Chapter-22 Inheritance

Q1 Differentiate b/w Genetics, inheritance & variation.

Answer : 1- Genetics :

Definition :- The branch of biology which deals with the study of inheritance and variation is called genetics.

History of genetics :

The word genetics was 1st time used by W. Betensin in 1906. where as G. Mendel discovered fundamental mechanism of inheritance and was thus considered as father of genetics.

2: Inheritance : (Heredity) -

Definition :- It is the process by which characters are transmitted from parents to offsprings.

Explanation :- Each cell in our body contains characters making molecules called DNA or genes. such molecules or chemicals produce a particular protein which make a character Such molecules (DNA, genes) are transfer from parents to offsprings to transfer a particular character.

3: Variation :

Definition :- Difference among the offsprings are called variation. -OR- The differences in individuals of the same species are called variation.

For example :- We see in our daily life that no two individuals of a species are not exactly similar even the

twins. This difference many be in height, skin, colour or intelligence. It is called variation.

Q2 write a short Life history of Mendels and his work.

Answer: History of Mendel:

Life span :- Mendel was born on july 22, year 1822 in Czech Repubic and died on 6th january 1884 in Brunn.

Monk :- Mendel was an austrain monk.

Father of genetics :- For his valuable work in genetics, mendel is ragarded as the father of genetics. He was the pioneer of classical geneticists. His experimental work become the basis of modern heredity theory. ← (ETEA-2007)

Experimental work on pea plant :

1: In 1854, mendel started working on garden peas.

2: He took 34-strains of garden peas.

3: He had cultivated about 28000 pea plants and prepare their pure-breed on the basis of 7-pairs of charasteristics.

4: From 1856 to 1866, Mendel performed a series of experi; by crossing different pure breeds in a variety of patterns and explained the mechanism of inheritance of parental characteristics to their offsprings.

5: Mendel presented his work in Brunn society for the study of natural science and delivered his first lecture on pea expesiments in the year 1865. He published his

paper — Experiments on plants hybridization in the year 1866.

6: He established certain laws of genetics which we know that they are true to plants and animals.

7: But unfortunatly his work made no impression or — neglected for the next 34 years due to following reasons.

Reasons for neglection of mendel work:

1: Darwin's theory :- Biologists were pre-occupied with Darwins theory of evolution which appeared in the year 1859

2: journal :- The journal in which mendel published his work was unorganized and not properly known to people.

3: statistical analysis :- The scientists of easly times were not familiar with the statistical analysis of experimental data presented by mendel.

Rediscovery of mendel work :- Later on, in 1900, three — botanists — Corren, De Varies and Tschermach rediscovered mendel's work independently.

Q3 why pea was the most suitable plant for mendels exp;

Answer: Reason for pea plant selection:

The main reasons for the selection of pea plants were as follows.

1: Easy to cultivate and easily handled.

2: Flowers are hermaphrodite (having male and female part).

3: It is normally a self fertilization plant but cross — fertilization (or pollination) can be easy made.

4: Time gap between the generations raising is short.
5: pea plant has very sharply distinct traits (characters) with two clear cut alternate and contrasting pair forms or alleles.
6: Numerous varieties are available.
7: These plants produced a large number of seeds.
8: They have prominent inherited characteristics.
9: It is easy to study their flower structure because - they do not have very complicated characters such as- gene interaction and incomplete dominance.

Q4 Discuss the seven characters studied by Mendel in pea plt

Answer: Seven characters in pea plants:

Mendel studied seven different characters in pea plant, in which each character have dominant and recessive form.

Dominant character :-

Those characters which appear in the offsprings of F_1 — generation are called dominant characters.

Recessive character :- Those characters which do not appear in the offsprings of F_1-generation are called recessive characters

Hybrids :- The F_1-offspring that result from two parents with different characteristics are called hybrids.

For example :- The following chart clearly shows the — dominant and recessive characters.

	Characters	Dominant	Recessive
1	Seed shape	Round	Wrinkled
2	Seed colour	Yellow	Green
3	Flower Colour	Violet	White
4	Pod shape	Full	Constricted
5	Pod Colour	Green	Yellow
6	Flower Position	Axial	Terminal
7	Stem height	Tall	Dwarf

Seven Characters in Pea studied by Mendel

Common terms used in genetics

(ETEA- 2005, 2007, 2011, 2012, 2014, 2020)

1: parental plants: <P_1-generation> These are the original pure breed which are used in a cross. It is homozygous breed.

2: Hybridization :- It is the process in which two different characteristics are combined together.

3: Hybrid :- The product <e.g F_1 generation> which is obtained by hybridization is called hybrid.

4: pure or true breed :- pure or ture breed are homozygous breed and are collected by self-pollination and the offspring of the self pollinating plant are of same variety.

5: Trait :- Trait is a character which is developed by a gene.

6: Gene :- Genes are sequence of nucleotides on DNA which are responsible for the expression <controlling> of any

character in the organism. Gene was named first of all by Jahannson in 1909.

7: Alleles :- The alternative form of a gene which occupies the same chromosome locus in pair form (one from mother and one from father) but showing contrasting characters.

8: Locus:- The position of alleles on homologous chromosome is called locus.

9: Dominant :- A strong trait or character which appear in F_1-generation (or hybrid) is called dominant.

10: Recessive :- It is a weak character which does not appear in the presence of a dominant one.

11: phenotype :- The character of a living organism which is visible or outlook of any trait is called phenotype.

12: Genotype :- The genetic makeup of any trait in an organism is called as genotype.

13: Genotypic ratio :- The genotypic ratio describes the No of times a genotype would appear in the offspring after a cross.

14: Homozygous :- An organism having a pair of identical alleles for a character or trait is known as homozygous. (TT)

15: Heterozygous :- an organism having two different alleles for a character or trait is called heterozygous i.e Tt.

16: Filial generation : (F_1, F_2-generation) The generation which is obtained as a result of a cross between two parents is called Filial (F_1, F_2)-generation.

17: Test cross :- cross between F_1-heterozygous generation

and its homozygous recessive parental generation is called Test cross. It is used to test whether an individual is - homozygous (pure) or heterozygous (hybrid) of F_1-generation

18: **Back cross :-** cross between F_1-heterozygous and any one of parental breed (i.e-homozygous dominant or - homozygous recessive) is called back cross.

19:- **Reciprocal cross :-** cross between different strains with the sex reversed is called reciprocal cross.

Q5 Explain the Mendel's inheritance of single trait.

Answer: Inheritance of single trait:

In Mendel hybridization or crosses experiments, first he studied the inheritance of single trait i.e- how a character is transferred from parents to their offsprings. In first experiment in which mendel studied inheritance of a single trait is called monohybrid cross.

Monohybrid cross:

Definition :- The cross between two parental breeds which are different only by a single trait (character) is called - monohybrid cross.

Example :- The cross between round seed homozygous (RR) with wrinkled seed homozygous (rr) pea plant.

Explanation of example: (ETEA-2019)

1: Mendel crossed true breeding round seed pea plant

with true breeding wrinkled seed pea plant. He called this parental generation denoted 'P'.

2: All the offsprings obtained in the next generation were round seed plant. He called this first Filial generation denoted by 'F_1'.

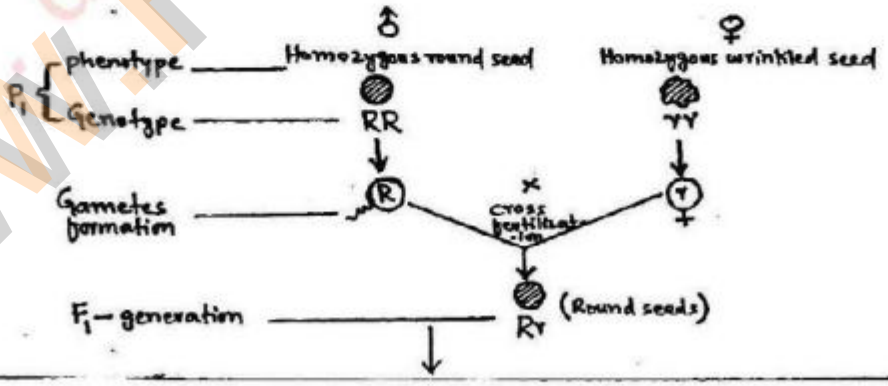
3: In F_1-generation the gene (allele) of the round seed plant express itself and was called dominant. while the gene of wrinkled seed could not express itself and was called Recessive.

4: Now the F_1-plants were self-fertilized (pollinated) and second Filial generation (F_2) was produced.

5: In F_2-generation, some plants were round seed plants like the original parental plant and some were wrinkled seed plants like the original parental plant in the ratio of 3:1 or 75% : 25% ← (ETEA-2013)

Diagrammatic presentation of monohybride cross:

IF Round seed plants respresented by 'RR' and wrinkled seed plants by 'rr' then the cross can be shown as—



F_2-generation = F_1 ♂ × F_1 ♀ — (Self fertilization)

Genotype — Rr Rr

Gametes — (R) (r) (R) (r)

Checker board = F_2

♀ \ ♂	(R)	(r)
(R)	RR Round	Rr Round
(r)	Rr Round	rr wrinkled

Summary chart = (F_2).

①-phenotypic ratio = 3 (round) : 1 (wrinkled) -OR- 75% : 25%

②- Genotypic ratio = 1 (pure round) : 2 (hybrid round) : 1 (wrinkled)

Q6 Explain the Mendel's predication.

Answer :. Mendel's predication :

Introduction :- Mendel predicated some visualizations from his own work on pea plant. Although he does not know about the genes but he indirectly predicated the reducation in chromosome number as occur in meiosis. still cytology branch was in primitive state — not well develop at that time.

Explanation :-

1: According to mendel, each male and female parent passed only one factor of a pair to their offspring.

2: likewise each factor retained its individuality from — generation to generation and does not mix with another.

3: Later on in future mendalian-factor's was called as genes by Johennson in 1909. ←(ETEA-2010)

Q7 Explain the Mendel's principles of inheritance

Answer: Mendel's principles of inheritance:

Although mendel by itself did not publish any law or principles in its own time. But the rediscovery of mendel experimental work demostrate the following 3-principles of inheritance.

1: law of Dominance.
2: law of segregation.
3: law of independent assortment.

Law of Dominance or segregation is develop due to mono-hybrid cross while law of independent assortment is develop due to dihybrid cross.

Symbols used to represent Mendel's laws:

1: Classical method of symbolism:- In classical methods of symboling dominant allele for a character is represented by capital Letter while recessive allele is represent by small Letter.

For example:- Allele for Tall character is represented by 'TT' while allele for dwarf (short) character is represented by 'tt'.

2: modified method:- In case of modified method the capital-'A' is used for normal allele while small-'a' is used for recessive allele in certain cases.

For example :- The condition of albinism (white) is due to - lack of black pigment in skin, hair, which occur due to recessive allele in homozygous condition (aa).

3: Method for wild organism :- This method is commonly used for wild organism. most occuring phenotype in such organism is called wild type represented by '+' sign and rarly occuring phenotype in such organism is called as mutant type - represented by '—' sign.

For example :- Red eye colour of wild type fruit fly - represented by w^+w^+ while white colour of mutant type fruit fly represented by w^-w^-.

1: Law of Dominance :

Statment :- This law states that one allele of a gene pair is always dominant over the other allele of the same gene pair.

Explanation :- According to this law of mendel each and every character is control by units called as genes(factors) which occurs in pairs. according to law of dominance one member of pair will be dominant over other member.

Example :

1- In 'Tt' pair, T is dominant over 't'.

2- In 'Rr' pair, R is dominant over 'r'.

3- In 'Yy' pair, Y is dominant over 'y'.

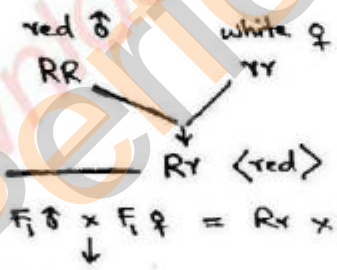
2: Law of segregation :- (Law of purity of gametes)

Statment :- This law states that genes exist in pairs, each

member (allele) of pair segregate or separate from other member (allele) of its pair during gamete formation without any affect.

Explanation :- This law is also called as law of purity of gametes in a heterozygous because both dominant and recessive alleles remains together without mixing with each other in F_1-generation and then these alleles separate during gamete formation in F_2-generation, so that each gamete receives only one allele, either dominant or recessive.

