8. Heredity - Board Exam Questions

2 Mark Questions

1) *List any two pairs of visible contrasting characters of garden pea plants used by Mendel for his experiments stating the dominant and recessive characters in each pair.*

Ans:

• Tall plant (dominant) and dwarf plant (recessive)
• Yellow seeds (dominant) and green seeds (recessive)

2) *(a) Explain how the proteins control the 'characteristics' in an organism with the help of an example of 'tallness' trait in pea plant. (b) Name the section of DNA that controls the 'characteristics' in an organism.*

(a) The height of a pea plant depends on the amount of a plant hormone.

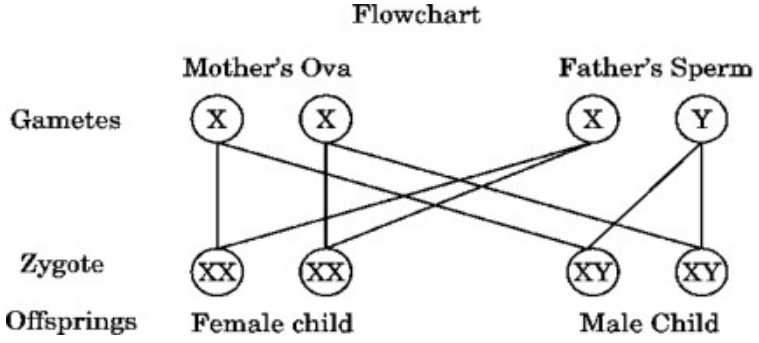
The hormone is made with the help of an enzyme. An enzyme is a protein.

The enzyme is made from the information in a gene (a part of DNA).

If the enzyme works well, more hormone is made, and the plant grows tall.

(b) Gene

3) *Explain with the help of a flow chart that in human beings father is responsible for the sex (male or female) of the child.*



A sperm with X + an egg (always X) = XX, a girl.

A sperm with Y + an egg (always X) = XY, a boy.

The mother gives only X. So the father's sperm decides the sex of the child.

3 Mark Questions

1) *(a) What are chromosomes? (b) Explain in brief how stability of DNA content of a species is ensured in sexually reproducing organisms?*

(a) Chromosomes are thread-like structures in the nucleus. They carry genes, which control the traits of an organism.

(b) Each cell has two copies of every chromosome, one from each parent.

When germ cells (gametes) are formed, the number of chromosomes becomes half.

When the male and female germ cells fuse, the zygote gets the normal number again. So the DNA content stays the same.

2) *Show the cross and observations made by Mendel when he crossed pure tall pea plant with a pure short pea plant to get F_1 progeny.*

Parents: TT (tall) × tt (short)

Gametes: T and t

F_1: Tt, all plants are tall.

Observations:

• No medium-height or short plants were seen in F_1.

• All the plants looked like one of the parents (tall).

3) *Mendel crossed pure tall pea plants (TT) with pure short pea plants (tt) and obtained F_1 progeny. When the plants of F_1 progeny were self-pollinated, plants of F_2 progeny were obtained. (a) What did the plants of F_1 progeny look like? Give their gene combination. (b) Why could the gene for shortness not be expressed in plants of F_1 progeny? (c) Write the*

ratio of the plants obtained in F_2 progeny and state the conclusion that can be drawn from this experiment.

(a) All the plants were tall. Gene combination: Tt

(b) Shortness is a recessive trait. It stays hidden when the dominant (tall) gene is present.

(c) Tall : Short = 3 : 1

Conclusion: Tallness is dominant and shortness is recessive.

4) *Study the given table and answer the following questions: (a) Depict the information given in the table in the form of a cross. (b) Deduce the F_2 phenotypic ratio / F_2 ratio showing external look as well as genotypic / genetic makeup, ratio.*

Parents	F_1	F_2
A pea plant with red flowers was crossed with a pea plant with white flowers.	30 seeds were sown and all bore plants with red flowers.	44 seeds were sown, 33 plants bore red flowers and 11 plants bore white flowers.

(a) Parents: RR (red) × rr (white)

Gametes: R and r

F_1: Rr, all red

F_2 (Rr × Rr): RR, Rr, Rr, rr

(b) Phenotypic ratio: Red : White = 33 : 11 = 3 : 1

Genotypic ratio: RR : Rr : rr = 1 : 2 : 1

5) *The gene combination of purple flowered pea plants is denoted as (WW) and that of white flowered pea plants as (ww), when these two plants are crossed F_1 generation is obtained. (a) List two observations made by Mendel in F_1 generation plants. (b) Give the (i) percentage of white flowered plants and (ii) ratio of the gene combinations WW, Ww and ww*

in F_2 generation. (c) Write one difference between dominant and recessive trait.

