Non Mendelian Genetics

TEKS

6 Science concepts. The student knows the mechanisms of genetics, including the role of nucleic acids and **the principles of Mendelian Genetics**. The student is expected to:

6F **predict possible outcomes of various genetic combinations such as monohybrid crosses, dihybrid crosses and non-Mendelian inheritance;**

Vocabulary

- Genetics
- Heredity
- Hybrid
- Monohybrid
- Dihybrid
- Gene
- Trait
- Allele
- Dominant allele
- Recessive allele
- Homozygous
- Heterozygous
- (F1 generation)
- (F2 generation)
- Phenotype
- Genotype
- True-breeding
- Incomplete Dominance
- Co-dominance
- Sex-linked trait

Prerequisite Questions

1. Where does an organisms get its genes from?

2. What does it mean for a trait to be dominant or recessive?

Essential Question

- What happens if a trait does not follow complete dominance rules?

Dihybrid Crosses
Poly-Genic Traits
Multiple-Allele Traits
Sex-linked Traits
Incomplete Dominance
Co-Dominance

Pea traits that Mendel identified

- Through multiple crosses, Mendel determined that all these traits displayed a mathematical predictability for inheritance.

	Seed Shape	Seed Color	Seed Coat Color	Pod Shape	Pod Color	Flower Position	Plant Height
P	Round X Wrinkled	Yellow X Green	Gray X White	Smooth X Constricted	Green X Yellow	Axial X Terminal	Tall X Short
F_1	Round	Yellow	Gray	Smooth	Green	Axial	Tall

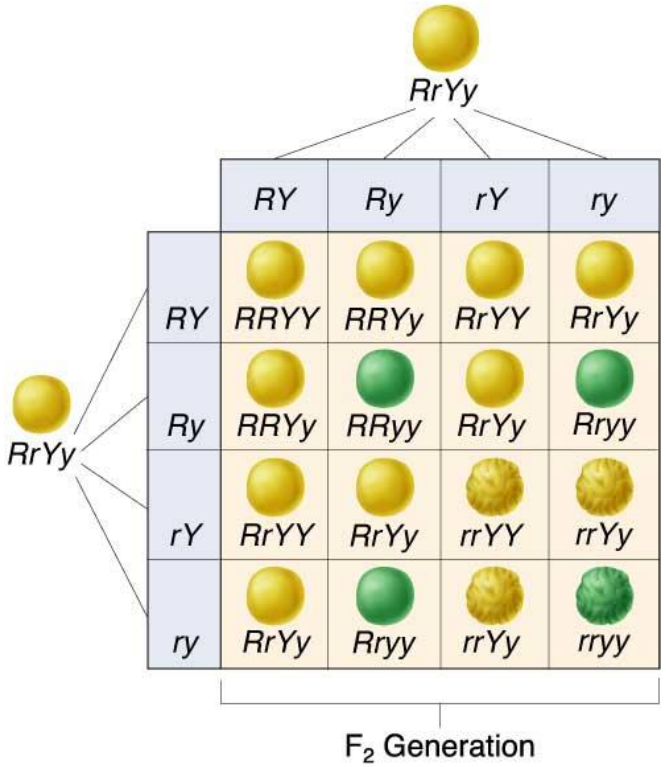
Law of independent assortment

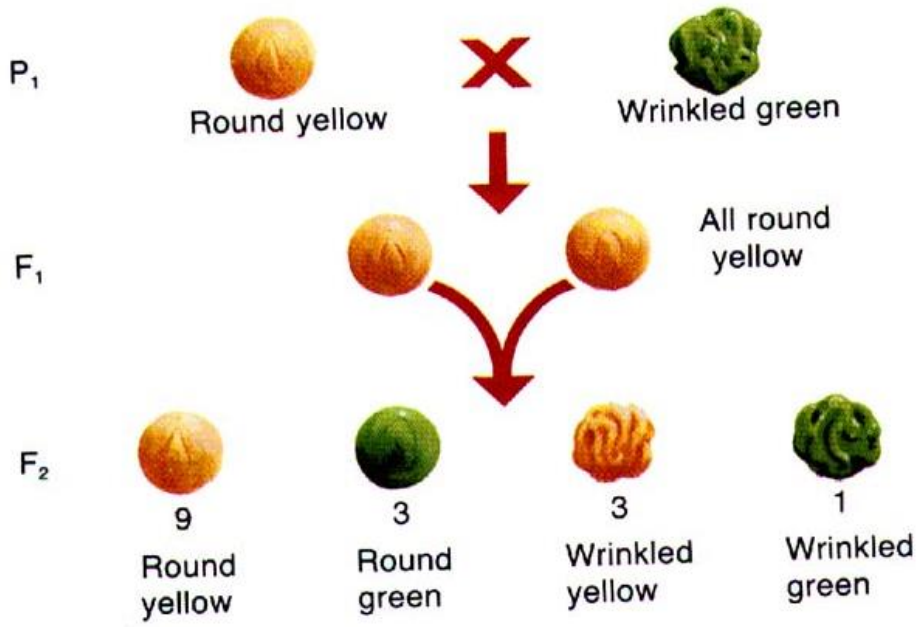
- Because organisms are made up of more than one trait, Mendel concluded that the inheritance of one trait *does not influence* the inheritance of a second trait.

