Unit B
Understanding Animal Body Systems

Lesson 8
Understanding Animal Genetics

Terms

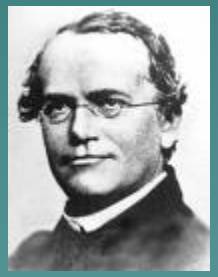
- Alleles
- Chromosome
- Co dominance
- Crossover
- Deoxyribonucleic acid
- DNA
- Dominant
- Genetic code
- Genome
- Genotype
- Heredity
- Heritability
- Heritability estimate
- Heterozygous
- Homozygous
- Incomplete dominance

Terms Cont.

- Linkage
- Mutation
- Phenotype
- Probability
- Punnett Square
- Qualitative traits
- Quantitative traits
- Recessive
- Sex chromosomes

Why is it important for a livestock producer to understand genetics?

- The study of genetics is concerned with the transfer of traits.
- Gregor Mendel discovered that these traits are inherited through units called genes. Genes were found in pairs and half of the inherited traits come from the father and half from the mother.



- This passing of traits from parents to offspring is called ***heredity***. Not all differences in animals are caused by genetics. Some are caused by the conditions under which the animal is raised.

Importance of Genetics

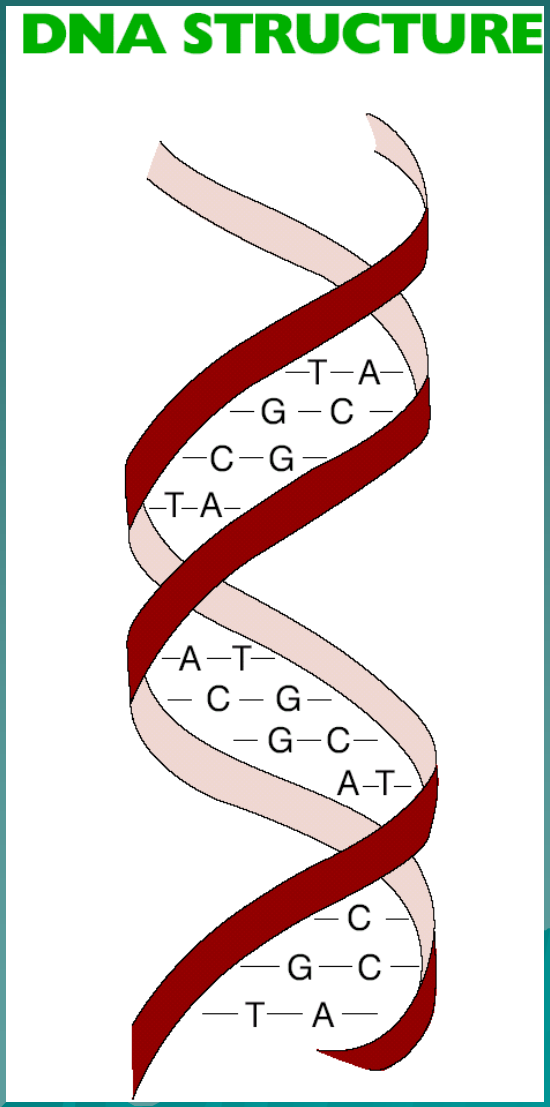
- A ***chromosome*** is a tiny threadlike part in a cell that contains the genetic material found in the nucleus.
- The genetic material found in the chromosomes is called the ***genome*** of the organism.

NUMBER OF CHROMOSOMES FOR SELECTED ANIMAL SPECIES

Species	Number of Chromosomes
Cat	38
Cattle	60
Chicken	78
Dog	78
Donkey	62
Horse	64
Human	46
Mule	63
Sheep	54

Importance of Genetics

- Chromosomes are made of genes that consist of DNA. ***DNA*** is a protein-like nucleic acid on genes that controls inheritance.
- Each DNA molecule consists of two stands shaped as a double helix
- There are 4 nitrogen bases found in DNA. They are: cytosine, guanine, adenine, and thymine.
- The ***genetic code*** is the sequence of nitrogen bases in the DNA molecule. Replicating itself allows for the molecule to pass genetic information from one cell generation to the next.