(a) All the plants had purple flowers. No plant had flowers of a mixed colour.

(b) (i) 25% (ii) WW : Ww : ww = 1 : 2 : 1

(c) A dominant trait shows itself even when the other (recessive) form is present. A recessive trait stays hidden when the dominant form is present.

6) *List two differences between dominant traits and recessive traits. What percentage of pea plants in the F_2 generation were with yellow seeds in Mendel's cross between the pea plants having yellow (YY) and green coloured (yy) seeds?*

Dominant trait	Recessive trait
When both traits are inherited, the dominant trait shows.	When both traits are inherited, the recessive trait stays hidden.
One copy is enough for it to show.	Both copies must be recessive for it to show.

75% of the F_2 plants had yellow seeds.

7) *A. In a family of four individuals, the father possessed long ears and the mother possessed short ears. If the parents had pure dominant and recessive traits respectively and F1 individual is married to an unrelated individual of the same genotype, then calculate the ratio of genetic makeup of F2 generation. Show a suitable cross. B. If father had short ears and the mother had long ears, and both the parents are homozygous for the allelic pair of genes, explain what effect it will have on the ratio of genetic makeup in F2 generation, if F1 individual is married to an unrelated individual of the same genotype.*

A. Parents: LL (long) × ll (short), so F1 is Ll.

F1 × F1: Ll × Ll gives LL : Ll : ll = 1 : 2 : 1

B. There is no change in the ratio. It is still a cross between a pure dominant and a pure recessive parent. It does not matter which parent has which trait.

8) *The lowest part of the ear called earlobe, is closely attached to the side of the head in some of us (Figure 'X'), and not in others, called free earlobe (Figure 'Y'). Attached and free earlobes are two variants found in human populations. The gene for free earlobe is dominant over attached earlobes. (a) A man with attached earlobes marries a woman having free earlobes. 50% of their children have free earlobes and 50% have attached earlobes. Explain the inheritance of this trait and write the trait combinations of the progeny. (b) Write the gene combinations of the father and the mother in the above case.*

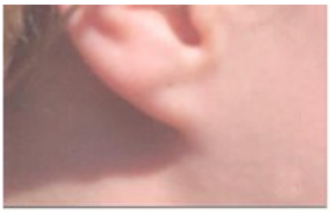


Figure 'X'



Figure 'Y'

(a) Free earlobe (F) is dominant and attached earlobe (f) is recessive.

The father (attached) must be ff. Half the children have attached earlobes, so the mother must be Ff.

Cross: ff × Ff gives Ff and ff, 50% each.

Children: Ff (free earlobes) and ff (attached earlobes)

(b) Father: ff Mother: Ff

9) *A pure pea plant having round (R), yellow (Y) seeds is crossed with another pure pea plant having wrinkled (r), green (y) seeds. Subsequently F_1 progeny is self-pollinated to obtain F_2 progeny. (a) What do the seeds of F_1 generation look like? (b) Give the possible combinations of traits*

in seeds of F_2 generation. Also give their ratio. (c) State the reason of obtaining seeds of new combination of traits in F_2 generation.

(a) Round and yellow.

(b) Round yellow : round green : wrinkled yellow : wrinkled green = 9 : 3 : 3 : 1

(c) The two traits (shape and colour) are inherited independently of each other.

10) *Based on Mendel's experiment show the cross between round, yellow seeds of pea plant (RRYY) with wrinkled and green seeds of pea plant (rryy) upto F_2 generation. Write the number of seeds/plants with following genetic (Genotype) makeup in F_2 generation: (i) RRYY (ii) rryy*

Parents: RRYY (round, yellow) × rryy (wrinkled, green)

F_1: RrYy (round, yellow). F_1 plants are self-pollinated.