- Example: Height of the pea plant does not influence the color of the peas
  - Height is independently assorted from color.

Dihybrid Cross

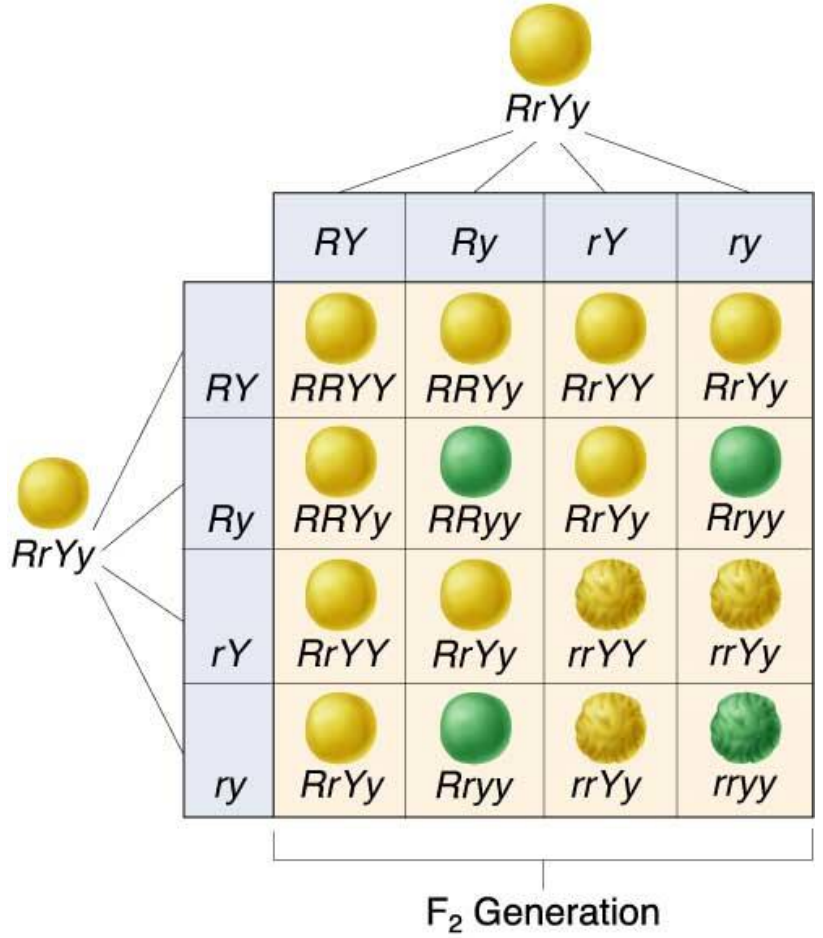
Dihybrid cross - working with two traits (gives twice as many gametes possibilities, so 4 times as many offspring) classical ratio of 9:3:3:1

