Topical test genetics and variation.

1. Which one of the following representations of genotypes would produce only one type of gametes?
   A. TtHh
   B. TtHh
   C. TTHh
   D. Tthh

   D

2. A man with allele for normal color vision married a woman whose father was color blind. The probability of a couple getting a child with a defective allele is
   A. ¼
   B. ½
   C. 1/3
   D. ¾

   A

3. A couple had children with a disorder that appeared only in sons. Which one of the following is true about this occurrence? The disorder is
   A. Sex linked and the mother is a currier
   B. Caused by multiple allele
   C. Sex linked and both parents are carrier
   D. Sex limited to males and the father is a carrier

   A

4. When a tall red flowered plant was crossed with a short and white flowered plant, all the offspring were tall and red flowered. When F1 plants were selfed, the F2 plants' phenotypes were in the ratio of 3:1. This occurrence suggests the occurrence of
   A. Epistasis
   B. Recombination
   C. Crossing over
   D. Linkage

   D

5. A man of blood group **B** married a woman of blood group **AB.** Which one of the following blood group types would not be of their child?
   A. AO
   B. BO
   C. AA
   D. BB

   C

6. Sickle cell anemia is caused by a double recessive gene and sufferers usually die before maturity. This continued existence of the sickle cell allele among the human population demonstrates
   A. Drug resistance
   B. Heterozygous advantage
   C. In-breeding
   D. Genetic drift

   B

7. Albinism in corn plant is due to double recessive gene which causes them to die before maturity. The trait however continues to appear in generation because
   A. Albina plant can develop chlorophyll when exposed to light
   B. Normal green plants may carry recessive alleles
   C. New varieties may be produced by crossing-over in albino plants
   D. Mutation may occur to change albino plant to green

   B

8. An occurrence of phenotypic ratio of 3:1 in a dihybrid cross is an indication of
   A. Linkage
   B. Crossing of over of chromosome
   C. Failure of homologous chromosome to separate
   D. Dominance

   A

9. In flowers, the heterozygous condition of the alleles for red petal [R] and white [W], are pink. Which one of the following proportions and color of petals is correct if a pink flowered plant is crossed with a red flowered plant
   A. 3red : 1 white
   B. 3 red : 1pink
   C. 1pink : 1 red
   D. 1 pink: 1 white

   C

10. Use the information to answer questions 10 and 11
    In mice, yellow for [Y] is dominant over grey for [y] when two mice were mated, the offspring were in the ratio of 2 yellow :1 grey. From the results, which of the following were likely genotype of the parents?
    A. Both were homozygous dominant
    B. Both are heterozygous
    C. one was heterozygous and the other homozygous dominant
    D. Both were homozygous recessive

    B

11. Which of the following best explains results?
    A. Double recessive allele for color is lethal
    B. Heterozygous condition for color is lethal
    C. For color could be sex link
    D. Double dominant allele for color is lethal

    A

12. According to Mendel, all the following are correct except
    A. Each characteristic of an organism is controlled by a pair of alleles
    B. Each allele is transmitted from generation to generation in a discrete unit
    C. There are several varieties of allele of each from each parent
    D. Each organism inherits one allele of each pair, from each parent

13. Which one of the following statements is not correct about a test cross?
    A. It is carried out on an organism with dominant phenotype
    B. The offspring of the cross may all have dominant phenotype
    C. The organism of unknown genotype is crossed with a homologous dominant individual
    D. The offspring of the cross may have the ratio of 1 dominant phenotype: 1 recessive phenotype

    C

14. Mendelian expected probabilities of genotypes in a cross occur when
    A. Small number of offspring are produced
    B. Migrations occur in the population
    C. Mutation arises
    D. Fertilization is random

    D

15. Establishing the genotype of an organism by crossing it with a homologous recessive individual is carrying out a
    A. Test cross
    B. Dihybrid cross
    C. Back cross
    D. Monohybrid cross

    A

16. In guinea pigs, the allele for rough coat (R) is dominant over one for smooth coat (r) and that for black coat (B) is dominant over one for white coat (b). the alleles for coat type and color are not linked. A cross between rough black pig and rough white one produced 28 rough black, 31 rough white, 11 smooth black and 10 smooth white. Which one of the following could be the genotype of the parent?
    A. RrBb xRrbb
    B. RRBB x RRbb
    C. RRBb x Rrbb
    D. RrBB x Rrbb

    A

17. Which one of the following is true about sex-linked characters in human?
    A. Female never suffers from the trait
    B. Father do not pass on the character to their son
    C. Females are either normal or carriers
    D. Male are either carriers or sufferers

