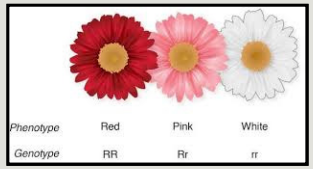
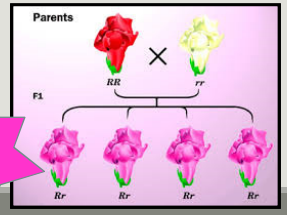
Complex Patterns of Inheritance

Think about this…

You are walking around outside and you notice a bush with two distinctly colored flowers: red and white. However, you notice a pink flower here and there. Is this possible considering what you have just learned? If not, what do you think is happening?



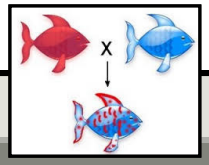


Phenotypes is affected by many different factors.

Incomplete and Codominance Video

Beyond Mendel

- Mendel's discoveries obviously did not work in this case and in many others.
- Mendel's work focused on traits that were "either/ or" traits- they would be round or wrinkled, red or white. It didn't focus on anything that didn't follow such a pattern.



Beyond Mendel

- Not all genes show simple patterns of dominant and recessive alleles
- Genetics is more complicated in most organisms

Exceptions to Mendel's Genetics

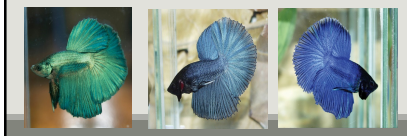
- Mendel's work did however, provide a basis for discovering the passing of traits in other ways including:

1. Incomplete dominance
2. Codominance
3. Multiple alleles
4. Polygenic traits
5. Sex-linked Traits

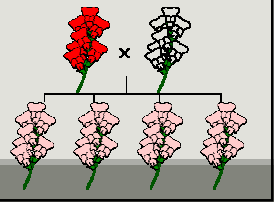
Incomplete Dominance

- One allele is not completely dominant over another
- The heterozygous phenotype is somewhere in between the two homozygous phenotypes
  - Examples: four-o'clock flowers, betta fish

B1B1 = green
B2B2 = steel blue
B1B2 = royal blue



RR = red
WW = white
RW = pink



Incomplete Dominance

Practice

A. Black Andalusian chickens have (BB) genes for feather color. White Andalusian chickens have (bb) genes for feather color. Blue Andalusian chickens have (Bb) genes for feather color. Determine the genes of offspring between one black and one white Andalusian chicken

Parents _____ x _____

Genotypes ratio:

____ : ____ : ____

Phenotypes ratio:

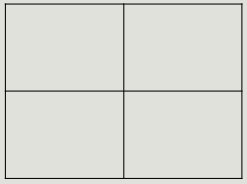
_____ : _____ : _____

Incomplete Dominance

Practice

B. The flowers of snapdragons are dominant in red (RR), recessive in white (rr) and (Rr) for pink. A pure red snapdragon is crossed with a pink snapdragon.

Parents _____ x _____



Genotypes ratio:

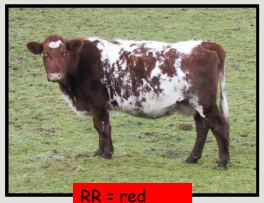
____ : ____ : ____

Phenotypes ratio:

_____ : _____ : _____

Codominance

- Both alleles are dominant and contribute to the phenotype
- Example: roan cattle, appaloosa horses, human blood type (AB)



RR = red
WW = white
RW = roan

GG = gray
WW = white
GW = appaloosa

Codominance

Practice

A. In cattle, white color is determined by the gene W, red color by the gene R, the heterozygote is roan colored. Cross a roan cow with a white cow.

Parents _____ x _____

Genotypes ratio:

Phenotypes ratio:

Multiple Alleles

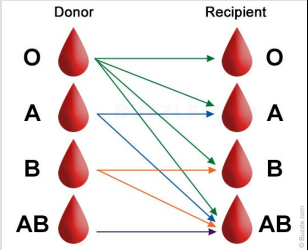
- Genes that have more than two alleles
- No individual can have more than two alleles, but more than two alleles can exist in a population
- Examples: human blood type

3 alleles

Multiple Alleles

- What is blood-typing?
  - Determining what blood type you are.
  - Depends on the presence or absence of specific proteins on your red blood cells.
- Governed by multiple alleles.
  - 3 alleles exist for blood types.(A,B,O)
- 4 Human blood types:
  1. **A**- I^Ai or I^AI^A
  2. **B**- I^Bi or I^BI^B
  3. **AB**- I^AI^B
  4. **O** - ii (recessive allele)
- A and B are both dominant alleles; this another example of codominance.