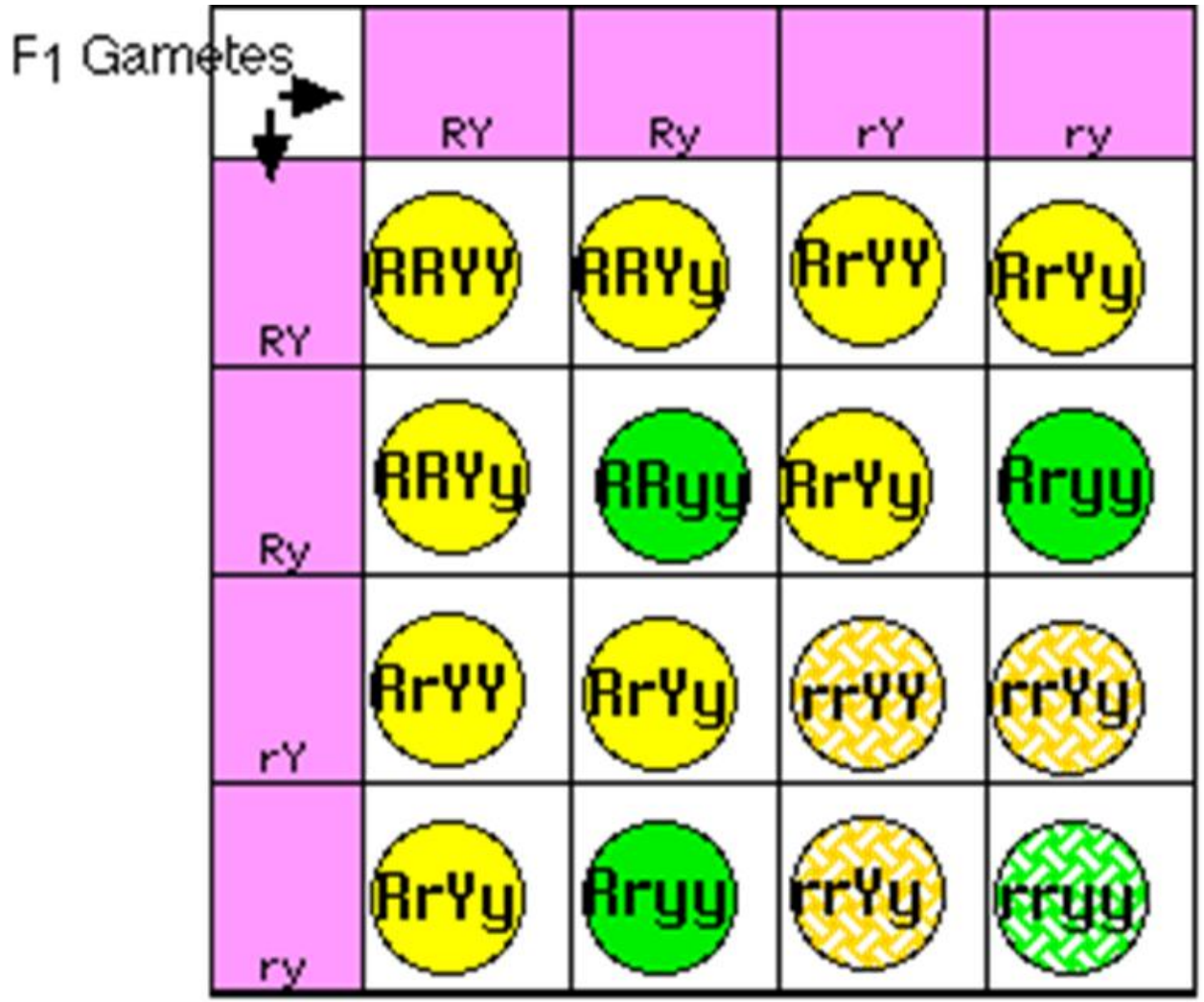




Using dihybrid crosses to show independent assortment

- A smooth, yellow pea (RrYy) can pass on these combinations of genes to its offspring: RY, Ry, rY, or ry.





