

[B] - Exception to law of Independent Assortment -

Linkage -

- It is the exception to the law of Independent Assortment

→ Collective inheritance of a character is called Linkage.  
or

“Linkage is the phenomenon of certain Genes being together during inheritance (without any change or separation) due to their being present on the same chromosome.”

Linked Gene

Unlinked gene

Such genes occurs on the same chromosome

occurs on the different chromosome

Do not show independent Assortment

Show independent Assortment

- In dihybrid cross -

Phenotype = 3:1

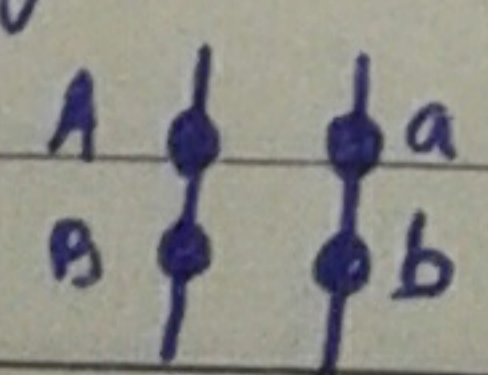
Test cross = 1:1

- In dihybrid cross -

Phenotype = 9:3:3:1

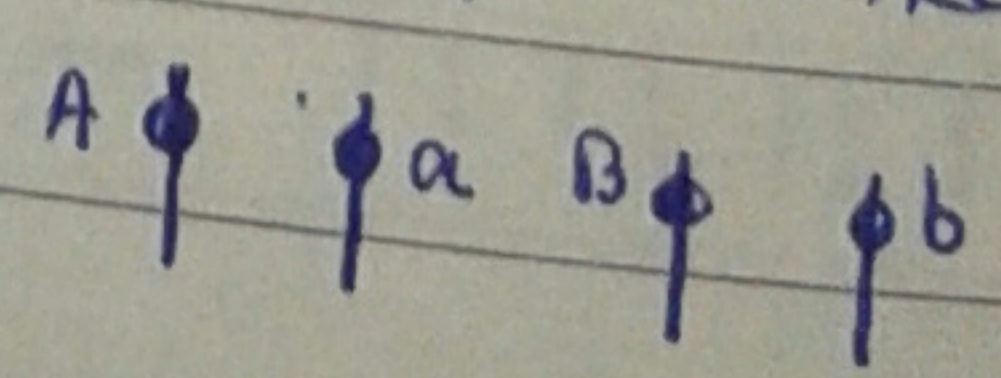
Test cross = 1:1:1:1

In case of Linkage in dihybrid AaBb



only 2 Types (AB, ab) Gametes are formed

In case of unlinked in dihybrid -



4 Types of Gametes (AB, ab, aB, Ab) are formed

$RRYY \times rryy$

$RrYy$  (Linked)

	$RY$	$ry$
$RY$	$RRYY$	$RrYy$
$ry$	$RrYy$	$rryy$

Phenotype = 3:1

Test cross = 1:1

2 awanish dk college

Bateson & Punnett (1906) -- First time seen linkage in Sweet pea (Lathyrus odoratus) & 'Gave coupling & repulsion phenomenon' But

They did not explain the linkage phenomenon.

Morgan (1910) -- clearly proved and defined linkage -- on the basis of his breeding exp in Drosophila -- And proposed chromosomal theory of linkage.

A/c theory --

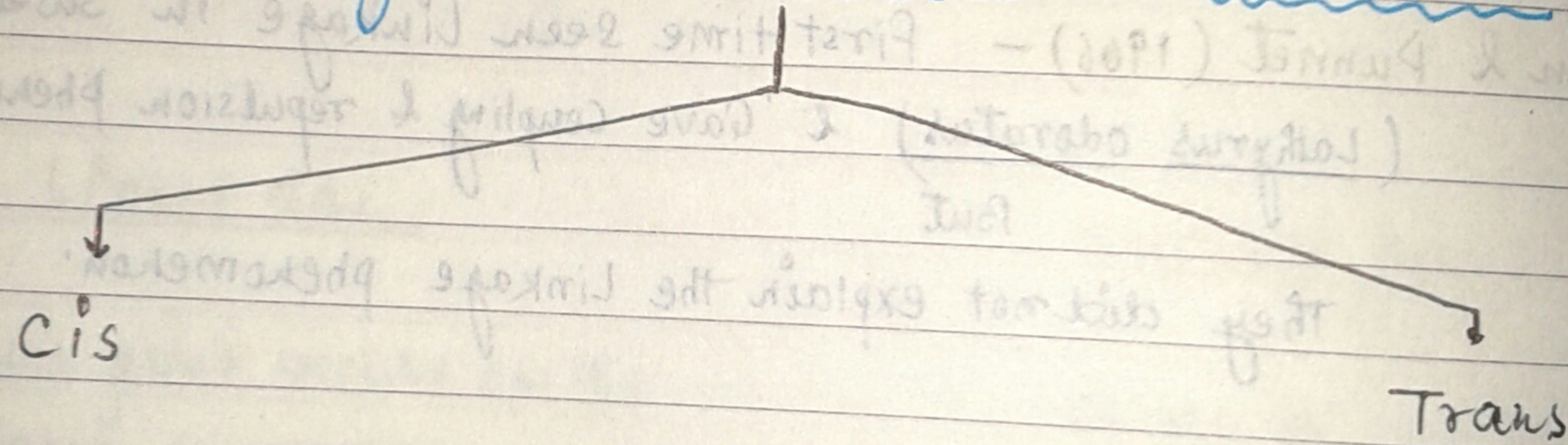
- (1) linked genes occur in the same chromosome.
- (2) They lie in a linear sequence.
- (3) They only separate if crossed over (otherwise maintain the parental)
- (4) Strength of linkage  $\propto \frac{1}{\text{Distance b/w two linked gene}}$
- (5) Frequency of crossing over  $\propto$  Distance b/w two gene.

