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Mutation And Role of Chromosomes in Animal Genetics

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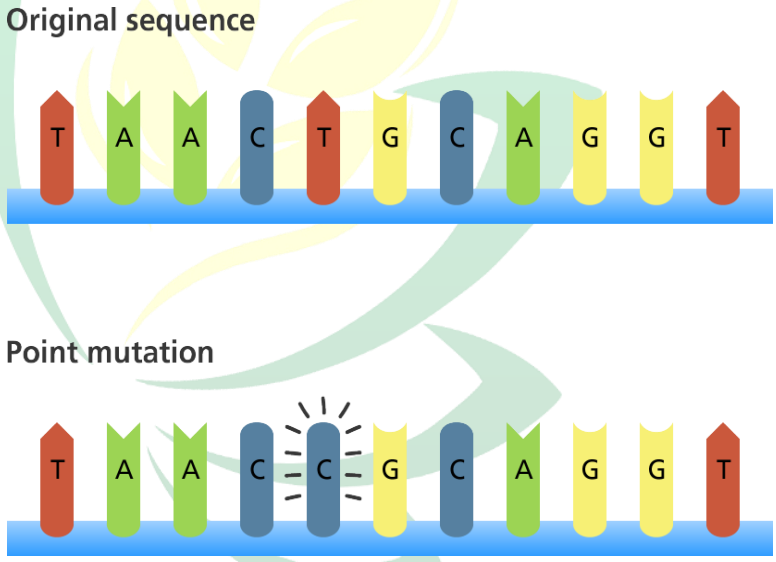
Definition –

A mutation is a sudden discrete and heritable change in genotype of an organisms is called Mutation. The change if it is in germinal cells is transferable from generation after generation. The term 'mutation' was introduced by Hugo De Vries, a Dutch Botanist. This results in changes in the proteins that are made. This can be a bad or a good thing. Mutations can occur during DNA replication if errors are made and not corrected in time.



An illustration to show an example of a DNA mutation

Types of Mutation

1. Gene mutation
2. Chromosomal mutation

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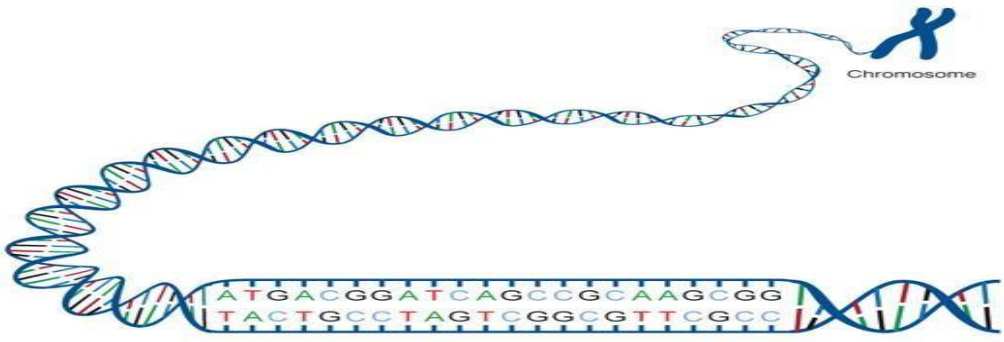

Gene mutation – Genes arise only from genes, and heredity is due accurate gene replication. The gene reproduction or replication is exact but occasionally it goes wrong; a copy of gene differs from its original and the modified gene goes on reproducing its changed structure.It is also called point mutation.

Effect of Gene Mutation

Types of Gene Mutation-

- Point Mutations
- Substitutions
- Insertions
- Deletions
- Frameshift

1. **Point Mutation**
    - Change of a single nucleotide
    - Includes the deletion, insertion, or substitution of ONE nucleotide in a gene
    - Sickle Cell disease is the result of one nucleotide substitution
    - Occurs in the hemoglobin gene

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2. Frameshift Mutation

- Inserting or deleting one or more nucleotides
- Changes the "reading frame" like changing a sentence
- Proteins built incorrectly
- Eg. Original: The fat cat ate the wee rat.
- Frame Shift ("a" added): The fat caa tet hew eer at.

3. Chromosomal mutation

- In an organism the chromosome complement usually divides or reproduces itself accurately:
- But from time to time, it may be altered by duplication – inversion in some chromosomes or change in number of chromosomes.
- Such an individual with change in chromosome structure or number is called a mutant.
- This mutation affects large number of characters.