How do genotype and phenotype differ?

- ***Genotype*** is the actual genetic code. It controls physical and performance traits. The genotype of an organism cannot be changed by environmental factors.
  - Genetics sounds like Genotype!

How do genotype and phenotype differ?

- ***Phenotype*** is the organism's physical or outward appearance. This is the part of the genotype the organism expresses or shows. In some instances, phenotype may be altered by the organism's environment.
  - Phenotype sounds like Physical Traits!

How do genotype and phenotype differ?

- A ***homozygous*** organism is one having similar ***alleles*** or genes on the DNA molecule for a particular trait.
- While a ***heterozygous*** organism is one having different alleles for a particular trait.

How can I estimate which traits will be inherited by offspring?

- Estimating is based on probability. ***Probability*** is the likelihood or chance that a trait will occur.
- Mating animals of particular traits does not guarantee that the traits will be expressed in offspring.
- ***Heritability*** is the proportion of the total variation (genetic and environmental) that is due to additive gene effects.

How can I estimate which traits will be inherited by offspring?

- A ***heritability estimate*** expresses the likelihood of a trait being passed on from parent to offspring. If a trait has a high heritability, the offspring are more likely to express that same trait

Heritability Estimates for Beef Cattle

Examples of Traits

Trait	Heritability (%)
Number born	5
Calving interval (fertility)	10
Percent calf crop	10
Services per conception	10
Conformation score at weaning	25
Cancer eye susceptibility	30
Gain on pasture	30
Weaning weight	30
Yield grade	30
Carcass grade	35
Age at puberty	40
Birth weight	40
Body condition score	40
Carcass—percent lean cuts	40
Conformation score at slaughter	40

(Continued)

Trait	Heritability (%)
Cow maternal ability	40
Efficiency of gain	40
Preweaning gain	40
Yearling frame size	40
Yearling weight	40
Fat thickness	45
Feedlot gain	45
Dressing percent	46
Marbling score	50
Mature weight	50
Scrotal circumference	50
Tenderness	50
Final feedlot weight	60
Retail yield	60
Rib eye area	70

Heritability

- The genes contained in an animal control traits of that animal. Some traits are controlled by only one pair of genes, while others require several pairs.
  - ***Qualitative traits*** are traits controlled only by a single pair of genes & cannot be altered by the environment. Their phenotype is either one thing or the other. For example, either black or white. These traits most easily show how genes are inherited. An example is coat color.

Heritability

- ***Quantitative traits*** are traits controlled by several pairs of genes. These traits are expressed across a range. These traits can also be altered by environment. Examples include rate of gain, growth rate, back fat depth, etc.

