Dr. UMESH KUMAR

DEPARTMENT OF BOTANY

U.R. COLLEGE ROSERA
(SAMASTIPUR)

B.Sc. PART- I
(BIOLOGY SUBSIDIARY).
[GROUP- B]

(i) MUTATIONS.

B. Sc. Part - I [Botany Subsidiary]

Group - 'B'

Mutations

Mutations [mutare: To change] → "mutations are sudden, permanent change in genes."

Sudden, permanent and hereditary changes are called mutations.

Mutations are sudden changes in genotypes, involving qualitative and quantitative alterations in the genetic material itself which change the phenotype of an organism.

Hugo-de-Vries (1901) was the first scientist who used the term mutation to describe the heritable phenotypic changes of the evening primrose Oenothera lamarckiana. According to Hugo-de-Vries mutations are basis of evolution. The main feature of mutations are as follows -

(1) Mutations may occur at any stage in the development of organism.

(2) Mutations may take place either in somatic cells or in the germinal tissue.

(3) Mutations may arise spontaneously in nature or may be induced artificially.

(4) Mutations may be harmful or useful.
(5) Mutations occur in all living organisms.
(6) They are rare.
(7) Mutations may be large or small.
(8) They may effect the structure and functioning of organism.
(9) Mutations are usually recessive and very mutations are dominant.
(10) They are usually lethal in their action but may be beneficial or atleast not harmful.

Types of mutations

Mutations are mainly of two types-

① Chromosomal mutations
② Gene mutations.

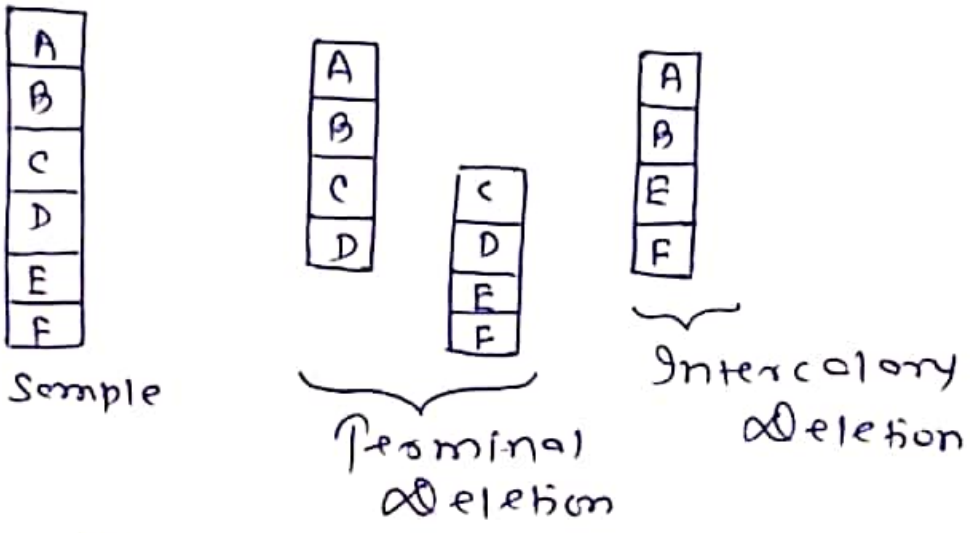
① Chromosomal mutations or Chromosomal Aberrations or Interspenic changes } ⇒ They may result in alternation in the amount or position of genetic materials.

Ⓐ Structural chromosomal mutation

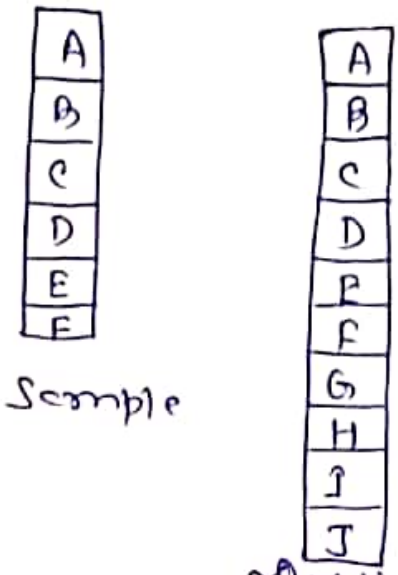
Gene disturbance is interspenic not involving their internal structure. This type of modification of chromosomes involves rearrangement of genes or

or loss of genes. These changes may be of following types -

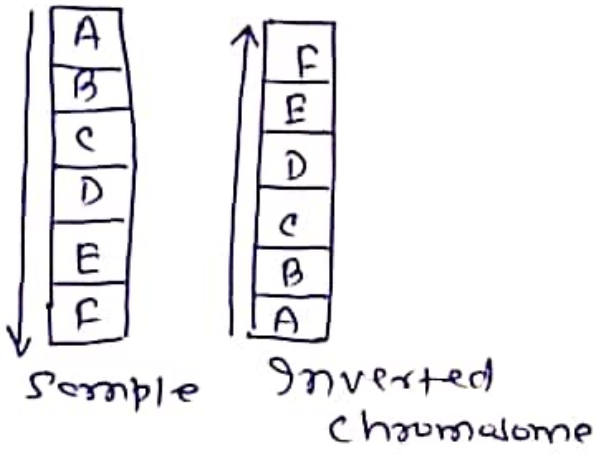
(i) Deficiency → In a deficiency a small segment of chromosome is lost completely (some genes are lost). This loss of segment may be terminal or intercolary. Intercolary deficiency is also called deletions. Deletion causes a disturbance in the genetic balance and gametes with deleted chromosomes are often non-viable.



