Linkage and Crossing Over

1. "The linked genes are inherited together from one generation to another generation with and with out new combination during the process of Linkage." Explain this statement with suitable examples. (4+4=8 marks)

OR

What is linkage? Describe different types of linkage with suitable examples. (8 marks)

- Def^{n}: Co-existance of two or more genes in the same chromosome as a result of which they are transmitted from one

generation to another in a group.

Types:

Based on linked gene and type of chromosome.

A. Autosomal linkage

B. Sex chromosomal linkage

A. Autosomal linkage:

- Refers to inheritance of the genes on a given autosomal chromosome.
- On the basis of occurance of non-parental combinations, linkage of two types:

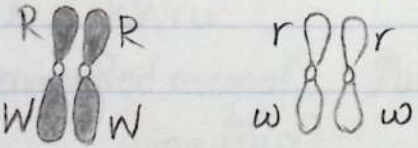
i. Complete linkage:

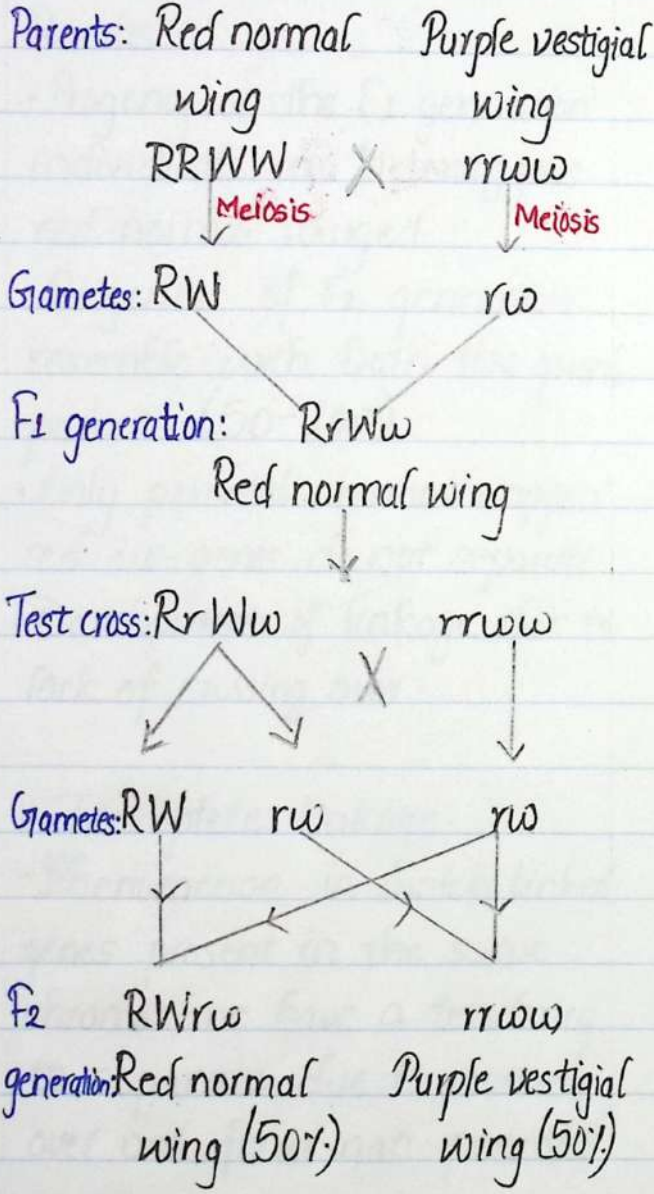
- Phenomenon in which the genes located in the same chr omosome do not separate and

are inherited together over the generation due to absence of crossing over.
- Produces only parental characters but not any non-parental characters.
- Example: Drosophila.

For this red normal winged Drosophila crossed with purple vestigial winged Drosophila.