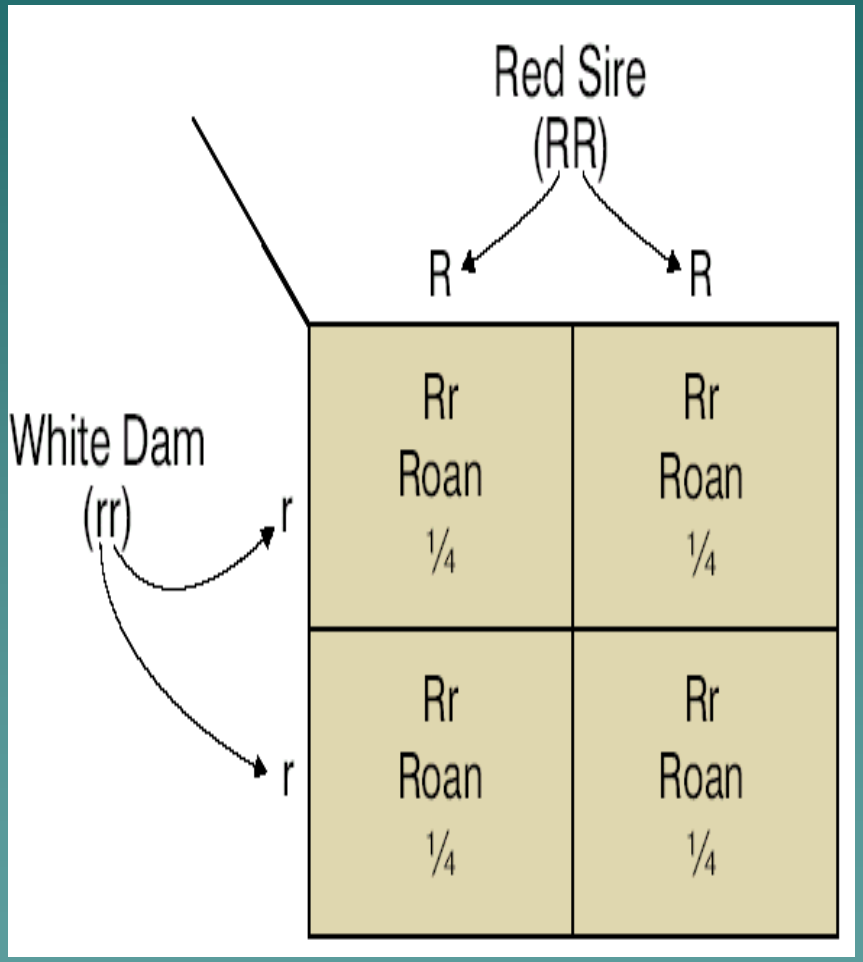
Heritability

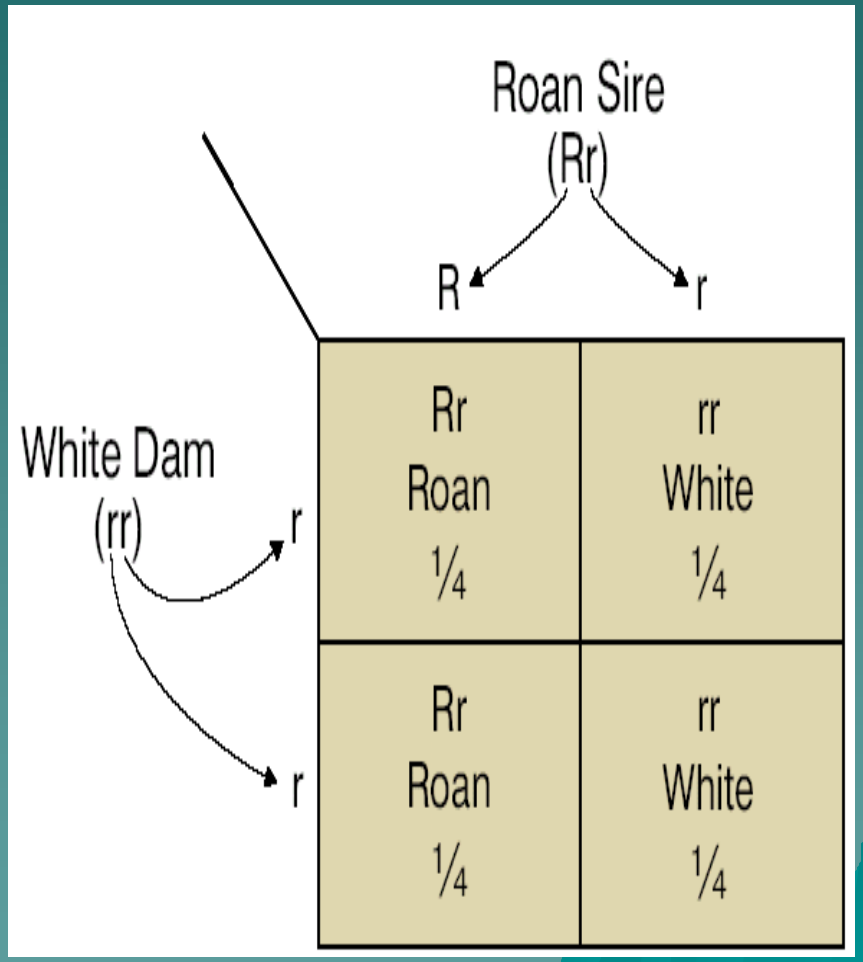
- Not all traits contained within an organism are expressed.
  - ***Dominant*** traits cover up or mask the alleles for ***recessive*** traits. In some organisms there are cases of ***co-dominance*** of traits in which both dominant and recessive genes are expressed. ***Incomplete dominance*** happens when a blending of the allele pair is expressed.