    B

18. Which of the following cannot be a parent of a child of blood group O?
    A. Man, of blood group A and woman of blood group B
    B. Both man and woman of blood group A
    C. Both man and woman of blood group B
    D. Man, of blood group AB and woman of blood group O

    D

19. A rhesus positive fetus whose mother is rhesus negative may not be born alive because the
    A. Mothers body produces antigens against fetal antibodies
    B. Fetus lack antibodies against the mothers' antigens
    C. Mother's body produces antibodies against the fetal antigens
    D. Mother's red blood cells mix with the fetal blood

    C

20. Which one of the following is true of linked characteristics? They
    A. Are always transmitted as a single block
    B. Are allelic to each other
    C. Occur on non-homologous chromosomes
    D. Can be transmitted independently

    A

Structured questions

21. In human albinism is caused by an autosomal receive allele. On average, 1 person in 10,000 is an albino.

(a) Give two characteristics of an albino. (02 marks)

- *Light coloured skin*
- *White hair Pink eyes.*

(b) Using Hardly formula $P^2 + 2Pq + q^2 = 1$, determine the

(i) Frequency of the albino allele in the human population. (03 marks)

frequency of the albino allele = q

Frequency of albinism $(q^2) = \frac{1}{1000}$

$$i.e.\ q^2 = \frac{1}{1000}$$

$$= \sqrt{0.0001}$$

$$= 0.01$$

Hence the frequency of the albino allele in the human population is 0.01.

(ii) Frequency of the heterozygous genotypes in the population. (03 marks)

P + q = 1

P + 0.01 = 1

But p + 2pq + q = 0.99

Also,

P2 + 2pq +q2 = 1

$(0.99)^2 + 2pq + (0.01)^2 = 1$

0.9801 + 2pq + 0.0001 = 1

2pq = 1-0.9802

2pq = 0.0198

Hence the frequency of the heterozygous in the population is 0.0198.

(c) Explain why it is difficult to eliminate allele from a population. (02 marks)

A large proportion of the recessive alleles in a population exist in the carrier heterozygotes. As a result, very few can be eliminated from the population in each generation. Only alleles present in the homozygous recessive organism will be expressed in the phenotype and so be exposed to environmental selection and possible elimination.

Also, certain recessive alleles confer extra advantage to organism containing then I heterozygous state. This maintains the allele in the population. For example, the sickle cell allele.

22. (a) Explain the meaning of the Hardy-Weinberg equilibrium principle. (02 marks)

Provided there are no disruptive influence such as mutations or selection, the frequency of alleles in a population remains constant, generation after generation.

There is continued movement of gene (gene flow) within the population due to breeding but the overall gene frequencies remain constant. This stability is referred to as genetic equilibrium.

(b) State four conditions that must be fulfilled in order for the principle to hold true (02 marks)

- *No mutation occurs*
- *Mating must be random*
- *The population must be large.*
- *No emigration or immigration from or into the population should occur*
- *Generations should not overlap*
- *All genotypes should be equally fertile, so that no selection occurs.*

(c) Brown eyes in a human population is caused by a dominant. If in a population, 84% of the people have brown eye, using Hardy-Weinberg formula, determine the percentage of the population who are.

(i) Heterozygous for eye colour. show your working. (04 marks)

*Let the allele for brown eyes be **B***
The allele for other eye colour be b
Frequency of allele B be p
Frequency of allele b be q
Given BB+ Bb constitute 84%
The hardy-Weinberg equation states

$P^2 + 2pq + q^2 = 1$

Given,

$p^2 + 2pq = 0.84$

$q^2 = 1 - 0.84$

$q^2 = 0.16$

$q = 0.4$

Also. $p + q = 1$

$P = 1 - 0.4$

$P = 0.6$

$(0.6)^2 + 2pq = 0.84$

$2pq = 0.84 - 0.36$

$2pq = 0.48$

Hence 0.48% of the population is heterozygous.

(ii) Homozygous dominant for eye colour. Show your working. (02 marks)

From the above, P = 0.6
=> BB = p2 = (0.6)2
.; BB = 0.36
% 0f BB = 36%
Hence, the percentage of individual homozygous dominant for eye color is 36%

