

Molecular Evidence for Evolution

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CHAPTER

1

Molecular Evidence for Evolution

Learning Objectives

- Describe molecular clocks.
- Explain the molecular evidence for evolution.



How similar are you to a chimpanzee?

Chimpanzees and humans turn out to be very similar—if you look at their DNA. When scientists determined the entire genetic code of both humans and chimpanzees, they found that we have over 98% identical DNA.

Molecular Evidence

Arguably, some of the best evidence of evolution comes from examining the molecules and DNA found in all living things.

Beginning in the 1940s, scientists studying molecules and DNA have confirmed conclusions about evolution drawn from other forms of evidence. **Molecular clocks** are used to determine how closely two species are related by calculating the number of differences between the species' DNA sequences or amino acid sequences. These clocks are sometimes called gene clocks or evolutionary clocks. The fewer the differences, the less time since the species split from each other and began to evolve into different species (**Figure 1.1**).

A chicken and a gorilla will have more differences between their DNA and amino acid sequences than a gorilla and an orangutan. That means the chicken and gorilla had a common ancestor a very long time ago, while the gorilla and orangutan shared a more recent common ancestor. This provides additional evidence that the gorilla and orangutan are more closely related than the gorilla and the chicken. Which pair of organisms would have more molecular differences, a mammal and a bird, a mammal and a frog, or a mammal and a fish?

On the other hand, animals may look similar but can have very different DNA sequences and evolutionary ancestry. Which would have more DNA sequences in common, a whale and a horse, or a whale and a shark?

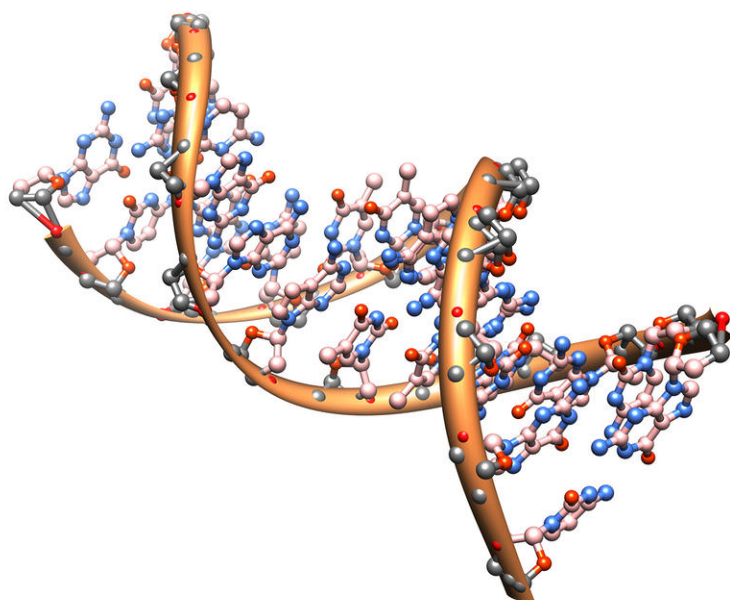


FIGURE 1.1

Almost all organisms are made from DNA with the same building blocks. The genomes (all of the genes in an organism) of all mammals are almost identical.

The **genomes**, or all the DNA sequences of all the genes of an organism, have been determined for many different organisms. The comparison of genomes provides new information about the relationships among species and how evolution occurs (**Figure 1.2**).

Molecular evidence for evolution also includes:

1. The same biochemical building blocks, such as amino acids and nucleotides, are found in all organisms, from bacteria to plants and animals. Recall that amino acids are the building blocks of proteins, and nucleotides are the building blocks of DNA and RNA.
2. DNA and RNA determine the development of all organisms.

3. The similarities and differences between the genomes confirm patterns of evolution.

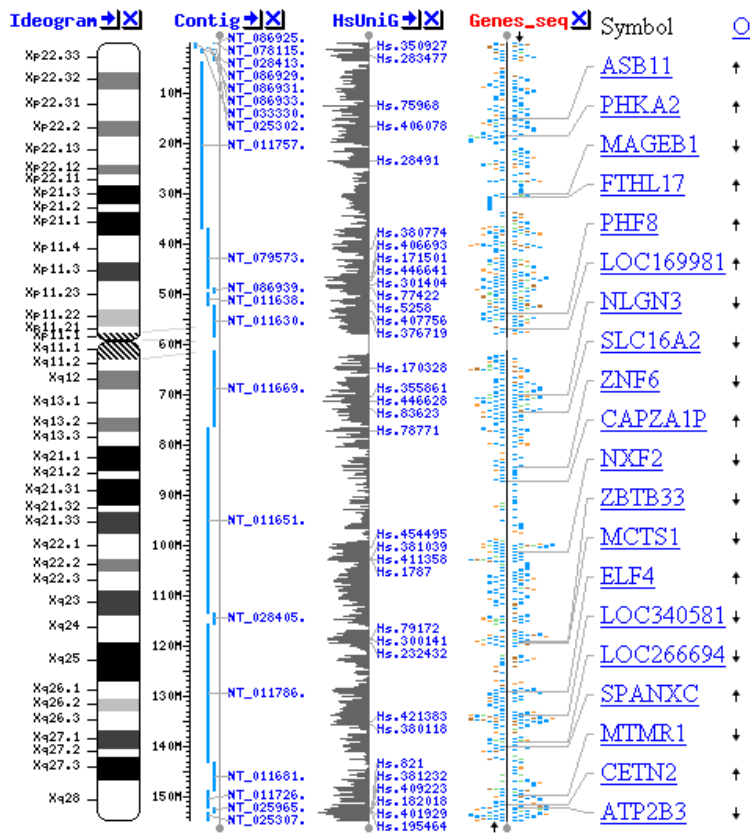


FIGURE 1.2

This is a map of the genes on just one of the 46 human chromosomes. How does this region of a chromosome compare to similar regions in other species? Similarities and differences between the genomes (the genetic makeup) of different organisms reveal the relationships between the species.

Summary

- Molecular clocks are used to determine how closely two species are related by calculating the number of differences between the species' DNA sequences or amino acid sequences.
- Molecular evidence for evolution includes that all living things share the same biochemical building blocks.

Explore More

Use the resources below to answer the questions that follow.

Explore More I

- **Genes Tell Us About Evolution - Shape of Life**



MEDIA

Click image to the left or use the URL below.

URL: <https://www.ck12.org/flx/render/embeddedobject/57488>

1. How is the genetic sequence of an organism like a blueprint of that organism?
2. If two organisms have almost identical sequences for the same gene, are they considered closely related?
3. What type of animal have scientists long thought was basal to all other animals? How has genetic analysis affected this view?
4. How has genetic analysis become quicker than it once was? How has that greatly helped with the search for a basal organism?

Explore More II

- **How Genes Direct Development - Shape of Life**



MEDIA

Click image to the left or use the URL below.

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1. What is a regulatory gene? How might they explain differences between organisms?
2. What are "hox genes"? What phase of development are they a part of? What organisms have hox genes?
3. If you find a fly with a leg coming out of its head and can identify what happened genetically to cause this, what have you discovered?

Review

1. Explain how scientists use a molecular clock to determine relationships between species.
2. What is a genome?
3. What two species from the following should have the fewest differences in their genomes: chicken, mouse, duck, gorilla?
4. What two species from the following should have the most differences in their genomes: frog, mouse, cow, human?

References

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2. Courtesy of the National Center for Biotechnology Information. [Map of genes on a human chromosome](#) . Public Domain