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12th CBSE Biology

2 Classical Genetics

Book Back Solved Questions - 1 Mark

1. Extra nuclear inheritance is a consequence of presence of genes in
a) Mitochondria and chloroplasts
b) Endoplasmic reticulum and mitochondria
c) Ribosomes and chloroplast
d) Lysosomes and ribosomes

2. In order to find out the different types of gametes produced by a pea plant having the genotype AaBb, it should be crossed to a plant with the genotype
a) aaBB *b) AaBB*
c) AABB *d) aabb*

3. How many different kinds of gametes will be produced by a plant having the genotype AABbCC?
a) Three *b) Four*
c) Nine *d) Two*

4. Which one of the following is an example of polygenic inheritance?
a) Flower colour in Mirabilis jalapa
b) Production of male honey bee
c) Pod shape in garden pea
d) Skin colour in humans

5. In Mendel's experiments with garden pea, round seed shape (RR) was dominant over wrinkled seeds (rr), yellow cotyledon (YY) was dominant over green cotyledon (yy). What are the expected phenotypes in the F_2 generation of the cross RRYY x rryy?
a) Only round seeds with green cotyledons
b) Only wrinkled seeds with yellow cotyledons
c) Only wrinkled seeds with green cotyledons
d) Round seeds with yellow cotyledons and wrinkled seeds with yellow cotyledons

6. Test cross involves
a) Crossing between two genotypes with recessive trait
b) Crossing between two F_1 hybrids
c) Crossing the F_1 hybrid with a double recessive genotype
d) Crossing between two genotypes with dominant trait

1. *a) Mitochondria and chloroplasts*
2. *d) aabb*
3. *d) Two*
4. *d) Skin colour in humans*
5. *d) Round seeds with yellow cotyledons and wrinkled seeds with yellow cotyledons*
6. *c) Crossing the F_1 hybrid with a double recessive genotype*

7. In pea plants, yellow seeds are dominant to green. If a heterozygous yellow seed plant is crossed with a green seeded plant, what ratio of yellow and green seeded plants would you expect in F_1 generation?

a) 9:1 *b) 1:3*
b) 3:1 *d) 50:50*

8. The genotype of a plant showing the dominant phenotype can be determined by

a) Back cross
b) Test cross
c) Dihybrid cross
d) Pedigree analysis

9. Select the correct statement from the ones given below with respect to dihybrid cross

a) Tightly linked genes on the same chromosomes show very few combinations
b) Tightly linked genes on the same chromosomes show higher combinations
c) Genes far apart on the same chromosomes show very few recombinations
d) Genes loosely linked on the same chromosomes show similar recombinations as the tightly linked ones

10. Which Mendelian idea is depicted by a cross in which the F_1 generation resembles both the parents

a) Incomplete dominance
b) Law of dominance
c) Inheritance of one gene
d) Co-dominance

11. Fruit colour in squash is an example of

a) Recessive epistasis
b) Dominant epistasis
c) Complementary genes
d) Inhibitory genes

12. In his classic experiments on Pea plants, Mendel did not use

a) Flowering position *b) Seed colour*
c) Pod length *d) Seed shape*

13. The epistatic effect, in which the dihybrid cross 9:3:3:1 between AaBb Aabb is modified as

a) Dominance of one allele on another allele of both loci
b) Interaction between two alleles of different loci
c) Dominance of one allele to another alleles of same loci
d) Interaction between two alleles of same loci

14. In a test cross involving F_1 dihybrid flies, more parental type offspring were produced than the recombination type offspring. This indicates

7. *d) 50:50*
8. *b) Test cross*
9. *a) Tightly linked genes on the same chromosomes show very few combinations*
10. *d) Co-dominance*
11. *b) Dominant epistasis*
12. *c) Pod length*
13. *a) Dominance of one allele on another allele of both loci*

a) The two genes are located on two different chromosomes
b) Chromosomes failed to separate during meiosis
c) The two genes are linked and present on the same chromosome
d) Both of the characters are controlled by more than one gene

15. The genes controlling the seven pea characters studied by Mendel are known to be located on how many different chromosomes?
a) Seven *b) Six*
c) Five *d) Four*

16. Which of the following explains how progeny can posses the combinations of traits that none of the parent possessed?
a) Law of segregation
b) Chromosome theory
c) Law of independent assortment
d) Polygenic inheritance

17. "Gametes are never hybrid". This is a statement of
a) Law of dominance
b) Law of independent assortment
c) Law of segregation
d) Law of random fertilization

18. Gene which suppresses other genes activity but does not lie on the same locus is called as
a) Epistatic *b) Supplement only*
c) Hypostatic *d) Codominant*

19. Pure tall plants are crossed with pure dwarf plants. In the F_1 generation, all plants were tall. These tall plants of F_1 generation were selfed and the ratio of tall to dwarf plants obtained was 3:1. This is called
a) Dominance *b) Inheritance*
c) Codominance *d) Heredity*

20. The dominant epistasis ratio is
a) 9:3:3:1 *b) 12:3:1*
c) 9:3:4 *d) 9:6:1*

21. Select the period for Mendel's hybridization experiments
a) 1856 - 1863 *b) 1850 - 1870*
c) 1857 - 1869 *d) 1870 - 1877*

22. Among the following characters, which one was not considered by Mendel in his experimentation pea?
a) Stem - Tall or dwarf
b) Trichome - glandular or non-glandular
c) Seed - Green or yellow
d) Pod - Inflated or constricted

14. *c) The two genes are linked and present on the same chromosome*
15. *a) Seven*
16. *c) Law of independent assortment*
17. *c) Law of segregation*
18. *a) Epistatic*
19. *a) Dominance*
20. *b) 12:3:1*
21. *a) 1856 - 1863*
22. *b) Trichome - glandular or non-glandular*

Book Back Solved Questions - 2 Marks

1. Give the names of the scientists who rediscovered Mendelism.

1. Hugo de Vries
2. Carl Correns
3. Erich von Tschermak

2. What is back cross?

- Back cross is the **cross** between **F_1 offspring** with any **one of the two parents.**
- It is of **two** types:
  1. *Dominant back cross*
  2. Recessive back cross - Test cross

3. Define Genetics.

Study of **transmission of characters from parents to offspring.**

4. What are multiple alleles?

- **Two** or **more alternative alleles** of a gene, they **occupy** the **same locus.**
- They control different alternatives of a **single trait.**
- They show **intragenic gene interactions.**
- Eg. *ABO blood group alleles.*

5. What is meant by cytoplasmic inheritance?

1. In cytoplasmic inheritance, the traits are governed either by the **chloroplast** or **mitochondrial gene.**
2. Cytoplasmic inheritance is an **extra chromosomal inheritance** or **extra nuclear inheritance**.
3. It is based on the **plasmagenes**.
4. It involves **cytoplasmic organelles** like **chloroplast** and **mitochondria.**
5. Both act as **inheritance vectors.**
6. It is a kind of **non-Mendelian inheritance.**

