Dominance, Incompete dominance and Codominance

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Dominance

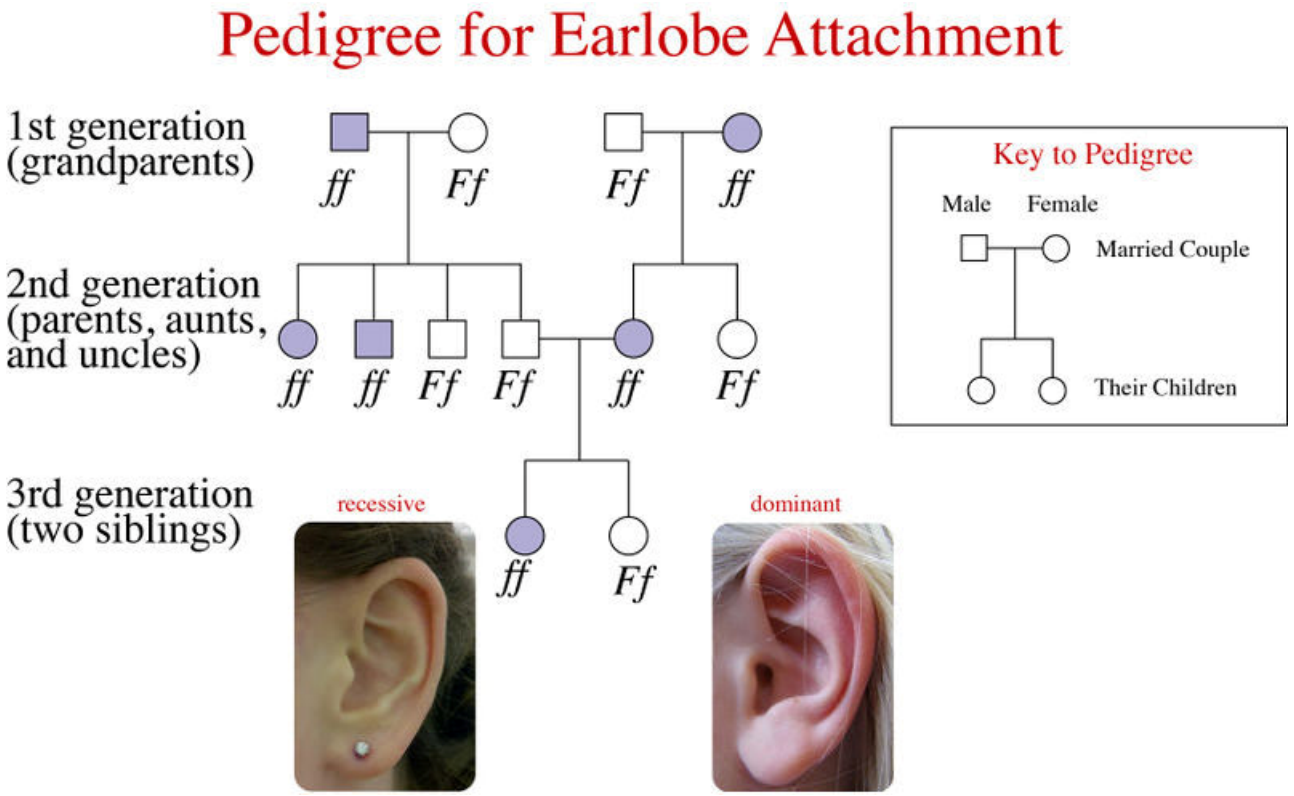
- In genetics, **dominance** is the phenomenon of one variant(allele) of a gene on a chromosome masking or overriding theeffect of a different variant of the same gene on the other copy of the chromosome. The first variant is termed **dominant** and the second **recessive**. This state of having two different variants of the same gene on each chromosome is originally caused by a mutation in one of the genes, either new (*de novo*) or inherited.
- **Dominant alleles** always expressed, even if heterozygous.
- Dominant genes mask recessive genes. For example, brown eyes are the dominant gene for eye color, and blue eyes are recessive, so when the genes for brown and blue eyes are combined in offspring, there is a 75% chance that the offspring will have brown eyes. This is why the majority of people in the world have brown eyes.