Example :- The dominant allele -'R' and recessive allele -'r' remains together in F_1-generation (hybrid) without mixing and the segregation of allele -'R' and allele -'r' from each other occur during gametogenesis of F_2-generation. i.e -



F_2 =

	R	r
R	RR red	Rr red
r	Rr red	rr white

phenotypic ratio = red : white = 3 : 1 (F_2)

Q8 Explain the inheritance of two traits.

Answer: **Inheritance of two trait :-** After the inheritance of single trait, next mendel decided to study inheritance of

two traits (characters) in a cross. For this purpose mendel performed dihybrid-crosses on pea plants and discovered a fundamental law of genetics called the law of independent assortment. Mendel began his experiments by first crossing two homozygous parental organisms which was different with respect of two character (traits). ←(ETEA-2006)

Dihybrid cross :

Definition :- The cross between two parental breeds which are different in two characters (traits) is called dihybrid cross.

Example :- In dihybrid cross mendel crossed a homozygous round and yellow seed pea plant with a homozygous wrinkled and green seed pea plant.

Explanation of example:

1: Mendel crossed true breeding round-yellow seeded plants with true breeding wrinkled-green seeded plants. He called this parental generation denoted by 'P'.

2: All the plant of the next generation produce seeds which were round and yellow. He called this first Filial-generation denoted by 'F_1'.

3: In F_1-generation the gene of round and yellow traits express itself and were called dominant, while the genes of wrinkled and green traits could not express itself and were called recessive.

4: Now the F_1-plants were self-fertilized and a second-

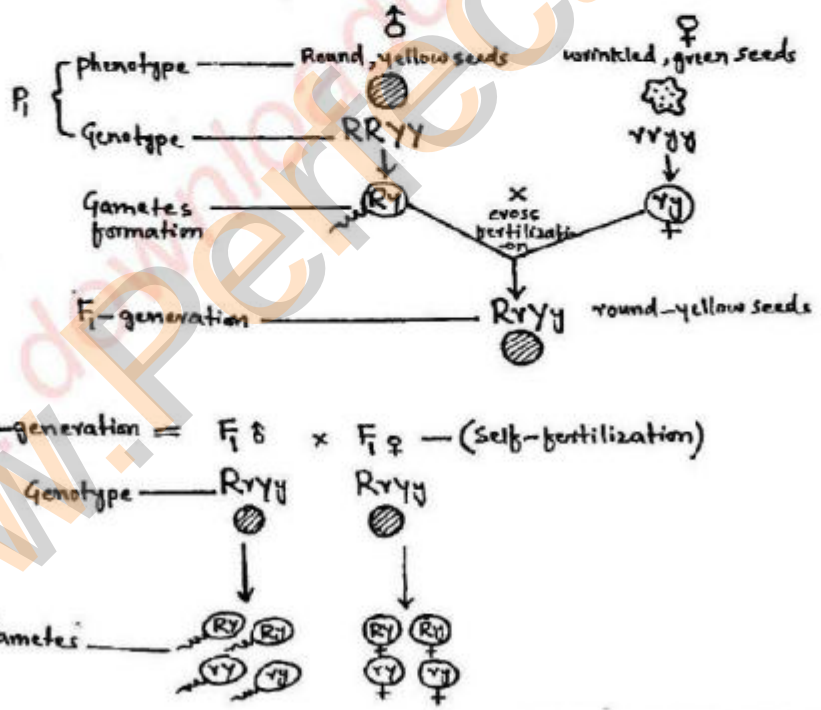
Filial-generation (F_2) was produced.

5: In F_2-generation the plants were of four types i.e- Round-yellow, Round-green, wrinkled-yellow and wrinkled-green in the ratio of 9:3:3:1.

Independent assortment of alleles :- Formation of two new combinations (phenotypes) indicated some sort of shuffing of alleles occured during gametes formation. Mendel called this shuffing as independent assortment of alleles.

Diagrammatic presentation of dihybride cross :

IF "R, Y, r, y" respresents - Round, yellow, wrinkled and green respectively, then the cross can be shown as -



Checker board: (F_2)

♀ \ ♂	RY	Ry	rY	ry
RY	RRYY round yellow	RRYy round yellow	RrYY round yellow	RrYy round yellow
Ry	RRYy round yellow	RRyy round green	RrYy round yellow	Rryy round green
rY	RrYY round yellow	RrYy Round yellow	rrYY wrinkled yellow	rrYy wrinkled yellow
ry	RrYy round yellow	Rryy round green	rrYy wrinkled yellow	rryy wrinkled green

Summary chart: (F_2) ←(ETEA-2012)

①- phenotypic ratio = 9 (round-yellow) : 3 (round-green) : 3 (wrinkled-yellow) : 1 (wrinkled green).

②- Genotypic ratio = 4:2:2:2:2:1:1:1:1

Conclusion :- From 2nd law of inheritance, Mendel concluded that the pairs of traits in the parental generation assorted independently from one another, from one generation to the next generation.

Q9 Describe the law of independent assortment.

Answer: Law of independent assortment: (ETEA-2020)

Statment :- This law states that when two contrasting pairs of traits are brought together in the same cross, the distribution of alleles for one trait in the gametes does not effect the distribution of the alleles for the other trait.

Explanation :- For study of independent assortment of genes Mendel was performed dihybrid cross. During -

F_2-generation of dihybrid cross alleles are separated from each other in such a way that each one allele is — independent of its fellow gene on the same chromosome. Thus, as a result of independent assortment of alleles, new phenotypes arise which are different from the parental plants.

For example:-

1: In humans diploid cells have 46-chromosomes with 23-chromosomes inherited from mother and 23-chromosomes from father.
2: pair of these similar chromosomes are called Homologous chromosomes.
3: During meiosis these 23-pairs of chromosomes again — segregate and assort randomly to gametes (n).
4: This means that all of mother chromosomes will not be separated to one cell and fatemal to other cell.
5: Instead after meiosis each haploid cells actually contain mixture of genes from father and mother of organisms.

Q10 write the scope of independent assortment in variation.

Ans: Scope of independent assortment in variation:

1: Independent assortment helps in recombination during meiosis.
2: Recombination produces new combination of genes.
3: Recombination ensures that genes assort indenpendently from one another.
4: This independent distribution of alleles during their —

inheritance to next generation produces variation in incoming progeny.

Exception :- certain genes which are located very close to one another on the same chromosome, called Linked genes, are not assort independently from one another is an exception to the law of independent assortment.

Q11 Explain the statistics and probability relevant to genetics.

Answer :- Statistics and probability Relevant to genetics :

There are two basic rules to solve genetics problems i.e-

1: Rule of multiplication : <product rule>

Rule of multiplication is also called product rule. According to this rule — "probability will occurs simultaneously is the product of their individual probabilities."

Example :- Let a heterozygous flower (Pp). what will be the probability of homozygous recessive offspring. ?

Solution :-

1- probability of egg (with recessive allele-p) = $\frac{1}{2}$

2- probability of sperm (with recessive allele-p) = $\frac{1}{2}$

overall probability = $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$ (25%)

i.e-

	P	p
P	PP 25%	Pp 25%
p	Pp 25%	pp 25% → (25%)

so $\frac{1}{4}$ chance is proved.

2: Rule of addition : This is also called "Sum rule".

According to this rule — "probability is the sum of separate

probabilities of various ways."

Example :- Let a heterozygous flower (Pp). what will the probability of heterozygous (Pp) offspring.

Solution :-

1- probability of egg (with dominant allele - P) = $\frac{1}{2}$

2- probability of sperm (with recessive allele - p) = $\frac{1}{2}$

Sum = $\frac{1}{2} + \frac{1}{2} = \frac{1}{4}$ — Equestion-①

3- probability of egg (with recessive allele - p) = $\frac{1}{2}$

4- probability of sperm (with dominant allele - P) = $\frac{1}{2}$

Sum = $\frac{1}{2} + \frac{1}{2} = \frac{1}{4}$ — Equestion-②

Now from Eq-① and Eq-② we have

$\frac{1}{4} + \frac{1}{4} = \frac{1}{2}$ - (50%)

i.e-

	P	p
P	PP	Pp
p	Pp	pp

50% Heterozygous or $\frac{1}{2}$

So $\frac{1}{2}$ chance is proved.

Statistical nature of inheritance :

Definition :- Statistics is a branch of mathematics deals - with the study of data-analysis in numerical form.

For example :- what will be the probability of white flowers from F_2-generation of a monohybride cross.

Solution :- we can proposed that there is 1/4 chance of white flower plants or 25% will have white flowers. i.e-

F_2 =

	P	p
P	PP purple	Pp purple
p	Pp purple	pp white

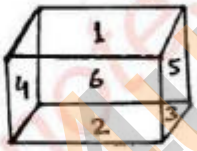
→ $\frac{1}{4}$ or 25% chance of white flower

Statistics and probability:

Statistics :- Statistics is a branch of mathematics which deals with the study of Data-analysis and interpretition.

probability :- Chance of an event to occurs is called probability.

Example :-



Heads / Heads + Tails $= \frac{1}{2}$

Tails / heads + Tails $= \frac{1}{2}$

probability $= \frac{1}{2} + \frac{1}{2} = 1$ for head or Tail.

or- product rule $= \frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$

Sum rule :- what will be probability that die will fall on spot-1 or 2 = ?

As - $\frac{1}{6} + \frac{1}{6} = \frac{1}{\cancel{6}_3} = \frac{1}{3}$ ✓

product rule : If die will fall on spot-1 and next - throw spot-2, so -

$\frac{1}{6} \times \frac{1}{6} = \frac{1}{36}$ ✓ as die has 6-sides.

Q12 Discuss the exceptions to Mendelian inheritance. -OR- what is dominance relation. write its different types.

Answer: Dominance relation:

Definition :- Dominance is a physiological effect of an allele over its partner allele on the same gene locus.

Explanation :- There are various ways in which alleles - interact with each other i.e- when two alleles are - interacting each other in such a way that one allele -

dominant over other allele completely or partially or 50% is called dominance.

Exceptions to Mendelian inheritance:

Definition:- when the heterozygous shows different dominance relation between two alleles other than Mendelian is known as exceptions to Mendelian inheritance.

Explanation:- Mendel had observed only one form of dominance relation called complete dominance, but Later on, many geneticists discovered many other dominating relation-ships which could not be explained by mendel complete-dominance. The inheritance of these dominating traits is called exceptions or non-mendelian inheritance.

Types of dominance relation:- Dominance relation may be-

1: complete dominance:

Definition:- Dominance in which one allele (dominant) - completely hidden the effect of other allele (recessive) is known as complete dominance.

Explanation:- In this type of dominance the information of a trait controlled by recessive allele is completely - ignored and hidden while the other dominant allele is - completely phenotypically expressed.

For example:1: The allele for round character i.e-R is completely dominant over the allele of wrinkled character i.e-r. so in the heterozygous condition (i.e-Rr) the round

character is completely expressed and hidden the wrinkled character.

2: purple flower colour is dominant over white colour.

3: Tallness is completely dominant over dwarfness.

4: yellow colour of pea seed is dominant over green colour.

2: Incomplete dominance: (ETEA-2008, 2013, 2017, 2020)

Definition:- Dominance in which one allele cannot completely hidden the effect of other allele is called incomplete dominance.

→ In this case the heterozygous individual has a phenotype which is intermediate between the phenotype of the homozygous individual.

Example:- A classic example incomplete dominance is found in flowering plant named—"Japanese 4 O' clock."

Explanation of example: (ETEA-2008)

1: Japanese Four O clock plant (Mirabilis Jalapa) produces two types of flowers, Red colour (RR) and white colour (rr).

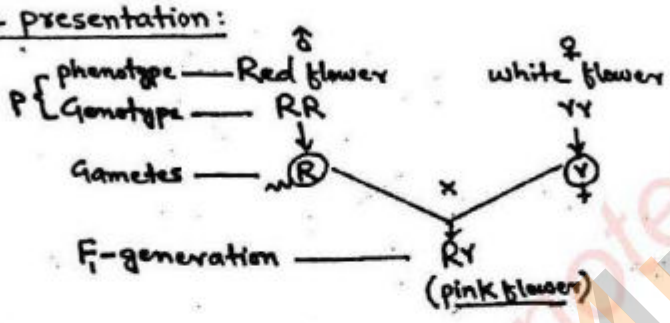
2: whenever a red colour variety is crossed with white colour variety, the F_1-offsprings will have pink colour (Rr), and pink is intermediate between Red and white colour.