Eg. 4 O' Clock plant *(Mirabilis jalapa)*

Book Back Solved Questions - 3 Marks

1. What is meant by true breeding lines or pure breeding lines/strains?

1. Plants having **stable trait inheritance** from parent to offspring.
2. They undergo **continuous self pollination.**
3. They are produced by the **fusion** of **pollen** and **eggs** of the same plant by **self fertilization.**
4. Pure line breeds refer to **homozygosity.**
5. It has **stable trait inheritance** from **parent** to **offspring.**
6. **Matings** within pure breeding lines produces **offspring** having **specific parental traits.**
7. They are constant in inheritance for **many generations.**

2. What are the reasons for Mendel's successes in his breeding experiment?

1. Applied **mathematics** and **statistical methods to biology.**
2. Applied **laws of probability** in his breeding experiments.
3. Followed **scientific methods.**

4. Kept **accurate** and **detailed records.**

5. Maintained **quantitative data** of the outcome of his crosses.

6. **Experiments** were **carefully planned.**

7. Used **large samples.**

8. Pairs of **contrasting characters** controlled by **factor** (genes) were **present** on **separate chromosomes.**

9. **Parental plants** selected were **pure breed lines.**

10. **Purity** was tested by **self-crossing** the **progeny** for **many generations.**

3. Name the seven contrasting traits of Mendel.

No.	Character	Dominant trait	Recessive trait
1	Plant height	Tall	Dwarf
2	Seed shape	Round	Wrinkled
3	Cotyledon colour	Yellow	Green
4	Flower colour	Purple	White
5	Pod colour	Green	Yellow
6	Pod form	Inflated	Constricted
7	Flower position	Axial	Terminal

4. Differentiate incomplete dominance and codominance.

Incomplete dominance	Codominance
1. No **blending** of **alleles.**	Simultaneous (joint) **expression** of **both alleles.**
2. F_1 heterozygote has **intermediate** phenotype **between** the **parents.**	F_1 heterozygote exhibits **dominant parent's trait.**
3. **F_1 hybrid** shows presence of **50%** of **functional protein** from **parents.**	**F_1 hybrid** shows presence of **both** the **parental seed proteins.**
4. It proves Mendel's **particulate** theory of **inheritance** and **law of** segregation.	It proves Mendel's **Law of segregation.**
5. Produces a **new phenotype**.	Does not produce a new phenotype.
6. **Neither** of the alleles are dominant	Both the alleles are **dominant.**
7. Eg. Flowers of *Mirabilis jalapa.*	Eg. **Flowers of *Camellia*.**

5. Explain the law of dominance in mono-hybrid cross.

1. The **character expressed** in the **F_1 generation of monohybrid cross** is called **dominant character.**

2. The **character** that is **not expressed in F_1 generation** is called **recessive character.**

3. **Both characters** are **controlled** by **factors** (alleles).

4. **Factors** occur in **pairs.**

5. When a **pair of factors** are **dissimilar**, one is **dominant** and the other is **recessive.**

6. **Dominant character** is expressed in F_1 generation.

7. Both the **parental characters** are expressed in **F_2 generation.**

8. The ratio of F_2 generation is

Tall	:	Dwarf
3	:	1

Book Back Solved Questions - 5 Marks

1. Describe dominant epistasis with an example.

In dominant epistasis, a dominant gene at one locus suppresses or masks the phenotypic expression of another gene at another locus.

1. It is a type of **intergenic gene interaction** or **non-allelic interaction.**

2. The **suppressing gene** is called epistatic gene.

3. The **suppressed gene** is called hypostatic gene.

4. When **both genes** are present, only **dominant epistatic gene** determines the **phenotype.**

5. Dominant epistasis was demonstrated in **summer squash fruit.**

6. The fruit appears in **three** colours namely,

- *Yellow - 'G'* - Hypostatic gene

Parent generation: White fruit WW gg x Yellow fruit ww GG

Gametes: Wg x wG

F_1 generation: White fruit WwGg

F_1 selfed: WwGg x WwGg

Gametes: WG Wg wG wg x WG Wg wG wg

F_2

	WG	Wg	wG	wg
WG	WWGG White	WWGg White	WwGG White	WwGg White
Wg	WWGg White	WWgg White	WwGg White	Wwgg White
wG	WwGG White	WwGg White	wwGG Yellow	wwGg Yellow
wg	WwGg White	Wwgg White	wwGg Yellow	wwgg Green

Phenotypes: White fruit : Yellow fruit : Green fruit

Phenotypic ratio: 12 : 3 : 1

Fig. Dominant epistasis in summer squash.

- *Green - 'g'* - Hypostatic gene
- *White - 'W'-Epistatic gene*

7. **Yellow colour** is controlled by the **dominant gene 'G'.**

8. **Green colour** is controlled by the **recessive gene 'g'.**

9. **White colour** is controlled by the **dominant gene 'W'.**

10. The **dominant 'W'** is **epistatic.** It **suppresses** both **'G'** and **'g'.**

11. **'G'** and **'g'** are **hypostatic.**

12. Hence, when dominant 'W' is present, it suppresses both G and g. **White colour** is produced.

13. In the **absence of 'W', 'G'** produces **yellow** and **'g'** produces **green.**

14. **Recessive 'w'** does **not suppress 'G'** and **'g'.** So **'w'** allows **yellow** or **green** colour to express.

15. The white fruit with genotype **'WWgg'** is **crossed** with yellow fruit with genotype **'wwGG'.**

16. The **F_1 plants** have **white fruit** and are **heterozygous WwGg**.

17. F1 plants are **selfed.**

18. It produces **F_2** with the phenotype ratio of

White	:	Yellow	:	Green
12	:	3	:	1

2. Explain polygenic inheritance with an example.

In polygenic inheritance, several genes combine to determine a single trait.

1. These genes are called **polygenes.**

2. It explains the **inheritance** of **continuous traits.**

Parent $R_1R_1R_2R_2$ (Dark red) X $r_1r_1r_2r_2$ (White)

F_1 $R_1r_1R_2r_2$ Medium red

F_2	Genotype	Phenotype	
1	$R_1R_1R_2R_2$	Dark red	15 red to 1 white
2	$R_1R_1R_2r_2$	Medium-dark red	
2	$R_1r_1R_2R_2$	Medium-dark red	
4	$R_1r_1R_2r_2$	Medium red	
1	$R_1R_1r_2r_2$	Medium red	
1	$r_1r_1R_2R_2$	Medium red	
2	$R_1r_1r_2r_2$	Light red	
2	$r_1r_1R_2r_2$	Light red	
1	$r_1r_1r_2r_2$	White	

Fig. Genetic control of colour in wheat kernels.

3. Swedish Geneticist, **H. Nilsson-Ehle** (1909) first demonstrated **polygenic inheritance** in **wheat kernels.**

4. **Kernel colour** is controlled by **two genes** having **two alleles** each.