Single Gene Autosomal Traits

Widow's peak | No widow's peak | Hitchhiker's thumb | No hitchhiker's thumb

https://www.ck12.org/book/ck-12-biology/section/8.2/

- Some people have their ear lobes attached to the side of the head and some people have free earlobes. This is due to a gene that is dominant for unattached ear lobes and recessive in case of attached ear lobes.

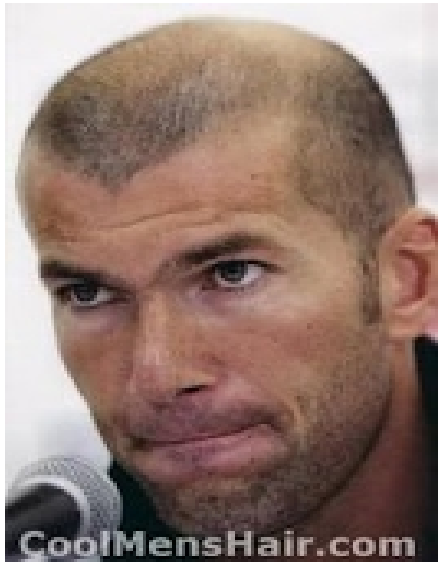


Having free-hanging earlobes is an autosomal dominant trait. This figure shows the trait and how it was inherited in a family over three generations. Shading indicates people who have the recessive form of the trait. Look at (or feel) your own earlobes.

https://www.ck12.org/book/ck-12-biology/section/8.2/

WidowsPeak

The widows peak allele is dominant and the straight allele is recessive.
A widow's peak or the mid-digital hairline is due to expression of the gene for hairline.
This gene has two alleles, one for widow's peak and one for straight hairline.
The widow's peak allele is dominant and the straight allele is recessive.
When two widow's peak alleles are present, the individual will have a peak.
Then one widow's peak and one straight allele is present, it will give rise to expression of a peak. However, when there are two recessive genes, that is, straight hairline alleles, the expression of the trait is a straight hairline.



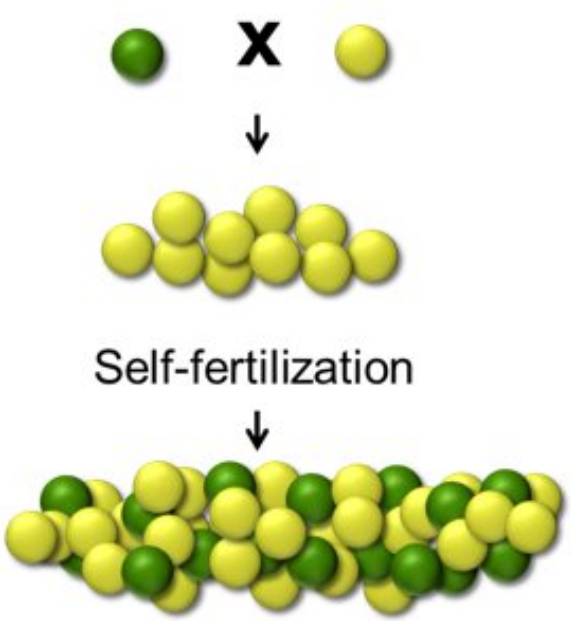
https://www.slideshare.net/zahra1219/dominant-and-recessive-traits-in-humans-12045727

Pea trait	Dominant trait		Recessive trait		Numbers in second generation (F2)	Ratio
Seeds						
Seed shape	Round		Wrinkled		5474:1850	2.96:1
Seed colour	Yellow		Green		6002:2001	2.99:1
Whole plants						
Flower colour	Purple		White		705:224	3.15:1
Flower position	Axial		Terminal		651:207	3.14:1
Plant height	Tall		Short		787:277	2.84:1
Pod shape	Inflated		Constricted		882:299	2.95:1
Pod colour	Green		Yellow		428:152	2.82:1

Mendel cross-bred peas with 7 pairs of pure-bred traits. First-generation (F1) progeny only showed the dominant traits, but recessive traits reappeared in the self-pollinated second-generation (F2) plants in a 3:1 ratio of dominant to recessive traits.

