NEET Important Questions with Solutions from Principles of Inheritance and Variation

Q.1. Which of the following is not a Mendelian disorder?

A) Thalassaemia

B) Phenylketonuria

C) Cri du chat syndrome

D) Haemophilia

Answer: Cri du chat syndrome

Solution: Mendelian disorders are mainly determined by alteration or mutation in the single gene. These disorders are transmitted from the parents to the offspring on the same lines as we have studied in the principle of inheritance.

The pattern of inheritance of such Mendelian disorders can be traced in a family by the pedigree analysis. Most common Mendelian disorders in human are red-green colour blindness, phenylketonuria, thalassaemia, haemophilia, cystic fibrosis, sickle-cell anaemia, etc.

Q.2. Which of the following crosses is a test cross?

A) $\mathrm{WW} \times \mathrm{WW}$

B) $\mathrm{WW} \times \mathrm{Ww}$

C) $\mathrm{Ww} \times \mathrm{ww}$

D) $\mathrm{Ww} \times \mathrm{Ww}$

Answer: $\mathrm{Ww} \times \mathrm{ww}$

Solution: By simply looking at the phenotype of a dominant trait, it is not possible to determine the genotypic composition. Thus, a test cross is performed to find out the genetic makeup of an organism for a character. A cross between an individual with unknown genotype and homozygous recessive individual is called as test cross.
In a hybridization test cross heterozygous dominant (Ww) is crossed with homozygous recessive (ww) individual producing equal number of plants with dominant and recessive trait.

$\mathrm{Ww} \times \mathrm{ww}$ (parents)------> $\mathrm{Ww},\ \mathrm{Ww},\ \mathrm{ww},\ \mathrm{ww}$ (progeny)

We get the progeny in the ratio $2:2$ which is $1:1$.

Q.3. According to Mendelism which pair of character is showing dominance?

A) Terminal position of flower and green colour of seed coat.

B) Wrinkled seeds and green colour of seed coat.

C) Yellow pod and round seeds.

D) Green pod and axial position of flower.

Answer: Green pod and axial position of flower.

Solution: Through the selective cross-breeding of common pea plant (*Pisum sativum*) over many generations, Mendel discovered that certain traits show up in offspring without any blending of parent characteristics. Mendel observed seven traits that are easily recognised and apparently only occur in one of two forms. Among those all traits green pod and axial position of flower are dominant the characteristics.

Q.4. All are autosomal recessive disorders, except

A) cystic fibrosis.

B) thalassemia.

C) phenylketonuria.

D) haemophilia.

Answer: haemophilia.

Solution: Autosomal disorders are those which are expressed in homozygous condition.

Haemophilia is a medical condition when a person's body is unable to form blood clot. It is X-linked recessive disorder.

Whereas, cystic fibrosis is an autosomal recessive disorder. It is caused due to mutations and affects lungs and digestive system.

Thalassemia is an autosomal recessive disorder in which red blood cells are being destroyed, further leads to anemia.

Phenylketonuria is also an autosomal recessive disorder. In this disorder, phenylalanine starts building up in the body which causes various problems like mental disorders, etc.