Universal donor= O



Universal receiver= AB

Codominance

Blood Type Practice

A. Cross one person that is homozygous for Type A with a person that is heterozygous for Type B.

Parents _____ x _____

Genotypes ratio:

Phenotypes ratio:

Polygenic Traits

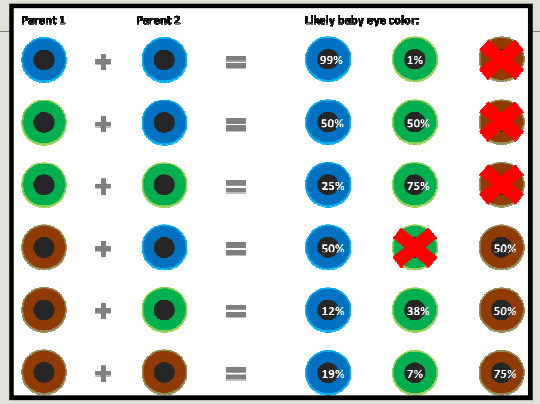
Poly = many genic = genes

- Traits are controlled by two or more genes
  - Examples: eye color (3 diff. genes, human skin color (4 diff. genes)

Order of dominance: brown > green > blue.

GENE NAME	DOMINANT ALLELE	RECESSIVE ALLELE
BEY1	brown	blue
BEY2	brown	blue
GEY	green	blue

Polygenic Traits



Epistatic Gene

- An epistatic gene can interfere with other genes.
- Example: albinism

Environmental Influence

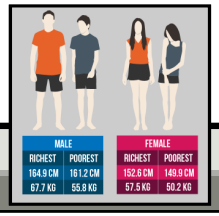
- Phenotype is a combination of genotype and environment

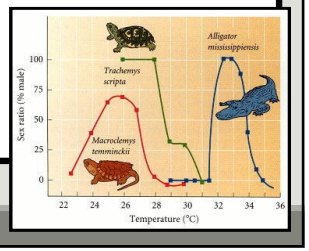
Examples:

sea turtles→ male or female

height→ amount of nutrition

hair color→ effects of sunlight



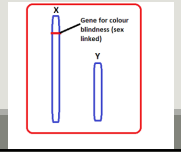


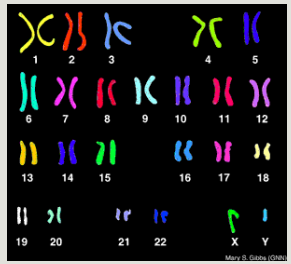
Sex-linked Traits

Sex-linked traits are traits that are passed through genes located on the X and Y chromosomes (23rd pair). *(usually the X chromosome!)*

Some classic examples are color blindness and hemophilia.

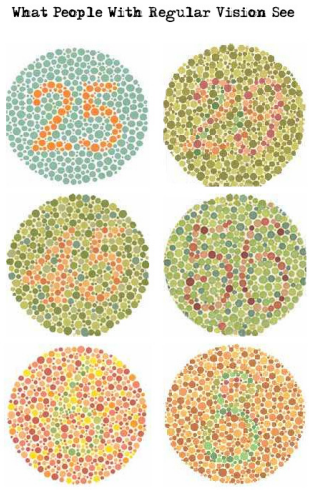
- Female sex chromosomes = **XX**
- Male sex chromosomes = **XY**





Ishihara Test For Color Blindness

What People With Regular Vision See



Sex-linked Traits

Thomas Hunt Morgan

In 1910, discovered traits linked to sex chromosomes.

Studied fruit flies

The gene for eye color was located on the X chromosome and not the Y chromosome.

Sex-linked Traits

- Morgan's discoveries led to the concept of **sex-linked traits**.
- Females are **carriers** of sex-linked traits if they have the heterozygous genotype. (X^RX^r = normal carrier)
- Female parents who are carriers can pass sex-linked traits to children, but males are usually the ones who express the trait.
- Males cannot be carriers because they only have one X chromosome. (X^RY = normal X^rY = colorblind)
- More males than females show a sex-linked trait.

Females		Males	
X^HX^H	= normal	X^HY	= normal
X^HX^h	= normal (carrier)	X^hY	= hemophilia
X^hX^h	= hemophilia		

Sex-linked Traits

Knowing the sex chromosomes for males and females allows us to determine the chances of having a male or female child. Parent _____ x _____

	X	Y
X	XX	XY
X	XX	XY

There will always be:

50% chance of a female child

50% chance of a male child

Sex-linked Traits

Working out a sex-linked traits problem is similar to completing a monohybrid Punnett square.