Gametes of F_1: RY, Ry, rY, ry

	RY	Ry	rY	ry
RY	RRYY	RRYy	RrYY	RrYy
Ry	RRYy	RRyy	RrYy	Rryy
rY	RrYY	RrYy	rrYY	rrYy
ry	RrYy	Rryy	rrYy	rryy

Out of 16: (i) RRYY = 1 (ii) rryy = 1

11) *In a genetic experiment, plants with pure round green seeds (RRyy) were crossed with plants with wrinkled yellow seeds (rrYY). (i) Show the gametes formed when F1 was self-pollinated. (ii) A total of 144 seeds were produced which developed into saplings. Show the ratio in which these traits are independently inherited in these 144 sapling.*

(i) F1 is RrYy. Its gametes are RY, Ry, rY and ry.

(ii) Ratio 9 : 3 : 3 : 1. Out of 144 (144 ÷ 16 = 9 in each part):

Round yellow: 81 Round green: 27
Wrinkled yellow: 27 Wrinkled green: 9

12) *(a) Giving two examples, justify the statement that the sex of the offspring in all animals is not always genetically determined. (b) Differentiate between the sex chromosomes of male and female human beings.*

(a) In some reptiles, the temperature at which the eggs are kept decides whether the young one will be male or female.

In snails, an individual can change its sex.

(b) A male has a mismatched pair (XY). A female has a perfect pair (XX).

13) *What is the probability of a girl or a boy being born in a family? Justify your answer.*

There is a 50% chance of a girl and a 50% chance of a boy.

A woman has a perfect pair of sex chromosomes (XX). A man has a mismatched pair: a normal X and a short Y (XY).

The child always gets an X from the mother.

If the child gets X from the father, it is a girl (XX). If it gets Y, it is a boy (XY).

Half the father's sperms carry X and half carry Y. So the chances are equal.

<u>4 Mark Questions (Case Study)</u>

1) *Mendel took garden pea plants with different characteristics, such as height to study the inheritance pattern of factors (genes). He crossed tall pea plant with short pea plant and obtained all the tall plants in the F_1 generation.*

(a) Why only tall pea plants were observed in F_1 progeny? (1)

(refer 3rd 3 mark question)

(b) By which method did Mendel obtain F_2 progeny? (1)

Self-pollination of the F_1 plants.

(c) (i) Write one difference between dominant and recessive trait. (2)
(refer 6th 3 mark question)

OR (c) (ii) Write two observations made by Mendel about F_1 progeny.
(refer 2nd 3 mark question)

2) *Mendel worked out the rules of heredity by working on garden pea using a number of visible contrasting characters. He conducted several experiments by making a cross with one or two pairs of contrasting characters of pea plant. On the basis of his observations he gave some interpretations which helped to study the mechanism of inheritance.*
(i) When Mendel crossed pea plants with pure tall and pure short characteristics to produce F_1 progeny, which two observations were made by him in F_1 plants? (1)
(refer 2nd 3 mark question)

(ii) Write one difference between dominant and recessive trait. (1)
(refer 6th 3 mark question)

(iii) (A) In a cross with two pairs of contrasting characters RRYY (Round Yellow) × rryy (Wrinkled Green), Mendel observed 4 types of combinations in F_2 generation. By which method did he obtain F_2 generation? Write the ratio of the parental combinations obtained and what conclusions were drawn from this experiment. (2)

By self-pollination of the F_1 plants.

Parental combinations: Round yellow : Wrinkled green = 9 : 1

Conclusion: The two traits are inherited independently.

OR (iii) (B) Justify the statement: "It is possible that a trait is inherited but may not be expressed."

When plants with yellow seeds are crossed with plants with green seeds, all F_1 plants have yellow seeds. The green trait is hidden.

When the F_1 plants are self-pollinated, some F_2 plants have green seeds. So the green trait was inherited in F_1, but it did not show.

3) *In order to trace the inheritance of traits Mendel crossed pea plants having one contrasting character or a pair of contrasting characters. When he crossed pea plants having round and yellow seeds with pea plants having wrinkled and green seeds, he observed that no plants with wrinkled and green seeds were obtained in the F_1 generation. When the F_1 generation pea plants were cross-bred by self-pollination, the F_2 generation had seeds with different combinations of shape and colour also.*

(a) Write any two pairs of contrasting characteristics of pea plant used by Mendel other than those mentioned above. (1)

• Tall and dwarf plants (height)

• Violet and white flowers (flower colour)

(b) Differentiate between dominant and recessive traits. (1)

(refer 6th 3 mark question)

(c) State the ratio of the combinations observed in the seeds of F_2 generation (in the above case). What do you interpret from this result? (2)

(refer 9th 3 mark question)

OR (c) Given below is a cross between a pure violet flowered pea plant (V) and a pure white flowered pea plant (v). Diagrammatically explain what type of progeny is obtained in F_1 generation and F_2 generation: Pure violet flowered plant (VV) × Pure white flowered plant (vv).

