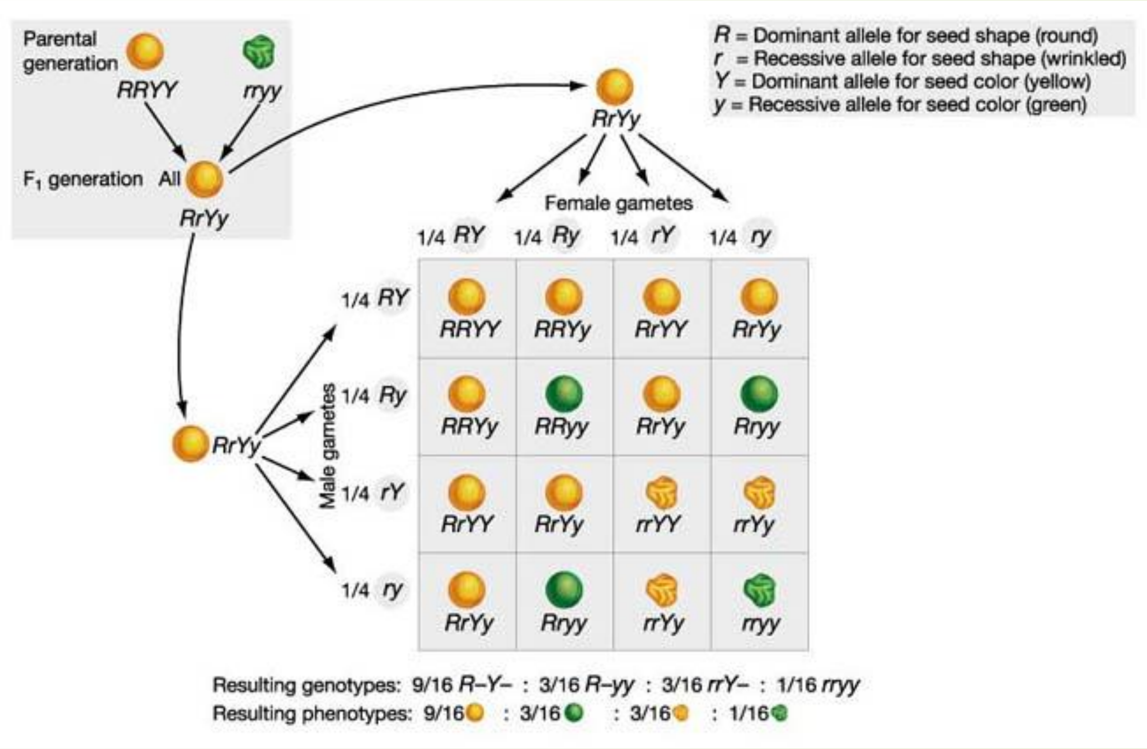
Y = Green
y = Yellow

How to's of Dihybrid Crosses

- 1. Figure out the **alleles**:
  - Identify what trait/letter is Dominant (B – Black fur)
  - Identify what trait/letter is Recessive (b – Brown fur)
- 2. Draw your **box** (16 squares for dihybrids!)
- 3. Determine the Possible **gametes** (sex cells) that could be made from the parents.
  - You should have 4 combinations (For AaBb: AB, Ab, aB, & ab)
  - The letters should be all **different** for each combination! (Yr or Ab)
- 4. **Label** each side of Box, **Plug & Chug**!
  - Put the same letters together again (AABb)
  - Make sure to put **dominant** alleles First! (AaBb)
- 5. Determine your possible **Genotypes**! (1/16 bbrr, etc)
  - Double check your work, all the possible genotypes should add up to 16!
- 6. Determine your possible **Phenotypes**! (1/16 brown wrinkled, etc)
  - Double check your work, all the possible phenotypes should add up to 16!

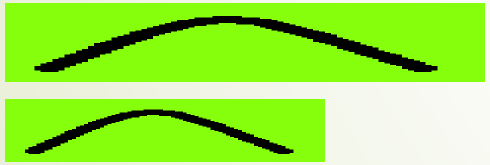
Expressing probabilities for genotypes & phenotypes (2 factor cross)

- Ratios:
  - 4/16 : fractions (parts of the total – don't reduce)
  - Genotype ratios are typically not used in 2 factor crosses
  - Phenotype ratios use the DD:DR:RD:RR pattern
  - Example- 9:3:3:1 (DD: DR: RD: RR)
- Percentages:
  - Need to label with trait

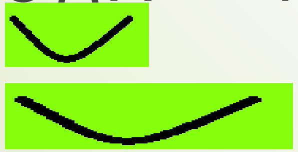


Finding the Gametes for Dihybrid Crosses

- Remember, each gamete must have ONE COPY of the two genes
- To find possible gametes for each parent, use the FOIL method



- $(x + 3)(x + 4) =$



$x^2 + 4x + 3x + 12$

Homozygous X Homozygous

- Parent 1: H H G G

Possible Gametes:

HG
HG
HG
HG

- Parent 2: h h g g

Possible Gametes:

hg
hg
hg
hg

Homozygous x Homozygous

Parent Genotypes: HHGG x hhgg

Offspring Ratios
-Genotype:
100% HhGg

-Phenotype:
100% Tall + Green

	HG	HG	HG	HG
hg	HhGg	HhGg	HhGg	HhGg
hg	HhGg	HhGg	HhGg	HhGg
hg	HhGg	HhGg	HhGg	HhGg
hg	HhGg	HhGg	HhGg	HhGg

Another Example: Heterozygous x Heterozygous

- Parent 1: H h G g

Possible Gametes:

HG
Hg
hG
hg

- Parent 2: H h G g

Possible Gametes:

HG
Hg
hG
hg

Heterozygous x Heterozygous

Parent Genotypes: HhGg x HhGg

Offspring Ratios

-Genotype: too complicated!