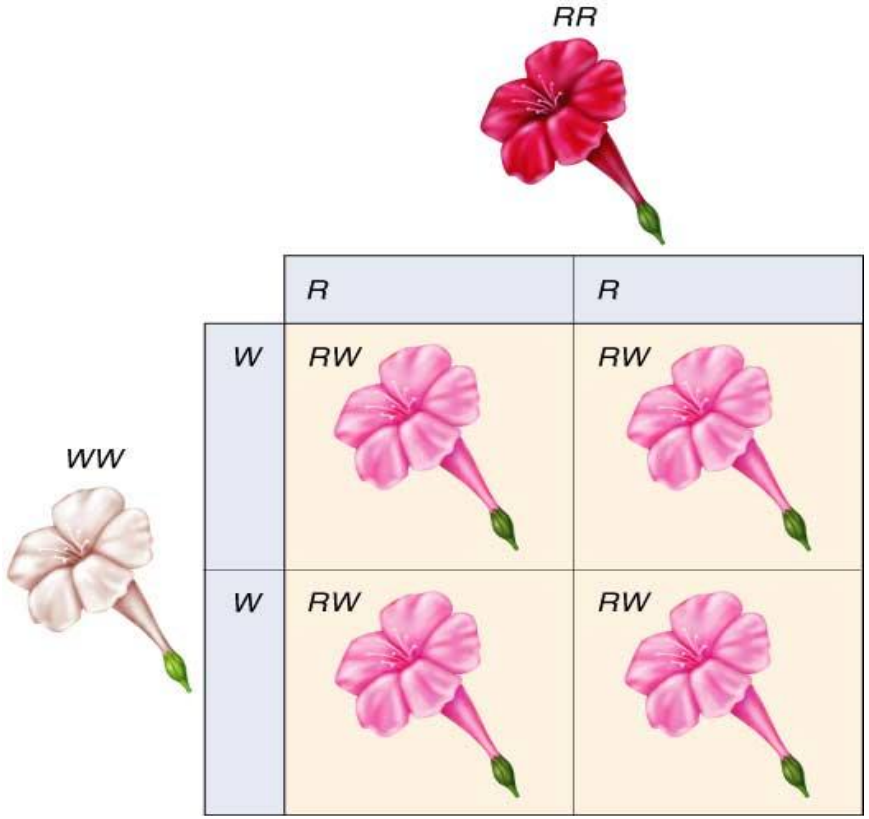
Results

round-yellow : round-green : wrinkled-yellow : wrinkled-green

9 : 3 : 3 : 1

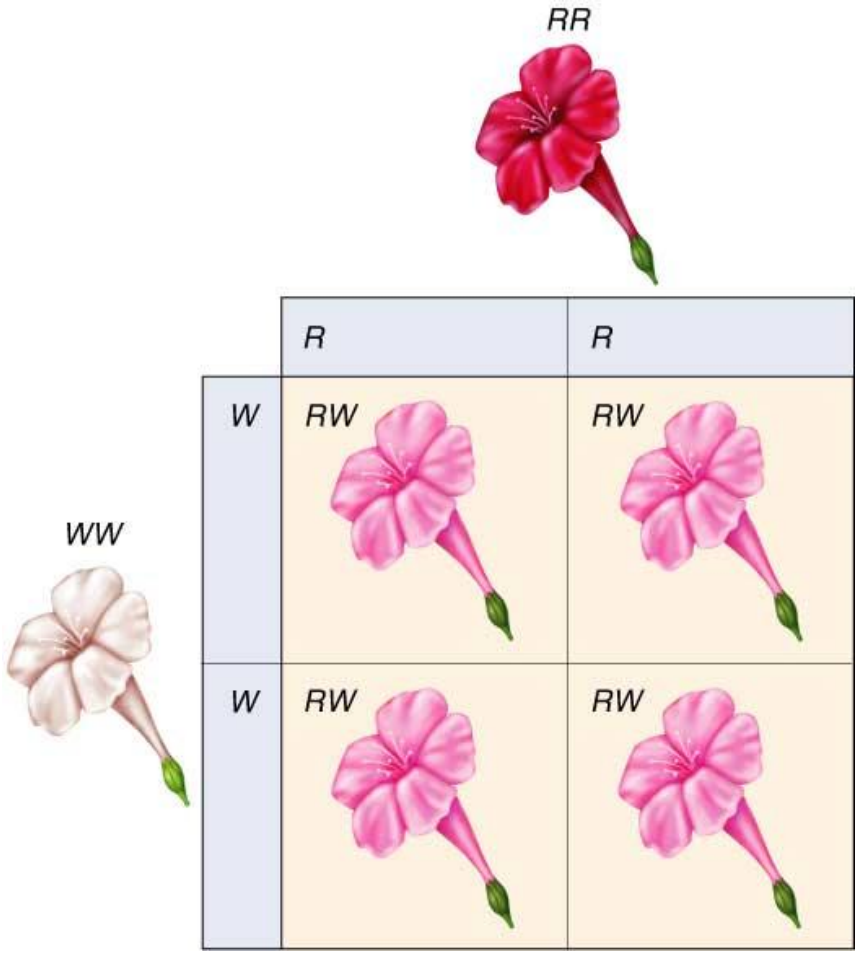
Incomplete dominance

- Both alleles for a trait blend together creating a new expression in the heterozygous condition
- examples: snapdragons



Variations on Mendel

- **<u>Incomplete dominance</u>**: the heterozygous genotype shows a ***blend*** of the two parents and ***not the dominant allele***



Co-dominance

- Both alleles for a trait show up equally
- Examples: roans, “checkered” chickens

Variations on Mendel

- **<u>Codominance</u>**: the heterozygous genotype shows both inherited alleles

- Example of roan horse coat:
  AA (dark red) x aa (white)

  → Aa (dark red and white)

Complete, Incomplete and Codominance Comparison

Cross two heterozygous individuals. Use the following alleles: **A** – black and **a** – white.

Complete Dominance

Cross: **Aa** x **Aa**

Punnett:

	A	**a**
A	**AA**	**Aa**
a	**Aa**	**aa**

Ratios:

Genotype
AA – 25%
Aa – 50%
aa – 25%

Phenotype
Black – 75%
White – 25%

Incomplete Dominance

Cross: **Aa** x **Aa**

Punnett:

	A	**a**
A	**AA**	**Aa**
a	**Aa**	**aa**

Ratios:

Genotype
AA – 25%
Aa – 50%
aa – 25%

Phenotype
Black – 25%
Gray – 50%
White – 25%

Codominance

Cross: **Aa** x **Aa**

Punnett:

	A	**a**
A	**AA**	**Aa**
a	**Aa**	**aa**

Ratios:

Genotype
AA – 25%
Aa – 50%
aa – 25%

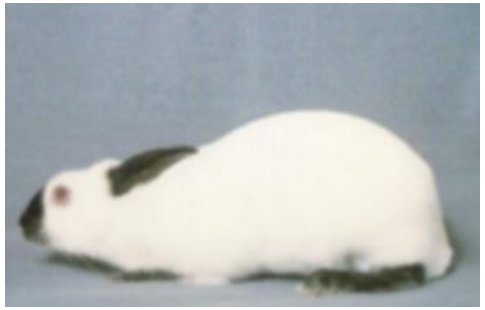
Phenotype
Black – 25%
Black & White – 50%
White – 25%

Multiple alleles

- More than two alleles for a trait
- Examples: coat color of rabbits

CC, Cc^{ch}, Cc^{h}, or Cc

$c^{ch}c^{h}$, $c^{ch}c^{ch}$, or $c^{ch}c$



$c^{h}c$ or $c^{h}c^{h}$

cc

Key

C = full color

c^{ch} = chinchilla

c^{h} = Himalayan

c = albino

Variations on Mendel

- **<u>Multiple alleles</u>**: when there are more than two alleles that code for a trait

- Example: ABO blood type

  A type = AA or Ao

  B type = BB or Bo

  O type = oo

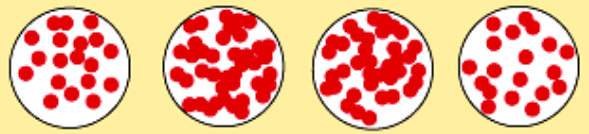
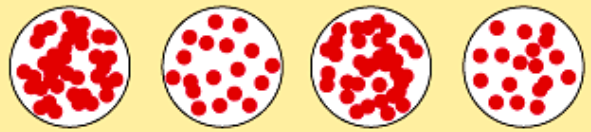
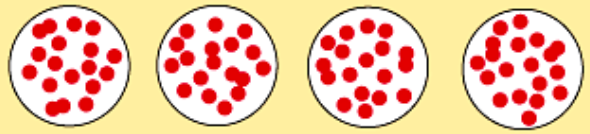
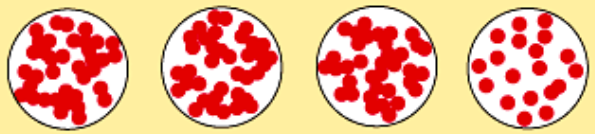
  AB type = AB