Q.5. Law of independent assortment can be explained by

A) monohybrid cross

B) reciprocal cross

C) dihybrid cross

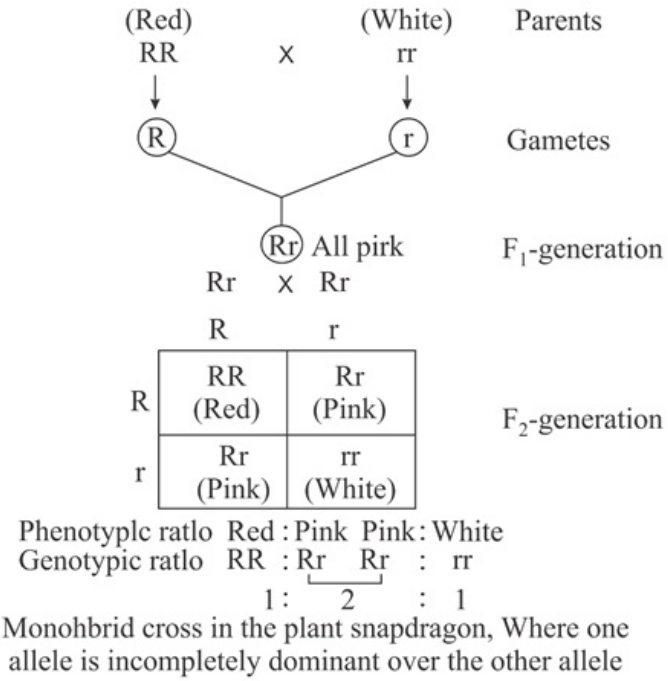
D) test cross

Answer: dihybrid cross

Solution: Based upon the results obtained in dihybrid crosses, Mendel proposed a second set of generalizations that we call Mendel's law of independent assortment. According to this law, when two pairs of traits (different characters) are combined in a hybrid, segregation of one pair of traits is independent of the other pair of traits. Or alleles for two or more than two pairs of contrasting characters assort independently of each other during gametogenesis.

The Law of independent assortment can be explained by the dihybrid cross.

It is a cross between two homozygous individuals differing in two characters. For example- Cross between homozygous dominant (Yellow, round seed shape- YYRR) is crossed with homozygous recessive (Green, wrinkled- yyrr) Pea plant.



Monohbrid cross in the plant snapdragon, Where one allele is incompletely dominant over the other allele

Now, it is clear that the segregation of one pair of factors will occur independently of the other pair, or they will assort independently. Accordingly, the gametes must carry all possible combinations of the factors in equal frequency.

Q.6. Select the correct option for the words to fill in the blanks A, B and C.

(i) __A__ are the unit of inheritance.

(ii) Term allele is used for contrasting forms of a _B_.
(iii) __C__ are slightly different form of the same gene.

A) (A – Genes), (B – Traits), (C – Alleles)

B) (A – Genes), (B – Characters), (C – Allles)

C) (A – Factors), (B – Gene), (C – Alleles)

D) (A — Factors), (B – Gene), (C – Traits)

Answer: (A – Genes), (B – Traits), (C – Alleles)

Solution: (1) Gene (Mendel called them factors): In a modern sense, an inherited factor that determines a biological character of an organism is called gene (functional unit of hereditary material). It is a sequence of nucleotides in DNA or RNA that encodes the synthesis of a gene product.

(2) Traits are physically observable characters determined by Genes of Mendelian factors. It is the expression of two contrasting forms of the genes called alleles.

For example-Dwarf and tall varieties of pea plants.

(3) Alleles or Allelomorphs: Alleles, the abbreviated form of term allelomorphs, mean alternative or slightly different forms of the same gene.
For example-tall TT and dwarf tt are alternation forms of the same gene.

Q.7. How many types of gametes will be produced by a plant having the genotype AABbCC?

A) Four

B) Nine

C) Two

D) Three

Answer: Two

Solution: The number of different gametes can be calculated by the formula: $(2)^n$, where n = number of heterozygous forms.

When genotype is AABbCC, value of n = 1.

Therefore, number of gametes = $(2)^1 = 2$

It would make only two types of gametes, which are ABC & AbC.

Q.8. In monohybrid cross what is the ratio of homozygous dominant and homozygous recessive individuals in F_2-generation :-

A) $1:2:1$

B) $2:1/1:2$

C) $3:1/1:3$

D) $1:1$

Answer: $1:1$

Solution: In case of monohybrid cross the genotype is TT x tt, and hence the gametes formed are T and t. The resulting F_1 generation will be Tt. Now the selfing of F_1 generation Tt x Tt, will result into a F_2 generation of TT, Tt, Tt, tt. Ratio between homozygous dominant and homozygous recessive in F_2 generation is 1:1.