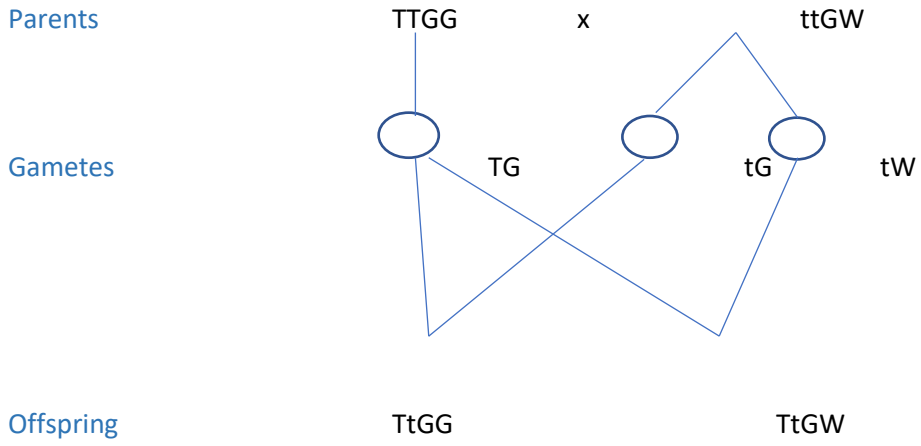
23. In an oil seed plant species, the allele for tallness is dominant over that for dwarfness. Meanwhile the allele for chlorophyll production and non-chlorophyll show incomplete dominance. The heterozygous plants are variegated.

(a) Using suitable symbols, construct a diagram of a cross between a tall plant with green leaves and a dwarf plant with variegated leaves, to show the genotype and phenotypes of the offspring

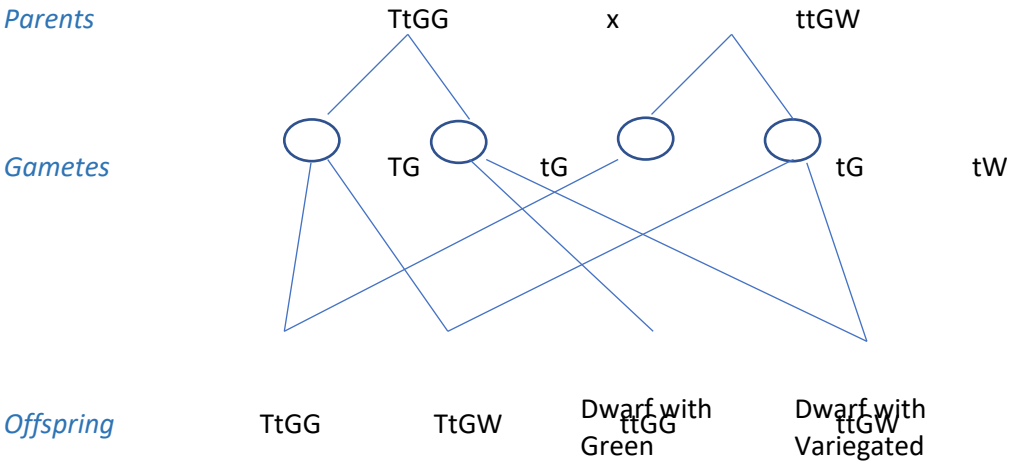
let

T be the allele for tall plant, t be the allele for dwarf plant

G be the allele for chlorophyll production, W be the allele for non- chlorophyll production
A tall plant with green leaves would have genotype TTGG or TtGG. While the dwarf plant with variegated would gave genotype ttGW. Two crosses are possible in this case.



Or



(b) Explain why 25% of the offspring of the cross in (a) would fail to survive. (02 marks)

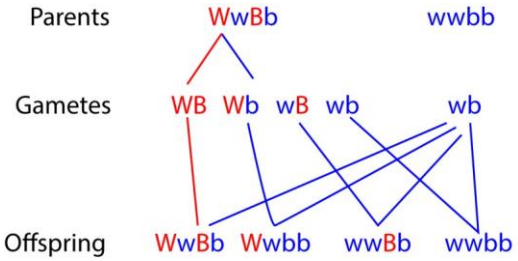
In the second cross, 25% of the offspring survival disadvantage in being dwarf with variegated leave. They cannot reach out for enough light do not have enough chlorophyll to absorb light for photosynthesis.

24. In poultry, feather color is controlled by two sets of alleles, **W** [white] dominant over **w** [colored] and B [black] dominant over b [brown] A foul heterozygous for both alleles [WwBb] is white.

(a) Explain why the genetic constitution of WwBb is white? (02 marks)

When both genes are present in the genotype, gene W presents the expression of gene B in phenotype, a condition called epistasis.