3: when the F_1-plants were crossed with one another, the plants produced in the F_2-generation were—Red, pink and white in a ratio of 1:2:1.

Incomplete dominance:- when allele for Red (R) and allele for white (r) were presented together in the same plant (Rr) neither of them masked the effect of other, rather these-

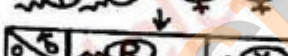
alleles showed incomplete dominance in the form of pink colour.

Graphic presentation:



F_2-generation = F_1♂ × F_1♀ — (self-fertilization)

Genotype — RY RY



Checker board:

♂ / ♀	R	Y
R	RR Red	RY pink
Y	RY pink	YY white

Summary chart:

Phenotypic ratio = 1-red flower : 2-pink-flower : 1-white flower

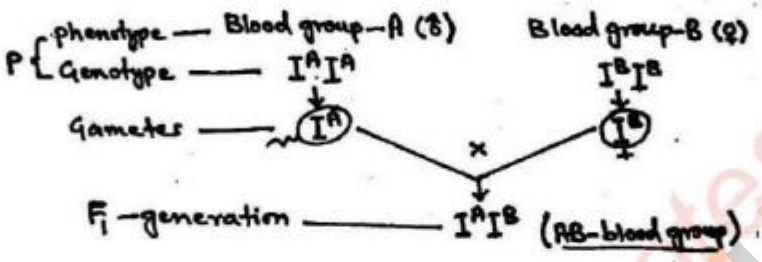
3: Co-dominance : (ETEA-2020)

Definition :- The dominance in which the heterozygous individual clearly shows the effect of both alleles is called co-dominance.

Explanation :- co-dominance occurs when both the alleles express independently in heterozygous. The co-dominant heterozygote would have both alleles which are equal express and produce mixed phenotype.

Example :- In case of blood group "AB" both antigen "A" and antigen "B" are expressed equally and the group is —

named as blood group 'AB'. i.e



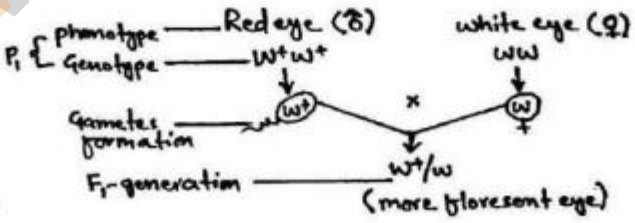
4: Over dominance: (ETEA-2016, 2018)

Definition:- Dominance in which phenotypic expression of heterozygous F_1-hybrid is more intense than pure parental homozygous breed is known as over dominance.

Explanation:- In over dominance, the F_1-heterozygous phenotype has exceeded <greater> expression from both the homozygous parents.

For example:- The example of over dominance in presence of fluoresence pigments in eyes of drosophila. In drosophila <fruit fly> the heterozygote has genotype <w^+w> which has more quantity floresence pigments in the eyes than wild red eye <w^+w^+> or white eye <ww> homozygous.

Graphic presentation:



Q13 write a short note on multiple alleles.

Answer: multiple alleles :

Allele :- Allele is the alternate form of a gene which code for one possible outcome of a phenotype.

Multiple allele : (ETEA-2005)

Introduction :- studing Mendalian laws we get the impression that genes occurs in two allelic forms only having dominant -recessive relationship to one another for two possible - phenotypes of one trait. But if there are four or more possible phenotypes for a particular trait, then more than two alleles for that trait must exist in the population. So such alleles that may exist in more than two different forms for a particular trait are called multiple alleles.

production of multiple allele:

Sometimes sudden change <mutation> can occur in the - chromosome or gene and due to this change many alleles are formed for a single gene called multiple alleles.

Explanation :-

multiple alleles occur at a single locus of chromosome and are responsible for making different phenotypic expression. Gene mutation produce different alleles of a gene. Some gene may have as many as 300- alleles. any two of these multiple alleles can be present in the genome of a diploid organism at a time because we inherit half of our -

genes (alleles) from mother and the other half from father, so we end up with two alleles for every trait in our phenotype. (ETEA-2017)

Example:- Blood groups of human are an excellent example of multiple alleles because blood groups are determined by a single gene with 3-possible alleles i.e- I^A, I^B, i.

Q14 Explain the phenotypic basis of ABO blood groups.

Answer: phenotypic basis of ABO blood groups:

Discovery:- Karl Landsteiner in 1901 discovered ABO blood group system in the process of trying to learn why blood transfusions sometimes cause death and at other times save a patient. In 1930, he received the nobel prize for his discovery of blood group.

Occurance:- ABO blood groups are found in all humans as well as other primates such as-apes, chimpanzees, gorillas.

Explanation:- Blood group is determined by the type of antigen (protein) present on the surface of the RBCs. an antigen is a substance which stimulates the production of antibodies. antibodies are immune system related proteins which fight against specific antigen.

phenotypic blood groups of ABO system:- ABO blood group system has 4-different phenotype blood groups i.e- A, B, AB, O. These four phenotypes are different from each other on the

basis of antigen (A or B) present on the surface of RBCs.

For example :-

1: Blood group-A :- if a person have antigen-A on their RBC surface so blood group of such person will be 'A'.

2: Blood group-B :- if a person have antigen-B on their RBC surface so blood group of such person will be 'B'.

3: Blood group AB : if a person have both antigen (A,B) on their RBC surface so blood group of such person will be 'AB'.

4: Blood group-O :- if a person have no antigen on their RBC surface so blood group of such person will be NiL (O).

Antibodies and blood transfusion : (ETEA-2012)

1: Blood group A antibody :- The blood serum of blood group-A contains antibody-B. They will agglutinate or clump the blood group with antigen-B on their RBCs.

Transfusion of blood group-A :- Blood group-A can be transfused only to a person with blood group-A or AB as they have no antibody-A.

2: Antibody of blood group-B :- The blood serum of blood group-B contains antibody-A. They will agglutinate or clump the blood group with antigen-A on their RBCs.

Transfusion of blood group-B :- Blood group-B can be transferred to a person with blood group-B or AB. as they have no antibody-B.

3: Antibody of blood group AB :- The blood serum of blood —

group-AB contains no antibodies therefore they will not agglutinate or clump the blood group with any type of antigen (A or B) on their RBCs surface.

Transfusion of blood group-AB:- In this case all types of blood group can be transfesred to a person with blood group 'AB'. That is why AB-blood group is called universal recipient.

4: Antibody of blood group-O:- The blood serum of blood group 'O' contains both antibody 'A, B' but has no antigens. They will agglutinated or clump blood with any type of antigen (A,B,AB)

Transfusion of blood group-O:- person with 'O'-blood group is called universal donor as their blood has no type of antigen.

ABO Blood group	Antigen (A,B)	Antibodies	Donors
A	A	Anti-B	A,O
B	B	Anti-A	B,O
AB	Both-A & B	None	A,B,AB,O
O	None	Both Anti-A, Anti-B	only-O

Q15 Explain the genetic basis of ABO blood group.

Answer:- Genetic basis of ABO-blood group:

Discovery:- This system was first explain by Bernstein in 1925.

Controlling gene:-(alleles) ABO-Blood group system is control by single polymorphic gene-I, which is present on chromosome No-9. This gene exists in three multiple alleles which produced through mutation. i.e.—

1: Allele $-I^A$, which specify the production of antigen-A.

2: Allele $-I^B$, which specify the production of antigen-B.

3: Allele $-i$, which does not specify any antigen production.

possible genotype :-

According to ABO-blood group system their are 4-phenotypes and six (6) possible genotypes as given in table.

phenotypes	Genotypes
A	I^AI^A, I^Ai
B	I^BI^B, I^Bi
AB	I^AI^B
O	ii
Total = 4	Total = 6

Dominance relation among alleles :

1: In ABO blood group system allele I^A and I^B is completely dominant over allele $-i$.

2: Whese as I^A and I^B are codominant to each other because each express equally (50%) in heterozygous state (I^AI^B) and produce AB-phenotype Blood group.

3: both I^AI^A and I^Ai will produce phenotype 'A'-blood group.

4: both I^BI^B and I^Bi will produce phenotype B-blood group.

5: while ii will produce O-blood group phenotypically.

ABO-blood group is genetically control :

The ABO-blood group alleles start expressing in early embryonic stage and keep on expressing throughout life. - therefore, blood group phenotype never changes during life.

Q16 write the different blood group system in human.

Answer :- Occurance of some other blood group system :

Introduction :- According to international society of blood

transfusion there are 30-major blood group systems are found in human. These different blood group systems are characterisitized by presence or absence of specific - molecules called antigens which are present on the surface of RBCs. most antigens are protein molecules.

Types of blood group system :-

Blood group system is classified into two group i.e-

1: Main blood group system :- In human there are two main blood group systems i.e- ABO-system and Rh-system. These two system of blood are more significan because - imcompatibility between donor and recipient blood with respect to these two blood system may become dangerous to life.

Example of main blood group system :

i- ABO blood group system :- In ABO blood group system the blood have 4-major groups or types i.e- A, B, AB, O.

ii- Rh blood group system :- In Rh blood group system the blood have two major group i.e- Rh positive and Rh negetive.

2: Rare blood group system :- There are more than 2-hundred minor blood groups other than ABO and Rh-System, but - these blood groups do not cause much complication during transfusion and are called as rare blood group system.

Example :-

Examples of rare blood group system are- MNS, P, Kell, Lewis, Lutheran, Duffy, Kidd, Diego, etc.

Q17 Explain Rh blood group system in detail.

Answer:- Rh blood group system:

Discovery :- This system was discovered by Karl land steiner in 1930 in Rhesus – monkey. It is also called Rhesus factor.

Phenotypic blood group of Rh-factor :- ABO blood group system is fusther differentiated by positive (+) and negative (–) sign. This positive and negative stand for the presence or absence of Rh-factor or antigen-D present on the surface of RBCs i.e.

1: positive blood group :- if a person have antigen-D on their RBCs-surface, the blood group of such person will be positive.

For example :- A^+, B^+, AB^+, O^+.

2: Negetive blood group :- If a person have no antigen-D on their RBCs-surface, the blood group of such person will be negetive

For example :- A^-, B^-, AB^-, O^-

Rh-antibody :- In Rh blood group system only the person which have Rh-negetive (–) will produce Rh-antibody which work against Rh-positive (+).

Universal recipient = AB^+
Universal donor = O^-

Blood transfusion in Rh-system :

1: Rh-positive blood group can be transferred their blood to Rh-positive recipient because both person have Rh-antigen but no Rh-antibodies.

2: Similarly Rh-negetive blood group can be given their blood to Rh-negetive blood group person because both have no Rh-antigens or antigen-D on RBC-surface.

3- IF an Rh-negative person receives Rh-positive blood, he will get Rh-antigens. so his blood will produce anti-Rh-body against Rh-antigens and it will result in coagulation.

4- But an Rh-positive person can receive Rh-negative blood because Rh-positive have no Rh-antibodies.

Genetic basis of Rh blood group system:

Controlling gene :-(alleles)- Rh blood group system is genetically controlled by 3-genes — C, D, E. among these gene-D is very important present on D-locus which produce D-antigens commonly called as Rh-factor.

Dominance relation among alleles:

Gene-D has two alleles i.e-'D' and 'd'. 'D'-allele is dominant over on allele-'d' in heterozygous condition.

1- A person having genotype-DD or Dd will be Rh-positive

2- A person having genotype-dd will be Rh-negetive.

Q 18 Discuss the Maternal foetal Rh incompatibility.

Answer: Maternal foetal Rh incompatibility:

Definition :- The rejection of foetal or embryo by the mothers antibodies due to Rh^+ baby within Rh^- mother in embryonic stage is called maternal-foetal Rh incompatability resulting in erythroblastosis fetalis.

Explanation:

1: This situation arise when mother is Rh^- and fetus is

Rh^+ due to his father. as a result the Rh^- mother produce antibodies against Rh^+ fetus when small amount of fetal blood cross the placenta and come in contact with her – Lymphocytes, usually in late pregnancy.

2: Howevers this problem is very rare in first baby because antibodies are not sufficiently produce for first time.

3: Howevers such incompatibility case will cause serious problems in incoming pregnancies because mother has already made memory cells against Rh antigen of first baby.