Parents: VV × vv

F_1: Vv, all violet

F_2 (Vv × Vv): VV, Vv, Vv, vv. Violet : White = 3 : 1

4) *In order to study patterns of inheritance, Neha had performed typical Mendelian experiments with pea plants in the field. In experiment one, she crossed a pea plant having white flowers (vv) with another pea plant bearing violet flowers (VV). In another experiment, in addition to the colour of the flower she also focussed on the height of the pea plant. This time she crossed a pea plant having violet flowers and tall height (VVTT)*

with another pea plant having white flowers and short height (vvtt). What percentage is expected for the following traits as a result of these experiments? Give a reason.

A. Violet flowers in F1 and F2 generation in experiment one? (1)

F1: 100% violet (all Vv). F2: 75% violet (VV and Vv). Violet is the dominant trait.

B. Tall height plants with white flowers in F2 generation in experiment two? (1)

3 out of 16 (18.75%). These plants have the dominant tall trait and the recessive white trait (vvTT, vvTt).

C. Percentage of medium height plants with light violet flowers in F1 and F2 generations in experiment two? Give a reason. (2)

Zero. No in-between (medium or light) traits appear. One copy of T or V gives the same result as two copies.

OR D. Percentage of short height plants with white flowers in F1 and F2 generations in experiment two?

F1: Zero. All F1 plants show only the dominant traits.

F2: 1 out of 16 (6.25%) are short with white flowers (vvtt). Both of these traits are recessive.

5) *The most obvious outcome of the reproductive process is the generation of individuals of similar design, but in sexual reproduction they may not be exactly alike. The resemblances as well as differences are marked. The rules of heredity determine the process by which traits and characteristics are reliably inherited. Many experiments have been done to study the rules of inheritance.*

(i) Why an offspring of human being is not a true copy of his parents in sexual reproduction? (1)

In sexual reproduction, a male and a female gamete fuse. The child gets traits from both parents, so it shows variation.

(ii) While performing experiments on inheritance in plants, what is the difference between F_1 and F_2 generation? (1)

In F_1, only the dominant traits show. In F_2, both dominant and recessive traits show.

(iii) (A) Why do we say that variations are useful for the survival of a species over time? (2)

If the surroundings of a population change badly, the whole population could die.

If there are variations, some individuals may be able to survive the change. So the species survives.

OR (iii) (B) Study Mendel's cross between two plants with a pair of contrasting characters. RRYY (Round Yellow) × rryy (Wrinkled Green). He observed 4 types of combinations in F_2 generation. Which of these were new combinations? Why do new features which are not present in the parents, appear in F_2 generation?

New combinations: Wrinkled yellow and round green.

They appear because the genes for the two traits are inherited independently.

6) *Pooja has green eyes while her parents and brother have black eyes. Pooja's husband Ravi has black eyes while his mother has green eyes and father has black eyes.*

(a) On the basis of the above given information, is the green eye colour a dominant or recessive trait? Justify your answer. (1)

Recessive. Pooja's parents have black eyes, but she has green eyes. So green shows only when both genes are recessive (bb).

(b) What is the possible genetic makeup of Pooja's brother's eye colour? (1)

BB or Bb

(c) What is the probability that the offspring of Pooja and Ravi will have green eyes? Also, show the inheritance of eye colour in the offspring with the help of a suitable cross. (2)

Pooja is bb. Ravi has black eyes but his mother has green eyes, so Ravi is Bb.

Cross: Pooja (bb) × Ravi (Bb)

	B	b
b	Bb	bb
b	Bb	bb

50% of the children can have green eyes.

OR (d) 50% of the offspring of Pooja's brother are green eyed. With help of cross show how this is possible.

Pooja's brother must be Bb, and his wife must be green-eyed (bb).

Bb × bb gives Bb, Bb, bb, bb. So 50% of the children can have green eyes.