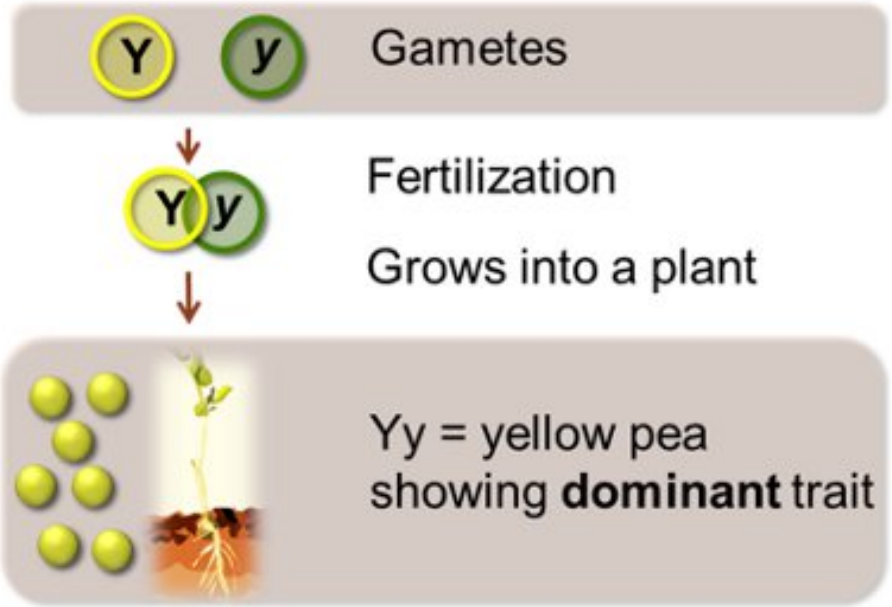
https://www.sciencelearn.org.nz/images/2478-pea-traits-studied-by-mendel

- Mendel's green and yellow peas taught us about dominant and recessive traits. Here is his experiment:



https://genetics.thetech.org/ask-a-geneticist/why-mendel-green-peas-are-recessive

- when Mendel bred a purebred plant with green peas to a purebred one with yellow peas, all the plants in the next generation had yellow peas. Then when these plants were bred, about one quarter of the plants had green peas and the rest had yellow.
- This can be explained if we assume that the pea plant has two copies of each of its genes. And that the genes can come in different versions.
- So the pea color gene comes in two versions or alleles, yellow and green. To make things simpler, geneticists usually label a dominant trait with a capital letter and the recessive trait with a lower case letter. In this case we will use Y for the yellow version and y for the green one. (These particular alleles also can go by I for yellow and i for green.)



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Incomplete dominance

Incomplete dominance is also called partial dominance or semi-dominance as the phenotype resulting from the genotype is a blend of dominant and recessive alleles.

An example of this is observed in flowers where the dominant allele is red, and the recessive is white.

However, the heterozygous flowers from these alleles might appear pink due to incomplete dominance.

In incomplete dominance, the dominant allele cannot completely dominate the recessive allele, as a result of which, the resulting phenotype becomes a mix of both.

Incomplete dominance is important as it explains the existence of a mix of two alleles thatare not described by Mendel in his experiment.

Mendel explained the Law of dominance to indicate that one of the two alleles is dominant asit always dominates the recessive character.

Incomplete dominance

Mendel couldn't study incomplete dominance as the pea plant he selected for his experiment didn't show incomplete dominance.

However, his model can still be used to determine the results of crosses of alleles by incomplete dominance.
According to his model, the resulting F1 generation will be in the genotypic ratio of 1:2:1 and the phenotypic ratio will be red: pink: white.