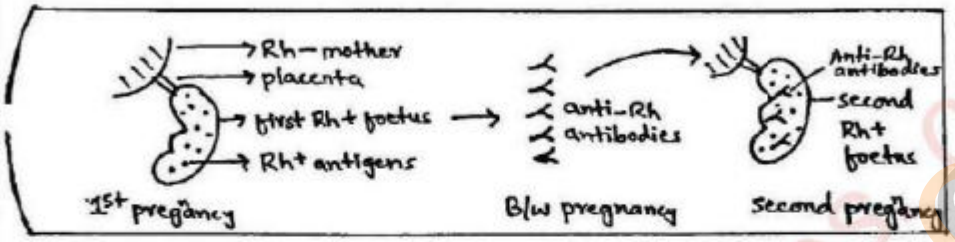
4: The already memorized immune system of mother will prepare antibodies and other immune cells against the blood of developing fetus (in second pregnancy and so on).

5: These Rh antibodies will cross the placenta and enter fetal circulation. inside fetus they start agglutination reaction with RBCs having Rh-antigen. as a result, the young or immature RBCs (called erythroblast cells) are destory.

6: This condition in which lots of erythroblasts of fetus are destory is known as Erythroblastosis fetalis.

Treatment :-

To avoid this risk, the mother should be injected with – anti-Rh antibodies (called Rhogam) after her Rh^+ baby. These anti-Rh antibodies will destory all the Rh^+ RBC which have entered into the mother's blood during the first – pregnancy. Now the mother is safe for future pregnancies.



Q19 what is gene interaction. explain epistasis with example.

Answer: Gene interaction:

Definition :- Gene interaction is the phenomenon where the effects of one gene is modified by one or several other genes.

Types of gene interaction :- It is two type i.e-

1: Allelic interaction :- The interaction between two alleles of same gene is known as allelic -interaction.

Example :- In mendelian experiment, the phenomenon of - dominance were gene interaction, between two contrasting - alleles of same gene or locus, is called allelic interaction.

2: Non-allelic interaction :- The interaction between two different genes or alleles present on different loci of same or different chromosome is called non allelic interaction.

Example :- In non allelic interaction, non local genes - interact in such a way to control a single phenotype. i.e-

Epistasis : (ETEA-2006)

Definition :- Epistasis is the type of gene interaction in - which one gene at one locus affects or control the - expression <action> of other gene at another locus.

Epistatic gene :- The gene which suppresses the action of another gene at another locus is called epistatic gene.

Hypostatic gene :- The gene which is suppressed by epistatic gene at another locus is called hypostatic gene.

Explanation :- when the effect caused by a gene at one locus interfers with or hides the effect caused by another gene at another locus such phenomenon of the gene interaction is called epistasis.

Epistasis Vs dominance :- Dominance is the relationship between alleles of the same gene present at the same locus while the epistasis is the interaction between different genes or alleles at different loci.

Example of epistasis :- (Bomby phenotype)

Definition :- A rare type of blood group which is phenotypically "O" but genotypically may be A, B, AB is called Bomby phenotype.

Discovery :- Bomby phenotype blood group was discovered for the first time in Bomby (now mumbai) in 1952 by Dr. Y.M. Bhende.

Ratio of Bomby phenotype :- Generally, The percentage of people with Bomby phenotype in the world is 0.0004% (4 per million) and 0.01% in mumbai local population (i.e- 1 in 10,000).

Explanation of Bomby phenotype :-

1: The expression of ABO blood group, which is produce by -

gene $-I^A, I^B, i$, depends upon the presence of another gene $-$ 'H' is called non-allelic interaction because ABO blood group gene is present on chromosome No-9 while gene-H is present on chromosome No-19.

2: The gene $-$H produces substance $-$H while gene $-I^A$ produces enzyme $-$A, which modifies the substance $-$H into antigen $-$A and displaying at RBC's surface, as a result phenotypically the blood group will be 'A'.

3: similarly, the gene $-I^B$ produce enzyme $-$B which modifies the substance $-$H (produce by gene $-$H) and displaying at RBCs surface as a result phenotypically the blood group will be 'B'. similarly for Blood group 'AB' are also conducted.

4: But remember that substance $-$H is produced by dominant 'H' allele with homozygous (HH) or heterozygous (Hh) genotypes and can't be produced by homozygous recessive (hh).

5: So, if a person is homozygous recessive (hh) for gene $-$H then they will not produce substance $-$H and antigen A,B can't be displayed at RBCs surface, as a result the person phenotypically be exhibiting blood group 'O'.

6: Now it is clear that, in the absence of substance $-$H the person will be phenotypically 'O' but genotypically A,B,AB, is known as bombay phenotype.

Blood sexum contains antibodies against specific antigen present of RBCs surface.

Antiserum is used to detected blood groups in Laboratories.

Activity No-1: <Text book page No-226>

Consider a child from a type AB-male and a type 'O' - female who are both heterozygous carriers of recessive 'h'-allele. what is the probability that this couple will have a type 'O' child? ←(ETEA-2011)

solution:

Male [AB] I^AI^B Hh

Female [O] ii Hh

Gamete — I^AH, I^Bh (male); iH, ih (female)

offsprings =

♂ \ ♀	I^AH	I^Bh
iH	I^Ai HH A-Blood gp	I^Bi Hh B-blood gp
ih	I^Ai Hh A-Blood gp	I^Bi hh O-blood gp

Probability:- ¼ or 25% chance of child have phenotypically 'O'-blood group due to homozygous alleles (hh), called bombay phenotype.

Q20 Differentiate b/w Qualitative and Quantative trait.

Answer: Qualitative Trait:

Definition:- The type of inheritance in which phenotype of a trait express according to the type of alleles present is called Qualitative trait.

Explanation:- Qualitative trait have a few phenotypes. They have clears and sharp differences among them. They show discontinuous variation.

Example of Qualitative trait :

1: Shape of seed in pea has two phenotypes – round and wrinkled.

2: Four O; clock flower colour has 3-phenotypes-red, pink, white.

3: Human blood group system has 4-phenotypes – A, B, AB and O.

2: Quantative trait :

Definition :- The type of inheritance in which phenotype of trait express according to the number of alleles present is called Quantative trait.

Explanation :- Quantative trait have many phenotypes from one extreme to another. They have less or small differences among them. They show continuous variation. Quantative trait is controlled by polygenes or many genes.

Example :- 1: Grain colour in wheat.

2: Human – height, weight, intelligence and skin colour.

Q21 what is polygenic inheritance. Explain it with examples.

Answer : polygenic inheritance :

Definition :- The inheritance of characters controlled by many genes is called polygenic inheritance.

polygenes:- When many genes collectively control a Quantative trait so such genes are called polygenes.

Explanation :— Genes always interact to produce final phenotype. Mendel focused on the traits which showed only two qualitatively different phenotypes by just two alleles

of a single gene. on other hand charles Darwin observed small continuous variation within individual of a fertile - population. This variation is observed in the form of spectrum. Similarly the intensity of trait depend upon the number of alleles present in genotypes.

Example :- polygenic inheritance can be explained by the following two examples.

1: wheat grain colour :

continues variation :- wheat gains colour shows continuous variation in colour from white to dark red. There are seven phenotypes in wheat population throughout the world. some are dark-red, some are white but mostly they have shades b/w light pink to moderately dark red. i.e -

Dark red	moderately dark red	Red	light red	pink	light pink	pure white
1 AABBcc	6 AABBcc	15 AABBcc	20 AABbcc	15 AAbbcc	6 Aabbcc	1 aabbcc

Explanation :- Nilsson Elle studied the inheritance of wheat gain colour. For this purpose he crossed pure breed of dark red grain plant with pure breed of white grain plant and - obtaind light red grain plants in F_1-generation which was - intermediate between dark red and white. It seemed as the wheat grain colour was incomplete dominance. But - when he self-fertilized the F_1-hybrid plants he obtained

the above seven phenotypes in F_2-generation. (see above table)

Alleles combination in progenies:- There are 3-gene pairs, Aa, Bb, Cc at 3-different loci, which control the colour of wheat grain, so each individual has six alleles. Three genes (A,B,C) - code for red colour pigmentation which is is called positive effect. where as gene-a,b,c does not code for red - colour pigment which is called negetive effect. So the - colour of wheat gain will be sum of positive and negetive - effects. Thus, larger the number of positive effects (A,B,C) darker the colour of wheat grain and similarly the larger the number of negetive effective (a,b,c) lighter the colour of wheat grain i.e -

1: IF all six alleles are 'AABBCC' then the grain would be dark red.

2: Similarly if all alleles are 'aabbcc' then the grain colour would be pure white.

3: If one allele dominant in all six alleles then grain colour - would be light pink.

4: In case of two dominant alleles the colour would be pink.

5: IF 3-alleles are dominant, the colour of grain would be light red.

6: In case of 4-dominant alleles the colour would be red.

7: In case of 5-dominant alleles the colour would be dark red.

2: Human skin colour:

polygenic trait:- Human skin colour is another good - example of polygenic inheritance. Human skin colour is

determined by amount of melanin pigment produced by skin. Darker skin produces more melanin while lighter skin produces less melanin. The amount of melanin produced is controlled by 3-genes. i.e—

1: Gene-A :- Gene-A is responsible for permanent survival and transfering of melanocytes.

2: Gene-B :- Gene-B code for enzyme-Tyrosinase which is responsible for melanin production from Tyrosine.

3: Gene-C :- Gene-C finally determine whether pheometanin or eumelanin is produced in human.

Genotype for skin colour :- Each gene has two form <alleles> Dark skin alleles are represented by capital letter <A,B,C> while light skin alleles are represented by small letter <a,b,c>. No allele is completely dominant over other allele and show incomplete dominance in heterozygous state.

For example :- When dark black <AABBCC> is crossed with white <aabbcc>, the offspring called mulatto is produced with phenotype light brown and genotype—AaBbCc. In F_2 each meiotic division produces 8-gametes which combine with the other 8-gametes in 64-possible ways, resulting in seven phenotypes. The seven different shades of skin colour ranging from very light <aabbcc> to very dark <AABBCC>. But the most individuals have the intermediate skin colour i.e— PTO →

phenotypes →	Dark Brown	moderately Dark Brown	Brown	Light Brown	pinkish Brown	whitish Brown	pure white
Ratio →	1	6	15	20	15	6	1

Q22 Discuss gene linkage and crossing over in detail.

Answer : 1: Gene linkage:

Linked gene :- Genes present very close to each other on the same chromosome are called linked genes.

Gene linkage :- The ability of linked genes to stay together on the same chromosome during transmission from one – generation to the next is known as gene linkage.

Explanation :- In every organism the number of chromosomes is limited but the number of genes is unlimited. Thus each chromosome carries many genes on it but some of them are going to be held very close together. So such genes which are present on same chromosome that tends to be inherited always together during their inheritance are called Linked gene. They are present on homologous chromosomes.

Origin of Linkage :- There are two types of linkages on the basis of type of chromosomes i.e–

1: Autosomal linkage :- If genes are linked on autosomes (non-sex chromosomes) their linkage is called autosomal linkage.

2: Sex linkage :- If genes are linked on sex-chromosome their linkage is called sex –linkage.

Linkage group:

Definition :- All linked genes found on the same homologous pair of chromosome form a group called linkage group.

Number :- The number of linkage groups in an organism is equal to the number of homologous pair of chromosome in that organism.

For example :

1: Human has 23 linkage groups while fruit fly have 4-groups.

2: Genes for Gout, colour-blindness, Hemophilia, form a linkage group on human x-chromosome.

3: Similarly, genes for- sickle cell anemia, Anemia, Leukemia and albinism make another linkage group on human chromosome No-11.

Types of gene Linkage :- Gene linkage has two types. i.e-

1: complete linkage :-

Definition :- when genes for a particular character are present very close to each other on same chromosome and have less chances of separation during gametes formation is known as complete linkage.

Significance :- Due to complete linkage only parental combinations appear in F_2-generation.

2: Incomplete linkage :

Definition :- when genes for a particular character are not present very closely on same chromosome and get separation at the time of gamete formation is called incomplete linkage.

Significane :- Due to incomplete linkage new combinations other than parental combination produce. (ETEA-2005)

Deviation :- Linked genes do not undergo recombination and assortment independently in offspring, so ideal Mendalian ratio of independently assortment is deviated.