Heritability

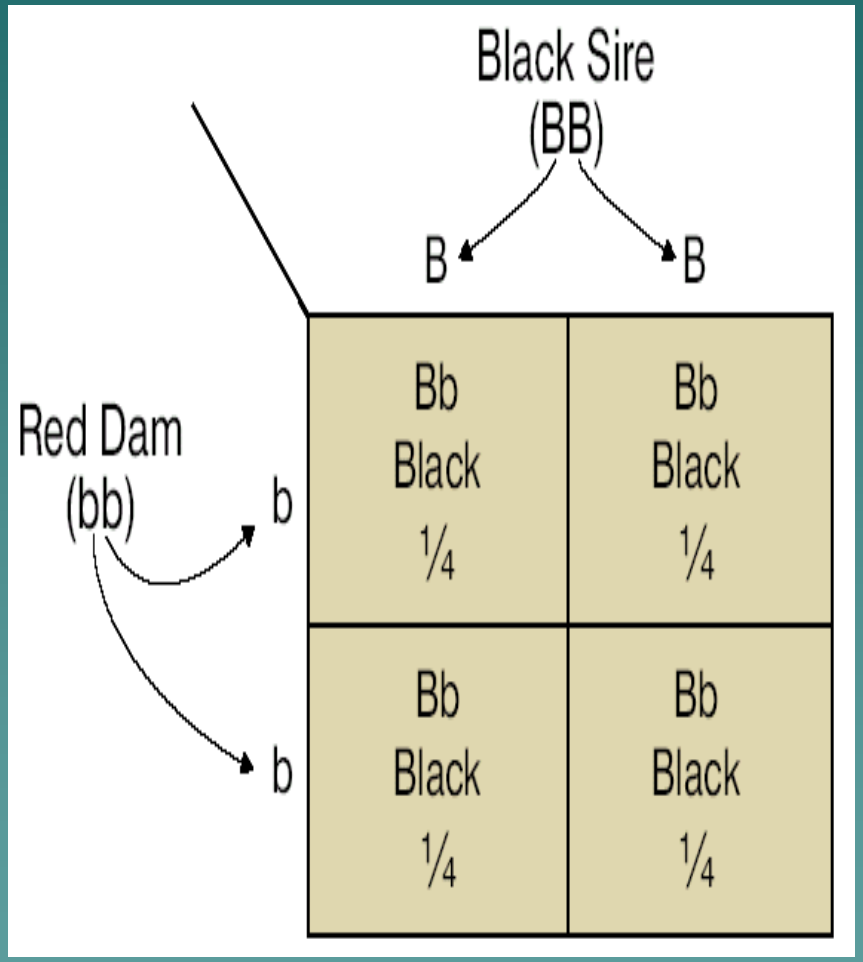
- The ***Punnett Square*** is a technique for predicting genotype. It considers the dominant and recessive genes of the male and female parents for one trait.

