Section Summary

All organisms and cells control and regulate the transcription and translation of their DNA into protein. The process of turning on a gene to produce mRNA and then protein is called gene expression. Gene expression in prokaryotes is regulated only at the transcriptional level, whereas in eukaryotic cells, gene expression is regulated at the epigenetic, transcriptional, post-transcriptional, translational, and post-translational levels.

Exercises

1. Control of gene expression in eukaryotic cells occurs at which level(s)?
    a. only the transcriptional level
    b. epigenetic and transcriptional levels
    c. epigenetic, transcriptional, and translational levels
    d. epigenetic, transcriptional, post-transcriptional, translational, and post-translational levels
2. Prokaryotic cells lack a nucleus. Therefore, the genes in prokaryotic cells are:
    a. all expressed, all of the time
    b. transcribed and translated almost simultaneously
    c. translated and then transcribed into proteins
    d. Transcribed and translated in the cytoplasm on the rough endoplasmic reticulum
3. Explain why it is important that cells are able to regulate gene expression.

Answers

1. (d)
2. (b)
3. By regulating gene expression, cells can conserve energy and space. If an organism was to express every single gene at all times, it would require a significant amount of energy. It is much more energy efficient to only turn on the genes when they are required. In addition, only expressing a subset of genes in each cell saves space because DNA must be unwound from its tightly coiled structure to be transcribe and translated. Cells would have to be enormous if every protein were expressed in every cell all the time.

Glossary

alternative RNA splicing: a post-transcriptional gene regulation mechanism in eukaryotes in which multiple protein products are produced by a single gene through alternative splicing combinations of the RNA transcript

gene expression: processes that control whether a gene is expressed

Chapter 11: Introduction Evolution

Figure 11.1 The diversity of life on Earth is the result of evolution, a continuous process that is still occurring. (credit "wolf": modification of work by Gary Kramer, USFWS; credit "coral": modification of work by William Harrigan, NOAA; credit "river": modification of work by Vojtěch Dostál; credit "protozoa": modification of work by Sharon Franklin, Stephen Ausmus, USDA ARS; credit "fish" modification of work by Christian Mehlführer; credit "mushroom", "bee": modification of work by Cory Zanker; credit "tree": modification of work by Joseph Kranak / Concepts of Biology OpenStax)

All living organisms, from the bacteria on our skin to the trees in our yards, have evolved at some point. Although it may seem that living organisms stay the same from generation to generation, that is not the case: evolution is ongoing. Evolution can be defined as a process through which allele and genotype frequencies change over time in a population, leading to changes in phenotype frequencies. Sometimes the changes are so dramatic that organisms within the population can no longer mate with one another. If this happens, a **speciation** event has occurred leading to the formation of a new species.

The theory of evolution is the unifying theme of biology, meaning it is the framework within which biologists ask questions about the living world. The Ukrainian-born American geneticist Theodosius Dobzhansky famously wrote that "nothing makes sense in biology except in the light of evolution."[1] All life is thought to have evolved and diversified from a common ancestor. This principle is the foundation from which we understand all other questions in biology. This chapter will explain some of the mechanisms for evolutionary change and the kinds of questions that biologists can and have answered using evolutionary theory.

Footnotes

1 Theodosius Dobzhansky. "Biology, Molecular and Organismic." *American Zoologist* 4, no. 4 (1964): 449.

11.1 Discovering How Populations Change

Learning objectives

By the end of this section, you will be able to:

- *Explain how Darwin's theory of evolution differed from the current view of his time*
- *Describe how the present-day theory of evolution was developed*
- *Describe how population genetics is used to study the evolution of populations*
- *Describe the four basic causes of evolution: natural selection, mutation, genetic drift, and gene flow*
- *Explain how each evolutionary force can influence the allele frequencies of a population*
- *Be prepared to define and explain all bolded terms*

The theory of evolution by natural selection describes a mechanism for genetic changes in populations over time. Charles Darwin is given credit as the first to explain the mechanism of natural selection, however, many other individuals before Darwin had observed that species change overtime. Darwin not only explained the mechanism of how genetic change occurred (natural selection), but also provided data that supported that change.

The view that species were static and unchanging was based on the writings of Plato. Other ancient Greeks at the time of Plato did not agree and expressed ideas that organisms changed or were altered with time. In the eighteenth century, ideas about the evolution of animals were reintroduced by the naturalist Georges-Louis Leclerc and even by Charles Darwin's grandfather, Erasmus Darwin. During this time, it was accepted that there were species that had gone extinct. In spite of this, many still felt that living organisms did not change from one generation to the next.

In the early nineteenth century, Jean-Baptiste Lamarck published a book that detailed a mechanism for evolutionary change that is now referred to as **inheritance of acquired characteristics**. Lamarck hypothesized that an individual could change or be modified based on the environment in which it lives. These changes or modifications could then be inherited by its offspring, which would then bring about changes in a population over time. While this mechanism for evolutionary change as described by Lamarck was not accurate, Lamarck's ideas were an important influence on evolutionary thought.