Human Genetics:
Problem Set V

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Abstract

This work contains the solutions to the problem set V of Human Genetics 2015 course at New York University.

Question 1 .

Solution. It is known that

$$\begin{aligned} \text{The concentration of A} &= \text{The concentration of T} \\ \text{The concentration of G} &= \text{The concentration of C,} \end{aligned}$$

and the above four bases are the only bases present. Consequently, as we have that the concentration of A is 19%, we have the following concentrations of each bases:

$$\begin{aligned} \text{The concentration of A} &= 19\% \\ \text{The concentration of T} &= 19\% \\ \text{The concentration of G} &= 31\% \\ \text{The concentration of C} &= 31\%. \end{aligned}$$

Question 2 .

Solution. One base pair gives 4 possibilities. Since $\log_4(321948059) \approx 14.13$, it is required to have 15 base pairs to have at least 321 million different possible DNA sequence.

Question 3 .

Solution. (a) We have the following relation:

$$\text{Heritability} = \frac{\text{Transmitted Variation}}{\text{Phenotypic Variation}}.$$

Since the heritability of the trait is 0.5, half of the total phenotypic variation of the trait in the population, is attributed to the genotypic variation.

(b) If the population became a socialist utopia where everyone had perfect access to resources, the heritability of the trait will increase over the succeeding generation. As the environmental factors will have less variance, and phenotypic variation will decrease, while the genetic variation, with its underlying principles not changed, will remain constant. Hence, the denominator of heritability stays the same, and the numerator decreases. Therefore, heritability will increase.

(c) The question entirely depends on the nature of phenotype under consideration. For instance, for an adult, it is much harder to find a way to change the lung volume, then change his or her hair color.

Question 4 .

Solution. (a) The figure 1 helix is right-handed, when the figure 2 helix is left-handed.

(b) The figure 2 helix has a major groove and a minor groove, when the figure 1 helix does not.

(c) Both figures have a proper combinatorial constraint with base-pairing. The figure 1 has purple-green, green-purple, red-blue, and blue-red base pairs. The figure 2 has red-green, green-red, blue-yellow, and yellow-blue base pairs.