5. He crossed **two pure** breeding wheat varieties of **two** different colours.

- *Dark red - Dominant - $R_1R_1R_2R_2$*
- *White - Recessive - $r_1r_1r_2r_2$*

6. Dark red colour is controlled by **two dominant genes** namely, **R_1** and **R_2.**

7. White colour is controlled by **two recessive genes** namely, **r_1** and **r_2.**

8. In the **F_1 generation, medium red** kernel was obtained with genotype **$R_1r_1R_2r_2$.**

9. F_1 generation is **selfed.**

Parent generation: Dark Red $R_1R_1R_2R_2$ x White $r_1r_1r_2r_2$

↓

F_1 generation: $R_1r_1R_2r_2$

↓

F_1 generation (selfed): $R_1r_1R_2r_2$ x $R_1r_1R_2r_2$

F_2 generation

♀ \ ♂	R_1R_2	R_1r_2	r_1R_2	r_1r_2
R_1R_2	$R_1R_1R_2R_2$	$R_1R_1R_2r_2$	$R_1r_1R_2R_2$	$R_1r_1R_2r_2$
R_1r_2	$R_1R_1R_2r_2$	$R_1R_1r_2r_2$	$R_1r_1R_2r_2$	$R_1r_1r_2r_2$
r_1R_2	$R_1r_1R_2R_2$	$R_1r_1R_2r_2$	$r_1r_1R_2R_2$	$r_1r_1R_2r_2$
r_1r_2	$R_1r_1R_2r_2$	$R_1r_1r_2r_2$	$r_1r_1R_2r_2$	$r_1r_1r_2r_2$

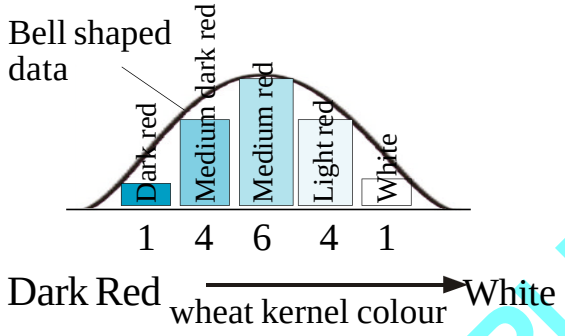


Fig. Polygenic inheritance in wheat kernel colour.

10. **F_1** generation produces **four** types of **gametes.**

- R_1R_2
- r_1R_2
- R_1r_2
- r_1r_2

11. They produce **16 combinations** in the **F_2** generation.

12. The **intensity** of the **red kernel colour** is determined by the **number of R genes** in the **F_2 generation.**

i) **Four 'R'** genes give **dark red** kernel colour.

Eg. $R_1R_1R_2R_2$ - 1

ii) **Three 'R' genes** give **medium-dark** red kernel colour

Eg. - $R_1R_1R_2r_2$
- $R_1r_1R_2R_2$ } 4

iii) **Two 'R' genes** gives **medium-red** kernel colour

Eg. - $R_1R_1r_2r_2$
- $R_1r_1R_2r_2$
- $r_1r_1R_2R_2$ } 6

iv) **One 'R' gene** gives **light red** kernel colour.

Eg. - $R_1r_1r_2r_2$
- $r_1r_1R_2r_2$ } 4

v) **Absence of 'R' gene** gives **white** kernel colour.

Eg. $r_1r_1r_2r_2$ - 1

13. The number of each phenotype is plotted against the **intensity of red kernel** colour.

14. The data produces a **bell shaped curve.**

15. It demonstrates **continuous variation** in wheat kernel from dark red to white in F_2 generation.

16. It was later discovered that **three** genes are involved in **affecting** the **wheat kernel colour.**

17. **Nilsson-Ehle** found the ratio of **63 red** (many shades) **: 1 white** in **F_2 generation.**

18. The phenotypic ratio in the F_2 generation can be shown as

1 : 6 : 15 : 20 : 15 : 6 : 1

Parents AABBCC Dark red wheat kernal x aabbcc White wheat kernal

↓

F_1 AaBbCc Intermediate red (selfed)

F_2

1	6	15	20	15	6	1
Dark red	Moderate red	Red	Intermediate red	Light red	Very light red	White

63 Red (many shades) : 1 White

Fig. Polygenic inheritance in wheat kernel.

3. Differentiate continuous variation with discontinuous variation.

Continuous Variation	Discontinuous Variation
1. Continuous variation shows **continuous gradation** of a **character** in a population.	1. Discontinuous variation shows **discontinuous range** of a **character** in a population separately.
2. **Quantitative** inheritance.	**2. Qualitative** inheritance
3. **Intermediate** forms are present	3. Intermediate forms are **absent**.
4. Variations are determined by combined effects of **inheritance** and **environmental factors.**	4. Variations are determined by **inheritance factors** only.
5. Characters are controlled by **many genes** (polygenes).	5. Characters are controlled by **one** or **two genes**.
6. Phenotypic expression is **affected** by **environmental conditions.**	6. Phenotypic expression is **unaffected** by **environmental conditions.**
7. Eg: *Human height* *Skin colour in man*	7. Eg: *Style length of Primula* *Plant height of garden pea.*

4. Explain with an example how single gene affects multiple traits and alters the phenotype of an organism.

- It is due to **pleiotropy.**
- *In pleiotropy, a single gene controls multiple traits and alters the phenotype of an organism.*
- This gene is called **pleiotropic gene.**
- It is an **intragenic gene interaction** or **allelic interaction.**
- Mendel noticed pleiotropy in pea plant, *Pisum sativum.*
- In pea plant, a single gene with **dominant** and **recessive alleles** controls three traits such as,
  - *Flower colour*
  - *Seed colour*
  - *Spots on the leaf axil*
- One variety of pea plant has the following traits:

- *Purple flowers*
- *Brown seeds*
- *Dark spots on the leaf axils*

- Another variety of pea plant has the following traits:
  - *White flowers*
  - *Light coloured seeds*
  - *No spots on the leaf axils*
- When these two plants are crossed, these three traits are **inherited** together as a **single unit.**
- Eg. *Sickle cell anemia.*

5. Bring out the inheritance of chloroplast gene with an example.

- Inheritance of characters through **chloroplast** is called chloroplast inheritance.
- It is also called,
  - *Extra chromosomal inheritance*
  - *Extra nuclear inheritance or*
  - *Cytoplasmic inheritance*
- It involves **chloroplast.**
- Chloroplast acts as **inheritance vector.**

Example

- 4 O' Clock plant - *Mirabilis jalapa*
- It has **two** types of **variegated** leaved plants.
  - *Dark green leaved plants*
  - *Pale green leaved plants*
- The colour of variegated leaves is controlled by **chloroplast gene.**
- These two plants are crossed in a **reciprocal** manner.
- In reciprocal cross, the F_1 generation of both the crosses must be **identical** as per the **Mendelian inheritance.**