# Factors Affecting Crossing over in Drosophila

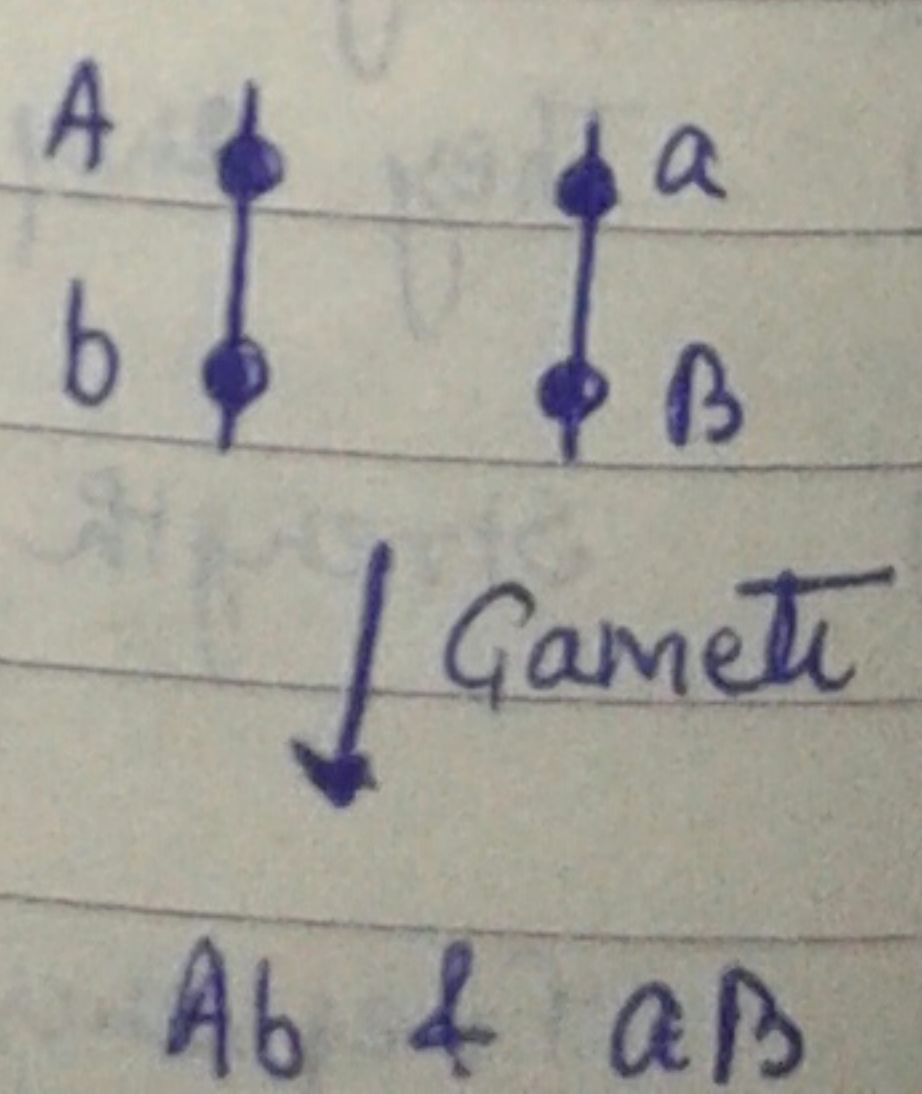
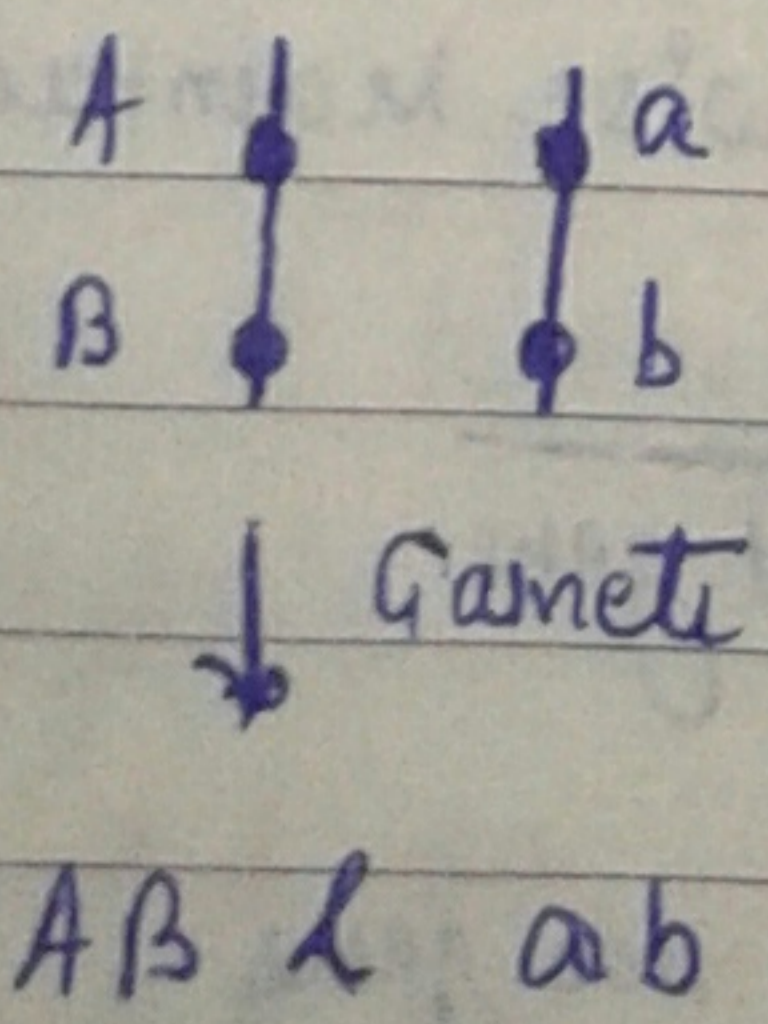
- (1) Distance B/w genes  $\uparrow$  = C.O  $\uparrow$
- (2) Temperature  $\uparrow$  = C.O  $\uparrow$
- (3) X-ray  $\uparrow$  = C.O  $\uparrow$
- (4) Age  $\uparrow$  = C.O  $\downarrow$
- (5) Sex (Male) = C.O  $\downarrow$