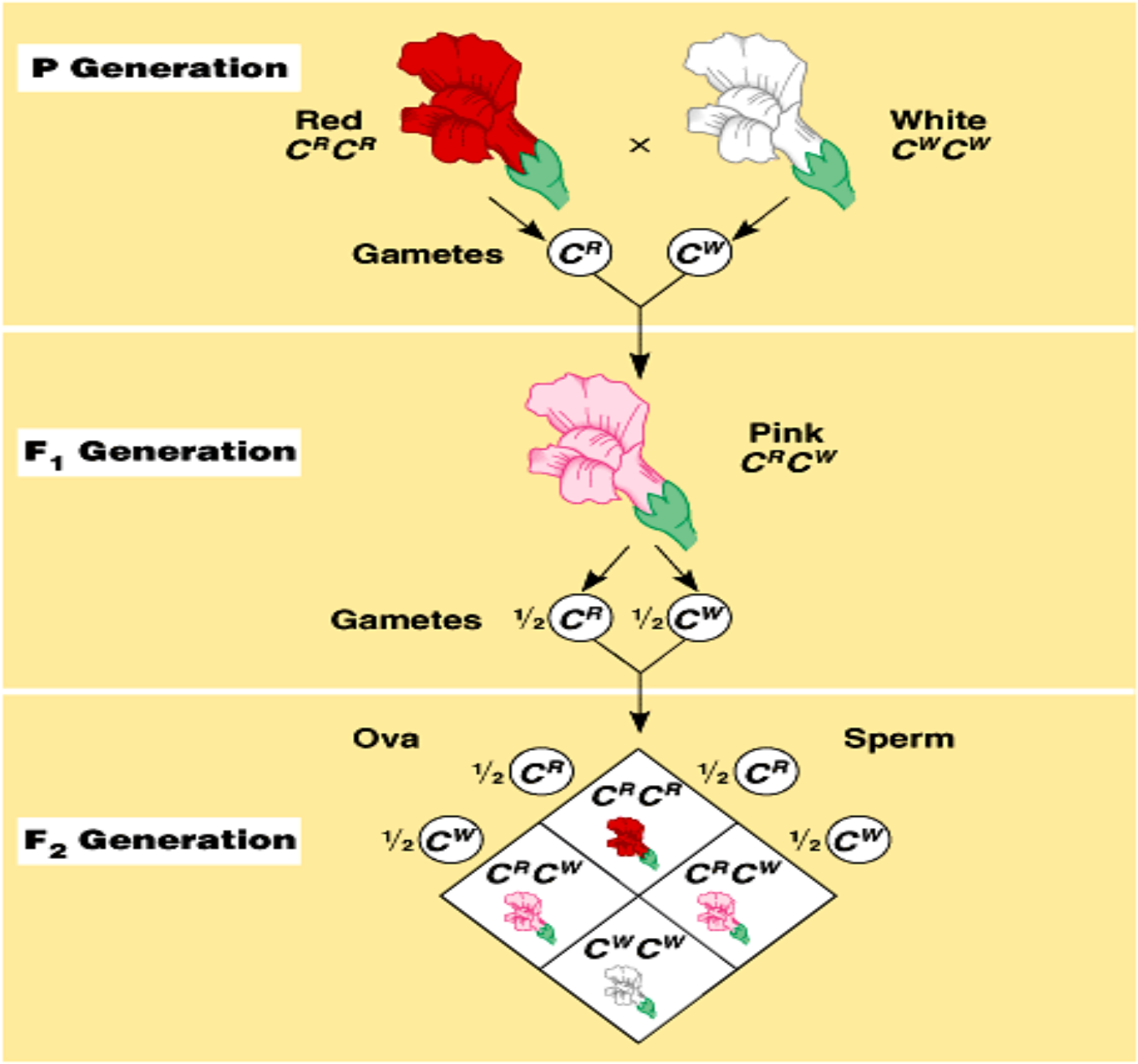
This result indicates that the alleles are still inherited according to Mendel's rule even with incomplete dominance.

