Pleiotropy

In pea plants, Mendel focused on how one gene is responsible for one characteristic. However, Mendel did notice with some characteristics, certain phenotypes tended to relate to one another. White flowering pea plants always had clear seed coverings, whereas violet flowering pea plants always had seed coverings that were brown. It is now understood that the gene that leads to flower color also impacts the color of the seed's cover. **Pleiotropy** is a pattern of inheritance where one gene controls two or more different characteristics (Figure 9.15).

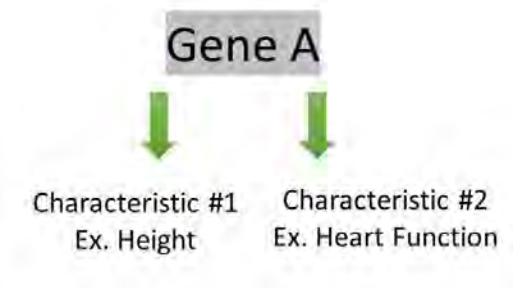

Figure 9.15 In this image, "gene A" affects multiple characteristics, both height, and heart function. This is an example of pleiotropy. (credit: Elizabeth O'Grady)

Fibrillin – 1 syndrome is an example of human pleiotropy and is caused by a single gene mutation. The gene mutation prevents individuals from making a necessary protein found in connective tissue. It can cause individuals to be abnormally tall and have digits, fingers and toes, that are long and thin, and they may have visual impairments. Individuals that have Fibrillin – 1 syndrome also often suffer from aortic aneurysms, a heart condition where the aorta bulges and can burst, leading to death. Although treatments are available to help with symptoms, there is no cure for Fibrillin – 1 syndrome.

Polygenic Inheritance

Mendel worked with traits that showed discontinuous variation. Recall that discontinuous variation is when each individual exhibit one of two easily distinguishable traits, such as violet or white flowers. However, at the time of Mendel many people supported the blending hypothesis because of what is commonly referred to as continuous variation. Continuous variation is when a character, such as height in humans, is influenced by several different genes. This also occurs with characteristics such as skin, hair, and eye color.

For example, when looking at eye color, it is evident that there are many different shades when it comes to blue and brown. In this case, there isn't just one gene that determines eye color, but rather many genes that contribute to this characteristic. Height can be just as complicated, with individuals ranging from very short to very tall. How does genetic inheritance lead to such variation? The answer lies in the fact that many different genes control characteristics such as height, skin color, and eye color. Each gene that an individual inherits has a small additive effect on the overall phenotype, a concept known as **polygenic inheritance**.

To see how polygenic inheritance has an additive effect on phenotype, click the link below to see how three genes, which are inherited separately, can lead to seven different wheat kernel colors (Figure 9.16).

Figure 9.16 Wheat kernel color variation is a characteristic under the control of polygenic inheritance. (credit: unknown / Public Domain)

CONCEPTS IN ACTION- Visualize the polygenic inheritance at this link - Link on Polygenic Inheritance

Environmental Influences

Often an individual's phenotype is impacted by environmental factors. Using height as an example, this characteristic is not only influenced by the number and type of genes inherited; it also depends on environmental factors. For instance, if a child does not receive the proper nutrients, including calcium for bone growth, he or she may be stunted or delayed in growth. Exercise and proper sleep quantities also influence a person's overall growth and stature. As you can see, genetics alone cannot always explain an individual's phenotype.

Many characteristics are thought to be dependent on both genetic and environmental factors; a concept often referred to as nature vs. nurture. Most humans are born with the physiological ability to make sound; however, the language that an individual learns to speak is heavily influenced by the environment in which they are raised. It is yet to be determined and agreed upon on how much of an organism's characteristics are based on genetics versus environmental factors. Most agree that an individual's phenotype is a result of some combination of both.

Section Summary

Alleles do not always behave in dominant and recessive patterns. Incomplete dominance describes situations in which the heterozygote exhibits a phenotype that is intermediate between the homozygous phenotypes. Codominance represents the simultaneous expression of both alleles in the heterozygous genotype. Pleiotropy is the term used to describe when one gene controls two or more different characteristics. Polygenic inheritance represents when multiple genes each have a small additive effect on the overall phenotype. Examples of polygenic inheritance include skin color, height, and eye color. Also, an individual's phenotype is impacted by environmental factors.

Exercises

1. If you cross a male who is $I^A\ I^A$ and a female who is $I^B\ I^B$ for blood type, what are the possible blood types of their offspring?
    a. AB and O
    b. only A or B
    c. only AB
    d. Only O
2. If black true-breeding mice are mated with white true-breeding mice, and the result is all gray offspring, what inheritance pattern would this be indicative of?
    a. dominance
    b. codominance
    c. multiple alleles
    d. incomplete dominance
3. Characteristics such as height are only influenced by your genetic makeup.
    a. TRUE
    b. FALSE
4. _____ is when each gene that an individual inherits has a small additive effect on the overall phenotype.
    a. Polygenic inheritance
    b. Pleiotropy
    c. Complete dominance
    d. Incomplete dominance
5. Could an individual with blood type O (genotype I^OI^O) be a legitimate child of parents in which one parent had blood type A and the other parent had blood type B?

Answers

1. (c)
2. (d)
3. (b)
4. (a)
5. Yes, this child could have come from these parents. The child would have inherited an *i* allele from each parent, and for this to happen, the type A parent had to have genotype I^AI^O, and the type b parent had to have genotype I^BI^O.