3.3 Inheritance

Question Paper

Course	DP IB Biology
Section	3. Genetics
Topic	3.3 Inheritance
Difficulty	Medium

Time allowed: 60

Score: /48

Percentage: /100

Question 1a

a) Human red blood cells can be categorised into different blood groups based on the structure of a surface glycoprotein (antigen). The ABO blood groups are controlled by a single gene with multiple alleles (A, B, O). The table below shows all the genotypes for all the possible blood groups.

Phenotype	Genotype
Blood Group A	I^AI^A I^Ai
Blood Group B	I^BI^B I^Bi
Blood Group AB	I^AI^B
Blood Group O	ii

A child has blood group AB and their father has blood group A.

Identify the possible phenotypes of the mother.

[2 marks]

Question 1b

b) Suggest which pattern of inheritance is exhibited in the AB blood group.

[1 mark]

Question 1c

c) A woman with a family history of colour-blindness and a man with normal colour vision wish to start a family but are concerned that all their children will be colour-blind. They decide to speak to a genetic counsellor

Suggest why the parents are concerned.

[2 marks]

Question 1d

d) Genetic testing showed that the woman was carrying the gene for colour-blindness. The genetic counsellor provided information about the chances of having children with colour blindness.

Using the following symbols:

X^B = an X chromosome carrying the normal allele for colour vision
X^b = an X chromosome carrying the allele for colour blindness

i) Identify all the possible genotypes for female and male offspring.

ii) Predict the probability of having a child with colour-blindness.

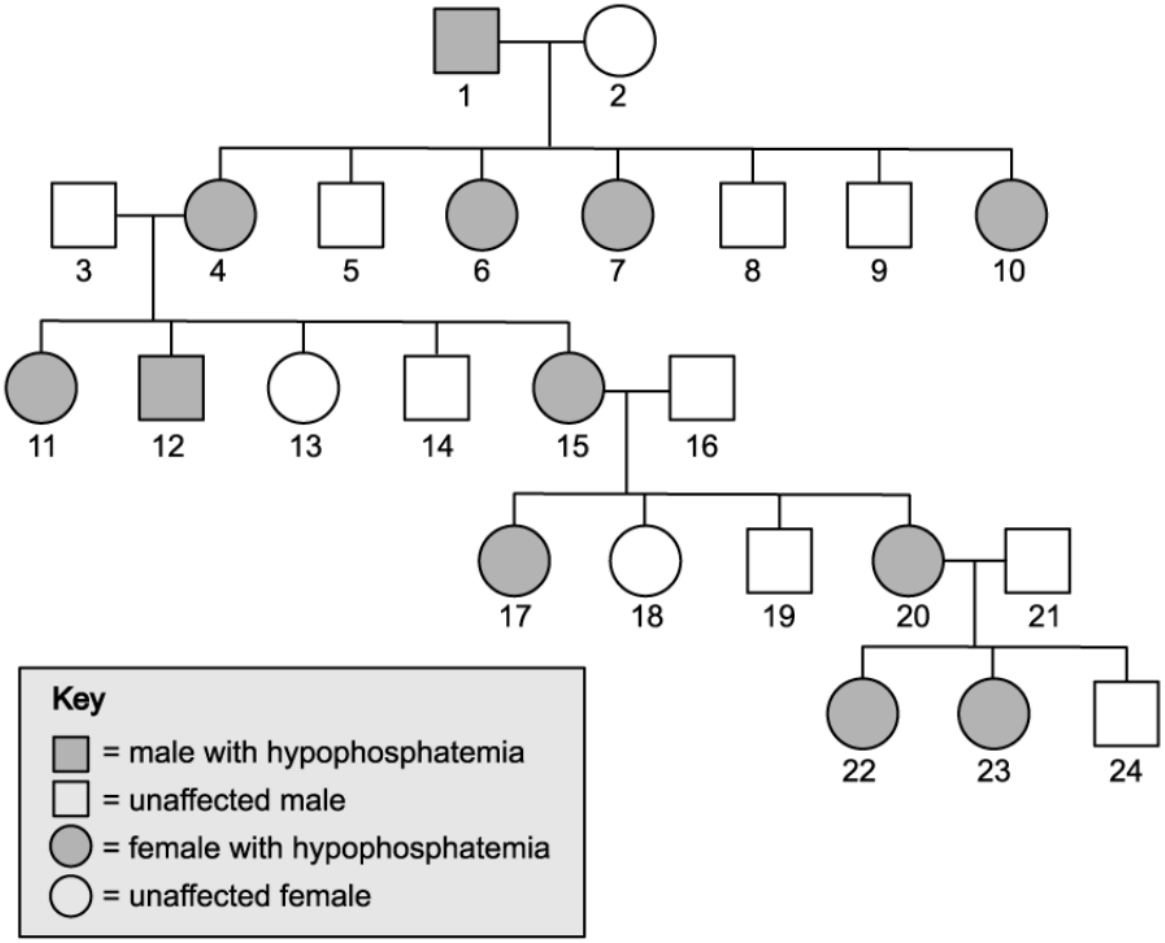
[3 marks]

Question 2a

a) Hypophosphatemia is a sex-linked inherited condition which results in abnormally low levels of phosphate in the blood which can cause the disease rickets. It is caused by a dominant allele.

The diagram below shows the inheritance of hypophosphatemia in one family.

Figure 1



State the evidence that suggests that hypophosphatemia is a sex-linked, dominant inherited disease.

[2 marks]

Question 2b

b) Using the following symbols,

X^H = an X chromosome carrying the allele for hypophosphatemia
X^h = an X chromosome carrying the normal allele
Y = a Y chromosome

Identify all the possible genotypes of each of the following persons from the diagram in part (a):

1 :
4 :
5 :
13 :

[2 marks]

Question 2c

c) Person 20, from the diagram in part (a), is pregnant for the fourth time. As the family has a history of hypophosphatemia, a test was carried out to discover the sex of the embryo.

