Questions

1.

a. What is Mendel's first principle? In your answer give an example of a cross that led Mendel to this explanation.

i. Mendel's first principle was the principle of segregation, which is when the individual organism's genetic characteristics are regulated by pairing genes randomly, but equally, during gamete formation. The result of this principle is that each gamete receives one allele, or gene, that contributes to the expression of certain phenotypic traits. In the table below, the dominant trait of round seeds (R) and the recessive trait of wrinkled seeds (r) are paired as follows:

	R	r
R	RR	Rr
r	Rr	rr

The table shows the phenotype of 3:1 round:wrinkled and the genotype 1RR:2Rr:1rr, which indicates that when the round seed trait (R) is present, the seeds will be round unless the genotype of the seed is homozygous recessive (rr) then will the seed be wrinkled.

b. What is meant by the term "testcross"? Explain by writing out such a cross.

i. A purple flower with an unknown genotype was crossed with a homozygous recessive white flower (pp).

	P	?
p	Pp	Pp or pp
p	Pp	Pp or pp

If the offspring of the flowers are all purple, then the parent must be homozygous dominant (PP). However, if half of the flowers are white and the other half is purple, then the parents must be heterozygous dominant (Pp).

c. What is meant by the term "true-breeding plants"? Explain by writing the genotypes of a cross between two true-breeding plants.

i. True-breeding is when a trait is homozygous at that gene. Therefore, when a homozygous dominant individual (AA) is crossed with a homozygous recessive individual (aa), the following results:

	A	A
a	Aa	Aa
a	Aa	Aa

2.

a. What is Mendel's second principle? Include in your answer the type of cross that led Mendel to this explanation.

i. Mendel's second principle is the principle of independent assortment, which is when every gene equally and independently separated. This yields all possible combinations of formed gametes. The dihybrid cross was used to explain Mendel's principle of independent assortment because it showed the independent traits of the pea plants.

b. What is a Punnett square? Explain your answer by showing the genotypes of all

possible progeny from a cross between PpSs x PpSs.

	PS	Ps	pS	ps
PS	PPSS	PPSs	PpSS	PpSs
Ps	PPSs	PPss	PpSs	Ppss
pS	PpSS	PpSs	ppSS	ppSs
ps	PpSs	Ppss	ppSs	ppss

3.

a. What is meant by the term "probability"? How would you calculate the probability of an event happening?
   i. Probability can be determined using both the sum rule and the product rule, which calculates the likelihood of whether or not something may or may not happen. The sum rule is used to determine the probability that independent events will happen while the product rule is used to determine the likelihood that events will happen independently but at the same time.
b. How are Mendelian ratios translated into probabilities? Give an example.
   i. The ratios can be translated into probabilities to predict the traits of the F_2 generation. For example, according to the product rule, the probability of an F_2 plant having yellow and round seeds is 9/16 because ¾ of all the F_2 plants should be round while ¾ should be yellow. Therefore, since two independent traits are happening at the same time, the product rule was used to determine the probability.
c. List all the possible gametes from a triple heterozygote assuming Mendel's 2nd Principle.
   i. For the F_1 generation, the resulting gametes from parents AABBCCxaabbcc are ABC, ABc, AbC, Abc, aBC, aBc, abC, and abc.

4.

a. Complete the following cross between a round pea plant and a wrinkled pea plant: Rr x rr.

	R	r
r	Rr	rr
r	Rr	rr

b. R = dominant round allele, r = recessive wrinkled allele. The plants with the round pea seeds are selfed. What proportion of the resulting F2 generation is expected to be wrinkled?

	R	R
r	Rr	Rr
r	Rr	Rr

The result for F_1 is round allele (Rr) since the parents that are being crossed are dominant round allele and recessive wrinkled allele (RRxrr)

	R	r
R	Rr	Rr
r	Rr	rr

The result for the F_2 generation is 3:1 dominant round allele:recessive

wrinkled allele. Therefore, ¼ of the F_2 generation is expected to be wrinkled.

c. We observe 340 wrinkled and 660 round pea plants in the F2 generation. Calculate the chi-square value of this cross, and determine if the principle of segregation explains these results. Use the table for c^2 values in your text.
   i. The chi-square value was determined to be 43.2 with a degree of freedom of n=1. Therefore, the p-value was calculated to be $p \leq 0.001$. However, the principle of segregation would not be used to explain these results because it states that the paired alleles are randomly separated during the formation of gametes. Therefore, each gamete would receive alleles with the same probability.

5.

a. In dogs, T = dominant allele for long tail, t = recessive allele for short tail,B = dominant allele for brown, and b = recessive allele for black. When completing the cross TtBb x TtBB, what proportion of the F1 is ttBB?
   i.

	TB	Tb	tB	tb
TB	TTBB	TTBb	TtBB	TtBb
TB	TTBB	TTBb	TtBB	TtBb
tB	TtBB	TtBb	ttBB	ttBb
tB	TtBB	TtBb	ttBB	ttBb

There is a 2/16 chance that a dog in the F1 generation will have a short tail with brown fur (ttBB).

b. What is the probability of a blue-eyed (recessive) mom and a brown-eyed (dominant) dad having a brown-eyed child? Consider all possible genotypes of Dad at this gene and give the probabilities associated with each genotype.
   i. If the mom (bb) is crossed with a homozygous dominant dad (BB) the following would result:

	B	B
b	Bb	Bb
b	Bb	Bb

The probability of having a brown-eyed child would be 100%.
If the mom (bb) is crossed with a heterozygous dominant dad (Bb) the following would result:

	B	b
b	Bb	bb
b	Bb	bb

There is a 50% chance that they would have a brown-eyed child.

c. If the couple in b, had a blue eyed child, what is the probability of them subsequently having a brown eyed child and a blue eyed child?
   i. Using the product rule, the probability of the couple in b subsequently having a brown eyed child and a blue eyed child is ¼, which is shown: ½ x ½ = ¼.