Here;
RRWW = Red normal wing
rrww = Purple vestigial wing




Parents: Red normal wing RRWW
Purple vestigial wing rrww
Meiosis
Meiosis
Gametes: RW
rw
F1 generation: RrWw
Red normal wing
Test cross: RrWw
rrww
Gametes: RW
rw
rw
F2 generation: RWrw
Red normal wing (50%)
rrww
Purple vestigial wing (50%)

Results:

- Progeny or the F_1 generation individuals are heterozygous red normal winged.
- Progenies of F_2 generation resemble with both the grand parents (50-50%)
- Only parental character appeared i.e. genes do not separate.
- Development of linkage due to lack of crossing over.

ii. Incomplete Linkage.

-Phenomenon in which linked genes present in the same chromosome have a tendency to separate due to crossing over and form non-parental

as well as parental gametes.
- Produces more parental and some parental characters.
- Example: maize plant.

For this a coloured full seeded maize plant crossed with colourless shrunken seeded maize.

Here

CCFF = Coloured full seed
ccff = Colourless shrunked seed

Parents: Coloured full seed × Colourless shrunken seed.

CCFF ↓ Meiosis — ccff ↓ Meiosis

Gametes: CF — cf

F1 generation: CcFf

Coloured full seed

Test cross: CcFf × ccff

Gametes: CF Cf cF cf — cf

F2-generation:

CcFf	Ccff	ccFf	ccff
Coloured and full	Coloured and shrunken	Colourless full	Colourless shrunken

Parental combination : 96.4%
Recombinants : 3.6%.

Results:

- Only few offsprings (3.6%) do not resemble with their grand parents.
- Non-parental characters appear; genes are separated.
- Development of non-parental character due to crossing over in F_1 generation.

2. What is sex-linked inheritance? Describe it with the refrence of eye colour in Drosophila:

OR

What is criss-cross inheritance? Discuss about the sex-linked inheritance with special refrence to eye colour of Drosophila (fruit fly). (8 marks)

- Sex-linked inheritance:
- Inheritance of traits due to linked genes of sex chromosome.
- Also called allosomal linked inheritance.

Criss-cross inheritance:
- A type of inheritance in which parents passes the traits to their grandchild of the same sex through opposite sex.

X-linked inheritance in Drosophilla.

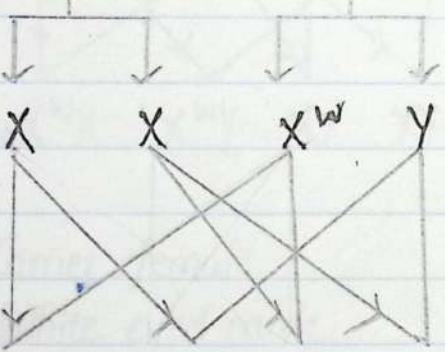
(Eyecolour of Drosophilla):

- T.H. Morgan first identified the X-linked traits in Drosophilla.
- Found the sudden appearance of one white eyed male from the culture of red-eyed female.
- Normal eye colour of fruitfly is red and white colour was the mutant form.
- Performed different crosses in order to know the pattern of inheritance.

Case-I

Cross between red-eyed female and white eyed male.

Parents: Red-eyed female XX × White-eyed male X^wY



F_1 generation: X^wX XY X^wX XY

Here,

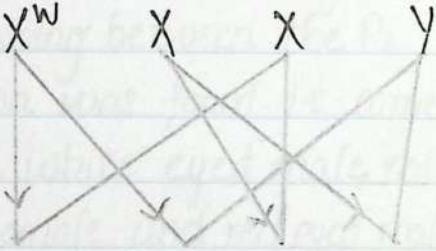
X^wX = Carrier female

XY = Red eyed male

Parents: Carrier female Red eyed male

X^wX × XY

Gametes: X^w X X Y



F2 generation: X^wX X^wY XX XY

X^wX : Carrier female

X^wY : White eyed male

XX : Red eyed female

XY : Red eyed male

Result:

- Cross between red eyed female and white eyed male, two types of F_1 generation was found. i.e carrier female and red eyed male.
- On crossing between the F_2 generation was found. i.e. carrier female, white eyed male, red eyed female and red eyed male.
- Hence, traits of parents transfered to same sex to opposite sex.