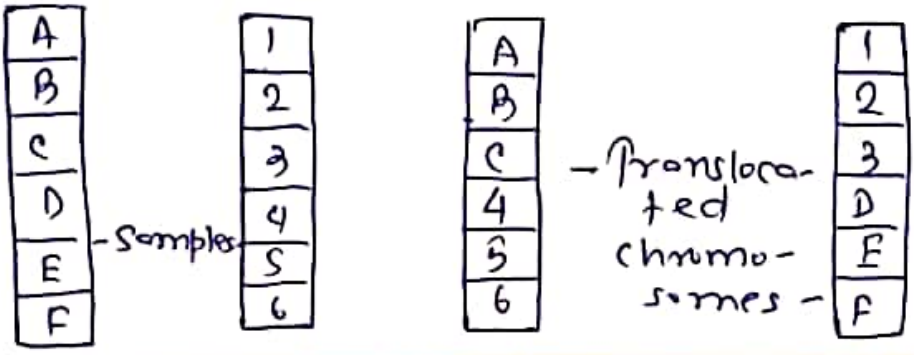
(ii) Duplication or Addition → A fragment of a chromosome after separation may remain free in the nucleus but it cannot survive without a centromere. This fragment may even remain attached with some other broken fragment.



(III) Inversion → A segment of chromosome gets inverted during rearrangement. It occurs at 180°.



(IV) Translocation → A broken bit of chromosome may get attached to some other chromosomes. Translocations are usually reciprocal different from crossing over as whole chromosomes are involved here.



(B) Numerical chromosomal Mutation → When mutation occurs in number of chromosomes, it is called numerical chromosomal mutation. It is of two types -

(i) Euploidy → When variation of chromosome number is through increase in one or more complete set of chromosomes or genomes. Euploidy is of two types -

(a) Haploidy or Monoploidy [2n-n] → When organisms have only one genome (n) in their body cells. Bacteria, Fungi, Algae, Gametophytic generation of Bryophytes are included here.

(b) Polyploidy → Polyploidy may occur in nature or may be artificially induced. An aquous solution of colchicine has a property of arresting and breaking the spindle so that cell division without cell wall formation may be affected leading to the doubling of chromosome number. Colchicine is an alkaloid extracted from the seed and corm of Colchicum autumnale.

- 2n+n = 3n
- 3n+n = 4n
- 4n+n = 5n
- 5n+n = 6n

Polyploidy is of two types -

- Autopolyploidy → The term 'auto' indicates that the ploidy involves only homologous chromosomes. H. Kihara (Japan) produced seedless watermelon. Other seedless autoploids are grapes, banana, sugarbeets.
- Allopolyploidy → The term 'allo' indicates that non-homologous sets of chromosomes. Allopolyploids do not occur in nature. However some cytologists have produced allopolyploidy in certain plants by selective breeding methods. Examples → • Raphanobrassica → It is crossed between radish (Raphanus sativus) and cabbage (Brassica oleracea) by Karpechenko in 1928.
  - Triticale → It is first man made crop (Triticosecale crossed between wheat (Triticum) and rye (Secale)

(iii) Aneuploidy → Loss or addition of 1 or 2 chromosomes in complete set of chromosomes is called aneuploidy. Aneuploidy is of following types

① Monosomy [2n-1] → Loss of one chromosome in complete set of chrome

me is called monosomy. ⑦

ⓑ Nullosomy [2n-2] → Loss of double chromosome from complete set of chromosomes is called nullosomy.

Monosomy and nullosomy are altogether called hypoploidy.

ⓒ Trisomy [2n+1] → Addition of single chromosome in complete set of chromosome is called trisomy.

ⓓ Tetrasomy [2n+2] → Addition of double chromosomes in complete set of chromosome is called tetrasomy.

Trisomy and tetrasomy are altogether called hyperploidy.

⟨2⟩ Gene mutations or Point mutations [Intragenic changes]

"They are new sudden inheritable discontinuous variations which are caused by a change in the nucleotide type and sequence of DNA segment representing a gene or cistron."

