

1). ABO blood groups. [25 Points]

Page 1

a) What are the expected offspring, and their frequencies, if mom is Type AB and dad is Type O? [10 points]

Mom - AB, Dad - ii

Offspring are

50% Ai = Type A

50% Bi = Type B

b) Suppose that dad is type Rh+, while mom is type Rh-. If their son is Rh+, and their two daughters Rh-, what are the genotypes of both parents at the Rh locus? [5 points]

Dad is Rh+, so genotype could be either Rh+Rh+ or Rh+Rh-

Mom is Rh -, so genotype is Rh-Rh-

c) An A+ woman has an O- son, and claims one of two persons is the father. Joe has type AB-, while Sam has type B+. Can either (or both) be excluded as the potential father? Why? [10 points]

Since mom is A+, offspring is O-, mom has to be Ai+- (as the son must get an i- from both parents)

Joe is AB-, and hence cannot have an O offspring (he can't pass along an i allele)

Sam is B+, but he could be Bi+- and hence give an i-offspring)

2) Basic probability. [25 points]

Page 2

Consider a population where the ABO alleles have frequencies
 $\text{freq}(A) = 0.5$, $\text{freq}(B) = 0.4$, $\text{freq}(i) = 0.1$

a) What is the expected frequency of an individual of blood type AB? [5 points]

$$2 * 0.5 * 0.4 = 0.4$$

b) What is the expected frequency of a type A individual? [5 points]

Type A = AA or Ai

$$\text{Pr}(A) = \text{Pr}(AA) + \text{Pr}(Ai) = 0.5^2 + 2 * 0.5 * 0.1 = 0.35$$

c) What is the probability of getting any genotype besides Type O? [5 points]

$$\text{Pr}(O) = \text{Pr}(ii) = 0.1^2 = 0.01$$

$$\text{Pr}(\text{Not } O) = 1 - \text{Pr}(O) = .99$$

d) How many individuals do we have to sample to have at least a 90 percent probability of drawing a type O? [10 points]

$$\text{Pr}(90\% \text{ chance of at least one } O) = \text{Pr}(10\% \text{ chance of all not } O) = .99^n$$

$$\text{Need to solve for } n \text{ in } 0.1 = .99^n$$

$$\text{or } n \log(.99) = \log(.1) \text{ , or } n = \log(.1) / \log(.99) = 229$$

3) DNA structure. [25 points]

Consider the following DNA sequence

5' A G T T C G A G G G G G G G C C A A 3'

a) Draw the complementary strand on the figure below [5 points]

5' A G T T C G A G G G G G G G C C A A 3'
3' T C A A G C T C C C C C C C G G T T 5'

b) Suppose you add a 5' G G C C 3' primer. Show on the sequence below (i) where this binds and (ii) the new DNA generated from this primer. [10 points]

5' A G T T C G A G G G G G G G C C A A 3'
3' T C A A G C T C C C C C C C G G 5'

c) You wish to use a PCR reaction to amplify the G G G G G G G region in the middle. What are the two four-base primers you need to do this? Hint: (i) Don't forget polarity, and (ii) your answer from (a) will be very useful! [10 points]

5' A G T T C G A G G G G G G G C C A A 3'
3' T C A A G C T C C C C C G G T T 5'
5' T C G T 3'

4) Short answers (one-two sentences)
[5 points each]

Page 4

a) What is the difference between genotype and phenotype?

Genotype = the genetic makeup of an individual
Phenotype = the appearance of an individual.
For example, Type A is a phenotype, AA is a genotype

b) List two advantages for forensics from using PCR.

Require much smaller sample
Can split sample for independent testing

c) What was Mendel's key idea about genetics?

Genes are discrete particles.

d) Give one reason while use now use STR markers in place of RFLP markers for forensics.

STRs are much more accurate to read. They are also much quicker to score

e) What are the AND and OR rules of probability?

AND = multiple probabilities
OR = add probabilities