3.3 Inheritance

Question Paper

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

Time allowed: 70

Score: /52

Percentage: /100

Question 1a

a)
State and explain **three** features of sweet pea plants that enabled Mendel to make meaningful genetic observations.

[3 marks]

[3 marks]

Question 1b

b)
Aside from his ground-breaking experiments in genetics, Mendel is also credited with establishing one of the most fundamental principles of good experimental practice.

Explain how his experiments allowed him to accomplish that.

[3 marks]

[3 marks]

Question 1c

c)
Human eggs and sperm cells are very different in size to each other.

Explain why, despite this size difference, both contribute equally to the genetic composition of a zygote.

[1 mark]

[1 mark]

Question 1d

d)
Explain the concept of, and the importance of, segregation of alleles.

[3 marks]

[3 marks]

Question 2a

a)
Explain why knowledge of blood groups is of critical importance when planning a blood transfusion.

[2 marks]

[2 marks]

Question 2b

b)
A man of blood group **AB** and a woman of blood group **B** have four children together.

- One child is blood group **AB**
- One child is blood group **A**
- Two children are blood group **B**

Assuming that the genotypes of the four children are representative of the expected genotype ratios, deduce the mother's and father's genotypes under the A, B, O blood grouping system.

[3 marks]

[3 marks]

Question 2c

c)
Using your knowledge of the A, B, O blood grouping system, suggest why people of blood group O are sought-after as blood donors.

[2 marks]

[2 marks]

Question 2d

d)
As stated in part (c), group O blood is highly valued for transfusions into other patients.

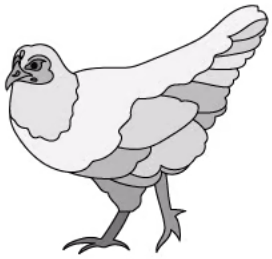
Explain the main **disadvantage** of a person having group O blood.

[2 marks]

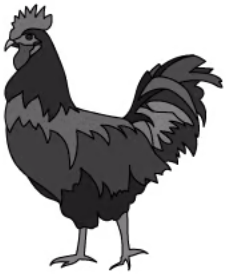
[2 marks]

Question 3a

a)
Chickens can produce pigmentation in their feathers to make them white, black or speckled, as shown in the diagram below.



White feathers



Black feathers

Speckled feathers

Homozygous white-feathered chickens can be crossed with homozygous black-feathered chickens to produce speckled offspring. This occurs via codominance.

Construct a Punnett grid to show the results of two of the speckled offspring being crossed. Use your Punnett grid to deduce the ratios of the various phenotypes that would come out of the cross.

[4 marks]

[4 marks]

Question 3b

b)
Explain why the traits shown in part (a) are referred to as *codominant*.

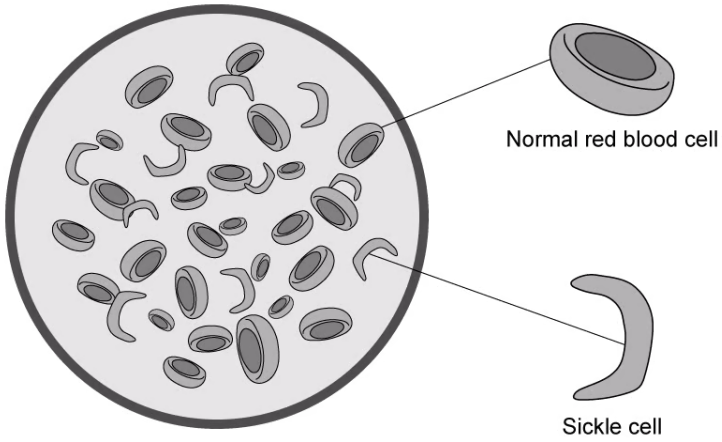
[2 marks]

[2 marks]

Question 3c

c)
The genetic disease sickle cell anaemia is caused by a faulty allele of the beta-globin gene, needed for the production of functional haemoglobin in red blood cells.

The faulty allele causes red blood cells to adopt a sickle shape when oxygen availability is low, as opposed to the conventional biconcave disc structure, as shown below. Sickle cells cause considerable suffering including severe cramping pains in fingers and toes, and general fatigue.



The following table gives information about the condition in its various forms.