Q.9. Which of the following is incorrect about Klinefelter's syndrome?

A) A chromosomal disorder

B) Karyotype of 44 + XXY

C) Gynaecomastia

D) Fertile males

Answer: Fertile males

Solution: Klinefelter syndrome is a chromosomal disorder caused by non-disjunction of chromosome during meiosis. Klinefelter males are generally infertile and show enlargement of breast tissues called as gynaecomastia due to one extra X chromosome.

Q.10. Lack of independent assortment of two genes 'A' and 'B' in fruit fly *Drosophila* is a due to

A) repulsion

B) recombination

C) linkage

D) crossing over

Answer: linkage

Solution: Genetic linkage is the tendency of genes that are located proximal to each other on a chromosome to be inherited together during meiosis. Genes whose loci are nearer to each other are less likely to be separated onto different chromatids during chromosomal crossover, and are therefore said to be genetically linked. In other words, the nearer two genes are on a chromosome, the lower is the chance of a swap occurring between them, and the more likely they are to be inherited together. Linkage and independent assortment are related as:

$$Linkage\ \alpha\ \frac{1}{Independent\ Assortment}$$

Q.11. Blue eye colour is recessive to brown eye colour. A brown-eyed man whose mother was blue-eyed marries a blue-eyed woman. The children shall be:

A) Both blue eyed and brown eyed $1:1$

B) All brown eyed

C) All blue eyed

D) Blue eyed and brown eyed $3:1$

Answer: Both blue eyed and brown eyed $1:1$

Solution: The brown-eyed man will have the genotype Bb and his wife bb . As it represents a monohybrid test cross, the progeny will have the genotype Bb (brown eye) and bb (blue-eye) in the ratio $1:1$.

Q.12. Select the incorrectly matched pair:

A) Klinefelter syndrome–Gynaecomastia

B) Turner syndrome–45 with XO

C) Down's syndrome–Point mutation

D) Cri-du chat syndrome–Deletion of short arm of 5th chromosome

Answer: Down's syndrome–Point mutation

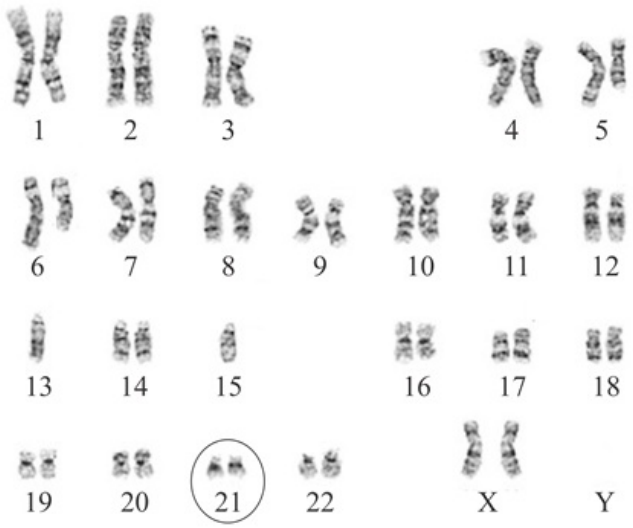
Solution: DOWN's SYNDROME:

Introduction: It was first described in 1866 by Langdon Down. The disorder develops due to trisomy of chromosome number 21. The disease is also known as Mongolian idiocy. It is an autosomal chromosomal abnormality.

Cause: It arises due to the formation of (n+1) male or female gamete by non-disjunction and the subsequent fertilization by normal (n) gamete. In the majority of the cases, the mother of an affected child is found to be more than 35 years of age.

Karyotype: [45 + XX/XY, +21]

Symptoms:
1. Short structure.
2. Small round head.
3. Epicanthus eyes (flat and broad eyes).
4. Furrowed tongue.
5. Partially open mouth.
6. Broad palm with characteristic palm crease (Simian crease and Sydney line).
7. Many 'loops' on fingertips.
8. Big and wrinkled tongue.
9. Physical development retarded (underdeveloped gonads and genitals, loose joints). Organs are sterile.
10. Psychomotor (nervous) and mental development are retarded.
11. Low to moderate I.Q. (Below 35).