In quantitative genetics, if the phenotype of heterozygous alleles is exactly between(numerically) that of the two homozygotes, this is considered as no dominance.
That is, for dominance to occur, the phenotype of heterozygote must lie closer to one of the homozygotes.

Pink flowers in *Mirabilis jalapa*

Incomplete dominance is also demonstrated when a pure line or homozygous with red petals(C1C1) is crossed to a pure line with white petals (C2C2), the F1 progeny has no red petals but pink petals (C1C2).

- If an F2 is produced, its progeny exhibits the following results :
- ¼ red petals – 1 C1C1, ½ pink petals – 2 C1C2¼, ¼ white petals – 1 C2C2
- The dominant trait for the color of the flowers is red, and the recessive trait is white.
- Thus the phenotype resulting from incomplete dominance is pink.
- The phenotype thus formed is a novel one that didn't exist in the generation with the homozygous parents.



Wavy hair in humans

Curly hair is the dominant trait in humans, whereas straight hair is the recessive trait.

- In heterozygous species, the resulting phenotype is wavy hair which is an intermediate between straight and curly.
- Thus, wavy hair results from incomplete dominance where the phenotype results due to the mixing of the two traits.
- Wavy hair, thus, represents a novel phenotype different from straight or curly hair.
- Offsprings formed from two parents with homozygous genotypes will have a genotypic ratioof 1:2:1 with the phenotypic ratio or curly: wavy: straight.

Co-dominance

Co-dominance is sometimes considered as no dominance at all as the heterozygote shows the phenotypes of both homozygotes.

- Thus, heterozygote genotype gives rise to a phenotype distinctly different from either of the homozygous genotypes.
- For co-dominant alleles, all upper case base symbols with different superscripts are used. The upper case letters indicate that each allele can express itself to some degree even when in the presence of its alternative allele.

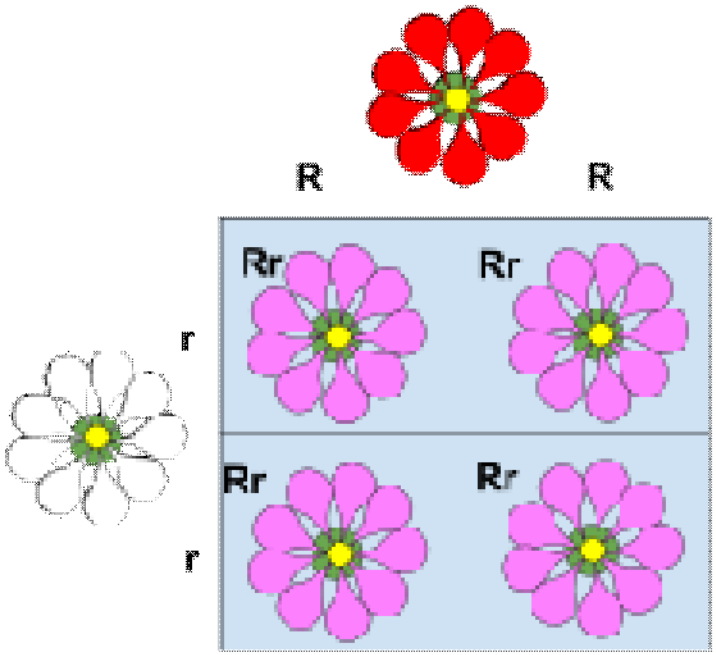
Co-dominance

- An example of co-dominance can be observed in plants where the dominant phenotype isred, and the recessive phenotype is white, and the heterozygote will have flowers with pinkand white spots.
- Like incomplete dominance, co-dominance was also not explained by Mendel as the modelhe chose didn't express co-dominance. However, his model can still be used to determine the results of crosses of alleles by co-complete dominance. According to his model, the resulting F1 generation will be in thegenotypic ratio of 1:2:1 and the phenotypic ratio will be red: spotted: white. Co-dominance can usually be easily detected in plants and animals with two different colors,but it might also occur in some less visible traits like the blood type.
- Thus, co-dominance is different from incomplete dominance as in co-dominance both the alleles co-exist but separately but in incomplete dominance, the phenotype will be a blend ofthe two alleles.