Parents: AO X BO

	A	O
B	A B	B O
O	A O	O O

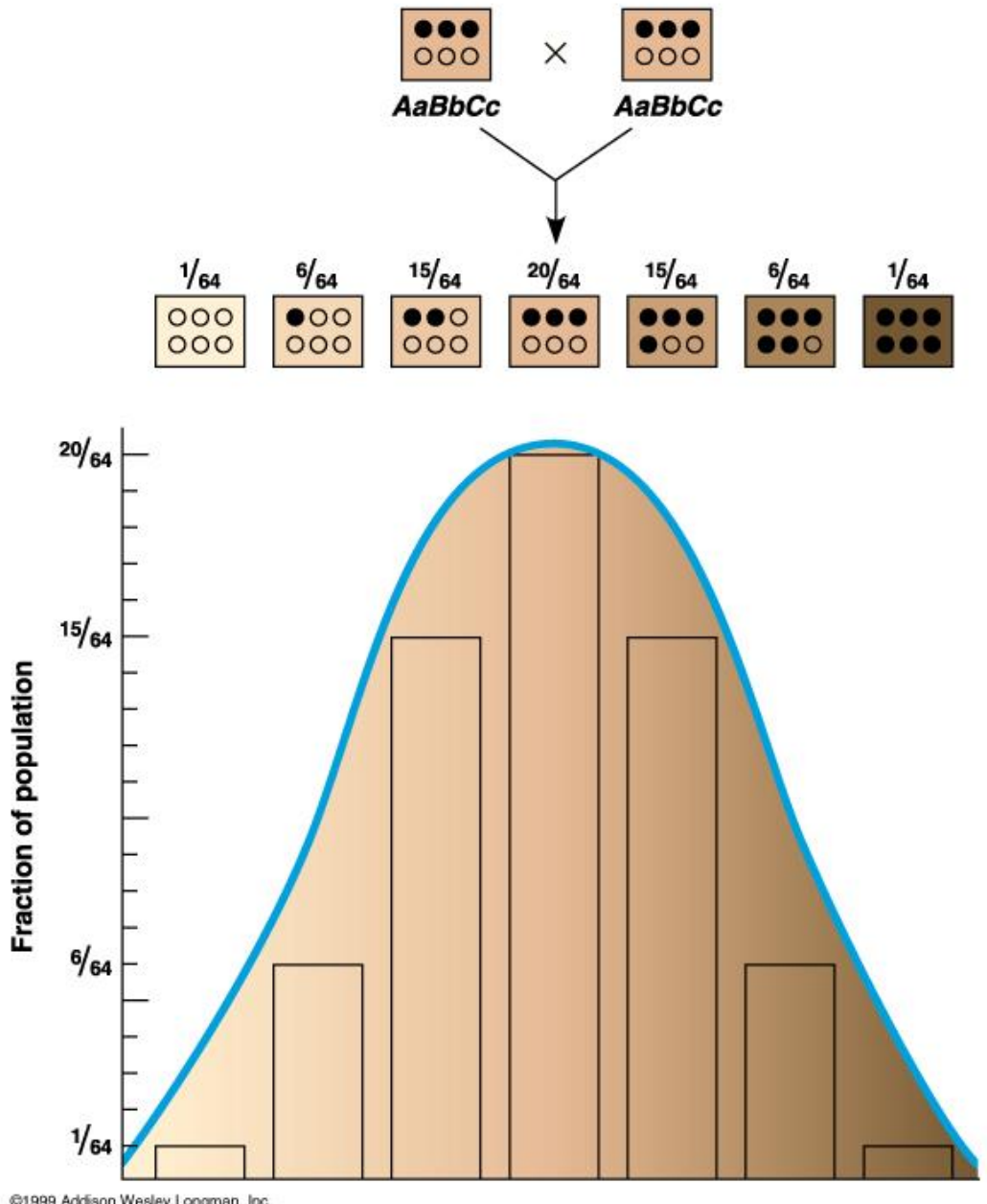
Offspring Phenotypes:
1/4 Type A, 1/4 Type B,
1/4 Type AB, 1/4 Type O

Blood typing

(a) Phenotype (blood group)	(b) Genotypes (see p.258)	(c) Antibodies present in blood serum	(d) Results from adding red blood cells from groups below to serum from groups at left			
			A	B	AB	O
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				

Polygenic inheritance

- Many genes affect the expression of the trait
- Examples: skin, eye, & hair colors



