

Genetics and Heredity

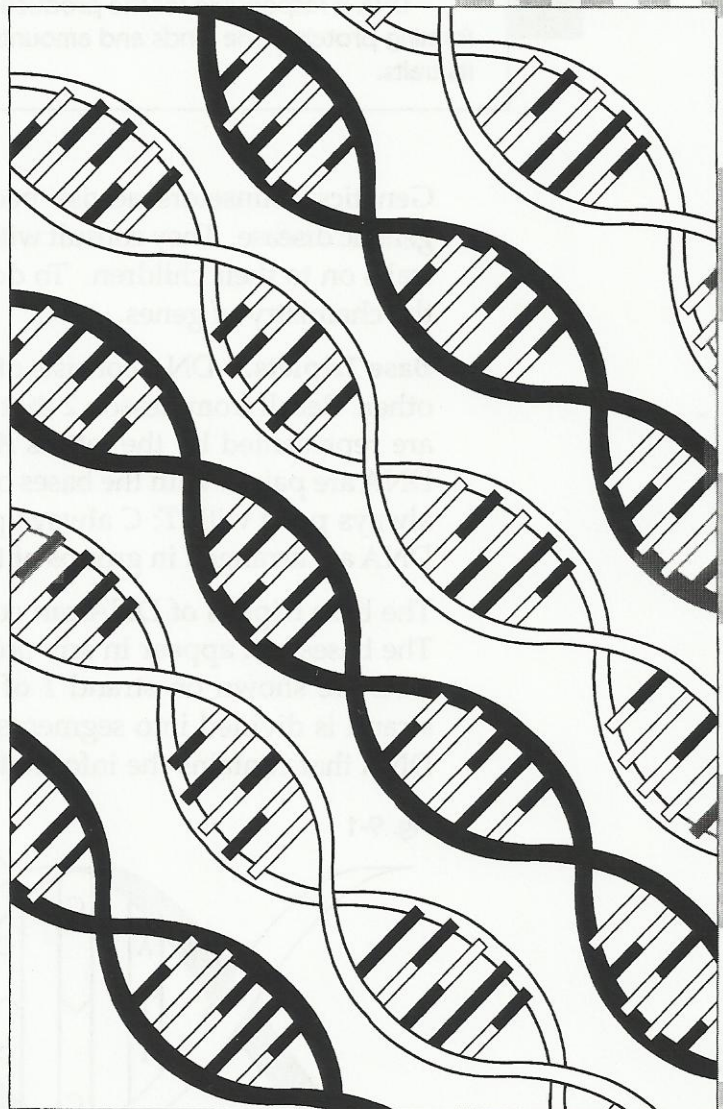
UNIT

2

Do you resemble one of your parents? Do people sometimes say you look just like another member of your family? Do you know anyone who is adopted? Does he or she look very different from his or her adoptive parents?

It is not by chance that children often look like their biological parents. Parents pass copies of their genetic material to their offspring. This genetic material controls the way people look and how their bodies work.

Sometimes copying errors happen when cells replicate. If an error is passed on to a child, the child can inherit a disorder. Using technology, doctors can sometimes find out if the genetic material of the parents contains errors. This information can help parents know in advance what the chances are of having a child with a certain disorder.



The Chemistry of Genes

Key Words

- base triplet:** group of three bases on a strand of DNA
- gene:** portion of DNA that contains the information needed to make a specific protein
- trait:** characteristic or property
- protein synthesis:** the process by which proteins form

KEY IDEAS

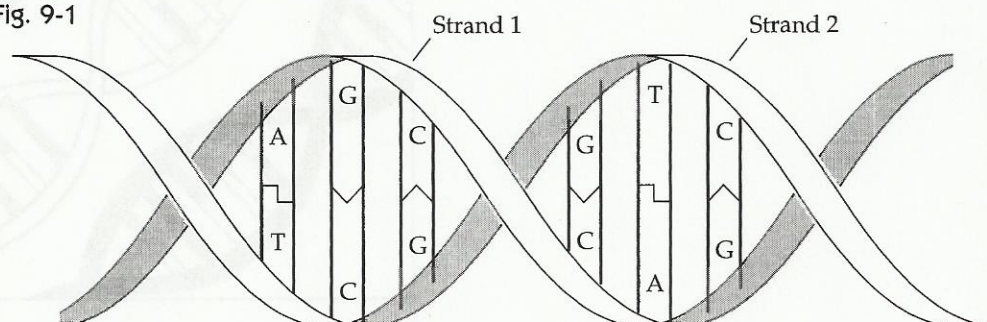
DNA is responsible for the production of proteins. DNA contains a genetic code for forming proteins. The kinds and amounts of proteins present in an organism determine its traits.

Genetics counselors advise people about whether they are carriers of a genetic disease. They consult with people about the possibilities of passing the traits on to their children. To do this, genetics counselors must understand the chemistry of genes.