Co-dominance

Neither allele masks the other so that effects of both alleles are observed in heterozygote without blending

Co-dominance in a Camellia cultivar



https://en.wikipedia.org/wiki/Dominance_(genetics)

Chickens and the Frizzle Trait

In 1936, researchers **Walter Landauer and Elizabeth Upham** observed that chickens that expressed the **dominant frizzle gene** produced feathers that curled outward rather than lying flat against their bodies.

However, this was not the only phenotypic effect of this gene — along with producing defective feathers, the frizzle gene caused the fowl to have abnormal body temperatures, higher metabolic and blood flow rates, and greater digestive capacity.

Furthermore, chickens who had this allele also laid fewer eggs than their wild-type counterparts, further highlighting the pleiotropic nature of the frizzle gene.

Blood type in humans

Blood type in humans is determined on the basis of the gene for the proteins that appear on the outside of the blood cells.

- The alleles present are A, B, and O, where A and B represent two different proteins, but Or epresents the absence of any proteins.
- The existence of A and B proteins, like two colors in flowers, can occur together as a result of co-dominance.
- Thus, if both the proteins A and B are inherited to the offsprings, and both are expressed, AB blood type might occur in the offsprings.
- However, the blood type O represents a dominant/recessive relationship where if A and B genes are expressed, then O doesn’t get expressed.

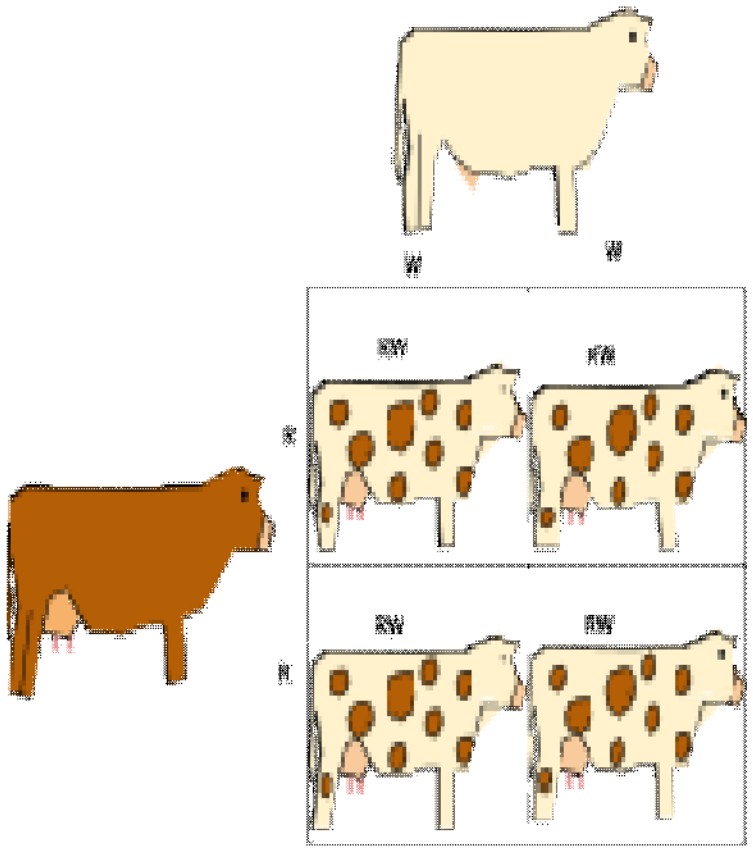
Livestock

Different animals have different colors on their skin and feathers as a result of co-dominance.

- When a chicken with white feathers breeds with a chicken with black feathers, the offsprings have both white and black feathers as a result of co-dominance.

- During co-dominance, both the traits are expressed independently of each other.
- A similar phenomenon is also observed in cows where the breeding of black and white cows results in cows with the spotting of white and black.
- As a result of co-dominance, both the traits are expressed independently of each other.

- The mixed coat of different colored hair in cattle is termed as roan, which is also a



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