Model Answers: Hard

Q1

The correct answer is **D** because:

- Both parents would need to be **carriers** of the **recessive** allele for any of the offspring to be dwarf plants, so this rules out option **C**.
    - If one parent is homozygous dominant, then all of the offspring will inherit at least one dominant allele in their genotype and therefore have the dominant phenotype.
- All offspring would have the dwarf phenotype in the cross in option **A** as the parents can only pass on recessive alleles.
- This leaves options **B** and **D:**
    - In option B each there is only a 0.25 chance that any offspring will have the recessive phenotype
- This leaves us with option **D**:
    - The ratio produced by crossing the individuals in this option would be 2:2 and so simplified to 1:1.
    - This is shown in the **punnett square** below:

	T	t
t	Tt	tt
t	Tt	tt

A is incorrect as	all the offspring would be dwarf plants as they can only inherit the t allele.
B is incorrect as	crossing two **heterozygous** parents gives the 3:1 ratio with 3 out of 4 plants being tall.
C is incorrect as	all the plants will be tall in this case as they can only inherit the **dominant** allele from one of the parents.

Q2

The correct answer is **C** because:

- For the daughter to have the condition she would need to inherit two recessive alleles, aa.
- To be a girl she will inherit an **X** chromosome from each parent
- There is a 50% chance that she will inherit the recessive allele from her mother. This is shown in the punnett square:

	X^a	Y
X^a	X^aX^a	X^aY
X^A	X^AX^a	X^A

Q3

The correct answer is **A** because the ribosomes are responsible for protein synthesis in all cells. They attach to the **mRNA** released from the **nucleus**. The **ribosome** is then involved in the assembly of the protein from amino acids based on the **sequence of bases** in the **mRNA**.

B is incorrect as	**chloroplasts** are the site of **photosynthesis.**
C is incorrect as	**mitochondria** are the site of **aerobic respiration**..
D is incorrect as	**cell walls** provide support for the cell.

Q4

The correct answer is **B** because:

- For some of the children to have a reduced risk of developing malaria they would need to have heterozygous genotypes.
- For some of the children to have all normal blood cells they would need to have the **homozygous** normal genotype (as heterozygotes produce both normal and abnormal red blood cells).
- So the parents would need to have the genotypes that would produce these two combinations. This is shown in the punnett square:

	Hb^A	Hb^S
Hb^A	$Hb^A Hb^A$	$Hb^A Hb^S$
Hb^A	$Hb^A Hb^A$	$Hb^A Hb^S$

- $Hb^A Hb^S$ produces children that have a reduced risk of developing malaria (which is why the incidence of being a carrier of sickle-cell is much higher in parts of the world where malaria is more common).
- $Hb^A Hb^A$ produces children that have all normal red blood cells.

Q5

The correct answer is **A** because:

- Males are **XY** and females are **XX**.
- In order for the sex of the offspring to be a female she will need to inherit an X chromosome from **each** parent.
- In order for the sex of the offspring to be a male he will need to inherit an X chromosome from his mother and a Y chromosome from his father.
- The mother can only give the offspring an X chromosome so the gamete Q must have the X chromosome.
- To be a male son **R** must be XY.

Q6

The correct answer is **D** because

- Blood group inheritance is an example of codominance.
- There are three possible alleles that can be inherited; but an individual can only have a maximum of two alleles.
- Alleles I^A and I^B are dominant over I^O, so as one parent is homozygous for blood group A, all of the offspring will inherit the **I^A** allele, meaning all the offspring will be in group A (as the partner has a heterozygous genotype with the recessive I^O allele.

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	I^A	**I^O**
I^A	I^AI^A	I^AI^O
I^A	I^AI^A	I^AI^O

Q7

The correct answer is **C** because:

- Dominant characteristics will show even if a recessive allele is present in the genotype (for example in an heterozygous individual).
- Organisms that are orange-eyed must be recessive as when crossed offspring always have orange-eyes.
- In order for there to be a mixture of red and orange-eyed individuals the red-eyed flies must have been heterozygous.
    - If R = red eyes and r = orange eyes then the punnett square for two orange-eyed individuals would be:

	r	**r**
r	rr	rr
r	rr	rr

    - The cross for red-eyed flies would be:

	R	**r**
R	Rr	Rr
r	Rr	rr

A is incorrect as	if the allele for orange eyes was dominant, then the results of the two red-eyed fly cross would be all red eyes and in this case the red eyes trait would be recessive (rr).
B is incorrect as	the 1:1 ratio would depend on the genotype of the red-eyed fly in the cross and can't be concluded from the information given.
D is incorrect as	we do not need to do a cross to find the 3:1 ratio just to find out which of the alleles are dominant.

Q8

The correct answer is **C** because:

- The parent without Huntington's (non-huntington's) must be homozygous recessive (hh).
- The parent with Huntington's must be heterozygous (Hh) as they have one child without the disease and the sufferer must have passed on a recessive allele.
- The punnett square for this will be:

	H	**h**
h	Hh	hh
h	Hh	hh

- This shows a 50% chance of any child from this cross being a sufferer of the disease.

Q9

The correct answer is **D** because:

- Blood group inheritance is an example of codominance.
- There are three possible alleles for the blood group (but remember a person can inherit a maximum of two alleles per gene).
- Alleles I^A and I^B are dominant groups over I^O
- Jignasha has two children with someone who has the A blood group phenotype.
- Jignasha's son is blood group B, meaning that Jignasha must have at least one I^B allele, as his father would not have this allele (the father must be I^AI^O).
- Jignasha's daughter's genotype is not shown, but she has one daughter who is blood type O and one who is blood type A. The child who is blood group O must be I^OI^O so the allele for I^O must have come from Jignasha making her I^BI^O.