X-linked or Sex linked

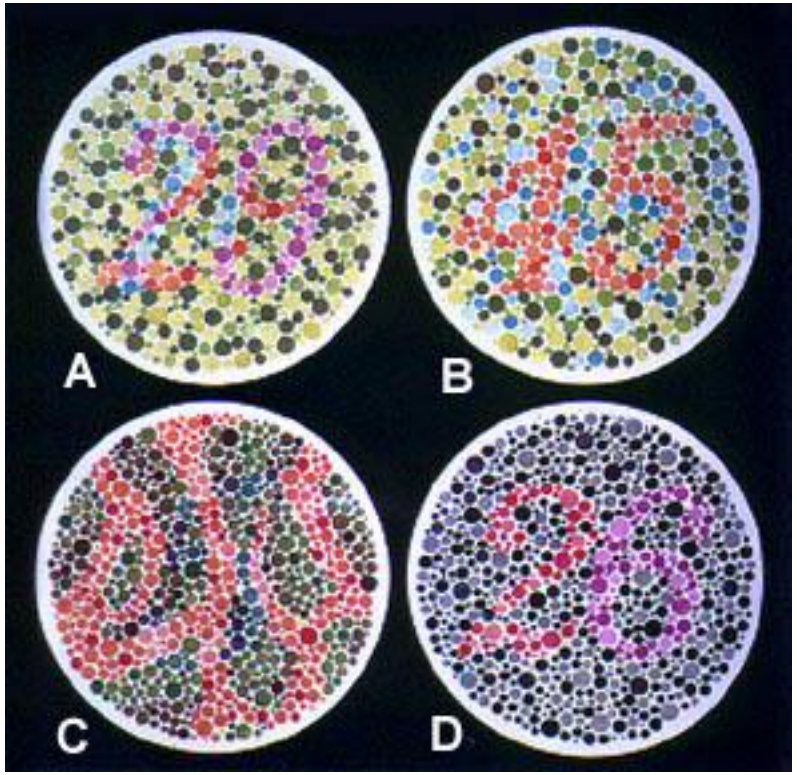
- Allele is carried on the X chromosome
- Because females have 2 X chromosomes, often a mutated allele is hidden by the other healthy X
- Only Females can be carriers for X linked
- examples:
  - Hemophilia, Color blindness, Male patterned baldness

- Usually written like this:
  - X X – normal female
  - X X^* - carrier female (* designates some mutated allele)
  - X^* X^*- affected female
  - X Y – normal male
  - X* Y – affected male

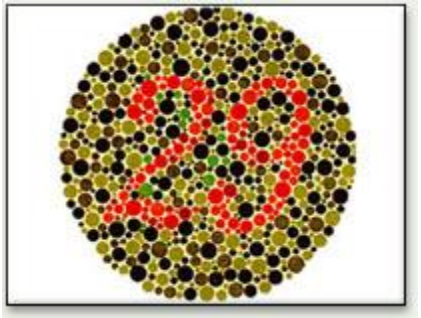
	X	Y
X	X X	X Y
X^h	X X^h	X^h Y

- **Sex-linked traits**
  - A recessive gene on the X chromosome
  - Examples: color-blindness & hemophilia

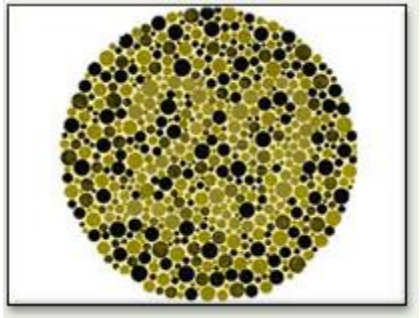
  - Genotypes: Phenotypes:
  - X^nY colorblind male
  - XX normal female
  - XX^n carrier female
  - X^nX^n colorblind female



normal vision



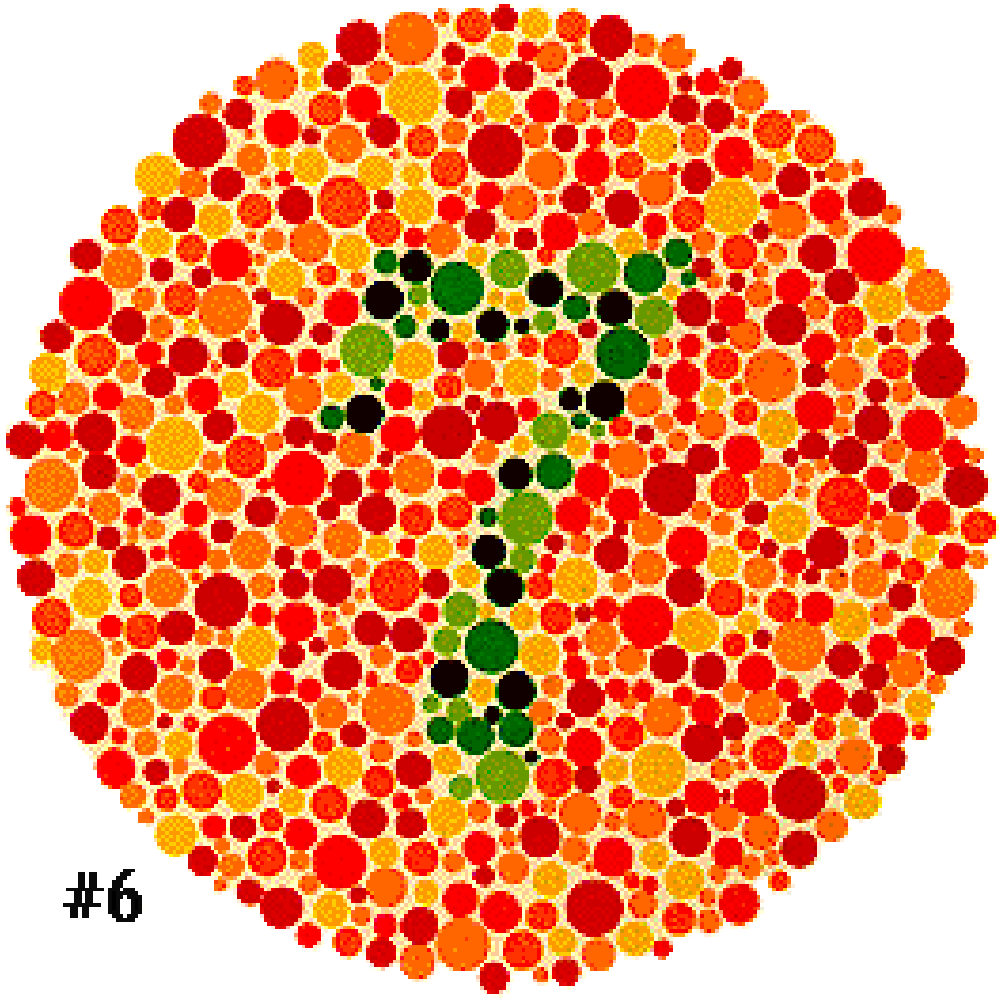
"weak red"