Types of Chromosome Mutation-

Five types exist: Deletion, Inversion, Translocation, Non disjunction, Duplication

1. **Deletion -** Due to breakage, A piece of a chromosome is lost
2. **Inversion-** Chromosome segment breaks off. Segment flips around backwards. Segment reattaches
3. **Duplication-** Occurs when a gene sequence is repeated
4. **Translocation-** Involves two chromosomes that aren't homologous. Part of one chromosome is transferred to another chromosomes

Non disjunction-

- Failure of chromosomes to separate during meiosis
- Causes gamete to have too many or too few chromosomes

Stages at which mutations occurs

- At the stage in the development of an organisms
- During the formation gametes.
- During the maturation of organisms.

Result of mutation –

- If mutant is lethal, the offspring never reach maturity.
- Mutant among the farm animals are polledness (hornless), low back, long body,short crooked legs etc.

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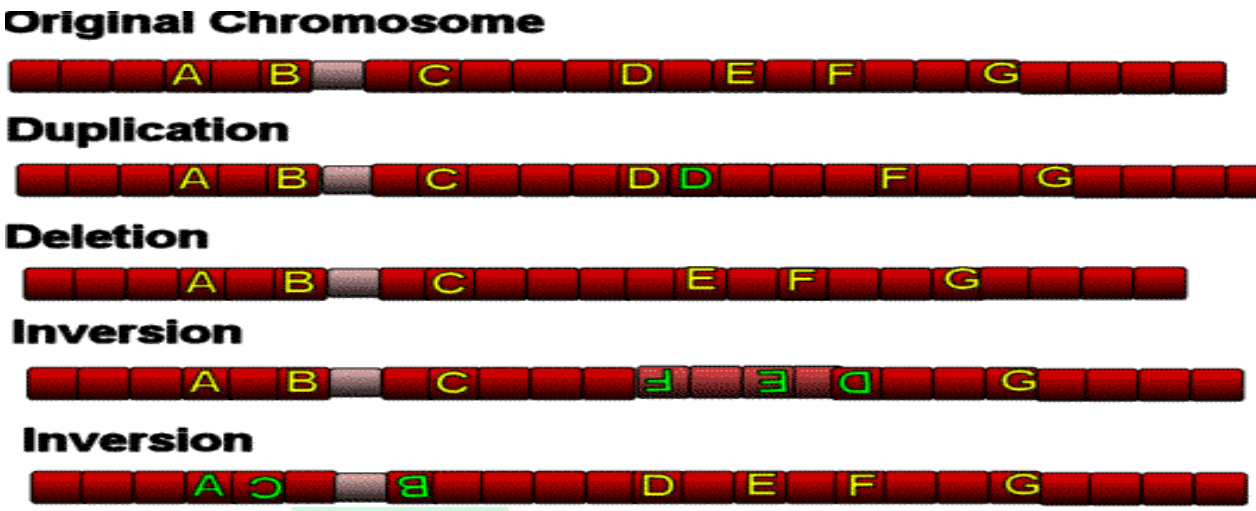
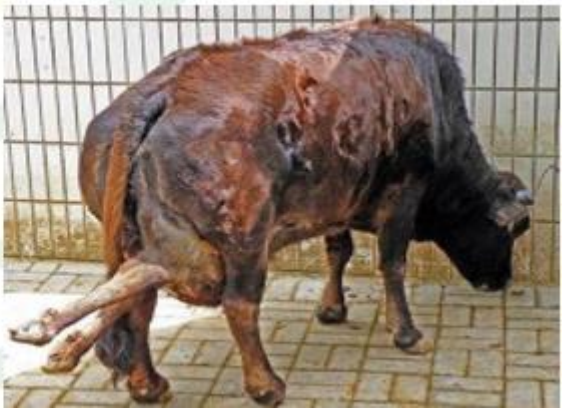


General characteristics of mutation-

- Gene mutations are sudden variations resulting from chemical, structural orpositional change in genes.
- Mutation generally occurs in one gene at a time.
- Mutation rates differ in different genes.
- Mutations are usually recessive and generally harmful or lethal.
- Mutations that are dominant show up at once.
- Mutation can be detected by breeding experiments.



Effect of Chromosomal Mutation

Definition- chromosome is a dark staining rod like or rounded bodies visible undermicroscope in the nucleus of the cell during metaphase stage of cell division.