Detection of gene linkage:

Introduction :- To find out whether the genes present on same chromosome are linked or not. we detect it by dihybrid test cross between F_1 hybrid with one of its homozygous recessive parents.

Explanation :- After performing the test cross, if all phenotypes are produced in the ratio of 1:1:1:1 then there would be no linkage between them. after test cross, if parental types are more than new recombinant types then there would be incomplete or partial linkage between them. after test cross, if only parental types are produced then there would be complete or tight linkage.

Experiment :- Experiment was perform on drosophilia for detection of gene linkage. T.H Morgon cross the Grey body and normal wings drosophilia (wild type) with black body and vestigial wings (mutant type) which gives F_1-generation dihybrid – Grey with normal wings. when the F_1-offsprings were further test crossed with recessive parent, he obtained the following phenotypic result.

1: Grey body with normal wing = 965 (parental combination).
2: Black body with vestigial wing = 944 (parental combination)
3: Grey body with vestigial wing = 206 (Recombinant combination)
4: Black body with normal wing = 185 (Recombinant combination)

Experimental result:- This experiment indicate that parental combination is greater than recombinant combination. Therefore the Linkage is incomplete type.

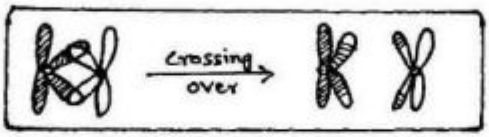
predication :- From the experiment Morgan predicated that genes for wings shape and body colour are located on the same chromosomes. However some mechanism occasionally breaks up the linkage between genes resulting in some non-parental offsprings which shows incomplete linkage. Later on, it was discovered that this break up of linkage is due to crossing over between genes on same chromosomes.

2: Crossing over :

Definition :- The exchange of segments between non-sister chromatids of homologous chromosomes during meiosis is called crossing over. (ETEA-2020)

Explanation :- Crossing over occur during meiosis-I in pachytene stage. first the two homologous chromosomes come together and form paring called synapse. while the chromosomes are synapsed, breaks occur at corresponding points in two of the non-sister chromatids. The broken sections are then exchanged between the chromosomes to

form completely new units, and each now recombined chromosome of the pair can go to a different gametes.



Importance :- The recombinant chromatids result from crossing over may bring alleles together in new combination so when they are distributed in different gametes, a wide variety of gametes are produced which causes variation in offsprings.

Morgan experiment :- In previous experiment morgan crossed Female fly having grey body and normal wing with male fly having black body and vestigial wing i.e

$$b^+ - vg^+ \times b - vg$$

Offsprings ——— 17% Non-parental recombinant
83% parental recombinant

Observation :- <Result> after above cross <fertilization>

T.H. Morgan observed that 17% offspring exhibited non-parental recombinant type. This indicate that out of every 100-flies, 17% are recombinants and 83% are parental combination. These 17% recombinants were the products of crossing over.

Recombination frequency :- <non-parental>

The recombinants frequency between the body colour and wing shape genes can be find out by the following formula. →

$$\text{Frequency in \%} = \frac{\text{Sum of Recombinants}}{\text{Sum of all combination}} \times 100 \quad \text{---(I)}$$

$$\text{Frequency \%} = \frac{206 + 185}{2300} \times 100 = 17\%$$

→ This 17% is called recombinant frequency between the body colour and wing shape genes of fruit fly.

parental recombinant frequency:

Total parental types = 965 + 944 = 1909

Now putting values in above formula No–(I).

$$\text{Frequency \%} = \frac{1909}{2300} \times 100 = 83\%$$

→ This 83% is called parental frequency or phenotype b/w the body colour and wing shape genes of fruit fly.

Genetic map :–(Linkage map)

Definition :- Maping of various genes along the length of chromosome is called genetic map.

Explanation :- Discovery of linked genes and recombination frequency due to crossing over led one of Morgans students, Alfred H. Sturtevant, to a method of constructing genetic-map. Sturtevant hypothesized that recombination frequency which is the result of crossing over depends upon the – distance between linked genes on the chromosome i.e–larger the distance between linked genes on a chromosome, more the probability of crossing over and hence more will be recombinant frequency chances.

Mathematical form :-<map of genes>- This was sturtevant who proposed the map of 3-genes along the length of chromosome.

1: b-gene for body colour of fruit fly.

2: Vg-gene for wing size of fruit fly.

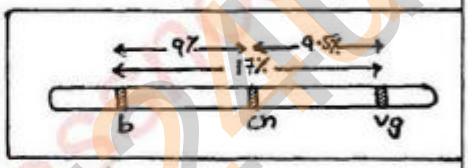
3: cn- gene for cinnabar (mutant) eye colour of fruit fly.

So the recombination frequency data for 3-genes are given below

1: cn—b = 9%

2: cn—vg = 9.5%

3: b—vg = 17%



Observation :-<importance of genetic map>-

1: With the help of given data the location of these genes can be made easily at chromosome.

2: Distance between two genes is respresented by map unit which is often known as centimorgan (cM).

3: Although 17% frequency is less than separate frequencies (i.e-9+9.5 = 18.5%) but this is due to crossing over, which many times occurs more than at one point. so — geneticists add smaller distance to theoretical value to get actual value.

Q23 what is sex chromosome. Diseuss chromosomal — pattern for sex-determination:

Answer: sex chromosomes:

Definition :- The chromosomes which determine the sex of the organism in early embryonic development is called sex-chro

For example :- usually the x and y-chromosomes - determine the sex so they are called sex chromosomes.

Sex determination :- The phenomenon in which sex-chromosomes determine the sex of the organism is called sex-determination.

patterns of sex determination :- As there are different sex determining patterns but only 3-are more common which are-

1: XO-XX types:

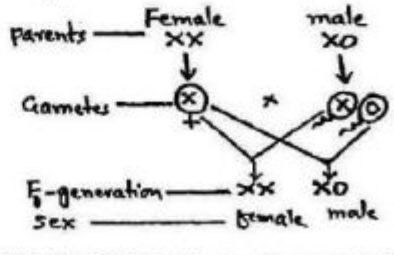
occurance :- This pattern of sex determination is found in-grasshopper and protenor-bug.

i-male chromosomes :- Male is XO because it has only one X-chromosome and other sex chromosome (Y) is missing.

Heterogametic :- male is heterogametic i.e- at the time of gamete formation it form two types of sperm. one sperm having x-chromosome along with autosomes and the other sperm having no sex chromosome but only contain autosomes so such gamete is called Nullo gamete.

ii- Female chromosomes :- Female is XX sex chromosomes.

Homogametic :- Female is homogametic or isogametic and it produces only one type of eggs. Every egg containing an x-chromosome along with autosomes.



iii-Sex determination :- In this pattern male or sperm is sex

determiner i.e—

Female :- if x—carrying sperm fertilizes with female x—carrying egg then offspring of xx—genotype will be produced—and it will be female sex.

Male :- if nullo sperm fertilizes with x-carrying egg then xo male offspering is produced.

Sex ratio :- sex ratio b/w male and female offspring is 1:1.

2: xy—xx type:

Occurance :- This type of inheritance is found in—human, —Drosophila (fruit fly) and many other mammals.

i- Male chromosome :- xy is male sex-chromosomes.

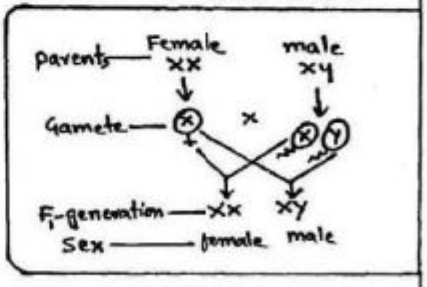
Heterogametic :- Male is xy and is heterogametic. i.e—one type of sperm contain x-chromosomes and other sperm contain y-chromosomes along with autosomes.

ii- Female chromosome :- xx is female sex-chromosomes.

Homogametic :- Female is xx and homogametic, producing only one type of eggs having x-chromosomes. ← (ETEA-2012)

iii- Sex determination :- Here male (sperm) determines the sex. i.e—

Female :- if an x-carrying sperm fertilizes the egg, the zygote will be xx and female is produced.



Male :- if y-carrying sperm fertilizes the egg, the zygote will be xy and male offspring will be produced.

Sex ratio :- The sex ratio between male and female offspring is 1:1

3: XX – XY :- <ZZ – ZW type> (ETEA-2017)

Occurance :- This type of pattern is found in birds, butterflies and moths.

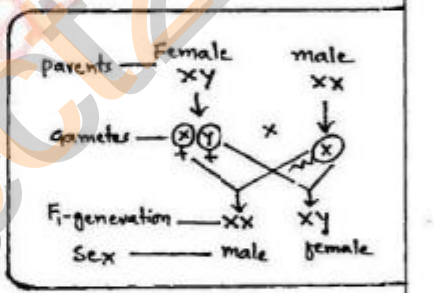
Discovery :- J. Seiler in 1914 discovered this type of pattern in moths. It is reverse of XY – XX pattern.

i- Male chromosomes :- XX <ZZ> is male sex-chromosomes.

Homogametic :- male is XX <ZZ> and is homogametic, producing only one type of gametes or sperms containing X <Z> chromosomes.

ii- Female chromosomes: XY <ZW> is female sex-chromosomes.

Heterogametic :- Female is XY <ZW> and is heterogametic. Two types of eggs are produced, one carrying X <Z> chromosome and other contain Y <W> chromosome along with autosomes



iii- Sex determination :- Here – female or eggs determines the sex of offsprings. i.e—

Male :- when an egg containing X <Z> chromosome is fertized by sperm then the male <XX> offspring will be produced.

Female :- when an egg contaning Y <W> chromosome is – fertilized by sperm then the female <XY> offspring produced.

Sex ratio :- Sex ratio between male and female offspring is 1:1.

Q 24 Compare the chromosomal determination of sex b/w Drosophila and human.

Answer: Drosophila sex vs Human sex:- In drosophila and humans the sex-determination pattern is xy-xx but there are some differences between them which are as follows-

1: SRY gene :- Both drosophila and human has y-chromosome but human has an adaptation of SRY-gene on y-chromosome which triggers the development of maleness in humans. it is absent in drosophila.

2: XO Turner's syndrome :- xo-Turner's syndrome in humans produced through non-disjunction which is a sterile female. But in case of drosophila xo is a sterile male.

3: Klinefelter syndrome :- In Klinefelter's syndrome, non-disjunction of gametes in humans produce xxy individual which is steril male but the same xxy-set of chromosome in drosophila produces a fertile female.

4: Autosome balance system :- Drosophila has x-chromosome-autosome balance system. In drosophila y-chrosome appears to have little influence in sex. Here actually the x-chromosome is female determining while autosomes are male determining.

5: sex determination : -<Genic balance mechanism>-

The sex in drosophila is determined by the ratio of number of x-chromosomes to that of the number of set of autosomes i.e-

1: An x:A-ratio of 1.00 or higher produce female. i.e

2x (if female) : 2 set of autosomes (diploid).

= 2x : 2A ⇒ 2/2 ⇒ 1.00 produce female sex.

2: Where an X:A-ratio of 0.5 or lower produce male i.e-

1X (if male) : 2 set of autosomes (diploid)

= 1X : 2A ⇒ 1/2 ⇒ 0.5 produce male sex

Q 25 Describe Morgan's historic work on sex linkage in drosophila

Answer: **Sex Linked gene:-** The gene present on sex chromosome is called Sex Linked gene.

Sex linked trait:- The trait whose gene is present on sex chromosome is termed as sex linked trait and the inheritance of that trait is called sex linked inheritance.

Sex linkage:- The genes responsible for sex linked traits are located on sex chromosomes and will inherit together with genes of sex is called sex linkage

Sex Linkage in drosophila:-

Introduction:- Morgan made his first demonstration in 1910 on sex linked trait. He conducted many experiment on drosophila and declared that the inheritance of eye colour and sex occurs in a coordinated fashion and not independently. Then he argued that eye colour genes are located on X chromosomes and absent on Y-chromosome.

Genotype for eye colour:- There are two alleles for eye colour i.e- X^R - dominant alleles codes for red eye colour while X^w - recessive alleles codes for white eye colour. The relationship b/w dominant (X^R) and recessive (X^w) alleles are given below-

1: A homozygous female with red eye color allele $\langle X^R X^R \rangle$ will have red eyes (wild type).