Base Triplets. DNA consists of two strands of nucleotides attached to each other. Recall from Lesson 2 that there are four kinds of bases in DNA. They are represented by the letters *A*, *T*, *C*, and *G*. The bases on one strand of DNA are paired with the bases on the other strand in a consistent pattern. *A* always pairs with *T*; *C* always pairs with *G*. The bases on either strand of DNA are arranged in groups of three called **base triplets** (bays TRIHP-lihts).

The base triplets of DNA can consist of any combination of the four bases. The bases can appear in any order along the strand. The triplets *AGC* and *GTC* are shown on strand 1 of the DNA molecule in Fig. 9-1. The DNA strand is divided into segments called genes. A **gene** (jeen) is a portion of DNA that contains the information needed to make a specific protein.

Fig. 9-1



A **trait** (trayt) is a characteristic or a property. One example of a trait is eye color. Genes control the traits that are passed from parents to offspring. Each kind of gene is different from every other kind of gene in its DNA molecule. The DNA in the genes of a simple virus consists of thousands of bases. The DNA contained in a human's genes consists of about *10 billion* bases.

There are an endless number of base combinations which can form an infinite number of genes. This explains how it is possible for so many different types of organisms to exist. It also explains why so much variety exists among organisms of the same species.

1. What is a base triplet? _____

2. What is a gene? _____

Formation of Protein. Genes control an organism's traits by controlling the formation of proteins. The kinds and amounts of proteins present in an organism determine its traits. Each kind of protein is made from a different arrangement of amino acids. Organisms contain twenty kinds of amino acids. If the order or kinds of amino acids in a chain change, a different protein is made.

A gene's DNA contains the code for forming proteins. This is a process called **protein synthesis** (PROH-teen SIHN-thuh-sihs). The code is in the sequence of the bases in the DNA molecule. The triplets in a gene determine which proteins it is coded to synthesize. Protein synthesis occurs in the cytoplasm at the organelles called ribosomes. However, DNA is found mainly in a cell's nucleus. The DNA cannot leave the nucleus.

RNA. RNA is a chemical that can move in and out of the nucleus. RNA acts as a messenger to bring the code from the nucleus to the cytoplasm. This type of RNA is appropriately called messenger RNA (mRNA).

The base sequence of a DNA strand is a code for the sequencing of bases on the messenger RNA. The bases of the mRNA line up in a sequence that corresponds to the sequence of bases on a strand of DNA. For example, where the DNA has base *G*, the RNA matches it with base *C*. See Fig. 9-2. However, RNA does not contain base *T*. So RNA produces a different base, *U*, to match base *A*. Like the bases in DNA, the RNA bases also form triplets.

Fig. 9-2

DNA	RNA
A	~ U
T	~ A
C	~ G
G	~ C

3. What RNA triplet would match the DNA triplet GTA? _____

Once it is coded, mRNA moves through the cytoplasm to a ribosome. The end of the mRNA attaches to the ribosome. Meanwhile, another kind of RNA called transfer RNA (tRNA) is at work. The tRNA grabs onto an amino acid in the cytoplasm. The base triplet at the end of the tRNA strand determines the kind of amino acid to which it attaches.

A number of tRNA strands bring their amino acids to the mRNA strand attached to the ribosome. A triplet in the middle of each tRNA pairs with a triplet on the mRNA. In this way, the tRNA line up their amino acids along the mRNA.

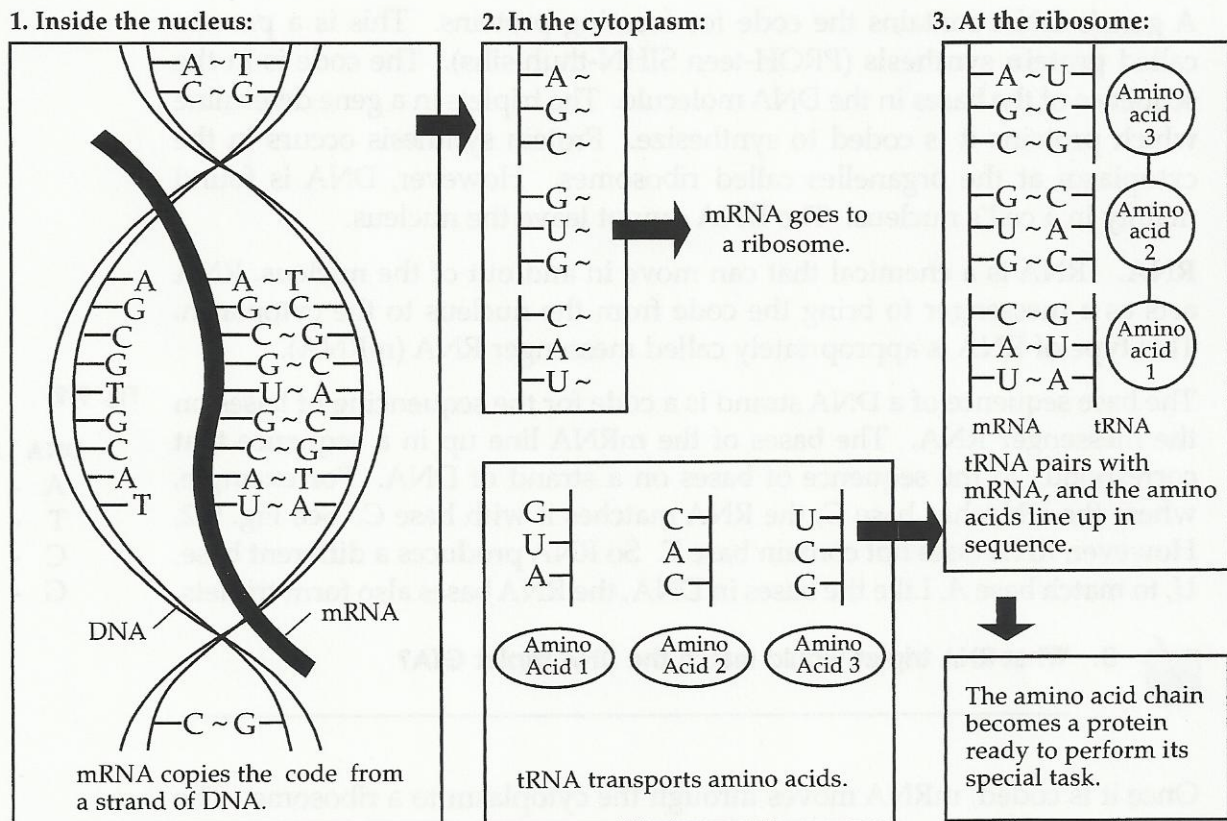
Each amino acid bonds to the amino acid next to it. The result is a bonded chain of specific kinds of amino acids arranged in a specific order. This chain results in a newly formed protein. When a chemical signal is received, the protein separates from the RNA. The protein is then ready to perform its special function in the organism.