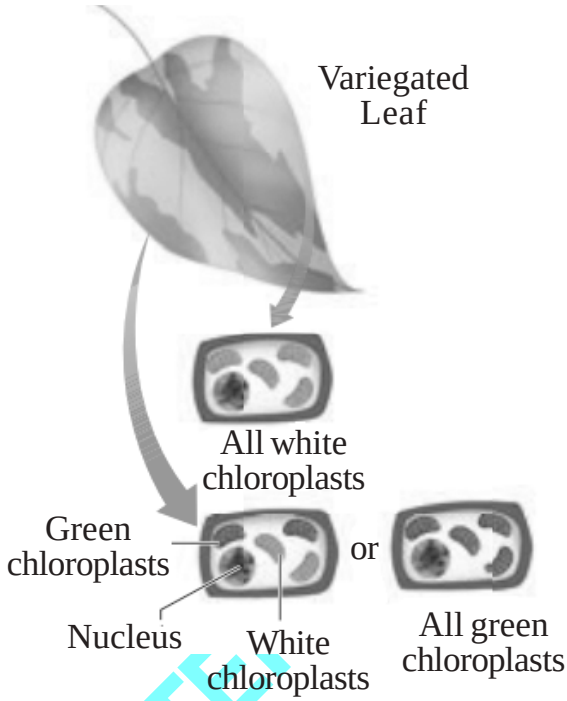


Fig. A cellular explanation of the variegated phenotype of leaves in Mirabilis jalapa.

- But in **this reciprocal cross,** both the F_1 generations are **not same but different.**
- F_1 plant *has the* character *of* ***female parent plant.***
- It is due to the **chloroplast gene** found in the **ovum** of the female plant.
- The **female gamete** contributes **cytoplasm** during **fertilization.**
- The **male gamete** contributes only **nucleus** and not cytoplasm.

Pale green leaved plant (Male)	x	Dark green leaved plant (Female)	→ F_1 Dark green leaved
Dark green leaved plant (Male)	x	Pale green leaved plant (Female)	→ F_1 Pale green leaved

Fig. Chloroplast inheritance.

3 Chromosomal Basis of Inheritance

Book Back Solved Questions - 1 Mark

Choose the Correct Answer

1. An allohexaploidy contains
a) Six different genomes
b) Six copies of three different genomes
c) Two copies of three different genomes
d) Six copies of one genome

2. The A and B genes are 10 cM apart on a chromosome. If an AB/ab heterozygote is testcrossed to ab/ab, how many of each progeny class would you expect out of 100 total progenies?
a) 25 AB, 25 ab, 25 Ab, 25 aB
b) 10 AB, 10 ab
c) 45 AB, 45 ab
d) 45 AB, 45 ab, 5 Ab, 5aB

3. Which of the following sentences are correct?
a. The offspring exhibit only parental combinations due to incomplete linkage
b. The linked genes exhibit some crossing over in complete linkage
c. The separation of two linked genes are possible in incomplete linkage
d. Crossing over is absent in complete linkage
a) 1 and 2 *b) 2 and 3*
c) 3 and 4 *d) 1 and 4*

4. Match list I with list II

List I	List II
A. A pair of chromosomes extra with diploid	i) monosomy
B. One chromosome extra to the diploid	ii) tetrasomy
C. One chromosome loses from diploid	iii) trisomy
D. Two individual chromosomes lose from diploid	iv) double monosomy

a) A - i, B - iii, C - ii, D - iv
b) A - ii, B - iii, C - iv, D - i
c) A - ii, B - iii, C - i, D - iv
d) A - iii, B - ii, C - i, D - iv

5. Accurate mapping of genes can be done by three point test cross because it increases
a) Possibility of single cross over
b) Possibility of double cross over
c) Possibility of multiple cross over

1. *c) Two copies of three different genomes*
2. *d) 45 AB, 45 ab, 5 Ab, 5aB*
3. *c) 3 and 4*
4. *c) A - ii, B - iii, C - i, D - iv*
5. *b) Possibility of double cross over*

d) Possibility of recombination frequency

6. Due to incomplete linkage in maize, the ratio of parental and recombinants are

a) 50:50 *b) 7:1:1:7*
c) 96.4: 3.6 *d) 1:7:7:1*

7. Genes **G S L H** are located on same chromosome. The recombination percentage between L and G is 15%, S and L is 50%, H and S are 20%. The correct order of genes is

a) GHSL b) SHGL c) SGHL d) HSLG

8. The point mutation sequence for transition, transition, transversion and transversion in DNA are

a) A to T, T to A, C to G and G to C
b) A to G, C to T, C to G and T to A
c) C to G, A to G, T to A and G to A
d) G to C, A to T, T to A and C to G

9. If haploid number in a cell is 18. The double monosomic and trisomic number will be

a) 35 and 37 *b) 34 and 35*
c) 37 and 35 *d) 17 and 19*

10. Changing the codon AGC to AGA represents

a) Missense mutation
b) Nonsense mutation
c) Frameshift mutation
d) Deletion mutation

11. Assertion (A): Gamma rays are generally used to induce mutation in wheat varieties.

Reason (R): Because they carry lower energy to non-ionize electrons from atom

a) A is correct. R is correct explanation of A
b) A is correct. R is not correct explanation of A
c) A is correct. R is wrong explanation of A
d) A and R is wrong

12. How many map units separate two alleles A and B if the recombination frequency is 0.09?

a) 900 cM *b) 90 cM*
c) 9 cM *d) 0.9* cM

Book Back Solved Questions - 2 Marks

1. What is the difference between missense and nonsense mutation.

Missense Mutation	Nonsense Mutation
1. Codon for **one amino acid** is changed into a codon for **another amino acid.**	Codon for **one amino acid** is changed into a **termination** or **stop** codon.
2. New codon encodes a **different amino acid.**	New codon leads to **premature termination** of **translation.**

6. *c) 96.4: 3.6* 7. *c) SGHL*
8. *b) A to G, C to T, C to G and T to A*
9. (No answer) Correct ans: 34 and 38
10. *a) Missense mutation*
11. *(b and c)*
b) A is correct. R is not correct explanation of A and *c) A is correct. R is wrong explanation of A*
12. *c) 9 cM*

2. 

from the above figure, identify the type of mutation and explain it.

Types of Mutation

☛ Reverse tandem duplication.

Explanation

♣ It is a type of **duplication** or **repeat.**

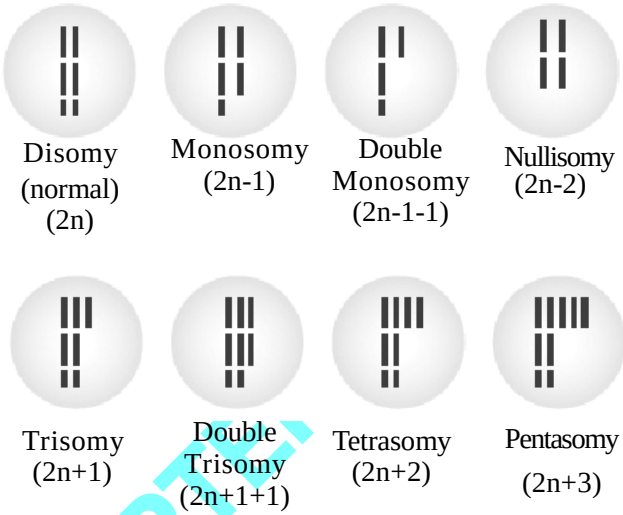
♣ It is a **structural chromosomal aberration,** that brings about changes in the **number** of **gene loci.**

♣ A **segment** in the chromosome is **duplicated.**

♣ The duplicated segment is **located immediately** after the normal segment.