"weak green"

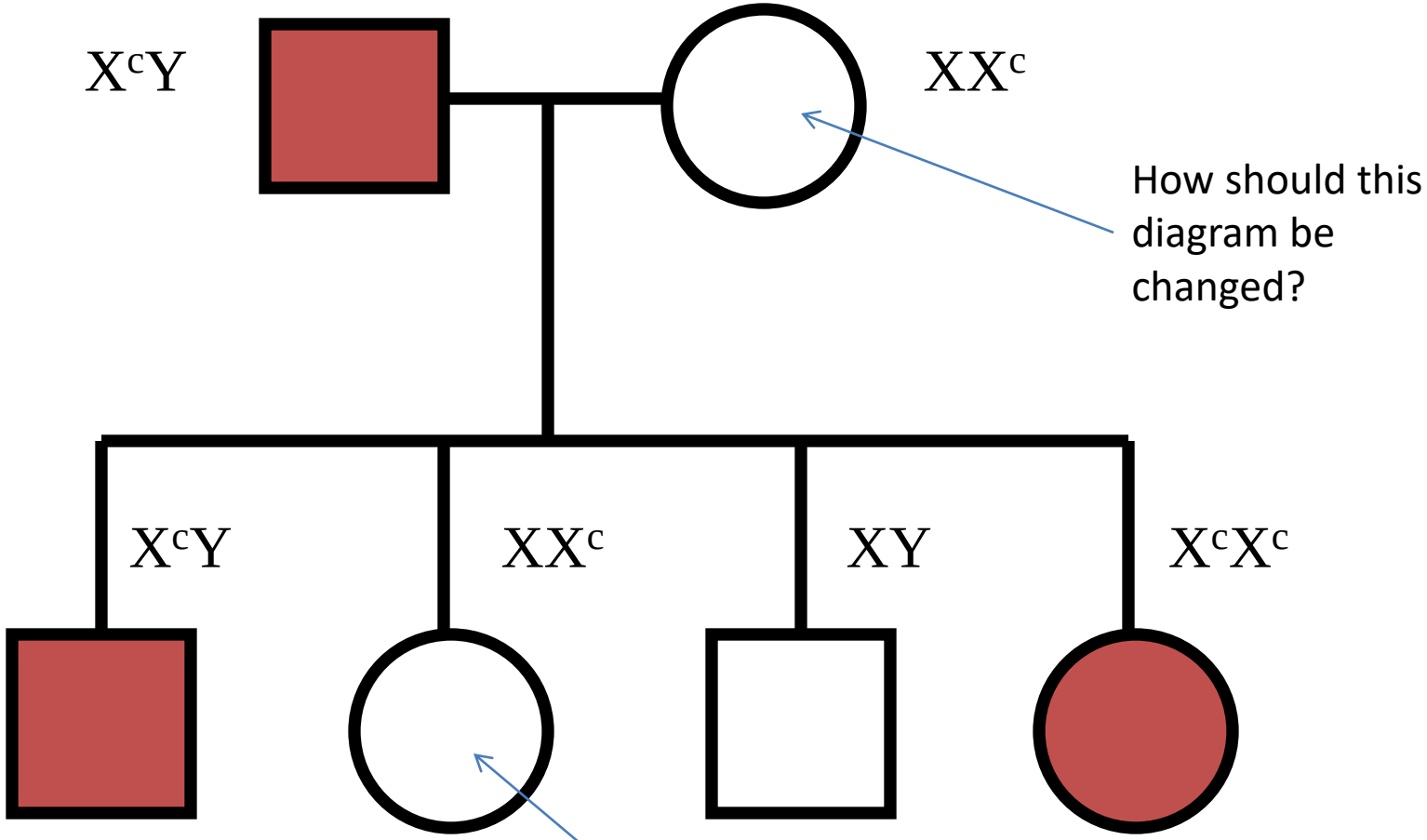
Are you red-green color blind?

