**PART I: Human Height**

1. Is the height of a human offspring equal to the average of the heights of his/her parents?
2. Do the heights of offspring correlate with the average height of parents?
3. What would this graph look like if there was a perfect 1-to-1 relationship between parental and offspring heights? Draw your prediction here.
4. What aspect of Galton’s data supports the argument that height is a heritable characteristic?
5. What aspect of Galton’s data supports the argument that height is not entirely determined by heritable factors?
6. Speculate about environmental factors that might affect a person’s final adult height.

**PART II: Rat blood pressure**

1. Giuseppe Bianchi and his colleagues studied blood pressure in rats. The scientists developed two colonies by breeding rats that had low blood pressure (BP) with each other in one colony, and rats that had higher BP with each other in the other colony. The scientists then sequenced several genes and found that one protein, *adducin*, had genetic differences between the two colonies. Adducin is a heterodimer, which means it is made of two different subunits: the α-subunit and the β-subunit, each encoded by a separate gene.

   The high BP rats were found to be homozygous for the $\alpha^f$ and $\beta^r$ versions of the adducin genes. The low BP rats were homozygous for the $\alpha^f$ adducin gene, and the colony had all three possible genotypes for the β subunit: homozygous $\beta^r$, homozygous $\beta^o$, and heterozygous with both $\beta^r$ and $\beta^o$. In the space above the Figure 16.2, write the genotype(s) associated with each type of rat.

2. Make a Punnett square for each type of mating that can occur when investigators mate low-BP rats with each other. Only consider the β subunit, since the α subunit is homozygous in low BP rats. Use “Q” and “R” to indicate each allele type.
3. Every generation, the investigators choose which rats will mate to propagate the colony based on the blood pressure of the individual rats. Which offspring from your Punnett square have the lowest BP (write their genotype)? What data support your conclusion?

4. Given that the investigators will always choose rats with the lowest BP to mate to each other in the low BP colony, make a Punnett square that shows the mating of rats with the lowest BP genotype.

5. After many generations of breeding individuals from one colony with other individuals from the same colony, most genes were found to be homozygous. Describe why the β adducin gene was found to be heterozygous in the low blood pressure colony.

6. Which of the genes, α or β adducin, has a greater effect on blood pressure? What evidence led you to that conclusion? Describe how the evidence supports your conclusion.
PART III: Plant growth near a smelting operation

Nicholas Caiazza and James Quinn studied two species of plants near a smelting operation in eastern Pennsylvania: slender sandwort and Japanese honeysuckle. They collected plants from sample sites that varied in their distance from the smelter, along the pollution gradient. The soil had more heavy metal contamination near the smelter than far.

They counted stomata, the gas exchange pores on leaves, and hairs on the leaves that they collected from the various sites over a period of 2 years (Figure 16.7). They also took seeds from the plants and grew them under standard conditions in a nearby courtyard; this procedure would help the researchers determine whether differences they might find near the smelter were due to the environmental gradient or genetic differences that had evolved among the various populations. After a period of time, they collected leaves from these courtyard grown plants and performed the same analyses (see Figure 16.7).

1. In honeysuckle, how does proximity to the smelter correlate with leaf hair density?

2. Do you think the relationship between proximity to the smelter and leaf hair density in honeysuckle is due to only environmental effects or is there a genetic component? Use the data to support your argument.

3. In sandwort, how does proximity to the smelter correlate with leaf hair density?

4. Do you think the relationship between proximity to the smelter and leaf hair density in sandwort is due to only environmental effects or is there a genetic component? Use the data to support your argument.

5. Speculate about how an environmental condition like heavy metal concentration could lead to genetic differences in the plants living near or far from a smelter. Consider that these populations of plants have been living in the vicinity of the smelter for several decades.
PART IV: Barnacle shell shape

Curtis Lively studied an acorn barnacle that has variation in shell shapes (Figure 16.8A). Barnacles are non-motile marine animals that cement themselves to rocks and other substrates in tidal zones.

A certain type of snail (Acanthina angelica) specializes on feeding on barnacles. Lively knew that few barnacles live near where a snail had a refuge. At intermediate distances from snail refuges, barnacles with the “bent” shell type occur sparsely, but more frequently than barnacles with the “cone” shell type. Far from snail refuges, cones occur at high density and more frequently than bent-shell barnacles.

To determine whether the variation in shell type was due to an environmental factor that affected the development of barnacle shell shape, Lively needed to distinguish between correlation and causation; the increased presence of bent-shell barnacles could be correlated with the presence of snails, or it could be caused by the presence of some other factor. The scientist set up an exclusion experiment with plots where the barnacles were allowed to develop with the snails present and with the snails excluded (Figure 16.8B). He then set up other plots where he placed barnacles of each shell shape, some plots with the snail predator and others without, and tracked the survival of barnacles with each shell shape over time (Figure 16.8C).

1. Which shell shape is more protective from predation by Acanthina snails? Refer to the data to support your argument.

2. In his exclusion experiment, Lively placed young (developing) barnacles near a snail refuge (snails present) or in an area where snails could not go (snails absent). Lively did not control the genotype of the barnacles – he simply took young barnacles from the local population. Based on the data, is the development of barnacle shell shape determined strictly by genetics, or is there an environmental component? Refer to the data to support your argument.