Genotype	Disease manifestation
Homozygous dominant	No disease All red blood cells are biconcave discs
Heterozygous	Mild symptoms at worst Mixture of biconcave discs and sickle-shaped cells at low oxygen levels
Homozygous recessive	Severe disease All red blood cells sickle-shaped at low oxygen levels, considerable suffering

Use the information above to explain why the condition is regarded as codominant.

[2 marks]

[2 marks]

Question 4a

a)

Explain why mutations only rarely lead to advantageous alleles, but when they do, there is a positive effect on a species.

[2 marks]

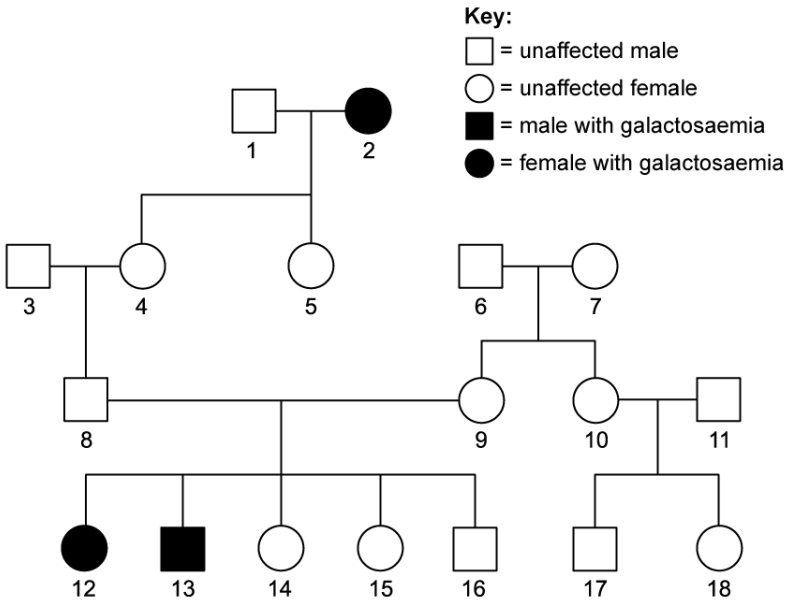
[2 marks]

Question 4b

b)

Galactosaemia is a condition that causes sufferers to be unable to metabolise the sugar galactose properly.

The pedigree chart below shows part of a family in which galactosaemia is an inherited condition.



Explain how this pedigree chart indicates whether galactosaemia is recessive, sex-linked or both.

[3 marks]

[3 marks]

Question 4c

c)
i)

Outline the cause of the genetic disease cystic fibrosis, along with its main symptoms.

[3 marks]

ii)
Two individuals, who do not exhibit symptoms of cystic fibrosis, want to have children together and have asked for guidance as to their potential risk of having a child with cystic fibrosis. The parents are not aware of their own genotypes.

What should they be told about their potential risks?

[2 marks]

[5 marks]

Question 5a

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

a)

i)

A certain species of flower grows with either red or white petals. The allele for red flowers, **R**, is dominant to the allele for white flowers, **r**.

Construct a genetic diagram to predict the outcome of crossing pure-bred red flowers with pure-bred white flowers. State the genotype and phenotype ratios that would be expected in the F_1 generation.

[3 marks]

ii)

Plants from the F_1 generation were crossed.
Construct a second genetic diagram to predict the outcomes.

State the genotype and phenotype ratios that would be expected in the F_2 generation.

[4 marks]

[7 marks]

Question 5b

b)
After the 1986 nuclear accident at the Chernobyl power plant in northern Ukraine, an exclusion zone of 2,600 km^2 was set up around the plant.

Explain why this measure was taken and is still in force, over 35 years after the incident.

[4 marks]

[4 marks]

Question 5c

c)
Huntington's disease is a genetic condition that affects the brain progressively. Problems with coordination worsen over time and can ultimately cause death by, for example, an inability to swallow or by injuries associated with falling.

i)
Huntington's disease is described as an ***autosomal dominant*** disorder. Explain the meaning of this description.

[2 marks]

ii)
The mutation in the Huntington's disease allele contains a higher-than-normal number of repeats of a certain nucleotide sequence coding for a protein called huntingtin.

Suggest the consequence to the protein huntingtin of the extra nucleotide repeats.

[2 marks]

[4 marks]