2: A heterozygous female with both eye colour allele $\langle X^R X^w \rangle$ will also have red eyes because X^R-allele is dominant over allele-X^w in heterozygous state.

3: A hemizygous male with dominant allele for eye colour $\langle X^R y \rangle$ will have red eye because there is no homozygous or Heterozygous case in male eye colour

4: Similarly, a hemizygous male with recessive allele for eye colour $\langle X^w y \rangle$ will have white eyes (mutant type).

5: while a homozygous female with recessive alleles for eye colours $\langle X^w X^w \rangle$ will have white eyes.

purpose of Morgan experiments:- It has two main purpose i.e-

1: To know whether eye colour gene is located on —— X-chromosome or Y-chromosome.

2: In 1910, a white eyed male appeared in a laboratory bottle. morgan made a cross to know that this new type appeared according to Mendelian inheritance or through spontaneous mutation in a gene controlling eye colour.

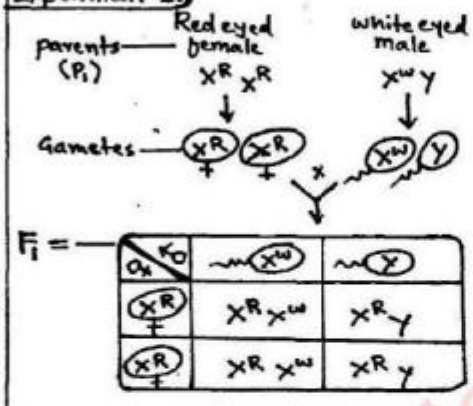
Experimental work of Morgan:- He perform the following exp;-

Experiment No-1:- Morgan first made a cross between a mutant type white eyed male with normal red eyed female to know that which allele or character is dominant.

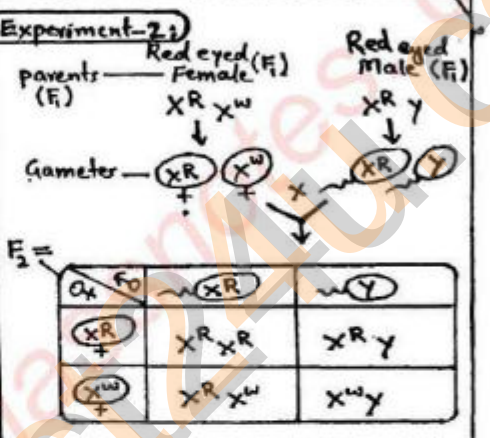
Result of exp; No-I:- Morgan obtained all the F_1-offsprings

(1237) red eyed which show that normal red eye colour allele (R) is dominant over mutant white eye colour allele (w).

Experiment-1:



Experiment-2:



Experiment No-2 :- Following the experimental procedure that mendel has established long ago, morgan crossed flies from F_1-generation of experiment No-I with each other to produce F_2-generation.

Result of exp; No-2 :- morgan found the following result—

1: 2459 — red eyed females offsprings.

2: 1011 — red eyed male offsprings.

3: 782 — white eyed male offsprings.

So both red eyed female and red eyed male gives 3470 red eyed progeny.

phenotypic ratio :- The proportion of 3470 red eyed to 782 — white eyed flies did not perfectly fit with mendelian ratio of

3:1 and did not provide clear evidence of segregation, — because the number of recessive phenotype individuals was too small.

Strange result :- In experiment No-2 one of the strange results was that all of the white eyed flies was males — and there was no white eye female in F_2-generation.

Conclusion for Experiment No-I, II :

From above experiments Morgan concluded that :

1: The eye colour genes are located on sex-chromosome and its alleles are only located on X-chromosomes and there is no allele for eye colour gene on Y-chromosomes.

2: Males are hemizygous $\langle X^RY$ or $X^wY\rangle$ and carry only one allele for eye colour while females may be homozygous $\langle X^RX^R\rangle$ or heterozygous $\langle X^RX^w\rangle$ for eye colour.

Experiment No-3 :

Test cross :- Morgan made hypothesis that eye colour genes are located on X-chromosomes so to confirm this hypothesis he carried out test cross between F_1-heterozygous female $\langle X^RX^w\rangle$ for red eyes with recessive parent $\langle X^wY\rangle$

Result of exp; No-3 :- $\langle$ phenotypic ratio $\rangle$

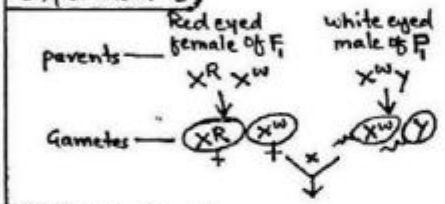
1: Half the female offsprings had red eyes $\langle 25\%\rangle$ and half had white eyes $\langle 25\%\rangle$.

2: Half the male offsprings had red eyes $\langle 25\%\rangle$ and half had white eyes $\langle 25\%\rangle$.

3: Thus 1:1:1:1 — ratio was produced from above test cross.

Observations for exp; No-3 :- From above test cross ratio morgan received white eyed female. according to morgan - females can only be white eyed if they have recessive alleles on both of their x-chromosomes $\langle x^w x^w \rangle$.

Experiment-3

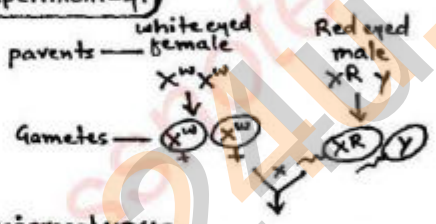


Testcross = $(F_1 \times P_1)$

♂ / ♀	x^w	y
x^R	$x^R x^w$	$x^R y$
x^w	$x^w x^w$	$x^w y$

ratio =
① - 25% - red eyed female ($x^R x^w$)
② - 25% - white eyed female ($x^w x^w$)
③ - 25% - red eyed male ($x^R y$)
④ - 25% - white eyed male ($x^w y$)

Experiment-4:



Reciprocal cross =

♂ / ♀	x^R	y
x^w	$x^R x^w$	$x^w y$
x^w	$x^R x^w$	$x^w y$

ratio =
① - 50% red eyed female ($x^R x^w$)
② - 50% white eyed male ($x^w y$)

Experiment No-4:

Reciprocal cross :- Morgan wanted to confirmed his result of test cross as he obtained white eyed females in expesiment No-3. Thus, morgan made a reciprocal cross as a confirmatory test between white eyed female $\langle x^w x^w \rangle$ and red eyed male $\langle x^R y \rangle$.

Result of exp; No-4 :- <phenotypic ratio>

1: All female offsprings were red eyed <50%> - $\langle x^R x^w \rangle$.

2: All male offspring were white eyed <50%> which means that they received x^w-chromosome from white eyed mother and -

Y-chromosome from red eyed fathex. <$x^R y$>.

Conclusion for exp; No-3 and 4 :- From above confirmatory test of experiment No-4, morgan concluded that eye-colour gene is located only on x-chromosomes of fruit fly and inherited with x-chromosomes during genetic crosses, so that is why this Link is called sex linkage.

Q26 what is sex linked traits. Explain sex linked trait types in human.

Answer: sex Linked traits :

Definition :- Those genes which are present on sex-chromosomes are called sex-linked genes and those traits <characters> which are control by sex linked genes are called sex linked traits.

Explanation : -<sex linked inheritance in human>-

Genes always present on chromosomes. Beside autosomes there are sex-chromosomes present such as xy in male and xx in female. In case of sex linkage, sex linked is a trait in which a gene is located on a sex chromosomes i.e.-

1: In human Linked genes are present on both x and y-chromosomes for different sex linked traits.

2: But in human, the sex linked traits generally refer to - traits that are influenced by genes on the x-chromosome. This is because the x-chromosome is large and contains many more genes than the smaller y-chromosome.

3: In case of sex-linked diseases, it usually males who are

affected because they have a single copy of x-chromosome which carries the mutation or sex linked diseases like- Haemophilia and colour blindness, etc.

Types of sex linked traits: – In human sex linked traits has two types i.e– x–linked traits and y– linked traits.

1: X–linked trait or inheritance :– (ETEA-2013)

Definition :– Those traits which are associated with x – chromosome are called x–linked traits and their – transmission from one generation to next is called x – linked traits inheritance.

Types of x–linked trait :– There are 2–types of x–linked traits i.e–

1–x–linked recessive inheritance (traits) :

Definition :– The type of trait or inheritance which is – transmitted as recessive traits through x–chromosome is known as x–linked recessive traits or inheritance.

Characteristics and transmission :– (ETEA-2020)

1: if female posses only one x–linked recessive trait (allele) will be considered as carrier (eg- x^hx) and generally she has no clinical symptoms of trait or disorder.

2: if male posses only one x–linked recessive trait (allele) will be considered as affected.

3: All offsprings (progeny) of carriers mother will have 50% chance to inherited x–linked recessive trait/disorder.

4: All female offspring (daughter) of affected father will

be carriers e.g x^hx.

5: No male child (son) of an affected father will be affected.

Example of x-linked recessive traits:- Example of x-linked recessive inheritance or trait are- colour blindness , — Haemophilia-A,B and diabetes insipidus. ←(ETEA-2020)

ii- X-linked dominant inheritance (Traits): (ETEA-2008)

Definition :- The type of trait or inheritance which is — transmitted as dominant traits through x-chromosome is known as x-linked dominant traits or inheritance.

Characteristics and transmission :

1: There is always 50% chance to any offspring (son and- daughter) from affected mother.

2: All daughters of affected father will be affected.

3: No son of an affected father will be affected.

Example Of X-Linked Dominant Traits: example of X-lined cominunt trait or inheritance are giving below.

1: Alport's Syndrome: it is a disease in which tiny blood vessels are damaged in kidneys leading to disease and kidney failure. It also causes hearing loss and eyes problems.

2: Coffin- Lowry Syndrome: it is a rare genetic disorder characterized by intellectual disability, abnormalities of the head and facial area, large and soft hands with short and thin fingers, short stature, skeleton abnormalities.

3: Idiopathic Hypoparathyroidism: it is a rare endocrine condition.

4: Vitamin-D Resistance Rickets: it is a disease in which the bone become painfully soft and bend easily due to low levels of phosphate in the blood.

24 Y- Lined Trait or Inheritance:

Definition: those traits which are associated with Y- chromosome are called Y-linked traits and their transmission from one generation to next is called

Y-linked trait inheritance.

Holandric trait or inheritance :- Y-linked trait or inheritance is also called Holandric trait or inheritance because the Holandric traits are those whose genes are located on Y-chromosomes so they are always transferred from father to son and have no effect on daughters of the next generation.

Transmission of Y-linked traits:

1: In Y-linked inheritance, son always receive Y-chromosomes and its related genes from father. so males (son) are - always affected (100% chance) from affected father.

2: where as daughters are not affected from Y-chromosomes (0% chance) as she do not inherit Y-chromosome from father.

3: Y-chromosome is shortest chromosome having very few - genes, so Y-linked traits or inheritance are rare and furthermore only male has Y-chromosome so Y-linked - diseases are also rare.

Example of Y-linked traits :- Example of Y-linked trait are -

1: Deletion of Y-chromosome can cause infertility in males

2: Hair on ear — It is also called sex limited trait.

Q27 Explain the X-linked recessive disorders in human.

Answer: X-linked recessive diseases:

1: Haemophilia :-(bleeds disease)-

Definition :- Haemophilia is a rare X-linked recessive trait or

genetic disorder in which of an individual fails to clot or clot slowly after a minor injury.

Causes of Haemophilia :- some common casues of Haemophilia are-

1: Blood clotting factor :- The cause of haemophilia is that it has either a reduction in normal function or malfunction or complete absence of blood clotting factors. e.g- factor-viii, xi, ix.

2: Genetic causes :- (ETEA-2010,2012)

1- Haemophilia is caused by recessive gene-'h' located on x-chromosomes and is expressed only in homozygous in female - $\langle x^h x^h \rangle$ and in hemizygous in male $\langle x^h y \rangle$.

2- Haemophilia is more common in males than females because male needs a single recessive allele on his x-chromosome $\langle x^h y \rangle$

3- Haemophilia is less common in females because females can be affected if they inherited both recessive alleles $\langle x^h x^h \rangle$ from both of their parents.

4- if female inherit only one recessive allele $\langle x^h x \rangle$ then they called carrier for haemophilia.

Types of Haemophilia :- Haemophilia have the following types.