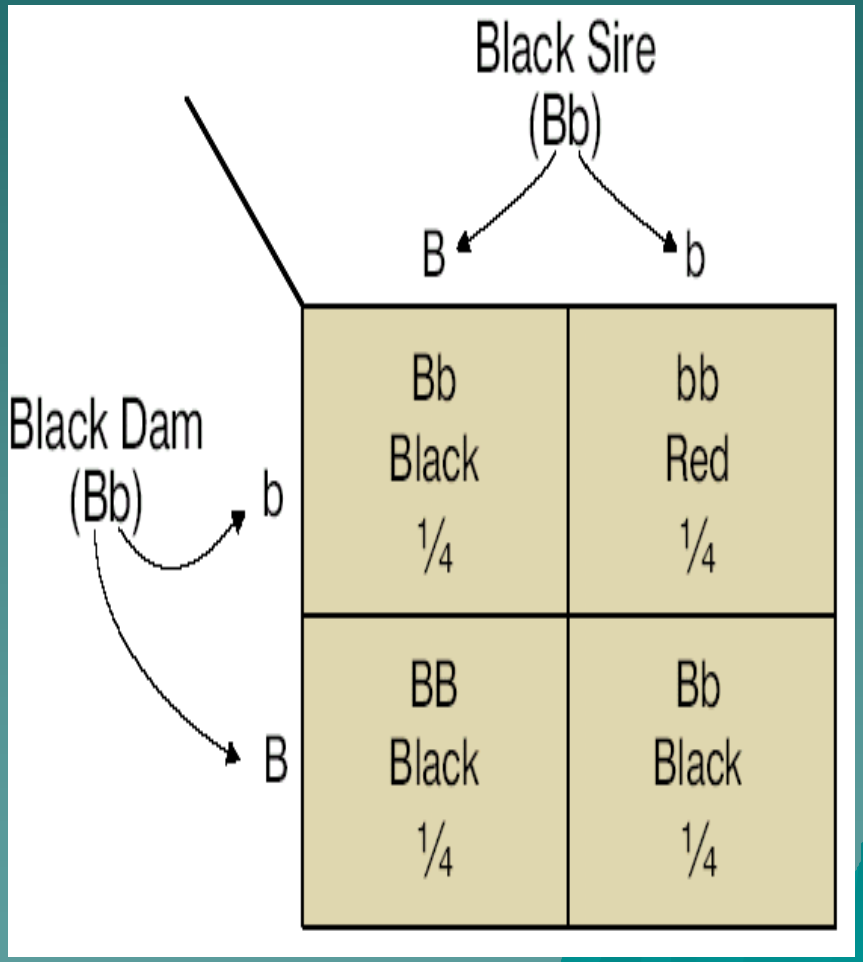
Estimating the Heritability of Certain Traits