-Phenotype: Next Slide!

	HG	Hg	hG	hg
HG	HHGG	HHGg	HhGG	HhGg
Hg	HHGg	HHgg	HhGg	Hhgg
hG	HhGG	HhGg	hhGG	hhGg
hg	HhGg	Hhgg	hhGg	hhgg

Another Example: Heterozygous x Heterozygous

Parent Genotypes: HhGg x HhGg

Phenotype:

9: 3: 3: 1

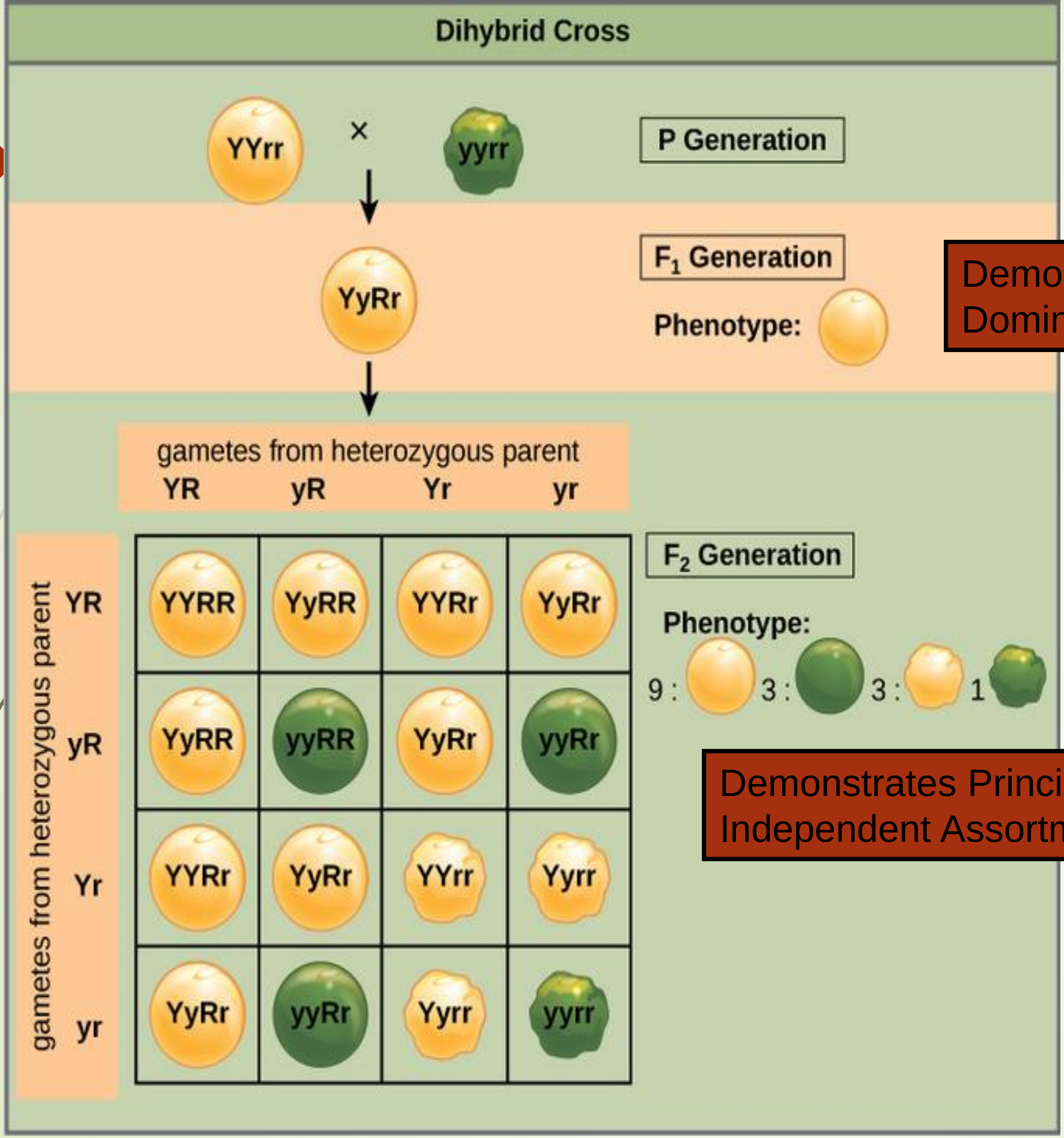
9 Tall, Green

3 Tall, Yellow

3 Short, Green

1 Short, Yellow

	HG	Hg	hG	hg
HG	HHGG	HHGg	HhGG	HhGg
Hg	HHGg	HHgg	HhGg	Hhgg
hG	HhGG	HhGg	hhGG	hhGg
hg	HhGg	Hhgg	hhGg	hhgg



Demonstrates Principle of Dominance

Demonstrates Principle of Independent Assortment