Q.13. Which law states that each gamete has an equal chance of possessing either member of a pair of homologous chromosomes?

A) Segregation

B) Independent assortment

C) Dominance

D) All of the above

Answer: Segregation

Solution: The principle of segregation states that two members of a gene pair (alleles) segregate (separate) from each other in the formation of gametes. Half the gametes carry one allele, and the other half carry the other allele.

Q.14. What is the genotypic and phenotypic ratio of monohybrid test cross :

A) 1:1

B) 1:2

C) 3:1

D) 1:2:1

Answer: 1:1

Solution: By looking at the phenotype of a dominant trait, we can not know the genotypic composition of the plant, i.e., we cannot predict that a tall plant from F_1 or F_2 generation has TT or Tt composition. Mendel crossed the tall plant from F_2 with a dwarf plant (tt), to determine the genotype of a tall plant at F_2 and this is known as test cross. An organism showing a dominant phenotype is crossed with the recessive parent instead of self pollination, in a typical test cross. So, when we cross a heterozygous tall plant (Tt) with a recessive parent (tt), we get two types of progenies, one with genotype Tt (heterozygous tall) and other with genotype tt (homozygous recessive and dwarf). So, out of two progenies, 1 is homozygous recessive, i.e., 50% of the total progenies are homozygous recessive while other is heterozygous dominant.

Q.15. When red and white flowered plants of *Mirabilis jalapa* are crossed then the ratio of F_2 -generation will be:

A) 2: 2

B) 3: 1

C) 1: 2: 1

D) 1: 1: 1: 1

Answer: 1: 2: 1

Solution: When two genes of allelomorphic pair do not show dominant-recessive relationship, still, when present simultaneously or come together, they show intermediate conditions or blend together, which is called **blending inheritance** or **incomplete dominance**.

* First case of incomplete dominance or blending inheritance was reported in *Mirabilis jalapa* or 4 o'clock plant by **Carl Correns**. He reported when a red or crimson flowered variety in this plant crossed with a white-flowered variety plant, pink flowers are produced in the F_1 generation. Selfing of F_1 hybrid results in three types of offspring in the F_2 generation, i.e., red, pink and white in the ratio of 1:2:1, respectively.
* Thus, in F_2 of this cross, the same genotypic and phenotypic ratios are observed.
* **Snapdragon** or **Dog flower** (*Antirrhinum majus*) also provides an example of incomplete dominance or blending inheritance.

Q.16. The individual with karyotype 47; XXY shows

A) Turner's syndrome

B) Klinefelter's syndrome

C) Down's syndrome

D) Edward's syndrome

Answer: Klinefelter's syndrome

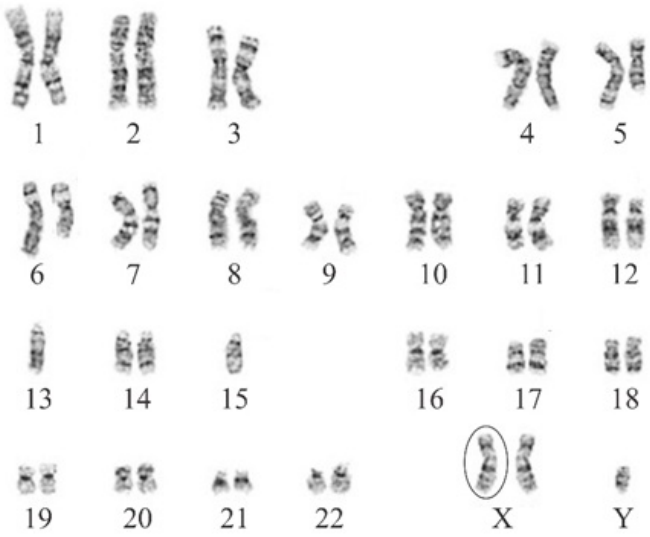
Solution: KLINEFELTER's SYNDROME:

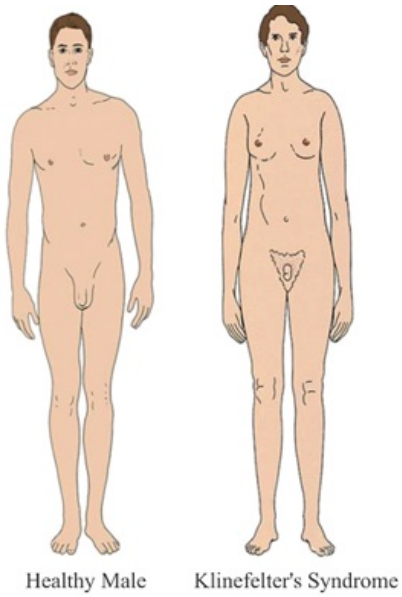
Introduction: It was first described in 1942 by Klinefelter. The disorder develops due to the trisomy of the sex chromosome. The disease is seen only in males. It is an allosomal chromosomal abnormality.

Cause: It is caused due to the presence of an additional copy of the X-chromosome resulting in 44+XXY type chromosome components. The defect arises due to the union of a normal egg (22+X) and abnormal sperm (22+XY) or abnormal egg (22+XX) and a normal sperm (22+Y).

Karyotype: [44 + XXY]

Symptoms:
1. Masculine development is normal.
2. Generally tall, with abnormal trunk to legs ratio (legs are abnormally tall).
3. Gynaecomastia.
4. I.Q. level is below average.
5. The testis is developed. Spermatogenesis is absent causing sterility.
6. Adam's apple is not formed. Deep and high pitch voice.
7. They show shyness in public places.
8. Shows the presence of Barr bodies.





Turner's syndrome is caused due to monosomic condition of the sex chromosome while Down's syndrome and Edward's syndrome are caused by the trisomic condition of the autosomes.

Q.17. Which one is correct?

A) Turner's syndrome - XO monosomy in females

B) Down's syndrome - XO monosomy

C) Klinefelter's syndrome - XXY in females

D) Sickle cell anaemia - X-linked dominant disease

Answer: Turner's syndrome - XO monosomy in females

Solution: **Monosomy**:- The organisms (plant) having the genetic constitution as (2n-1), i.e., lacking one complete chromosome, and this phenomenon is known as monosomy.
An important example of monosomy in human beings is '**Turner's syndrome**, which is monosomic of XO type. These are sterile females and have a webbed necks.

Q.18. In a dihybrid cross between AABB and aabb, the ratio in between AABB, AABb, aaBb and aabb in F_2 generation is :-

A) 9: 3: 3: 1

B) 1: 1: 1: 1

C) 1: 2: 2: 1

D) 1: 1: 2: 2

Answer: 1: 2: 2: 1

Solution: In a dihybrid cross between AABB and aabb, the genotype of the parent generation is: AABB X aabb. The resulting generation from the cross of parents formed has the genotype as AaBb. Now, F1 generation is AaBb and selfing of F1 generation is AaBb X AaBb. Hence, from the following cross the different genotypes formed as follows: AABB = 1, AABb = 2, aaBb = 2, aabb = 1. Now we can see that the ratio is 1:2:2:1.

Q.19. Different mutations referable to the same locus of a chromosome give rise to:

A) Multiple alleles

B) Pseudoalleles

C) Polygenes

D) Oncogenes

Answer: Multiple alleles

Solution: Multiple alleles are multiple alternatives or alleles of the same gene which occur in the population of the same species. Multiple alleles have developed as a result of mutation. Despite the presence of three alleles of the same gene in a population, an individual (2n) can have only two alleles. Therefore, multiple alleles can be detected only in a population. Polygene is a gene, a single dominant allele of which express only a unit of the trait. Polygenes are the genes controlling quantitative inheritances. Oncogenes are cancer-causing genes.