♣ The **order** of the gene sequence is **reversed.**

3. Draw the diagram of different types of aneuploidy.



Book Back Solved Questions - 3 Marks

1. Write the salient features of Sutton and Boveri concept.

Sutton and Boveri independently proposed **chromosomal theory of inheritance.**

Salient Features

1. ♣ **Somatic cells** of organisms are derived from the **zygote** by repeated cell division (**mitosis**).

♣ These cells consist of **two identical** sets of chromosomes. One set is received from **female parent** and the other from **male parent.**

♣ These **two chromosomes** constitute the **homologous pair.**

2. Chromosomes retain their **structural uniqueness** and **individuality** throughout the life cycle of an organism.

3. Each chromosome carries **specific determiners** or **Mendelian factors** (genes).

4. **Genes** or **factors** are located on **chromosomes.**

2. What is gene mapping? Write its uses.

Gene Mapping

• *Diagrammatic representation of position of genes and related distances between the adjacent genes.*

• It is also called **linkage map** and **genetic mapping**

• It is **directly proportional** to the **frequency** of **recombination** between them.

Uses

1. To determine **gene order.**
2. To identify the **locus** of a **gene.**
3. To calculate the **distances** between genes.
4. To predict **results** of **dihybrid** and **trihybrid crosses.**
5. To understand the overall **genetic complexity** of particular organism.

Book Back Solved Questions - 5 Marks

1. When two different genes came from same parent, they tend to remain together.
(i) What is the name of this phenomenon?
(ii) Draw the cross with suitable example.
(iii) Write the observed phenotypic ratio.

(i) The name of the phenomenon is **linkage.** It is **coupling** or **cis configuration.**

(ii) • This phenomenon was observed in **sweet pea** (*Lathyrus odoratus).*

Alleles in coupling of cis configuration

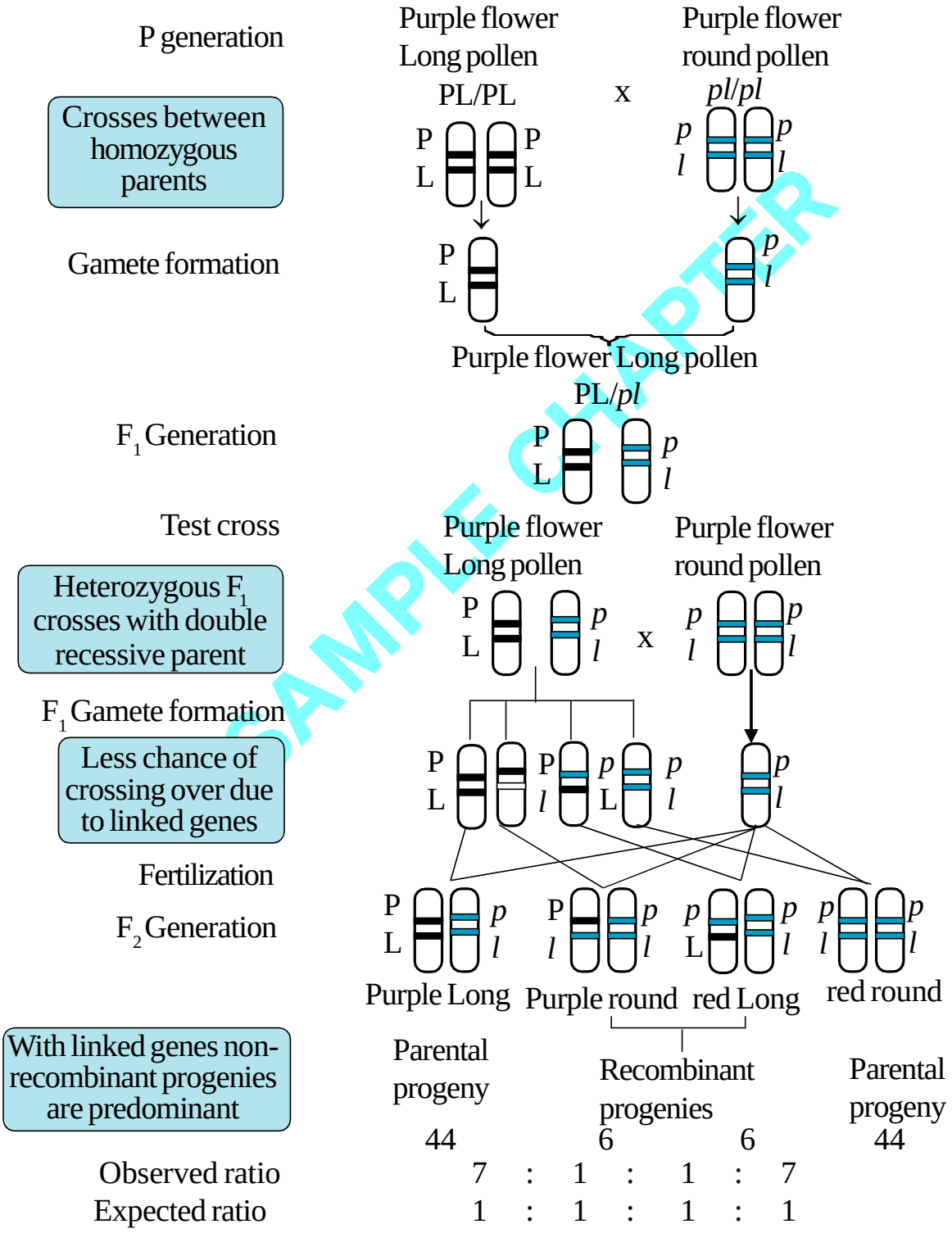


Fig. Coupling or cis configuration of linkage in sweet peas.

- This was reported by **William Bateson** and **Reginald C. Punnett.**

Experiment

1. William and Reginald crossed **one homozygous** strain of sweet pea having **purple flowers** and **long pollen grains** with another **homozygous** strain having **red flowers** and **round pollen grains.**

2. All **F_1 progenies** had **purple flower** and **long pollen grains.** This shows that **purple flower long pollen** was dominant over **red flower round pollen.**

3. They crossed the **F_1 progeny** with **double recessive parent** (red flower round pollen) - test cross.

4. In the **F_2 generation,** they did not get the expected **1:1:1:1** ratio as in **independent** assortment.

5. They got the **below result:**

- **Larger** proportion with **purple flowers** and **long pollen.**
- **Smaller** proportion with **red flowers** and **round pollen.**

6. They concluded that genes for **purple flower** and **long pollen** were **found close together.**

7. Similarly, genes for **red flower** and **round pollen** were found together.

8. These genes **do not assort independently.** They are referred to as **linkage.**

9. The two **dominant alleles** or **recessive alleles** are present in the **same homologous** chromosome. So, they **inherit** together into **same gamete.**

10. Thus, it shows **coupling** or **cis configuration of linkage.**

iii) Observed phenotypic ratio is,

Purple long	:	Purple round	:	Red long	:	Red round
7	:	1	:	1	:	7

2.