- ✓ 4. What is the difference between mRNA and tRNA?
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TAKE ANOTHER LOOK

Study the relationship between DNA and RNA shown in Fig. 9-3.

Fig. 9-3



Check Your Understanding

Write a sentence explaining the connection between each pair of words.

5. amino acid, protein _____

6. cytoplasm, ribosome _____

7. gene, DNA _____

8. base triplet, code _____

For each numbered box in the mRNA strand shown in Fig. 9-4, write the letter of the missing base that matches the DNA base.

9. _____

10. _____

11. _____

12. _____

13. _____

14. _____

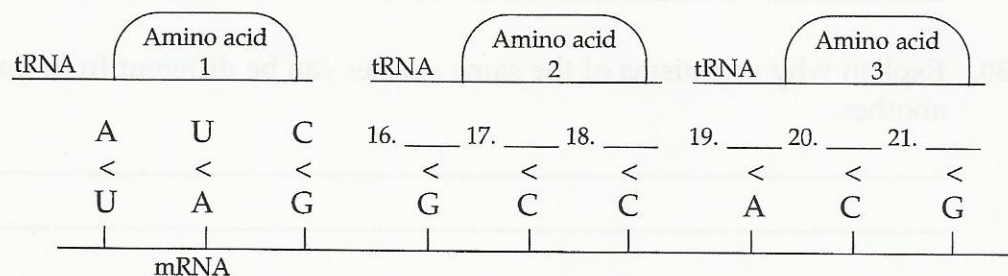
15. _____

Fig. 9-4

DNA	mRNA	DNA	mRNA
A	U	G	12
G	9	C	13
C	G	T	G
T	10	A	14
C	G	A	15
A	11	T	A

On each numbered line in Fig. 9-5, write the letter of the base on the tRNA that pairs with the base on the mRNA.

Fig. 9-5



Fill in the blanks in the sentences with the proper term from the list below. You will use two of the terms twice.

DNA mRNA tRNA protein

In the nucleus, the mRNA bases align in a sequence that corresponds to the sequence of bases on the (22)_____. The (23)_____ carries the code to the ribosomes. In the cytoplasm, (24)_____ attaches to a specific amino acid. At the ribosomes, the (25)_____ carrying the amino acids attaches to the (26)_____. The amino acids line up to form a chain. This chain of amino acids is called a (27)_____.

What
Do You
Know?

28. Place the following steps in the proper sequence to show how protein synthesis takes place. Use the numbers 1– 6.

- _____ tRNA attaches to mRNA
- _____ mRNA attaches to a ribosome and tRNA attaches to an amino acid
- _____ mRNA copies the DNA code
- _____ newly formed protein detaches from the RNA
- _____ chain of amino acids is arranged in a specific sequence along the mRNA
- _____ mRNA transfers the code from the nucleus to a ribosome

29. Based on what you have learned in this lesson, explain the chemical basis for why there can be so many different types of organisms in the world.

30. Explain why organisms of the same species can be different from one another.

31. Suppose scientists found parts of the DNA from a dinosaur. What information would this discovery provide to the scientists? What information would it not give them?

32. Imagine that an unknown base triplet is missing from the gene for the height of an animal. Suppose scientists were able to correct the code. What information would they need before they could do this? How could they find this information?