Describe what possible observations of the chromosomes would be expected when determining the sex of an embryo.

[2 marks]

Question 2d

d) State the probability that the child Person 20 is pregnant with will be a male with hypophosphatemia.

Explain your answer by drawing a genetic diagram, using the following symbols:

X^H = an X chromosome carrying the allele for hypophosphatemia
X^h = an X chromosome carrying the normal allele
Y = a Y chromosome

[4 marks]

Question 3a

a) A horticulturist investigated the inheritance of flower colour in *Camellia japonica*, a widely cultivated ornamental plant commonly known as Japanese camellia.The horticulturist crossed a homozygous parent with red flowers and a homozygous parent with white flowers. All of the F1 generation had the same colour flowers. Using the following symbols:

C^R = Red flowers
C^W = White flowers

Sketch a genetic diagram / Punnett square to deduce all the genotypes in this cross.

[2 marks]

Question 3b

b) Each of the F1 generation plants had flowers that were patterned red and white. The horticulturist undertook a self-cross with these F1 hybrids.

i) State all the possible phenotypes of the F2 hybrids

ii) Deduce the probability of obtaining a white flower.

[2 marks]

Question 3c

c) Describe, with a reason, what pattern of inheritance is exhibited in the horticulturist's experiment.

[3 marks]

Question 4a

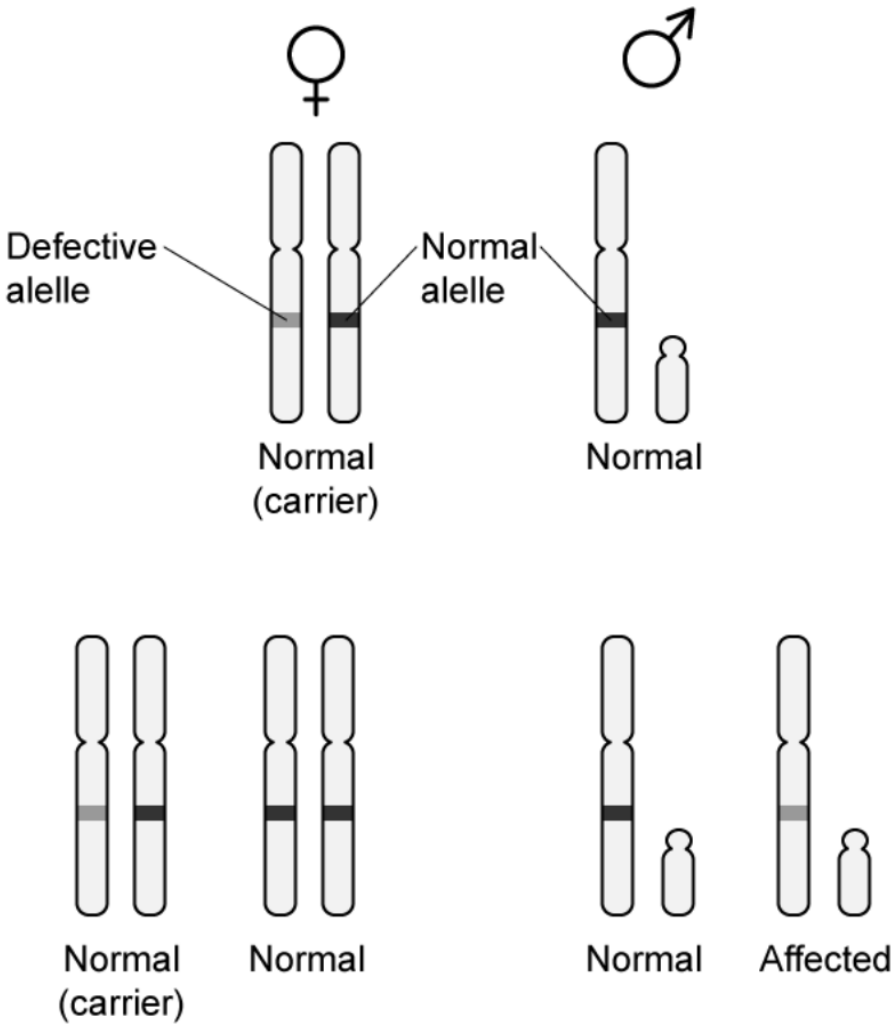
a) FG syndrome is a recessive disorder that can cause a characteristic facial appearance, developmental delays and hyperactivity. FG syndrome is a rare X-linked genetic disorder that occurs almost exclusively in males, it is caused by a mutation in the *MED12* gene on the X chromosome.

Suggest why FG syndrome occurs almost exclusively in males.

[2 marks]

Question 4b

b) The diagram below shows the familial inheritance of an X-linked recessive disease.



Describe the patterns of inheritance that hold true for X-linked conditions.

[3 marks]

Question 4c

c) Haemophilia is due to a sex-linked recessive gene X^h whereas the normal gene is X^H. A haemophiliac man and a woman, who does not have haemophilia, have two children. Their first child is male and has haemophilia.

Deduce what this tells us about the mother.

[1 mark]

Question 4d

d) Their second child is female.

Deduce, with a reason, the probability that their daughter will also have haemophilia.

[2 marks]

Question 5a

One mark is available for clarity of communication throughout this question.

a) Radiation and mutagenic chemicals can cause mutations in DNA that result in new alleles.

Explain how mutations in DNA can affect the final protein product.

[3 marks]

Question 5b

b) Outline the consequences of radiation after the Chernobyl power plant accident.

[5 marks]

Question 5c

c) Outline the inheritance of colour-blindness.

[7 marks]