Estimating the Heritability of Certain Traits



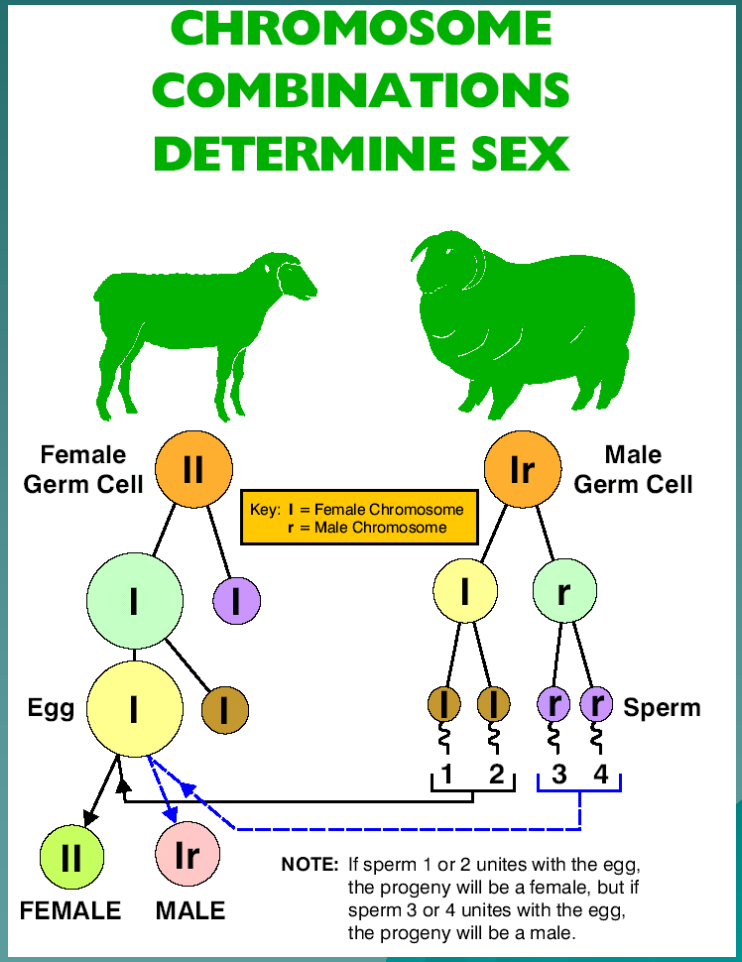


Sex Determination, Linkage, Crossover, and Mutation

- There are several other factors that are important for livestock producers to understand.
  - Sex determination—Determination of the sex of zygote depends on the ***sex chromosomes***.

Sex Determination

- Mammals—Male sex chromosomes are either X or Y. A zygote that receives a Y chromosome from sperm will be male and a zygote that receives an X chromosome from sperm will be female. The male makes sex determination as all eggs from female receive an X chromosome.
  - Therefore, a female zygote will have two X chromosomes (XX) while a male zygote will have one X and one Y chromosome (XY).

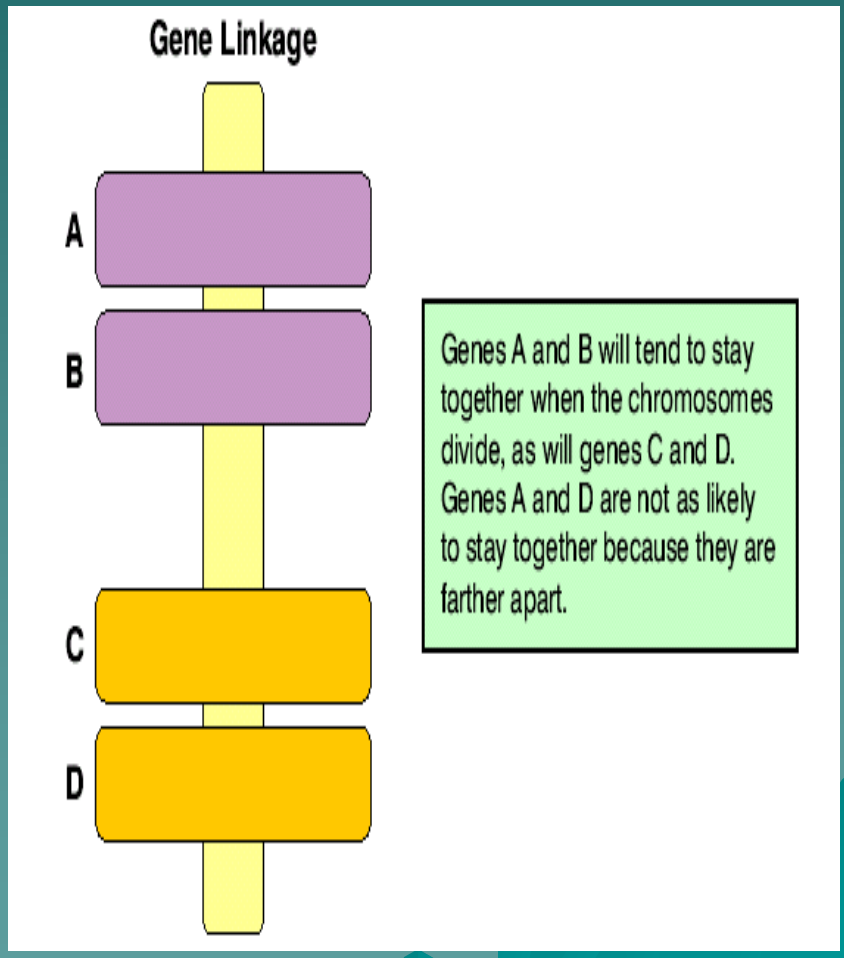


Sex Determination

- Poultry—The female determines the sex of the offspring. The male carries two sex chromosomes (ZZ). The female carries only one sex chromosome (ZW). After meiosis, all the sperm cells carry a Z chromosome. Only half of the egg cells carry a Z chromosome; the other half carries a W chromosome.

