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**Genetics:**

Lesson 7 – Codominance and Incomplete Dominance

**A-Codominance**

Sometimes patterns of inheritance are not so cut and dry as in regular Mendelian Dominant/Recessive patterns. Sometimes phenotypes are created when BOTH ALLELES for a trait are expressed EQUALLY. This results in a striped, spotted, mottled, or some combination of both alleles showing in the organism=CODOMINANCE

Ex.



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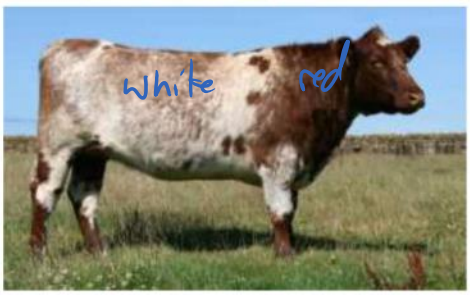



Roan Cow (product of a white parent and a red parent)

In codominance, the two alleles are represented using one capital letter for the gene, with different superscript letters for each allele. For example, the Roan colour on the cow above, would be $H^RH^W$. It is the product of a mating between a red cow ($H^RH^R$) and a white bull ($H^WH^W$). The red and white hairs may be present in patches or they may be completely intermingled.

Example:

For each of the following construct a Punnett Square and give phenotypic and genotype ratios of the offspring.

a) a roan cow and a white bull

roan cow $H^RH^W$

white Bull $H^WH^W$

| | $H^W$ | $H^W$ |
|---|---|---|
| $H^R$ | $H^RH^W$ | $H^RH^W$ |
| $H^W$ | $H^WH^W$ | $H^WH^W$ |

Genotypes:

$H^RH^W$

$H^WH^W$

Phenotypes:

Roan 2/4 (50%)

white 2/4 (50%)

Red cow: $H^RH^R$ Roan Bull: $H^RH^W$

b) a red cow and a roan bull

| | $H^R$ | $H^R$ |
|---|---|---|
| $H^R$ | $H^RH^R$ | $H^RH^R$ |
| $H^W$ | $H^RH^W$ | $H^RH^W$ |

Phenotypes:
Red 50%
Roan 50%

Human Blood Types involve Codominance

In humans, a single gene determines a person's ABO blood type. The gene is designated I, and it has three common alleles: $I^A$, $I^B$, and i. The different combinations of the three alleles produce four phenotypes, which are commonly called blood types. These four blood types are:

A ( $I^AI^A$ homozygous or $I^Ai$ heterozygous)

B ($I^BI^B$ homozygous or $I^Bi$ heterozygous)

AB ($I^AI^B$ heterozygous)

O (ii homozygous)

**Example: Use a Punnett Square to predict the possible offspring of a woman with AB blood and a man heterozygous for B Blood.**

| | $I^B$ | $i$ |
|---|---|---|
| $I^A$ | $I^AI^B$ | $I^Ai$ |
| $I^B$ | $I^BI^B$ | $I^Bi$ |

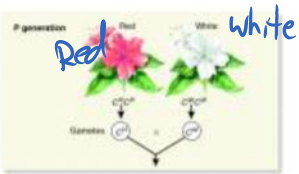
**Genotypes:**
$I^AI^B$
$I^BI^B$
$I^Bi$
$I^Ai$

**Phenotypes:**
type AB 25%
type B 50%
type 25%

## B - Incomplete Dominance:

This is the condition in which neither of the two alleles for the same gene can completely dominate over the other. The "incomplete dominance" involves a heterozygote showing a phenotypes that is a BLEND of the dominant and recessive phenotype. The easiest way to remember this is:

RED x WHITE --→ PINK

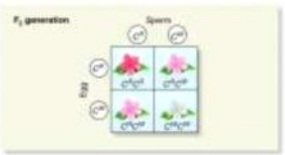



Red are represented by $C^RC^R$

White are rep by $C^WC^W$ ✓

Pink are rep by $C^RC^W$ ✓


Predict using a Punnett Square, the offspring of a White Parent plant with a Pink Parent plant.



| | $C^W$ | $C^W$ | |
|---|---|---|---|
| $C^R$ | $C^RC^W$ | $C^RC^W$ | $C^R$ |
| $C^W$ | $C^WC^W$ | $C^WC^W$ | $C^W$ |

Phenotype
2/4 Pink (50%)
2/4 white (50%)

NOTE: We also use alleles with superscripts to represent incomplete dominance (aka blending inheritance).

Practice, Practice, Practice

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**Genetics:**
Lesson 8– Sex Linked Inheritance

Humans have 23 pairs of chromosomes. One of these pairs is our sex chromosomes.