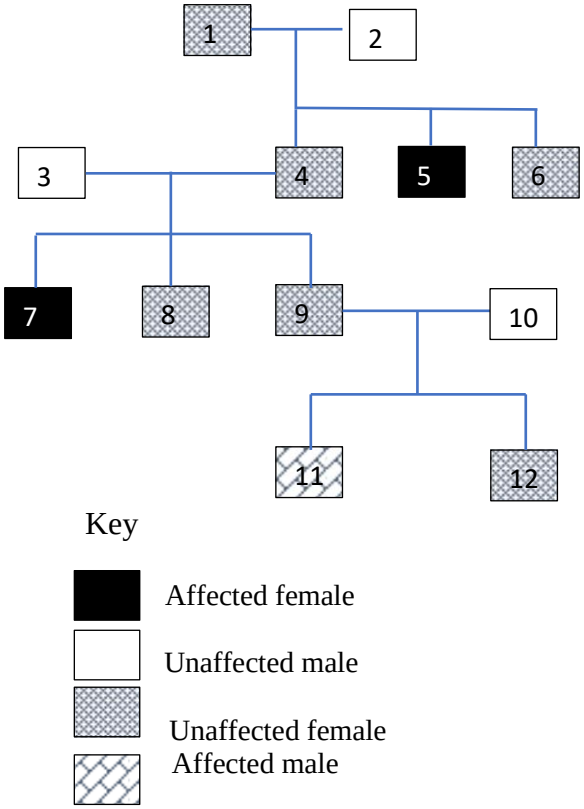
(b) Work out to show the phenotypic ratio of crossing a white cock (WwBb), with brown hen. (08 marks)



(c) State the possible genotype of a black fowl

wwBB and wwBb

25. The figure below shows how sickle cell anemia has affected a family line. Sickle cell anemia is a recessive genetic defect which is not sex linked individuals are numbered 1 2 3…12



(a) State the number of all individuals in the family line that are certain to be heterozygous for this gene. (1marks)

4, 9

(b) What is the probability that individual **6** is heterozygous for this gene? (show your working)? (03 marks)

Possible heterozygous include: 1, 2, 3, 4, 6, 8, 9, 10, 12

Number of possible heterozygotes = 9

Probability that 6 is heterozygous = 1/9

(c) The parasite which cause malaria digest hemoglobin in the red blood cells. Suggest two reasons an individual who is heterozygous for this gene may show resistance to malaria. (03 marks)

- *some of their red blood cells have reduced capacity of oxygen that they may not be able to support intracellular parasite*
- *the sickle shaped have reduced life span to complete the life span of parasite*
- *haemoglobin s may not be digestible*

(d) State the difference between individuals who have sickle cell anemia and those that have sickle cell trait. (3marks)

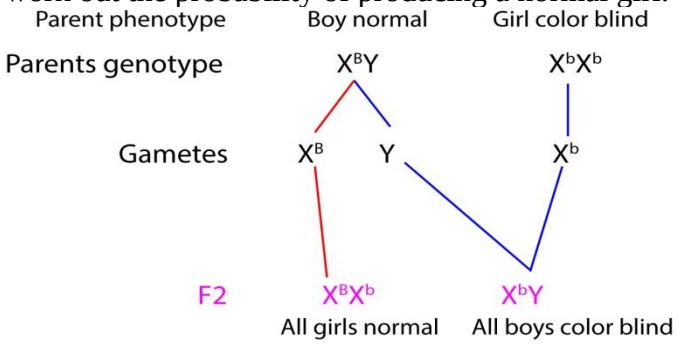
*Individuals with sickle cell anemia have over 60% of their red blood cells containing haemoglobin S which is defective. While those with the sickle cell trait have not more than 50% of abnormal haemoglobin **S.***

26. (a) Distinguish between sex linked and sex-limited genes. (03 marks)

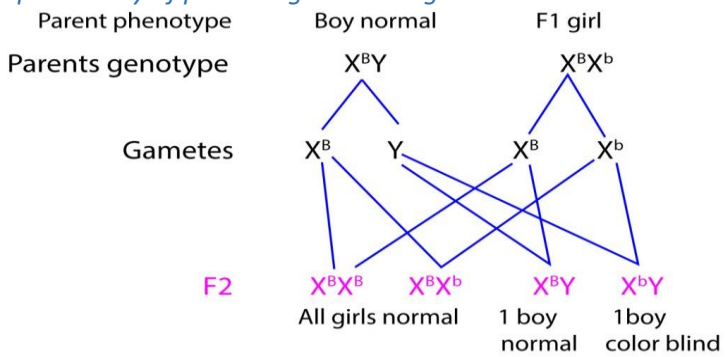
Sex-linked characteristics are those whose genes are carried on the sex (X-) chromosomes for example in humans are color blindness, and hemophilia while sex limited traits are characters that that show up exclusively in one sex only e.g. ovary in female

(b) Color blindness in man is caused by a recessive gene found on X-chromosome.