1: Haemophilia A,B :- Haemophilia 'A' and 'B' are non-allelic-recessive x-linked disorder which affect more men than women. Haemophilia-A is due to lack of factor-VIII in blood. while Haemophilia-B is due to defect in factor-IX.

2: Haemophilia C :- Haemophilia-C is autosomal recessive trait which affects both male and female equally.

Inheritance of Haemophilia :-

1: Haemophilia – A and B inherit zig2ag from mothernal grandfather through carrier daughter to grandson. It is neaver passes direct from father to son.

2: Haemophilia – C passes to children from both parents equally.

2: Colour blindness :-

Definition :- It is x-linked recessive genetic disorder in - which a person can't differentiate between red and green colours and both appear grey is called colour blindness.

Causes of colour blindness : some common causes are –

1: Genetic causes :-

1- Colour blindness is caused by recessive gene – 'c' located on x-chromosomes which does not allow the formation of colour sensitive pigments like green and red necessary for maturation of cones – cells of retina of eyes because cones cells are sensitive to colour vision.

2- Colour blindness is expressed only in homozygous in female $\langle x^c x^c \rangle$ and in Hemizygous in male $\langle x^c y \rangle$.

3- colour blindness is more common in male than females because male needs a single recessive allele on x-chromosome.

4- Colour blindness is less common in females because females can be affected if they inherited both alleles $\langle x^c x^c \rangle$ from both of their parents.

5- if female inherit only one recessive allele $\langle x^c x \rangle$ then they

are called carrier for colour blindness. ←(ETEA-2012)

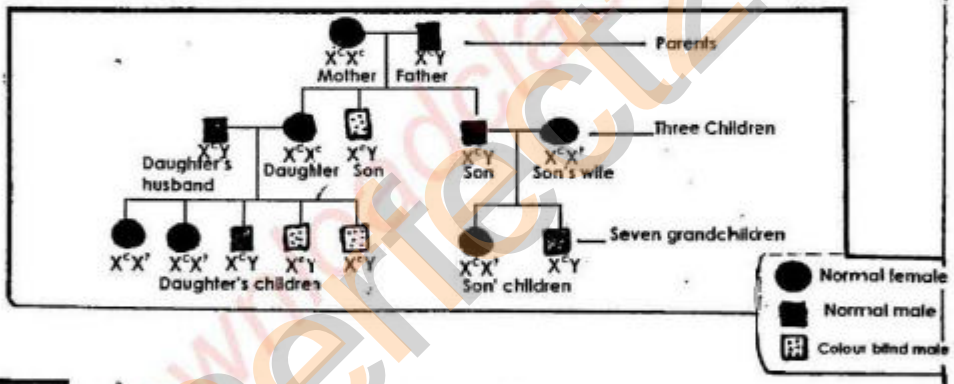
2: other causes :- certain factors which also causes colour blindness are- Medication, diseases, aging, chemicals, UV,

Inheritance of colour blindness :

1: Colour blindness can passes zigzag from maternal — grandfather through a carrier daughter to grandson.

2: It does not pass direct from father to son.

3: So there is a 50% chance that a son will inherit the colour blind trait from a carrier mother $\langle X^cX \rangle$.



Q28 Discuss sex related traits.

Answer : Sex related traits:

Definition :- Those traits which are related to maleness or femaleness (sex of organism) are called sex related traits.

Explanation :- Genes for sex related traits are found in male and female of an organism. Although it is not necessary that their genes must be sex-linked but they may be — controlled by sex-linked or even autosomal genes.

Types of sex related trait :- Sex related trait may be —

1: Sex Limited traits:

Definition :- Those traits which are limited only to one sex (i.e- male or female) due to anatomy differences are — called sex limited traits.

Explaxation :- Genes for sex-limited traits may be found in both males and females but express only in one gender (sex). The expression of sex-limited traits is dependent upon — anatomy of individual.

Example :- 1:— Milk production in female cattles.

2— Women does not grow beard.

2: sex influenced traits:

Definition :- Those traits which are found in both males and females (sexes) but more commonly occur (express) in one sex due to hormonal differences are called sex influenced T;

Explanation :- sex influenced traits are controlled by dominant allele in one sex (gender) but recessive allele in other genders. This difference is due to hormonal difference b/w sexes. It is not necessary that these genes must be on sex-chromosome but it can be on autosomes also.

Example :- Baldness (گنجا پن) is found in both male and female but more frequently occurs in males than females because a — heterozygous male is bald where as a heterozygous female is carrier. A female will be bald if she is homozygous recessive for that trait.

Exercise

Exercise MCQs

A. Multiple Choice Questions (MCQs).

1. *If a male inherits a sex-linked gene for colour blindness _____.*
   (a) it will only be expressed 25%
   (b) it will never be expressed
   (c) it will be expressed only if two copies are present
   (d) it will always be expressed
2. *The pattern of sex determination found in drosophila is:*
   (a) WZ-ZZ type (b) XY-XX (c) X0- XX (d) Compound sex
3. *Which of the followings is male in grasshopper?*
   (a) XX (b) XY (c) X (d) Y
4. *The female in butterflies is:*
   (a) XX (b) XY (c) X0 (d) X
5. *Which of the following is true for Drosophila sex determination?*
   (a) Males are produced by presence of Y chromosome
   (b) Females are produced by presence of Y chromosome
   (c) Two X chromosome will always produce a female
   (d) Two Y chromosome will always produce a male
6. *Sex-linked genetically inherited traits:*
   (a) can appear in both males and females
   (b) are only found in males
   (c) are only found in females (d) are found on autosomes
7. *Y-linked traits are inherited:*
   (a) only by females (b) only by males
   (c) by both males and females (d) but not expressed
8. *Harmful X-linked traits are:*
   (a) inherited only from mothers (b) more numerous than Y-linked ones
   c) most likely to show up in the phenotype of daughters
   d) most likely to show up in the phenotype of sons
9. *If both dominant and recessive alleles are present for a given trait the allele expressed will be*
   (a) autosomal (b) dominant (c) somatic (d) recessive
10. *The form of inheritance in which the heterozygous state is expressed as an intermediate is _____.*

(a) incomplete dominance (b) polygenic inheritance
(c) sex-linked inheritance (d) multiple-allele inheritance

11. A person who inherits the A and the O blood type alleles will possess which blood type
(a) A (b) AB (c) B (d) O

12. Why males tend to inherit more sex-linked characters?
(a) There is no corresponding allele on their Y chromosomes
(b) There is no corresponding alleles on their X chromosomes
(c) They have two X chromosomes (d) They have two Y chromosomes

13. A permanent change in the genetic structure of a gene is called:
(a) translocation (b) linkage (c) mutation (d) nondisjunction

14. Traits that display continuous phenotypic variation are usually determined by this form of inheritance.
(a) sex-linked inheritance (b) multiple-allele inheritance
(c) incomplete dominance (d) polygene inheritance

15. Heterozygous individuals that can pass on recessive, abnormal conditions even if they do not express the disease are referred to as _____.
(a) deleterious donators (b) carriers
(c) zygotic (d) phenotypically challenged

16. Genes that are located on the same chromosome are said to be:.
(a) crossed (b) syncopated (c) linked (d) dominant

17. In the human blood type AB, the alleles are _____.
(a) dominant (b) polygenic. (c) sex-linked (d) codominant

18. The universal blood donors for the ABO system are type:
(a) A (b) B (c) O (d) AB

19. Heterozygous parents who have had one child with a recessive disease will still have a _____ chance of their second child being born with the same recessive disease.
(a) 75% (b) 25% (c) 12.5% (d) 50%

20. Across is made between parents with genotypes AABB and aabb. If there were sixteen offspring, how many of them would be expected to exhibit both dominant characteristics?
(a) 25%. (b) 50%. (c) 75%. (d) 100%.

Answer:(key)

1-d	2-b	3-c	4-b	5-c
6-a	7-b	8-b	9-b	10-a
11-a	12-a	13-c	14-d	15-b
16-c	17-d	18-c	19-b	20-d

Short Questions

Q1:- Briefly explain how Mendel produced plants that had genes for both contrasting traits of a characteristics.

Answer: Hybridization :-

During experiment on plant hybridization, Mendel cross the two contrasting traits pea plants called parental generation (P_1) or true breed plants. The first plants called F_1-generation which produced during hybridization are hybrid which means F_1-plants contain genes of each parental trait in which one gene (allele) or trait is dominant so it expressed while the other contrasting gene (allele) or trait is recessive so it can not expressed in hybrid or F_1- plants. In F_2-generation or plants such contrasting traits or genes are expressed or separated in 3:1 ratio.

For example:- Heterozygous Tall pea plant (Tt) have genes for both contrasting traits i.e. Tall (T) and dwarf (t).

Q2:- How genes are different from alleles.

Answer: Genes Vs Alleles:

1: A Gene is a portion of DNA while allele is a specific form of gene.

2: Genes are responsible for the expression of traits where as alleles are responsible for the variations

in which a given trait can be expressed.

3: Genes do not occur in pairs while alleles occur in 2 pairs

4: Various types of genes are called Alleles where as - alleles have two types i.e - paternal vs maternal or Dominant vs recessive.

Q3:- How did Mendel F_1-generation plants differ from his F_2-generation plants.

Answer: F_1-plants vs F_2-plants:

1: F_1-generation plants :- The F_1-generation results from cross pollination (cross fertilization) of two true breed parent plants. All F_1-generation plants are genotypically heterozygous (hybrid) and phenotypically like dominant characters of parental plants.

2: F_2-generation plants :- The F_2-generation results - from self-pollination (self fertilization) of F_1-plants. F_2-generation plants are genotypically contain 25% of true or pure breed of dominant characters and 25% of true (pure) breed of Recessive characters and 50% of heterozygous dominant characters. while phenotypically ratio is 75% dominant like characters and 25% recessive like characters are present in F_2-plants.

Q4:- many inherited disorders of humans appear in children of parents who do not have the disorder. How can you explain this.

Answer :- Appear of inherited diseases in children not in parent

1: The case with the inherited diseases in a family – examplifies the principle of dominance. Although the parents may not express the trait for the inherited disorder, they still may be carrying the trait for it. However, if a child inherits two recessive genes, he or she will be afflicated with the disorder. —OR—

2: A trait controlled by a recessive factor had no – observable effect on an organisms appearance when that trait was paired with a trait controlled by a dominant factor. an affected child inherits a recessive allele from each parent.

Q5: – why pea was the most suitable plant for Mendel's exp;

Answer :- See Question No-3.

Q6: – Differentiate between dominance and epistasis.

Answer :- Dominance Vs epistasis :

1: Dominance :- Deminance is the relationship between alleles of the same gene present at the same locus.

Example :- The relationship between Tall and dwarf alleles Round shape and wrinkled shape of pea plants.

2: Epistasis :- Epistasis is the interaction between – different genes or alleles at different loci.

Example :- Bomby phenotype which is a rare blood group –or– relationship b/w gene-I and gene-H.

Q7:- state the dominance relations among the alleles of ABO blood group system.

Answer:- see Question No-15 (write only- Dominance relation among alleles in Question No-15).

Q8:- what were the mendel's observations about the phenotypes and genotypes in F_2-generation of monohybrid cross

Answer:- Monohybrid cross:

1: phenotypies of F_2-generation:- Mendel found that the phenotypic ratio between round and wrinkled pea plants are 3:1. i.e- every 3- offsprings (3/4) of F_2-generation were round (75%) and one (1/4) was wrinkled (25%) of F_2-generation plants.

2: Genotypes of F_2-generation:- In F_2-generation, one-fourth (1/4) of the offsprings were homozygous round (RR), two-fouth (2/4) of the offsprings were heterozygous round (Rr) while one-fouth (1/4) were homozygous wrinkled (rr) i.e- 1:2:1.

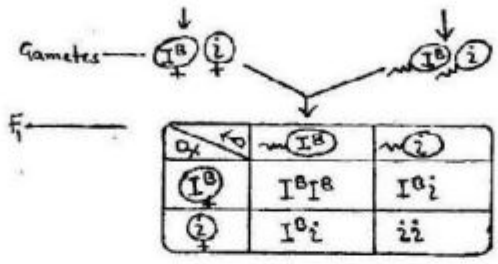
Q9:- Differentiate b/w sex limited and sex influenced traits.

Answer:- see Question No- 28.