Sex Chromosomes: X and Y chromosomes which determine a person's biological sex. Typical female: XX typical male XY

50% Chance ♀ (female) | 50% Chance ♂ (male)

The father has X-sperm and Y-sperm

The father will determine the sex of the child.

Sex Linked: Genes: Genes located on X or Y

X Linked Genes: found on X chromosomes (most diseases)

1) **X Linked Recessive:**

lowercase

GENOTYPES: **Healthy Female = XX** | **Healthy Male = XY**

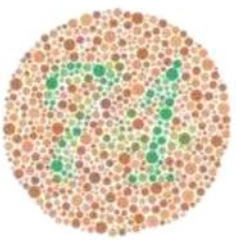
**Female with disease = $X^cX^c$** | **Male with disease = $X^cY$**

**Female that is a Carrier of the disease = $X^cX$ (not affected herself but can pass disease onto her children)**

Ex. Colour Blindness

What results are possible if a carrier female and a normal male have children

♀ = $X^cX$ ♂ = XY



| | X | Y |
|---|---|---|
| $X^c$ | $X^cX$ | $X^cY$ |
| X | XX | XY |

Phenotypes:

Females: 50% Carrier
50% normal

Males: 50% normal
50% C.B / Carrier

2) **X Linked Dominant:** **Healthy Female = XX** **Healthy Male = XY**

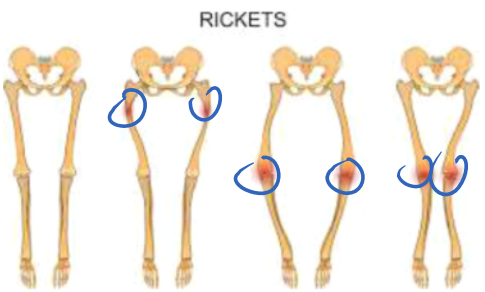
**Female with disease = $X^CX^C$** **Male with disease = $X^CY$**

**Or $X^CX$**

Ex. Rickets

**Hereditary hypophosphatemic rickets** can have several patterns of **inheritance**. When the condition results from mutations in the PHEX **gene**, it is **inherited** in an X-linked dominant pattern. The PHEX **gene** is located on the X chromosome, which is one of the two sex chromosomes. **Hypophosphatemic rickets** is a disorder characterized by **hypophosphatemia**, defective intestinal absorption of calcium, and **rickets** or osteomalacia unresponsive to vitamin D. It is usually hereditary. Symptoms are bone pain, fractures, and growth abnormalities.

Low Calcium




Normal

Practice, Practice

YOU TRY NOW:

mom dad

1. Which sex is more likely have a recessive, sex-linked trait? Male Female
2. Which parent do sons inherit recessive, sex-linked traits from? Mother Father
3. Which type of sex chromosome do you find most sex-linked traits on? X Y
4. Colorblindness is a recessive, sex-linked disorder in humans. A colorblind man has a child with a woman who is a carrier of the disorder.

a. What is the genotype of the man? $X^cY$

b. What is the genotype of the woman? $X^cX$

c. Fill in the Punnett Square to the right.

| | $X^c$ | $Y$ |
|---|---|---|
| $X^c$ | $X^cX^c$ | $X^cY$ |
| $X$ | $X^cX$ | $XY$ |

d. What is the chance that the child will be colorblind? 50%.

e. What is the chance that a daughter will be colorblind? 50%.

f. What is the chance that a son will be colorblind? 50%.

5. In fruit flies, red eyes are dominant over white eyes. Eye color is a sex-linked trait. A red-eyed male mates with a white-eyed female. (this is regular dominance/recessiveness)

a. Make a key with eye color in fruit flies. $X^R$ = _____ $X^r$ = _____

b. What is the genotype of the male? _____

c. What is the genotype of the female? _____

d. Fill in the Punnett Square to the right.

e. What is the chance that there will be an offspring with white eyes? _____

Practice

6. Hemophilia is a disease caused by a gene found on the X chromosome. Therefore, it is referred to as a sex-linked disease. The **recessive allele** causes the disease. A man with hemophilia marries a woman that is homozygous dominant fe[redacted]t.

Normal

a. Make a key for the trait. $X^N$ = Normal _____ $X^n$ = hemophilia

$X^nY$ → diseased male

$X^nX^n$ → diseased female

b. What is the genotype of the male? $X^nY$

c. What is the genotype of the female? $X^NX^N$

d. Fill in the Punnett Square.

| | $X^N$ | $Y$ |
|---|---|---|
| $X^N$ | $X^NX^n$ | $X^NY$ |
| $X^N$ | $X^NX^n$ | $X^NY$ |

No females have disease

No males have disease

e. Will any of their offspring have the disease?

NO!!!