7) *Figures (a) to (d) given below represent the type of ear lobes present in a family consisting of 2 children – Rahul, Nisha and their parents. Excited by his observation of different types of ear lobes present in his family, Rahul conducted a survey of the type of ear lobes found {Figure (e) and (f)} in his classmates. He found two types of ear lobes in his classmates as per the frequency given below:*



a) Rahul's Father



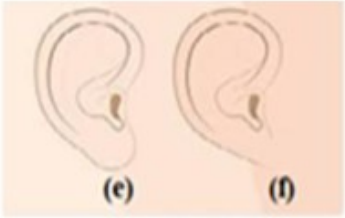
b) Rahul



c) Rahul's Mother



d) Rahul's sister Nisha



Type of ear lobes

Sex	Free	Attached
Male	36	14
Female	31	19

a) Which of the two characteristics - 'free ear lobe' or 'attached ear lobe' appears to be dominant in this case? Why? (1)

Free ear lobe is dominant. Most of the people have free ear lobes.

b) Is the inheritance of the free ear lobe linked with sex of the individual? Give reason for your answer. (1)

No. Free ear lobes are found in both males and females, in the family as well as in the class.

c) What type of ear lobe is present in father, mother, Rahul and his sister Nisha? Write the genetic constitution of each of these family members which explains the inheritance of this character in this family? (Gene for Free ear lobe is represented by F and gene for attached ear lobe is represented by f for writing the genetic constitution). (2)

Father: free (Ff) Mother: free (Ff)

Rahul: attached (ff) Nisha: free (Ff)

OR Suresh's parents have attached ear lobes. What type of ear lobe can be seen in Suresh and his sister Siya? Explain by giving the genetic composition of all.

Father ff, mother ff, Suresh ff and Siya ff. All have attached ear lobes.

Both parents have only the recessive gene (f), so the children can get only f.

8) *All human chromosomes are not paired. Most human chromosomes have a maternal and a paternal copy, and we have 22 such pairs. But one pair called the sex chromosomes, is odd in not always being a perfect pair. Women have a perfect pair of sex chromosomes. But men have a*

mismatched pair in which one is normal sized while the other is a short one.

(a) In humans, how many chromosomes are present in a Zygote and in each gamete? (1)

Zygote: 46 (23 pairs) Each gamete: 23

(b) A few reptiles rely entirely on environmental cues for sex determination. Comment. (1)

(refer 12th 3 mark question)

(c) "The sex of a child is a matter of chance and none of the parents are considered to be responsible for it." Justify it through flow chart only. (2)

(refer 3rd 2 mark question and 13th 3 mark question)

OR (c) Why do all the gametes formed in human females have an X chromosome?

A woman has two X chromosomes (XX). Each egg gets one of them, so every egg has an X.

9) *In some families, either rural or urban, females are tortured for giving birth to a female child. They do not seem to understand the scientific reason behind the birth of a boy or a girl. In fact the mother is not responsible for the sex of the child and it has been genetically proved that the sex of a newborn is determined by what the child inherits from the father.*

(a) State the basis on which the sex of a newborn baby is determined in humans. (1)

(refer 3rd 2 mark question)

(b) Why is the pair of sex chromosomes called a mismatched pair in males? (1)

(refer 13th 3 mark question)

(c) How is the original number of chromosomes present in the parents restored in the progeny? (2)

(refer 1st 3 mark question)

OR (c) Explain by giving two examples of the organisms in which the sex is not genetically determined.
(refer 12th 3 mark question)

10) *In human beings, there are 23 pairs of chromosomes. Out of these 23 pairs of chromosomes (i.e. 46 chromosomes), 22 pairs of chromosomes are called autosomes and one pair of chromosomes. i.e. two chromosomes are called sex chromosomes. The sex chromosomes are of two types – 'X' chromosomes and 'Y' chromosomes. The sex of a child (i.e. progeny), is decided at the time of fertilisation. In other words, at the time of zygote formation the sex chromosomes inherited from the parents of a child decide whether the new born will be a boy or a girl.*
(a) What are chromosomes? (1)
(refer 1st 3 mark question)
(b) Why is the pair of sex chromosomes in human males called mismatched pair? (1)
(refer 13th 3 mark question)
(c) (A) Show with the help of a flow chart that the statistical probability of getting a boy or a girl is 50 : 50. (2)
(refer 3rd 2 mark question and 13th 3 mark question)
OR (c) (B) Mention two examples of animals where sex is not determined genetically like human beings. Describe in brief the method of sex determination in these animals.
(refer 12th 3 mark question)