Q.20. Occasionally, a single gene may express more than one effect. The phenomenon is called

A) Multiple allelism

B) Mosaicism

C) Pleiotropy

D) Polygeny

Answer: Pleiotropy

Solution: When a single gene has multiple effects then that gene is known as pleiotropic gene and this phenomenon is known as pleiotropy. This phenomenon is seen in phenylketonuria disease in which mutation occurs in the gene which codes for an enzyme, i.e., phenylalanine hydroxylase that shows multiple effects which prevent the processing of phenylalanine and stops the synthesis of melanin pigment, etc. When multiple genes are present and they code for a single trait then that is known as polygeny. When for one individual trait three or more alternative forms of a gene are present then it is known as multiple allelism. Example: ABO blood grouping etc. A condition in which cells within the same person have different genetic makeup is known as mosaicism.

Q.21. Mendel's Law of independent assortment holds good for genes situated on the

A) non-homologous chromosomes

B) homologous chromosomes

C) extra nuclear genetic element

D) same chromosome

Answer: homologous chromosomes

Solution: According to the Mendel, genes (i.e., pairs of factors) are located on chromosomes. During cell division, the chromosome separates and become a part of separate gametes. Synapsis formation occurs during meiosis during which the homologous chromosome segregate independently in different cells. It is a quantitative basis of segregation and of independent assortment which is a hereditary factor. Mendel's law is applicable to those genes which are present on the homologous chromosome.

Q.22. In a dihybrid cross, if you get $9:3:3:1$ ratio it denotes that

A) the alleles of two genes are interacting with each other

B) it is a multigenic inheritance

C) it is a case of multiple allelism

D) the alleles of two genes are segregating independently.

Answer: the alleles of two genes are segregating independently.

Solution: If a cross involves two contrasting characters then it is called as dihybrid cross. The two flowers of each trait will assort randomly and independently at the time of meiosis (gametogenesis). Randomly as well as independently they will rearrange itself in the offspring producing both parental and new combinations of traits. This explained the law of independent assortment which is given by Mendel.

Q.23. In sickle cell anaemia glutamic acid is replaced by valine. Which one of the following triplets codes for valine?

A) GGG

B) AAG

C) GAA

D) GUG

Answer: GUG

Solution: Sickle cell anaemia is an autosomal recessive genetic disease. On the 6^{th} position of the beta-globin chain of haemoglobin, glutamic acid is replaced by valine. Due to this the shape of the RBC's gets distorted. The normal shape of the RBC is biconcave, but now it will be elongated and sickle-shaped. The formation of sickle shape occurs due to less oxygen stress. The oxygen-carrying capacity of haemoglobin in sickle cell anaemic patients will also become less. The codon of glutamic acid is GAG which will become GUG after replacing with valine.

Q.24. All genes located on the same chromosome

A) Always show incomplete dominance

B) form one linkage group

C) will not from any linkage groups

D) Always show co-dominance

Answer: form one linkage group

Solution: Chromosomal theory of inheritance was proposed by Sutton and Boveri. According to which many genes are located in each chromosome in a linear fashion. All the genes on a single chromosome can be a part of a linkage group. During cell division, all the genes which are located on the same chromosome will move to the same pole. Incomplete dominance and co-dominance are shown by alleles which are present on two different homologous chromosomes

Q.25. If a heterozygous tall plant is crossed with a homozygous dwarf plant then what shall be the percentage of dwarf in offspring :-

A) 25%

B) 100%

C) 75%

D) 50%

Answer: 50%

Solution: When a cross is made between a heterozygous tall plant and a homozygous dwarf plant then the percentage of a dwarf in offspring will be 50%. Here, assume the heterozygous tall plant have genotype Tt and homozygous dwarf plant have genotype tt. Then cross is made:Tt X tt.

	T	t
t	Tt	tt
t	Tt	tt

Hence, the dwarf plant percentage will be 50%.

Practice more on Principles of Inheritance and Variation