- These are the compact bundle of deoxyribonucleic acid molecule,

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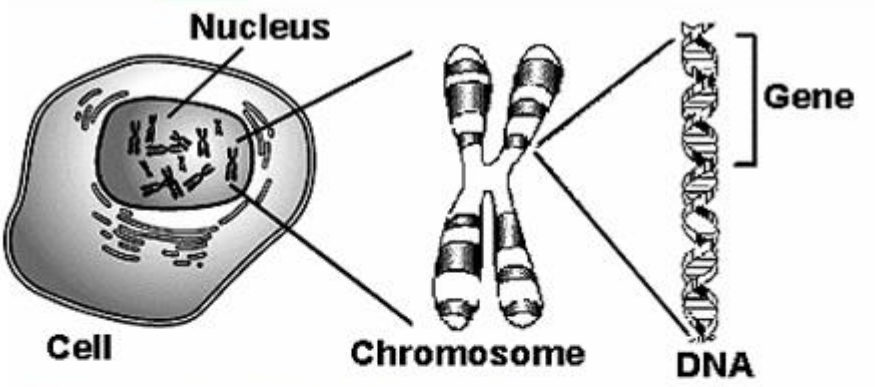
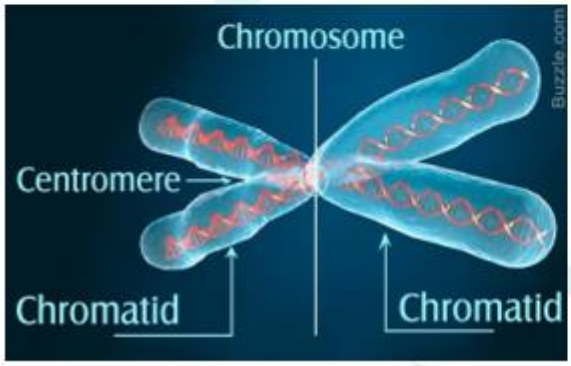
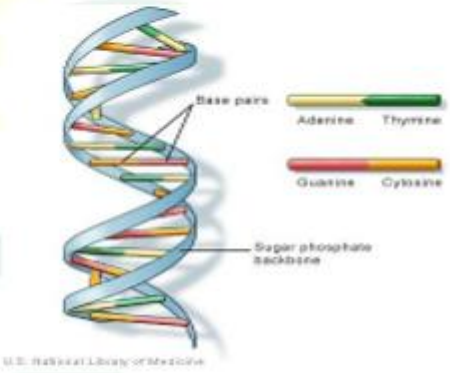
portion of which represents gene.

- Chromosomes occur in pairs in body cells and the number is constant for species
- Chromosomes are made of protein and nucleic acids.
- In mammals in general, the females have two X chromosomes and the male hasone X and one Y chromosome.
- The Y chromosome is usually different from X chromosome in size.







Chromosome Numbers of Animals-

Species	2n	n
1. Chicken	78	39
2. Cattle	60	30
3. Goat	60	30
4. Sheep	54	27
5. Buffalo-(swamp)	48	24
(water)	50	25

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6. Horse	60	30
7. Ass	58	29
8. Human	46	23
9. Pig	38	19

Chromosome Abnormalities- Abnormal behaviour of chromosomes also plays a major role in altering the basic genetic arrangements. Some of these changes are hereditary

Chromosome abnormalities are-

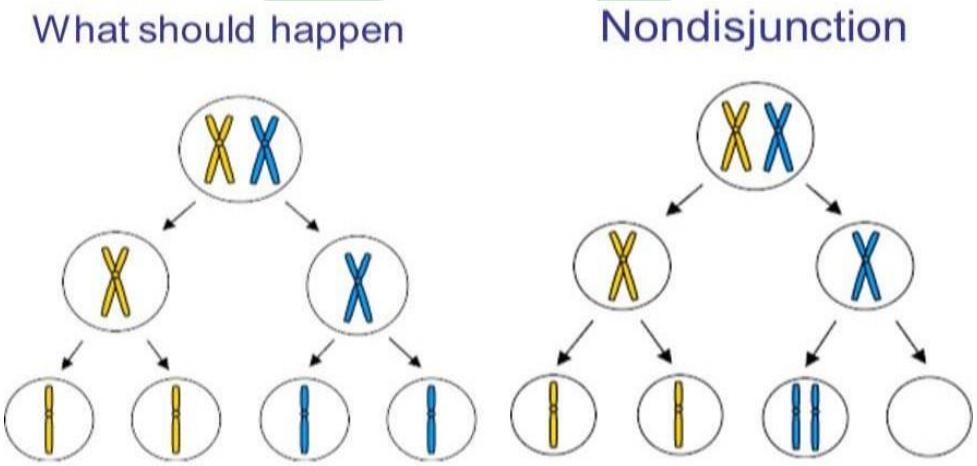
A. Non disjunction

B. Abnormalities from chromosomes breakage

- Deletion
- Inversion
- Duplication
- Translocation

A. Non-Disjunction: -

Sometimes one or more pairs of homologous chromosomes fail to separate during gamete formation. This results in formation of some gametes which lack an entire chromosomeand an equal number of gametes have an extra chromosome. Zygote formed by uniting a normal gamete with one lacking chromosomeare not usually viable , probably a lethal recessive on the unpaired chromosome