However, instead of using only capital and lowercase letters, we must also include **X** and **Y** to represent female and male.

Example of a sex-link cross:

female \ male	X^r	Y
X^R	X^RX^r	X^RY
X^r	X^rX^r	X^rY

- The allele for a trait is always shown as a superscript letter on the X chromosome
- **The Y chromosome never has a superscript letter with it!**

Sex-linked Traits

Morgan's Experiments

1st Cross:

Red-eyed female (X^RX^R) x white-eyed male (X^rY)

Genotypes:

Phenotypes

Sex-linked Traits

2nd Cross: Used offspring from first cross

X^RX^r x X^RY

Sex-linked Traits

Practice

A. In humans, hemophilia is a sex linked trait. Females can be normal, carriers, or have the disease. Males will either have the disease or not (but they won't ever be carriers). Not (H) having hemophilia is dominant over having (h) hemophilia.

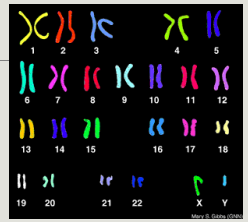
Show the cross of a man who has hemophilia with a woman who is a carrier. Parents _____ x _____

Genotypes:

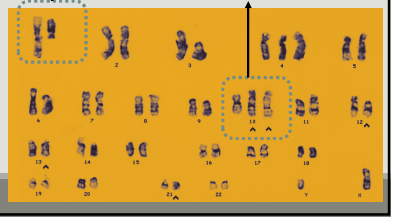
Phenotypes:

Karyotypes

A karyotype is a picture of all the chromosomes in a cell.

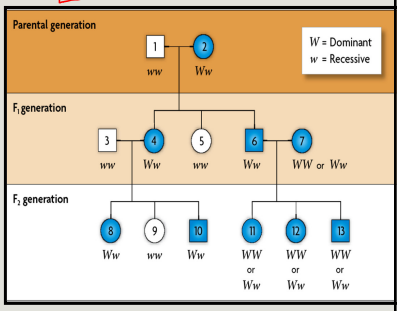


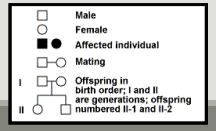
- Karyotypes can show changes in chromosomes.
  - deletion or loss of chromosome
  - extra chromosomes or duplication of part of a chromosome



Pedigrees

- A pedigree chart is used to trace the phenotypes and genotypes throughout a family.
  - Boxes = males
  - Circles = females
- Shaded shape = person shows the trait
- White shape = person doesn't show trait
- Half-shaded = person is a carrier





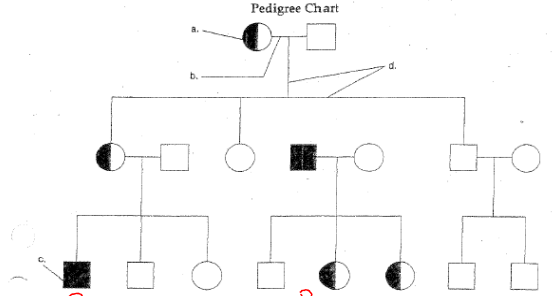
Pedigree Chart

Pedigree Practice

1. What does a pedigree chart show? _____

Match the labels to the parts of the pedigree chart shown below. Some of the parts of the pedigree chart may be used more than once.

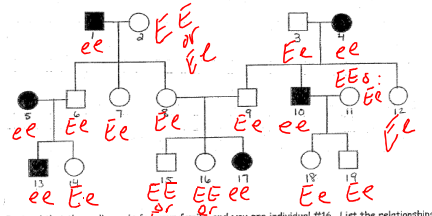
Pedigree Chart



C 2. A person that has the trait
C 3. A male
A 4. A carrier of the trait
B 5. Represents a marriage
A 6. A female
D 7. Connects parents to their children

PEDIGREES

The pedigree below shows the pattern of inheritance through a specific family. The trait being shown is earlobe shape. Free earlobes (E) is dominant over attached earlobes (e). Shaded individuals have attached earlobes (ee).



Pretend that the pedigree is for your family, and you are individual #16. List the relationships of the following people to you. Be sure to indicate their gender in your answer.

1. Individual #15 brother
2. Individual #7 aunt
3. Individual #19 cousin-boy
4. Individual #9 Dad
5. Individual #11 aunt by mama's
6. Individual #4 grandmother or dad's sidy

List the genotypes of the following people. Start by writing the genotypes onto the pedigree, then fill in the blanks below.

7. Individual #16 EE or Ee
8. Individual #17 ee
9. Individual #3 Ee
10. Individual #9 Ee
11. Individual #19 Ee
12. Individual #11 EE or Ee