S.no	Gamete types	Number of progenies
1.	ABC	349
2.	Abc	114
3.	abc	124
4.	AbC	5
5.	aBc	4
6.	aBC	116
7.	ABc	128
8.	abc	360

i) What is the name of this test cross?

ii) How will you construct gene mapping from the above given data?

iii) Find out the correct order of genes.

(i) Three point test cross.

(ii) It is represented in the following table:

S.No	Gamete types	Number of Progenies	Recombinant for loci		
			A and B	A and C	B and C
1.	ABC	349	-	-	-
2.	Abc	114	R	R	-
3.	abC	124	-	R	R
4.	AbC	5	R	-	R
5.	aBc	4	R	-	R
6.	aBC	116	R	R	-
7.	ABc	128	-	R	R
8.	abc	360	-	-	-
	Total	1200	239	482	261

1. For **A and B loci,** the recombinants will be **Ab** and **aB.**

The number of recombinants = 114+5+4+116

= 239

$$\text{Recombinant frequency (RF)} = \frac{\text{Total number of recombinants}}{\text{Total number of progenies}} \times 100$$

$$= \frac{239}{1200} \times 100$$

RF = 19.9 %

2. For **A and C loci,** the recombinants will be **Ac** and **aC.**

The number of **recombinants** = 114 + 124 + 116 + 128

= 482

$$RF = \frac{482}{1200} \times 100$$

RF = 40.1 %

3. For **B and C loci,** the recombinants will be **Bc** and **bC.**

The number of **recombinants** = 124 + 5 + 4 + 128

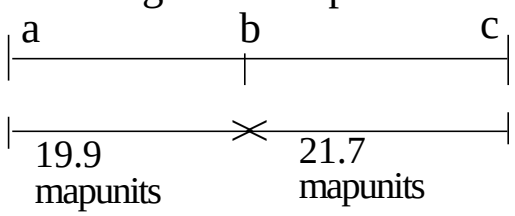
= 261

$$RF = \frac{261}{1200} \times 100$$

RF = 21.7 %

- All RFs are less than 50%.
- So, the loci are **linked.**
- A and C loci show **highest RF.**
- So, they are **for apart** from each other.
- B lies between **A and C.** The genes are **abc.**

- Hence genetic map is drawn as



(iii) The correct order of genes is **abc.**

3. If you cross dominant genotype PV/PV male Drosophila with double recessive female, you obtain F_1 hybrid. Now you cross F_1 male with double recessive female.

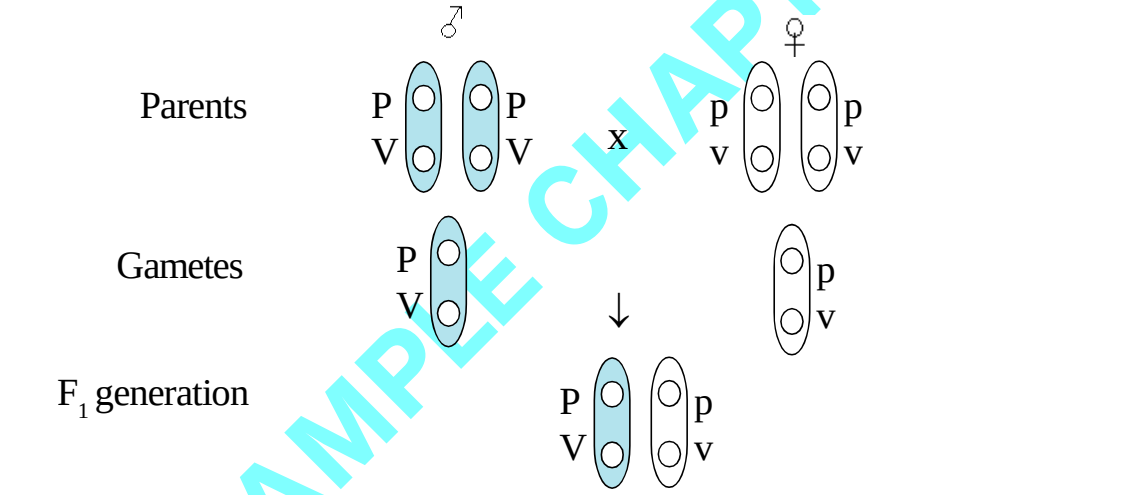
i) What type of linkage is seen?

ii) Draw the cross with correct genotype.

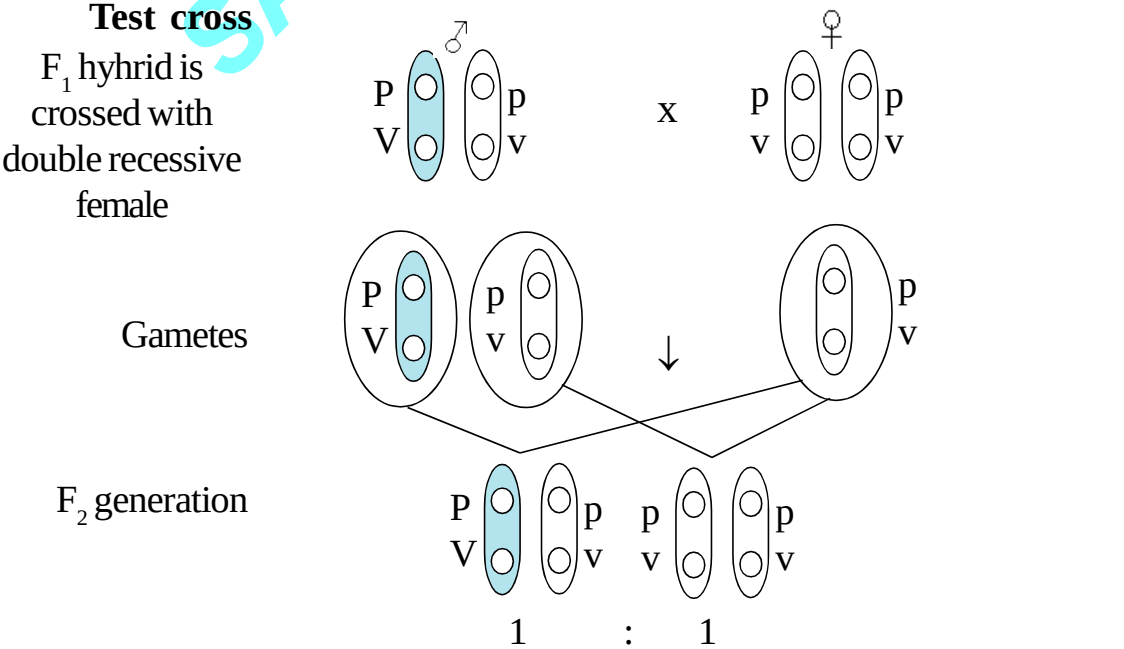
iii) What is the possible genotype in F_2 generation.