Q10:- what are the possible blood types of a child whose parents are both heterozygous for B-blood types.

Solution:-

	Mother blood group		Father blood group
	Heterozygous-B.		Heterozygous-B.
parents	$I^B i$	×	$I^B i$
	↓		↓



possible Blood type: <Ratio>-

1:- 75% childs have Blood group-'B'

2:- 25% childs have Blood group-'O'.

Long Questions

Q1:- Define and explain the law of segregation.

Answer:- See Question No-8. (write only-law of segregation)

Q2:- How Mendel performed dihybrid cross. what did proposed on the basis of his observations in this cross.

Answer:- See Question No-9 < Note- write dihybrid cross completely with diagram and for propose-"see inheritance of two trait (Topic) in Question-9 (start topic)" >.

Q3:- Describe the genetic basis of ABO blood group system.

Answer:- See Question No-15.

Q4:- what is polygenic inheritance. Explain it mode of inheritance by taking an example in human.

Answer:- See Question No-21 with only one example of human skin colour.

Q5:- Describe Morgan's historic work on sex-linkage in Drosophila.

Answer:- See Question No-25.

Genetic problems

Q1:- Two flies with long wings were mated and the offspring included 77 with long wings and 24 with short wings. wh is the phenotype ratio of the offspring. Is the short winged condition dominant or recessive what are the genotype of the parents.

Solution:- Long wings fly (Heterozygous) × Long wings fly (Heterozygous)

offsprings —— 77-offsprings (Flies) his long wings
24-offsprings (flies) his short wings

1: phenotypic ratio:- 77% offsprings or flies have long wings while less or 24% offsprings or flies have short wings.

2: short wings:- In above cross short wings condition is recessive because the result or number of short wing phenotypes individuals (flies) is too small.

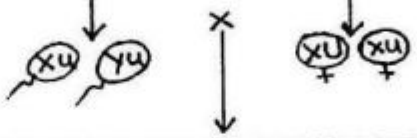
3: parental genotypes:- In the above cross both the parents are heterozygous state for wings size.

Q2:- A man with attached earlobes marries a woman with Free - ear lobes, whose father had attached ear lobes Free ear lobes (U) is dominant over attached —

earlobes (u). what are the genotypes of all individuals mentioned.

Solution :-

♂ XY (uu) ♀ XX (UU)



offsprings:

♂ / ♀	Xu	Yu
XU	XX(Uu) Free	XY(Uu) Free
Xu	XX(uu) attached	XY(uu) attached

a: Man with attached ear lobes : u u

b: Woman with – Free – ear lobes : U u

c: Father : u u

Q3:– In certain flowers, colour is inherited by genes that have incomplete dominance. In such flowers, a cross between homozygous red and a homozygous white will always result in a pink flower. A cross is made between two – pink flowers. what is the predicted phenotype ratio of the colour red, pink and white appearing in the offsprings.

Answer :- See Question No-13 < draw only Graphic – presentation of incomplete dominance example only >.

Q4:– In humans, the condition for normal blood clotting dominates the condition for non-clotting or hemophilia. Both alleles are linked to the x-chromosome. A male hemophiliac – marries a woman who has is a carrier for this –

condition. In this respect, a carrier is a woman who has an allele for normal blood clotting and an allele for hemophilia. what are the chances that if they have a male child he will be normal for blood clotting.

Solution:

Male-Hemophiliac X^hY × female-carrier X^HX^h

Gametes — X^h, Y × X^H, X^h

♀ \ ♂	X^h	Y
X^H	X^HX^h	X^HY ✓
X^h	X^hX^h	X^hY

50% chance of male child having normal blood clotting

Q5:— In humans, the allele for A-type blood and the allele for B-type blood show codominance. A person with both alleles has blood type AB. Both A and B dominate type 'O'. A person with an allele for type A blood and type 'O' blood marries — someone with an allele for type B blood and type 'O' blood. List the types of offsprings they could have and the probability for each blood type in the offspring.

Solution:

Male (Blood gp-A) × Female (Blood gp-B)

Genotype — I^Ai × I^Bi

Gametes — I^A, i × I^B, i

Offspring — with blood group:

♂ \ ♀	I^A	i
I^B	I^AI^B (AB type)	I^Bi (B-type)
i	I^Ai (A type)	ii ('O' type)

Q6:— In horses, black colour (B) dominates chestnut colour (b). The Totting gait (T) dominates the pacing gait (t). A cross is made between a horse homozygous for black colour and the pacing gait and a horse homozygous for chestnut colour and the trotting gait. List the probable genotype and phenotype of offspring resulting from such a cross.

Solution :-

♂ Black colour and pacing gait × ♀ chestnut colour and Trotting gait

BB tt bb TT

Gametes — (Bt) (bT)

F_1-generation — BbTt (Hybrid)-Heterozygous. (Black colour and Trotting gait)

F_2 = F_1 ♂ × F_1-♀

BbTt BbTt

Gametes — (BT) (Bt) (bT) (bt) × (BT) (Bt) (bT) (bt)

♂ \ ♀	BT	Bt	bT	bt
BT	BBTT	BBTt	BbTT	BbTt
Bt	BBTt	BBtt	BbTt	Bbtt
bT	BbTT	BbTt	bbTT	bbTt
bt	BbTt	Bbtt	bbTt	bbtt

phenotypic ratio = 9 (BT) : 3 (Bt) : 3 (bT) : 1 (bt).

Genotypic ratio = 4:2:2:2:2:1:1:1:1

Previous Entry Test MCQ's of Biology Chapter No -22: (Inheritance)

2005 ETEA

1. **The alternative form of given gene is called:**
   (a) Dominant (b) Recessive
   (c) Phenotype (d) Alleles
2. **The allele that exist in more than two different forms are called:**
   (a) Polygenic alleles
   (b) Mutagenic alleles
   (c) Multiple alleles
   (d) Heterogenic alleles
3. **Law of independent assortment cannot be applied on:**
   (a) Dominant genes
   (b) Recessive genes
   (c) Linked genes
   (d) Autosomal genes

2006 ETEA

4. **In gene interaction the gene that mark the expression of another gene is termed as:**
   (a) Hypostatic (b) Epistatic
   (c) Hemistatic (d) Neostatic
5. **The total of the all allele in a population is called:**
   (a) Genetic drift (b) Genotype
   (c) Gene pool (d) Gene mutation
6. **On the basis of which of the following ratio We can prove law of independent- Assortment:**
   (a) 9:3:3:1 (b) 9:3:4
   (c) 1:2:1 (d) 2:1:1

2007 ETEA

7. **A cross between F_1 hybrid with either of parents is called:**
   (a) Back cross (b) Test cross
   (c) Reverse cross (d) None of them
8. **Who is considered to be the father of Genetics?**
   (a) Weisman (b) Bateson
   (c) Mendel (d) Morgan

2008 ETEA

9. **If red and white colour flowers in mirabulus jalapa are crossed, the F1 generation will show:**
   (a) All red (b) All white
   (c) All pink
   (d) 1 red, 2 pink, & 1 white ratio
10. **In which case the genotypic and phenotypic ratio will be 1:2:1?**
    (a) Complete dominance
    (b) Incomplete dominance
    (c) Co-dominance (d) None of them
11. **Which one of the following characteristic in man is controlled by a recessive gene?**
    (a) Tongue rolling (b) Diabetes
    (c) Skin colour (d) Eye colour

2010 ETEA

12. **The term gene was used by:**
    (a) Johannsson (b) Correns
    (c) Tschmarch (d) Purkinje
13. **If father of a baby is hemophilic and mother is carrier, then chances of the baby in inheriting the disease will be:**
    (a) 0% (b) 50%
    (c) 75% (d) 100%

2011 ETEA

14. **A punnet square is used to determine the:**
    a) Result of mitosis
    b) Result of meiosis

c) Actual outcome of a cross
d) Probable outcome of cross

15. A woman is homozygous for A-negative blood type. A man has AB-negative blood type. What is the probability that the couple's child will be type of B-negative?
(a) 0% (b) 25%
(c) 50% (d) 75%

16. A cross between dissimilar individuals to bring together their best characteristics is called:
(a) Genetic engineering
(b) Hybridization
(c) Inbreeding (d) Sequencing

2012 ETEA

17. An individual with contrasting alleles is called:
(a) Homozygous (b) Monoecious
(c) Heterozygous (d) Dioecious

18. How many genotypes will be produced by crossing of two alleles "A" and "a"?
(a) One (b) Two
(c) Three (d) Four

19. A single ovum of human being contains:
(a) X-chromosomes
(b) XX-chromosomes
(c) YY-chromosomes
(d) XY-chromosomes

20. In the dihybrid cross, how many homozygous offspring's can be produced?
(a) 4 (b) 3
(c) 2 (d) 9

21. In human being, the carrier of colour blind is:
(a) Male (b) Female
(c) Both male and female
(d) None of them

22. Hemophilia affects males more than Females because of:
(a) Dominant autosomes
(b) Dominant X-linked
(c) Recessive X-linked
(d) Y-chromosomes linked

23. A Test Cross is:
(a) Tt x Tt (b) Tt x tt
(c) TT x Tt (d) TT x TT

24. Organism phenotypically similar but genotypically different are said to be---
(a) Monozygous (b) Homozygous
(c) Heterozygous (d) Multizygous

25. Which blood group transfusion can be made without risk:
A) Group A to group B
b) Group AB to group O
c) Group A to group O
d) Group B to group AB

2013 ETEA

26. In which of the following the phenotypic and genotypic ratio is the same:
(a) Co-dominance (b) Over dominance
(c) Epitasis
(d) Incomplete dominance

27. Which one of the following is a sex-linked inheritance?
(a) Baldness (b) Albinism
(c) Eye colour (d) Myopia

2014 ETEA

28. The cross between two dissimilar individuals is called-
a) Test cross b) Interbreeding
c) Epistasis d) Hybridization

29. If two heterozygous tall plants are crossed together, the proportion of phenotypically tall plants will be -

a) 50% b) 25%
c) 75% d) 100%

2016 ETEA

30. The florescent pigments in the eyes of fruit fly is an example of:
a) Over dominance
b) Complete dominance
c) Incomplete dominance
d) Co-dominance

2017 ETEA

31. ABO blood group is an example of:
(a) Multiple alleles and incomplete dominance
(b) Codominance and incomplete dominance
(c) Incomplete dominance only
(d) Multiple alleles and codominance

32. XX-XY types of sex determination pattern is present in which of the following organisms?
(a) Humans (b) Butterflies
(c) Grasshopper (d) Drosophila

33. In a mating between two individuals that are heterozygous for a recessive lethal allele. What genotypic ratio (homozygous dominant: heterozygous: homozygous recessive) would you expect to observe in the offspring?
(a) 1:2:1 (b) 3:1:1
(c) 1:2:0 (d) 0:2:1

34. If black and white true breeding mice are mated and the result is all grey offspring, what inheritance pattern would this be indicative of?
(a) Dominance (b) Codominance
(c) Multiple Alleles
(d) Incomplete Dominance

2018 ETEA

35. A heterozygote fruit fly has more florescent pigments in their eyes than a wild homozygote fruit fly, this is an example of:
(a) Co-dominance
(b) Incomplete dominance
(c) Over dominance
(d) Complete dominance

36. ___ in drosophila results in sterile:
(a) Female (b) Male
(c) Both (A) & (B) (d) No effect

2019 ETEA

37. A pure breeding tall plant was crossed to dwarf plant. What would be the probability of "Tt" genotype in F2?
(a) 0 (b) 0.25 (c) 0.5 (d) 0.75

2020ETEA

38. Which traits are most likely to affect men than women?
a. X linked recessive
b. X linked dominant
c. Autosomal dominant
d. Autosomal recessive

39. Alleles both have an effect on the phenotype heterozygotes organism
a. Dominant b. Recessive
c. Multiple d. Co-dominant

40. When both the allele of a gene is same, the organism is said to be:
a. Heterozygous b. Genotype
c. Homozygous d. Phenotype

Key: -

1.d	2.c	3.c	4.b	5.c	6.a
7.a	8.c	9.c	10.b	11.b	12.a
13.b	14.d	15.a	16.b	17.c	18.a
19.a	20.a	21.b	22.c	23.b	24.c
25.d	26.d	27.a	28.d	29.c	30.a
31.d	32.b	33.a	34.d	35.c	36.b
37.c	38.a	39.d	40.c		