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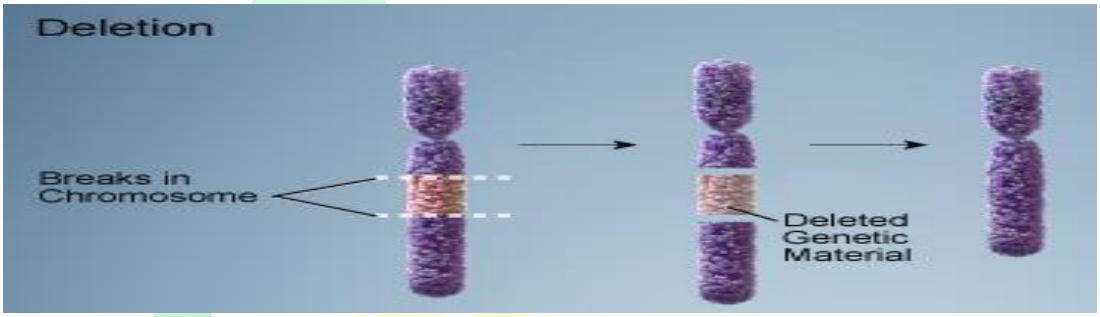
B. Abnormalities from Chromosome Breakage:

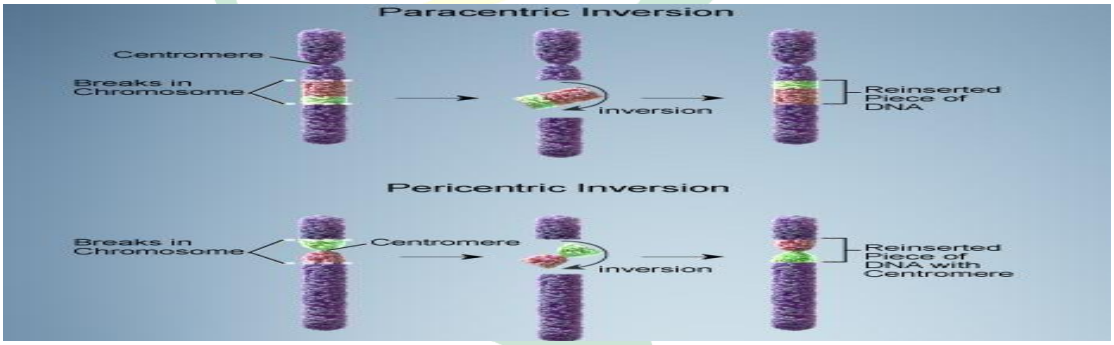
Deletion-

A deletion is the loss of segment of chromosome containing one or more genes. Deletion results when a broken segment fails to rejoin the segment containing the centromere. Deletion may contain many or few genes and they may occur on anysegment of the chromosome. Deletion results in loss of genes and cause death, abnormalities or no change,depending on the function of the gene lost.



a. Inversion- -

An inversion occurs when the segment of chromosome breaks off and rejoins the opposite ends from the original arrangement, resulting in the inverse order for genes on this segment. Inversion changes the gene order but do not result in the loss of genes.



b. Duplication-

If a part of one chromosome breaks and the broken part gets attached to the homologous pair, a condition is obtained where certain genes are present in double gene in one chromosome while the same genes are deficient in the other chromosomes of the pair This is known as duplication.

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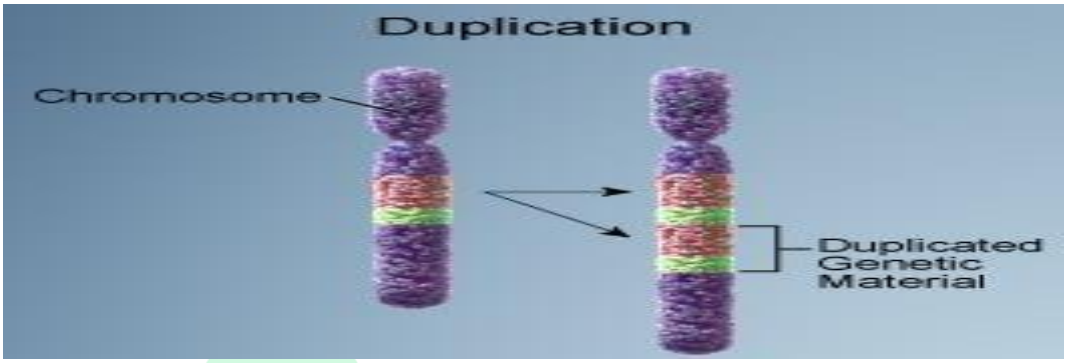

c. Translocation-

When a piece of chromosome becomes broken off affected to another chromosome, usually of another pair, the phenomenon is called as Translocation. This causes a change in relation of linkage group. A new sex linkage is formed when translocation occurs in sex chromosome. Translocation may be simple, when one chromosome of a pair break and gets attached to another chromosome of a different pair.