(i) **Complete linkage** is seen.

(ii)



Test cross



(iii) Possible genotype is **1PV/pv** and **1pv/pv.**

4. Explain the mechanism of crossing over.

Crossing over is the biological process that produces new combination of genes by interchanging the corresponding segments between non-sister chromatids of homologous pair of chromosomes.

It involves the following stages:

1. *Synapsis*
2. *Tetrad formation*
3. *Cross over*
4. *Terminalization*

1. Synapsis

- It is the **intimate pairing** between two **homologous chromosomes.**
- It is initiated during **zygotene stage** of **prophase I** of **meiosis I.**
- **Homologous chromosomes** are aligned side by side.
- It results in a pair of homologous chromosomes called **bivalents.**

2. Tetrad Formation

- Each homologous chromosome of a bivalent split to form two **identical sister chromatids.**
- These sister chromatids **remain together.**
- They are attached to the **centromere.**
- Each, bivalent has **four chromatids.** Hence, this stage is called **tetrad stage.**

3. Cross Over

- Crossing over occurs in **pachytene stage.**

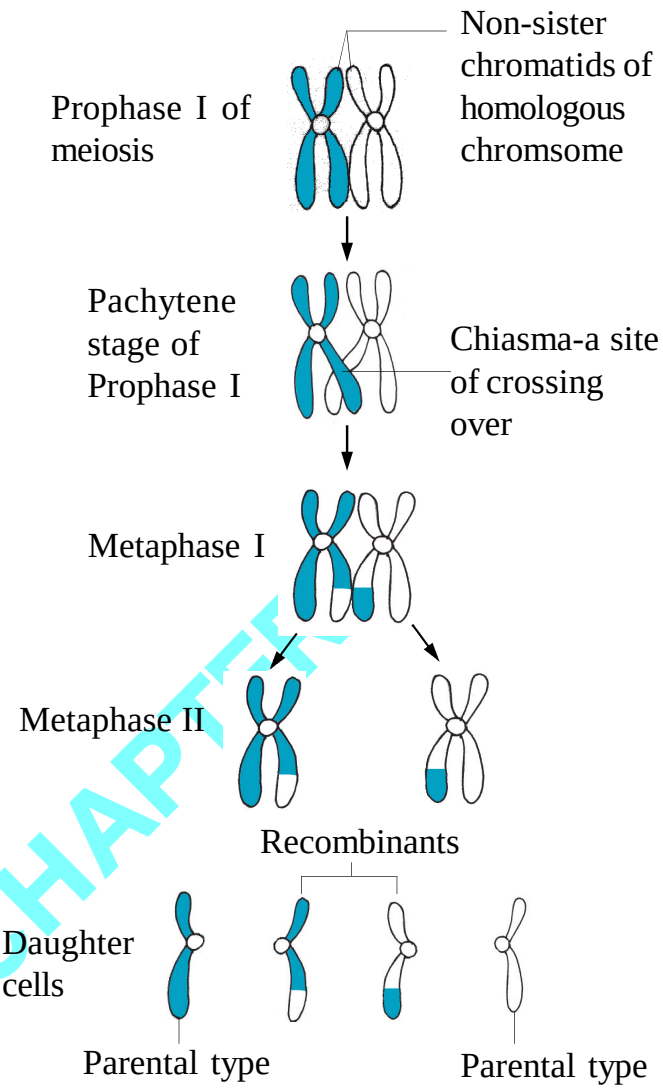


Fig. Mechanism of crossing over.

- **Non-sister chromatids** of homologous pair make contact at **one or more points.**
- These points are called **chiasmata.**
- **X-shaped** or **cross-shaped** structures are formed at **chiasmata.**
- **Breaking** and **rejoining** of two **chromatids** occur.
- This results in **reciprocal exchange** of **equal** and **corresponding segments** between them.

4. Terminalization

- After crossing over, **chiasma** moves towards the **terminal** end of chromatids.

a) 0.1 *b) 1*
c) 0.01 *d) 10*

49. Distance between two linked genes is measured in map units that depict ...
a) Ratio of crossing over between them
b) Cross over value
c) Number of genes between them
d) None of the above.

50. Sex determination in *Silene latifolia* is controlled by ..... in Y- chromosome
a) Three distinct regions
b) Four distinct regions
c) Five distinct regions
d) Two distinct regions

Additional Solved Questions - Two Marks

1. State chromosomal theory of inheritance.

- *Mendelian factors (genes) have* **specific locus** *on chromosomes.*
- *They* **carry information** *from one generation to the next generation.*

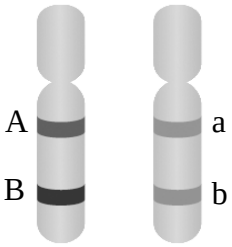
2. Define sex linkage.

Linked genes connected together on **sex chromosome** is called sex linkage.

3. What is meant by cis configuration?

- When two **dominant alleles** or **recessive alleles** occur in the **same homologous chromosome**, they tend to **inherit together** into **same gamete.**
- This is also called **coupling.**

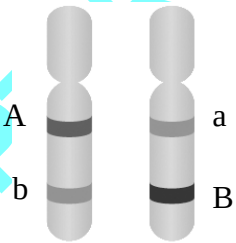
Cis AB/ab



4. What is meant by trans configuration?

- When **dominant** or **recessive** alleles are present on **two different,** but **homologous** chromosomes, they **inherit apart** into **different gametes.**
- It is also known as **repulsion.**

Trans Ab/aB



5. What are the types of linkages found by Morgan ?

1. *Complete linkage*
2. *Incomplete linkage*

6. On what basis did Morgan classify linkages.

Absence or presence of **new combination of linked genes.**

7. Define linkage groups.

Groups of **linearly** arranged **linked genes** on a chromosome.

8. Write about the linkage groups in organisms with examples.

In any species, the **number** of linkage groups corresponds to the number of **haploid set** of **chromosomes.**

49. (b) *Cross over value*
50. (a) *Three distinct regions*

Eg.

Organisms	Number of haploid set of chromosomes	Linkage groups
Mucor	*2*	*2*
Drosophila	*4*	*4*
Sweet pea	*7*	*7*
Neurospora	*7*	*7*
Maize	*10*	*10*

9. How to construct a gene map?

1. *The diagrammatic representation of position and distance of related genes on a chromosome.*
2. It is also known as ***linkage map***.
3. ***Recombinant frequency*** - (RF). It is calculated. It is given in ***map units.***
4. If the RF value is less than 50%, the genes are ***closer*** and are ***linked.***
5. If the RF value is more than 50%, the genes are ***apart*** and are ***not linked.***

10. Differentiate tetrasomy from tetraploidy.

	Tetrasomy	Tetraploidy
1.	Type of ***Aneuploidy***	1. Type of ***Euploidy***
2.	Addition of ***a pair*** of chromosomes to diploid set.	2. ***Four basic*** sets of chromosomes in an organism.
3.	Represented as ***2n+2.***	3. Represented as ***4x.***

11. Differentiate missense mutation from non sense mutation.

	Missense Mutation	Nonsense Mutation
1.	Codon for ***one amino acid*** is changed into a codon for ***another amino acid.***	1. Codon for ***one amino acid*** is changed into a ***termination*** or ***stop*** codon.
2.	New codon encodes a ***different amino acid.***	2. New codon leads to ***premature termination*** of ***translation.***

12. What is the biological process that takes place during pachytene stage of prophase I of meiosis? Define it. Write the important stages of this process.