Case - II (Test cross of first case)

Cross between F_1 carrier eyed female and white eyed male (test cross with recessive).

Parents: Carrier female White eyed male

$XX^w \times X^wY$

Gametes: X X^w X^w Y

F1-generation: X^wX XY X^wX^w X^wY

X^wX = Carrier female
XY = Red eyed male
X^wX^w = White eyed female
X^wY = White eyed male.

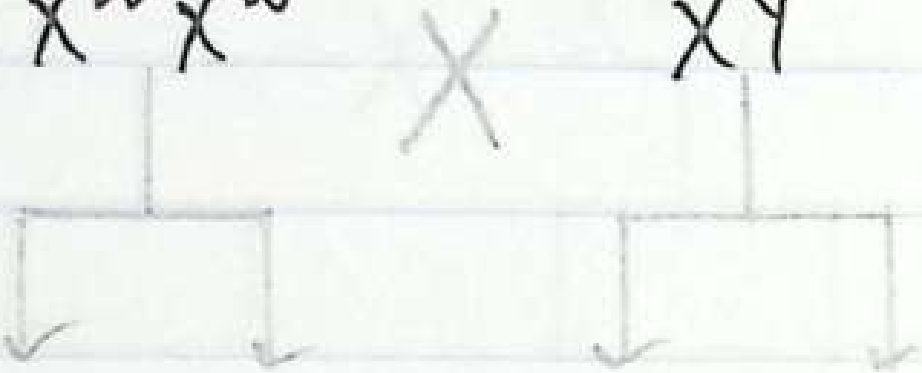
Result:

- Test cross between F1 carrier female with recessive parents; then carrier female, white eyed female, red eyed male and white eyed male was found.

Case-III (Reciprocal cross of 1st case)

Cross between white eyed female and red eyed male

Parents: White eyed female X^wX^w × Red eyed male XY



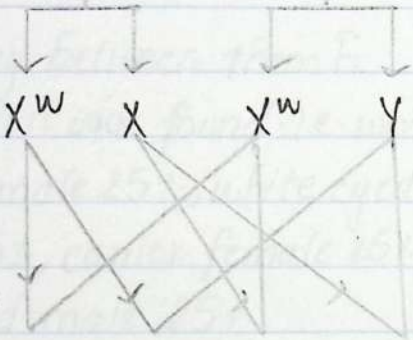
Gametes: X^w X^w X Y

F1-generation: X^wX X^wY X^wX X^wY

X^wX = Carrier female

X^wY = White eyed male

Parents: Carrier female X^wX × White eyed male X^wY



X^wX^w = White eyed female
X^wY = White eyed male
X^wX = Carrier female
XY = Red eyed male

Result:
- Cross between white eyed female

and red eyed male two types of F_1 generation was found. i.e. carrier female and white eyed male.

- Crossing between them F_2 gencration was found. i.e. white eyed female 25%, white eyed male 25%, carrier female 25%, red eyed male 25%.

3. "A character of grandfather is transmitted to grandson, but not in son." State and explain the pattern of inheritance verifying the statement with example showing receprocal crosses up to second filial generation with

ratio. What is called this type of inheritance? (8 marks)

- Case of criss-cross inheritance due to the inheritance of a recessive sex-linked gene or X-linked gene.
- Criss-cross inheritance: Type of inheritance in which sex-linked traits appearing in a male are transmitted through his daughter to his grandsons where they are expressed.
- For example:
  - In the cross, grandfather is colourblind. i.e. due to defective gene in X-chromosome.
  - If colourblind grandfather

married a normal woman, all sons normal while daughters will be carrier.

- Due to sons receive normal X-chromosomes from mother while daughters receive one normal and another defective X-chromosome.
- If his daughter married a normal son in-law, defective X-chromosome of grandfather is passed on to 50% of her grandsons making colourblind; while 50% of grandsons receive normal X-chromosome making them normal.

-50% grand daughters normal while 50% of grand daughters are carrier.