3 awanish dk college

## Arrangement of Linked Gene on Chromosome



- When Two dominant Gene are + on one Chromosome & Both recessive on other
- It is an original arrangement
- When one dominant & one recessive on one Chromosome & other D & Recessive on other
- NOT original & occurs due to cross over



Types of Linkage -

4 awanish dk college

(1) Complete Linkage -

- Such genes are located very close on the chromosome
- Crossing over is Absent
- So Never form New combination
- Hence always show Parental combination.
- This linkage is very rare in Nature.
- ex - Male drosophila  
Female Silk Moth

(2) Incomplete Linkage

- Crossing over occurs Hence
- New combination also appear along with Parental combination in offspring (50% New : 50%)

Linkage Group :  $\rightarrow$  It is no. of Haploid chromosome = no. of Homologous chromosomes in an organism.

	2n	n	Pair	Linkage Group
Drosophila	= 8	= 4	= 4	= 4
Pea	= 14	= 7	= 7	= 7
Barley	= 14	= 7	= 7	= 7
Maize	= 20	= 10	= 10	= 10
Human	= 46	= 23	= 23	= 23
Mouse	= 42	= 21	= 21	= 21

# Linkage map

(Genetic/Chromosome/Cross over map)

\* It is linear graphical representation of the sequence & relative distances of various genes present in a chromosome.