- Yes, if you have a difficult time distinguishing a number from this picture



Colored blindness – Sex linked

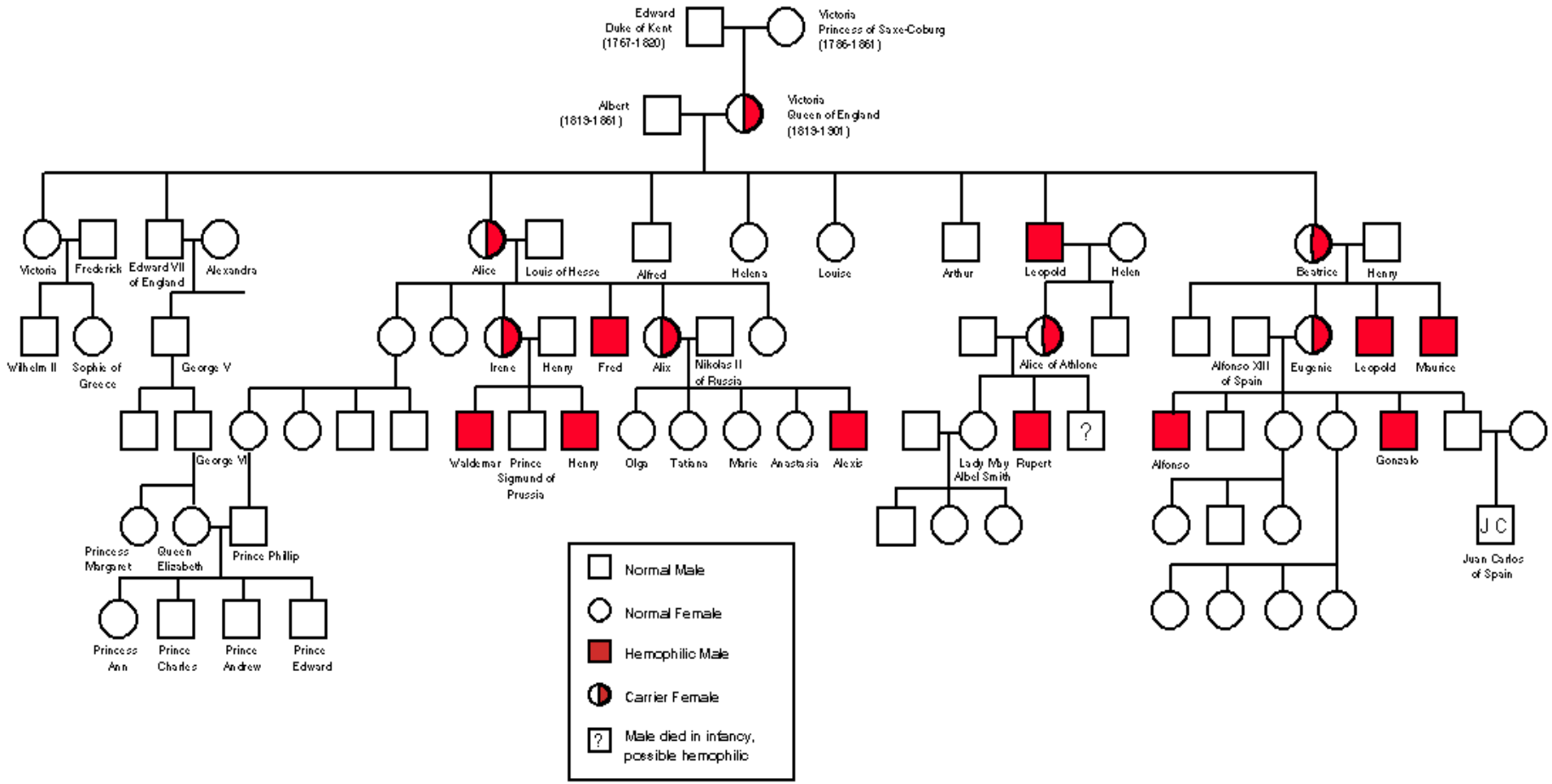
How could a girl become colorblind?



Hemophilia

Intermarriage caused the disease **hemophilia** to be inherited by many members of Europe's royal families.

Victoria was a carrier of the gene for hemophilia, a serious bleeding disorder


Edward
Duke of Kent
(1767-1820)
Victoria
Princess of Saxe-Coburg
(1786-1861)
Albert
(1819-1861)
Victoria
Queen of England
(1819-1901)
Victoria
Frederick
Edward VII
of England
Alexandra
Alice
Louis of Hesse
Alfred
Helena
Louise
Arthur
Leopold
Helen
Beatrice
Henry
Wilhelm II
Sophie of
Greece
George V
Irene
Henry
Fred
Alix
Nikolas II
of Russia
Alice of Athlone
Alfonso XIII
of Spain
Eugenie
Leopold
Maurice
George VI
Waldemar
Prince
Sigmund of
Prussia
Henry
Olga
Tatiana
Marie
Anastasia
Alexis
Lady May
Abel Smith
Rupert
?
Alfonso
Gonzalo
Princess
Margaret
Queen
Elizabeth
Prince Phillip
J C
Juan Carlos
of Spain
Princess
Ann
Prince
Charles
Prince
Andrew
Prince
Edward
Normal Male
Normal Female
Hemophilic Male
Carrier Female
?
Male died in infancy,
possible hemophilic