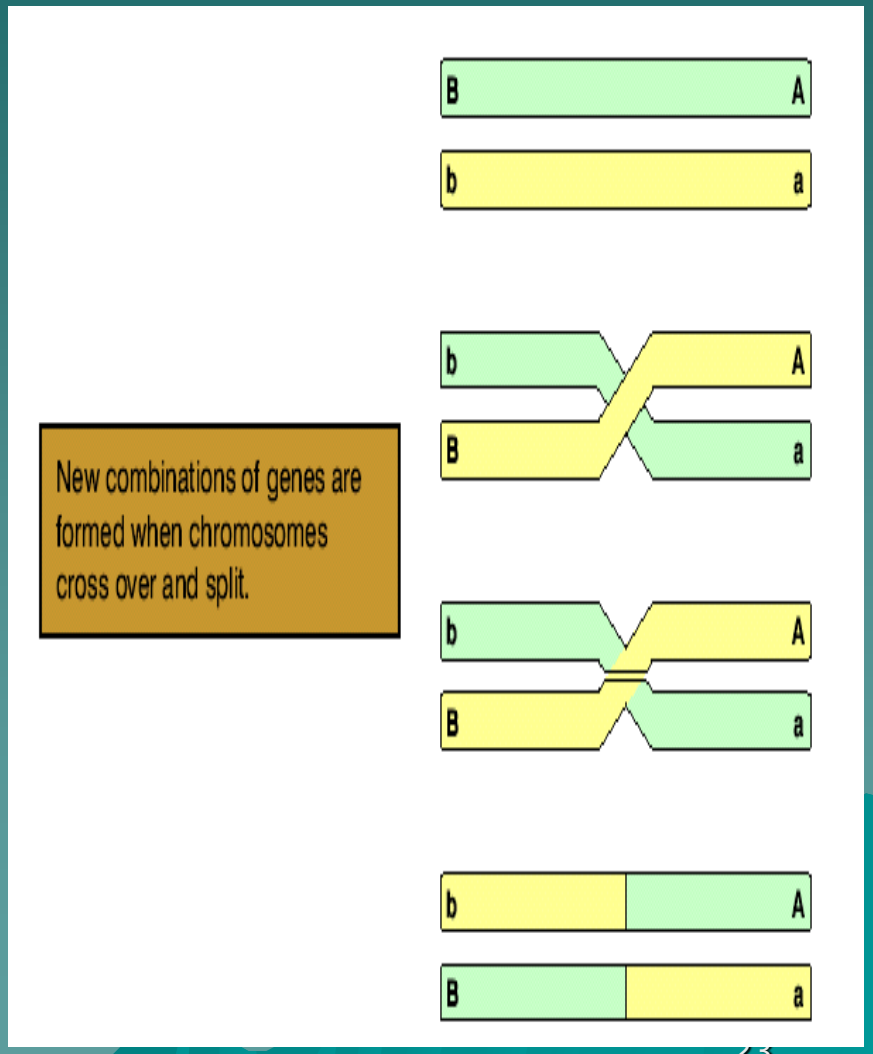
Linkage

- The tendency for certain traits to appear in groups in the offspring is called ***linkage***.
- Early studies in genetics were based on the idea that all genes are redistributed in each mating. It was found, however, that some groups of traits seemed to stay together in the offspring.



Crossover

- ***Crossover*** is the formation of new chromosomes resulting from the splitting and rejoining of the original chromosome. This forms new chromosomes with different combinations of genes.



Mutation

- ***Mutation*** is the appearance of a new trait in the offspring that did not exist in the genetic makeup of the parents.

Review/ Summary

- How are genotypes and phenotypes different?
- How is heritability estimated in animals?
- What happens during crossover and mutation?