Biological Process

Crossing over

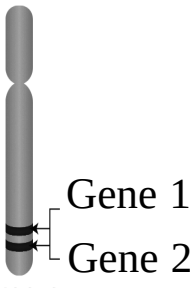
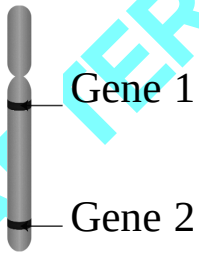
Definition

The process in which, **new combination** of **genes** *are produced by* **inter-changing** *the corresponding segments between* **non-sister chromatids** *of* **homologous pair of chromosomes.**

Stages in Crossing Over

1. *Synapsis*
2. *Tetrad formation*
3. *Cross over*
4. *Terminalization*

13. Differentiate linked genes from syntenic genes.

Linked Genes	Syntenic Genes
1. The genes are located **close together** on the same chromosome.	The genes are **far apart** on the same chromosome. Hence, called **unlinked genes.**
2. The genes are **inherited together.**	The genes are **not** inherited together.
3. Recombination frequency value is **less than 50%.**	Recombination frequency value is **more than 50%.**
4. They show **strong linkage.**	They show **weak** linkage.
5. 	

14. What are the two types of crossing over based on the site of occurrence? Write their differences.

Types of Crossing Over

1. *Germinal crossing over*
2. *Somatic crossing over*

Differences

Germinal Crossing Over	Somatic Crossing Over
1. It occurs in the **germinal cells.**	It occurs in **somatic cells.**
2. It occurs during **meiosis.**	It occurs during **mitosis.**
3. It occurs **usually** and has **universal.**	It occurs **rarely.**
4. It is also called **meiotic crossing over**	It is also called **mitotic crossing over.**

15. What is meant by bivalents?

Homologous chromosomes are aligned **side by side** and result in a **pair** of **homologous chromosomes** are called bivalents.

16. Explain the second stage in crossing over.

- **Tetrad formation** is the second stage.
- Each **homologous chromosome** of a bivalent split to form **two identical sister chromatids.**

- These sister chromatids are held together by a **centromere.**
- Each bivalent will have **four chromatids.**

14. Define chiasmata and explain what happens at chiasmata during crossing over.

Chiasmata

- Chiasmata are **points of contact** between **non-sister chromatids** of **homologous chromosomes.**

Changes occurring at Chiasmata

- **Cross-shaped** or **X-shaped** structures are formed.
- **Breaking** and **rejoining** of two chromatids.
- **Reciprocal** exchange of **equal** and **corresponding** segments between them.

15. Define synaptonemal complex (SC).

1. A **highly organised** structure of **chromatids.**
2. It is formed in the region of chiasma.
3. It facilitates **synapsis** *and* **chiasma formation.**

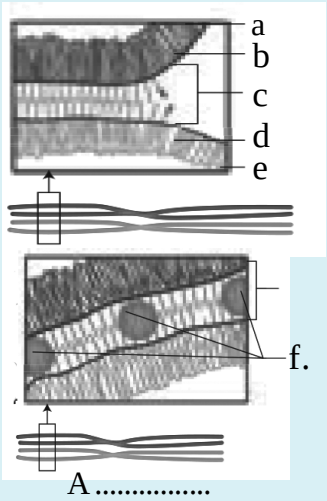
16. What is the contribution of Montgomery to the historical development of chromosome theory.

1. He first suggested the occurrence of **distinct pairs** of **chromosomes.**
2. He concluded that **maternal chromosomes** pair with **paternal chromosomes** only during **meiosis.**

17. Define recombinants.

- *Organism in which* ***new combination*** *of* ***characters*** *are formed due to* ***crossing over.***
- Organism produced by **genetic manipulation** in **rDNA technology.**

18. Identify the given diagram A and label the parts marked as a,b,c,d,e and f.



Ans: A - Structure of Synaptonemal complex

a. Sister chromatid 1
b. Sister chromatid 2
c. Synaptonemal complex
d. Sister chromatid 3
e. Sister chromatid 4
f. Recombination nodules

19. Which is the widely accepted model of DNA recombination?

- **Holliday's hybrid DNA model** is the widely accepted model.
- This model was proposed by **Robin Holliday** in 1964.

20. Define recombination frequency.

The **percentage** of **recombinant progeny** in a cross.

Recombinant frequency (RF) = $\frac{\text{Number of recombinants}}{\text{Number of offsprings}} \times 100$

21. What is meant by map unit?

- A map unit (m.u) is the **unit of distance** in a **genetic map.**
- One map unit is equivalent to **one percent** of **crossing over.**

22. What are multiple alleles?

Three or **more allelic** forms of a gene occupying the **same locus** in a given pair of **homologous chromosomes** are called multiple alleles.

23. What is meant by self-incompatibility?

- Self incompatibility means, the **pollens** from a plant are **unable** to **germinate** on its **own stigma.**
- It cannot bring about **fertilization** in the ovules of the **same plant.**
- It is also known as **self-sterility.**

24. Write the characteristics of sexually monomorphic plants?

Plants with following characters are said to be sexually monomorphic.

1. Monomorphic plants produce a **single type** of flowers.
2. **Both sex organs** are present in the **same flower** and **plant.**
3. N**o separate** male and female plants.
4. **94%** of flowering plants are **monomorphic.** Eg. *Hibiscus.*

25. What are dimorphic plants?

1. Dimorphic plants produce **two types** of flowers.
2. They have **separate male and female plants**.
3. **Male** plants produce flowers with only **stamens.**
4. Female plants produce flowers with **only carpels.**
5. The flower may contain either **androecium** or **gynoecium.**
6. **6%** of flowering plants are **dimorphic.** Eg. *Papaya.*

26. How can sex be determined in plants?

Sex can be determined in plants based on the following:

1. *Genes*
2. *Environment*
3. *Hormones*

27. How is sex determination in *Silence latifolia* controlled?

1. *Silence latifolia* is a **dioecious plant** where **male** and **female** plants are **separate.**
2. Sex is determined by **XY system.**
   Females have **XX**
   Males have **XY**
3. X chromosome plays an essential role in **reproductive development** and **embryogenesis.**
4. **Y chromosome** plays a major role in **sex determination.**
5. Y chromosome has **three sex determining regions**, namely:
   - A **female suppressor** region.
   - An **early stamen** development region.
   - A **late stamen** development region.
6. **None** of these regions are necessary for development of **female reproductive** organs.