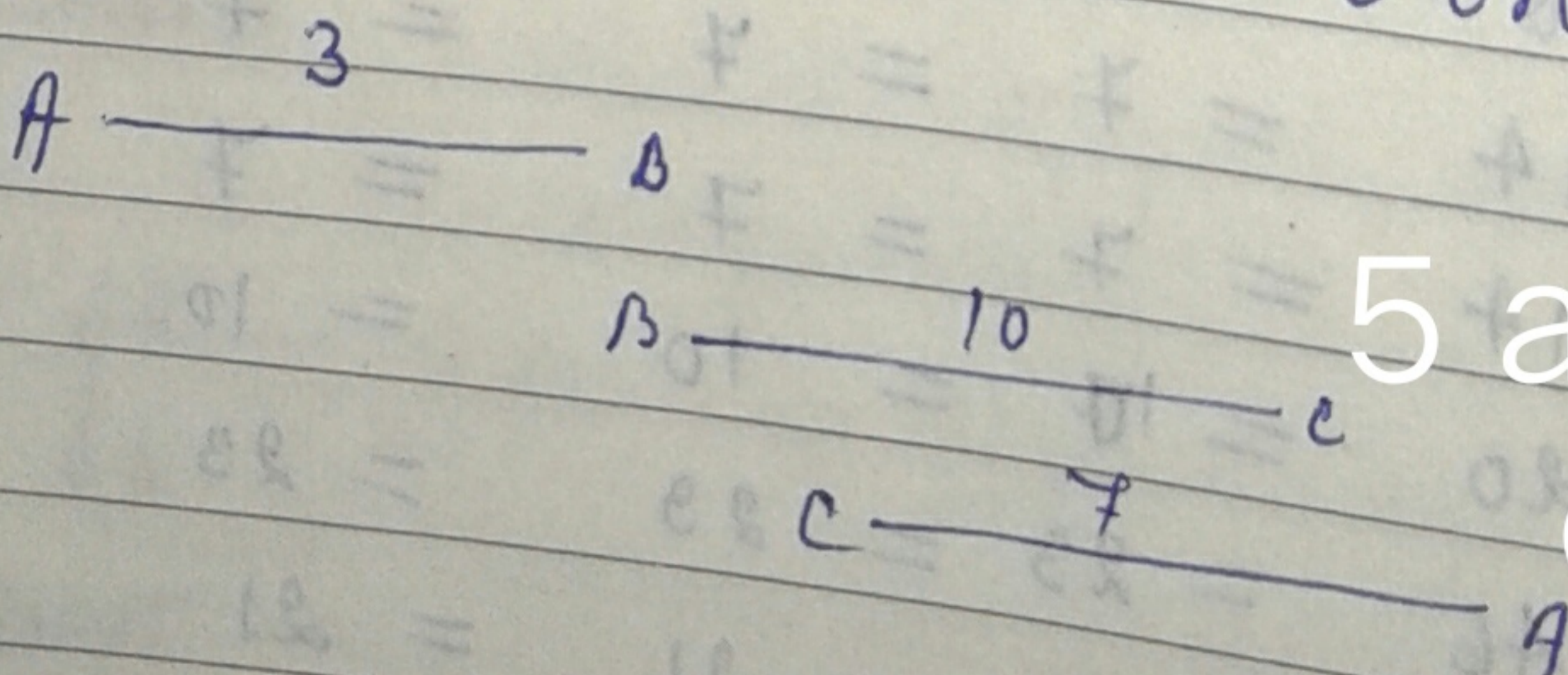
\* It resembles the linear road map that depicts all the stations & relative distances among them.

\* Map unit - 1% crossing over = 1 map unit or M (m.u.)  
B/w two linked genes

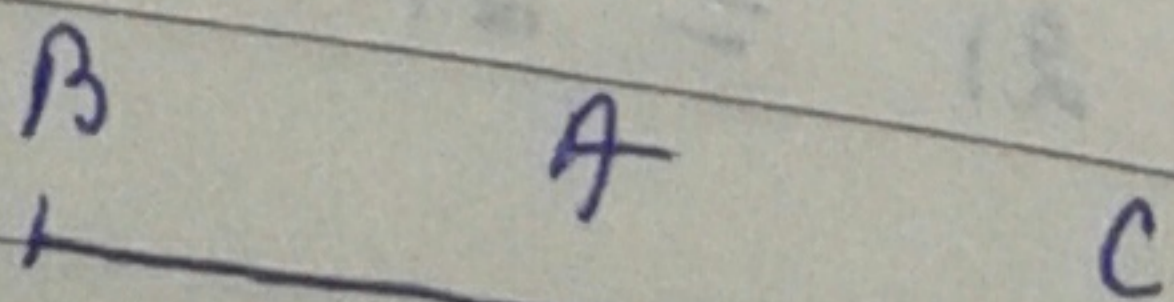
$$\text{Strength of linkage} \propto \frac{1}{\text{Distance b/w linked genes}} \propto \frac{1}{\text{Crossing over}}$$

If map distance B/w Genes A & B is 3 unit, or 3% recomb  
B/w B & C is 10 unit or 10%  
B/w C & A is 7 unit or 7%.

What will be the order of genes on the linkage map?



Ans →



5 awanish dk college