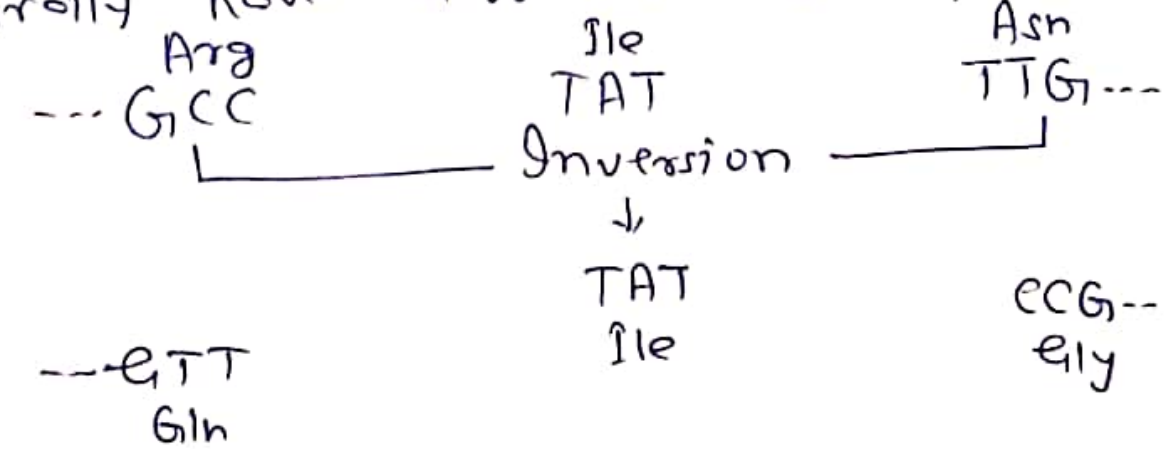
The smallest part of a gene that can undergo mutation is known as mutons. It can be as small

as a single nucleotide. most of the gene mutations involve a change in only a single nucleotide or nitrogen base of the cistron. These gene mutations are called point mutations. A mutation involving more than one base pair is termed as gross mutation. Gene mutations usually occur during replication of DNA. It is therefore also called "copy error mutation". A gene may undergo several point mutations.

Methods of Gene mutations

Gene mutations occur by three methods -

(i) Inversion → A distortion of DNA by mutation can change the base sequence of a cistron in the reverse order. This process is called inversion. The new sequence will naturally have different codon, e.g.



(11) Substitution (Replacement) → In ⑨

Substitution a nitrogen base is changed with another. It is of two types,

ⓐ Transition → A nitrogen base is replaced by another of its type, that is, one purine is replaced by another purine (adenine ⇌ guanine), while one pyrimidine by another pyrimidine (cytosine ⇌ thymine or uracil)

Arg	Ile	Asn
---GCC	TAT	TTG
Arg		
---ACC	TAT	TTG
Trp	Ile	Asn

ⓑ Transversion → Here a purine base is replaced or substituted by a pyrimidine base and vice versa, e.g. uracil or thymine with adenine and cytosine with guanine.

Arg	Ile	Asn
--GCC	TAT	TTG--
Gly		
--CCC	TAT	TTG
Gly	Ile	Asn

Try Ile Asn
--ACC TAT TTG

TyP A

--TCC TAT TTG
Arg Ile Asn

(iii) Frome-shift mutation → They are those mutations in which the reading of the frome of a base sequenie shifts laterally either in the forward direction due to insertion (addition) of one or more nucleotides or in the backward direction due to deletion of one or more nucleotides. It is of two types-

(a) Insertion → one or more nucleotides are added in the segments of DNA representing a cistron or gene.

Try Ile
--ACC TAT TTG--
↓ +A ↓
--CCT CTA TTG--
Leu Asp Asn

(b) Deletion → one or more nucleotide are lost from a segment of DNA representing a cistron or gene.

Trp Ile Asn
--ACC TAT TTG--
↓ -A
--CCT ATT TG--
Gly stop

Roles of mutations

(1) Variability → Mutations are the sources of all variability in a population. Variability increases the adaptibility of the organism to its environment and ward off death or deterioration in a unfavourable environment.

(2) Study of genes- Unless and until a gene mutates and has a recessive or intermediate allele, it will remain unnoticed and its importance in the physiology and phenotype of the individual cannot be evaluated.

(3) Industrial microbiology → workers are continuously developing newer mutant races of micro-organisms for better fermenting ability (e.g.- yeast) better yield of antibiotics (e.g; Penicillium) and several other biochemicals.

(4) Health Hazard → Increasing use of mutagens exposes workers and other segments of population to hazards of having deterious mutation. Therefore some countries have already imposed restrictions and regulations on the use of mutations.

(5) Agriculture → Gustafson estimated that less than 1 in 1000 mutants produced may be useful in plant breeding.

In wheat several useful mutations e.g. branched ear, lodging resistance, high protein and lysine content, amber seed colour and awned spikelets were utilized in plant breeding. A variety "Sharboti Sonara" has been developed through mutations.

In rice a high yielding variety 'Reimie' was developed through mutation.

In barley mutants known as 'erectoides' and 'ecerifrum' have been developed. These are high yielding

Dr. Umesh Kumar
Department of Botany
U.R. College, Rajpur
At LNMU. Darbhanga
9430850876