(i) A boy with normal eye sight married a color blond girl. Using suitable symbols, work out the probability of producing a normal girl. (05 marks)



The probability of producing a normal girl is 1

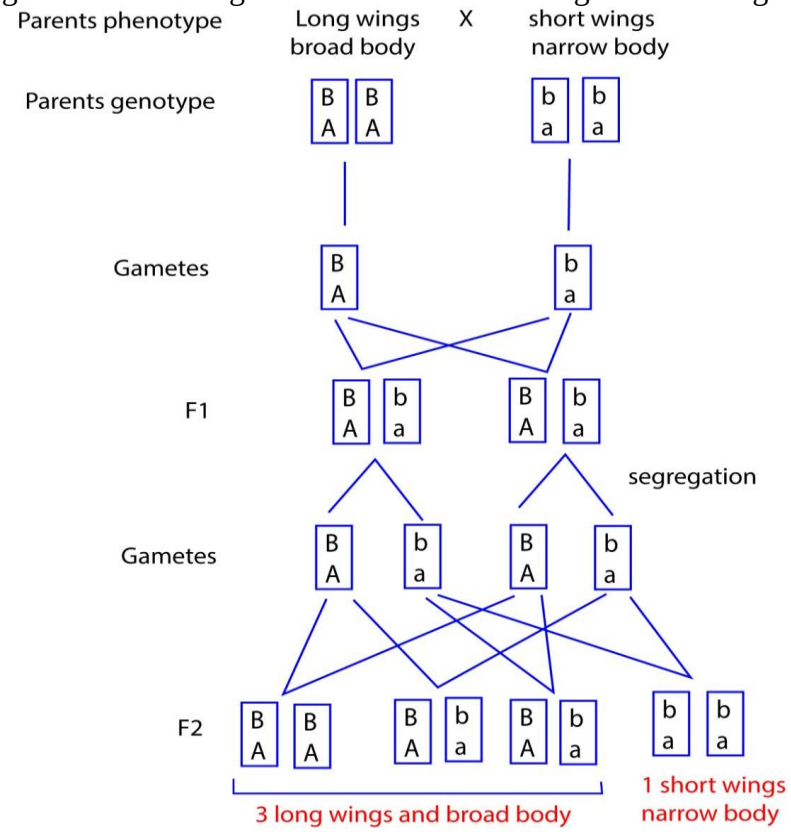


(ii) If one the daughters from the marriage in (b)(i) above married a man with normal eyesight, what is the probability that they will produce a boy with normal eyesight? (02 marks)

Probability of a normal boy = ½

27. In drosophila, the gene for Broad abdomen and long wings are dominant over the genes for narrow abdomen and vestigial wings. Pure breeding strains of the double dominant variety were crossed with a double recessive variety and a test cross was carried out on F1 generation.

(a) Using suitable symbols, work out the expected phenotypic ratio of the test cross of the F1generation. If the genes for abdomen and length of the wing are liked. (7marks)



(b) It was however observed that when the test cross of F1 generation was carried out, the following results were obtained. (3marks)

Broad abdomen, long wings	380
Narrow abdomen, vestigial wings	396
Broad abdomen, vestigial wing	14
Narrow abdomen, long wing	10

Calculate the distance in units between the genes for abdomen width and wing length

Crossing over value = $\frac{numbe\ of\ organisms\ with\ small\ proportions\ of\ exchanged\ character}{total\ numbe\ r\ of\ individuals}$

$$= \frac{10+14}{380+396+10+14} = \frac{24}{4220} = 0.006\ or\ 0.6\%$$

28. (a) State four situation where Mendel's laws would not apply.

- *Multiple alleles*
- *Linkage*
- *Incomplete dominance.*
- *Co-dominance*
- *Mutation.*
- *Gene interaction e.g., epitasis complementary genes or polygenic inheritance*

(b) In an animal's species, individual that are homologous for gene A or its allele die. Another independent gene B in the homozygous state, blocks this lethal effect, otherwise gene B has no other effect on the organism.

(i) Workout the expected phenotypic ratio of the viable offspring in a cross of individuals of AaBb and AaBB genotypes.

male x female

Parental genotype. AaBb. X AaBB

Gametes. AB, Ab, aB, ab X AB, aB,

Random fertilization

as shown in the pannet square below:

	AB	Ab	aB	Ab
AB	AA Bb Survives	Aa BB dies	AaBB survives	AaBb Dies
aB	Aa BB Survives	AaBb dies	aa BB survives	aaBb dies

From the table, there 4 viable offspring and 4 non-viable offspring

(ii) State the type of gene interaction in (b) (i)

Epistasis

END