S5 Biology Practice Paper 1 | Mendel, blood groups, sex linkage, DNA replication, population genetics

Senior Secondary Biology

S5 Biology practice paper 1 with full solutions: Mendelian ratios, ABO and Rh blood groups, sex-linked inheritance, DNA replication, codons and Hardy-Weinberg frequencies.

1. Mendelian monohybrid crosses (16 marks)

In peas, tall stem (T) is dominant to dwarf stem (t) and height is controlled by one pair of alleles. The first cross is between two heterozygous tall plants (Tt x Tt) and gives 320 offspring; the second cross is between a heterozygous tall plant and a dwarf plant (Tt x tt) and gives 240 offspring. Assume the offspring numbers reflect the theoretical ratios.

#	Question
1	(a) In the first cross (Tt x Tt), what is the theoretical ratio of tall to dwarf offspring, and how many of each?
2	(b) Among the offspring of the first cross, how many are homozygous tall (TT) and how many heterozygous tall (Tt)?
3	(c) How many tall and how many dwarf plants result from the second cross (Tt x tt), and in what ratio?
4	(d) If one plant is picked at random from the 320 offspring of the first cross, what is the probability that it carries the t allele? Give the answer as a percentage.

2. Dihybrid cross (16 marks)

In peas, round seed (R) is dominant to wrinkled seed (r) and yellow cotyledon (Y) is dominant to green cotyledon (y). The two gene pairs lie on different chromosomes, so they assort independently. Two round yellow plants (RrYy x RrYy) are crossed and give 800 offspring.

#	Question
5	(a) What is the theoretical ratio of the four phenotypes, and how many plants show each?
6	(b) What percentage of the offspring is round yellow, and what are the number and percentage of wrinkled green offspring?
7	(c) How many offspring have the genotype RrYy?
8	(d) How many plants are homozygous round yellow (RRYY) and how many are homozygous wrinkled green (rryy)?

3. ABO and Rh blood group inheritance (18 marks)

ABO blood group is controlled by three alleles I^A, I^B and i; I^A and I^B are dominant to i, and I^A with I^B gives group AB. The first couple is a father of group A (I^A i) and a mother of group B (I^B i), with 400 children recorded. The Rh factor is controlled by a separate pair of alleles, with Rh positive (D) dominant to Rh negative (d).

#	Question
9	(a) Which blood groups can the children of this couple have, in what ratio, and how many of the 400 children fall in each group?

#	Question
10	(b) A second couple has a father of group O (ii) and a mother of group AB (I^A I^B). How are their 320 children distributed by blood group?
11	(c) Can a father of group AB and a mother of group O have a child of group O? Explain in terms of alleles.
12	(d) A Dd x dd couple has 200 children. How many are Rh positive and how many Rh negative?

4. Sex-linked inheritance and the frequency of colour blindness (18 marks)

Red-green colour blindness is caused by a recessive allele (c) on the X chromosome; the normal allele (C) is dominant and the Y chromosome carries no corresponding gene. A carrier mother (X^C X^c) and a father with normal vision (X^C Y) have 400 children, 200 sons and 200 daughters. In another population 16 of 200 men are red-green colour blind.

#	Question
13	(a) In that family, how many sons and how many daughters are colour blind?
14	(b) What phenotypes result from a colour-blind father (X^c Y) and a homozygous normal mother (X^C X^C), and what proportion of the daughters are carriers?
15	(c) What is the frequency of colour blindness among the men, what is the allele frequency q of c, and what percentage of women would be expected to be colour blind?
16	(d) Under Hardy-Weinberg equilibrium p = 1 - q. What is the frequency 2pq of carrier women (X^C X^c)? Give it as a percentage.

5. DNA base pairing, replication and protein synthesis (16 marks)

A double-stranded DNA molecule contains 1200 base pairs, that is 2400 bases, and adenine (A) makes up 30 per cent of all the bases. During replication each original strand acts as a template on which a new strand is built, giving two identical molecules. In translation every three mRNA bases form one codon coding for one amino acid.

#	Question
17	(a) How many A, T, G and C bases are there in this DNA molecule?
18	(b) What percentage of all the bases is A plus T, and what percentage is G?
19	(c) After three successive rounds of replication, how many molecules are produced, and how many newly made DNA strands are there in total?
20	(d) An mRNA of 90 bases can form how many codons and code for how many amino acids at most? If a protein has 45 amino acids, what is the minimum number of mRNA bases needed (ignoring the stop codon)?

6. Hardy-Weinberg equilibrium and allele frequencies (16 marks)

An island carries 500 snails whose shell colour is controlled by one pair of alleles, dark (D) being dominant to pale (d). A survey finds 320 dark and 180 pale snails, and the population is in Hardy-Weinberg equilibrium, that is p squared + 2pq + q squared = 1 with p + q = 1. The climate then changes and all pale snails are eaten by predators.

#	Question
21	(a) Find q squared, q and p; how many dark homozygous snails (DD) would be expected?
22	(b) How many heterozygotes (Dd) would be expected, and does the total with DD equal the number of dark snails?
23	(c) After all pale snails are removed, what is the frequency of allele D among the remaining dark snails?
24	(d) If the remaining population mates at random, how many pale snails are expected among 500 offspring?