# (Clues to) Copying the Code: examining the evidence

**Background**

After the basic structure of DNA had been determined, researchers had to work out how DNA passes information from one generation to the next (replication) and how the information stored in DNA is used to make protein (transcription/translation). To James Watson and Francis Crick, it seemed obvious that the arrangement of nucleotides in the DNA molecule is a code that regulates these processes.

But how does it all work?

To find the answers, many scientists worked together to develop new experimental procedures and make careful observations. Their data could not be biased. It was important for the researchers to make connections between seemingly unrelated facts and to identify patterns where none were quickly obvious.

**Gathering evidence**

As a biologist, you must be aware of the difference between observations and inferences, and how these differ from interpretations of observations and opinions.

1. Consider the following definitions:
   - Observations—data collected with any of the senses or tools such as graduated cylinders, balances, rulers or pH meters.
   - Inferences—conclusions or deductions based on observations.
   - Opinions—everyone has them and everyone's opinion should be respected, but they should be left out of data collection and analysis.

   With these definitions in mind, examine the list of clues in the table called *Possible clues to DNA replication and transcription/translation.* Some of the clues are legitimate observations, but others may be inferences, or even opinions.

2. Sort through the clues in your mind to decide which ones represent solid evidence of DNA replication and transcription/translation.

3. **Go to *DNAi* (www.dnai.org) > Code > Copying the Code.**

   Start with the problem, and work through players, pieces of the puzzle, and putting it together.

   As you watch the video clips and animations, consider the data collected by the scientists involved. If a clue provides evidence for replication or transcription/translation, place an "X" beside the clue in the table, under "Supports replication" or "Supports transcription/translation". If the clue does neither, or is not acceptable data, place an "X" in the "Does not support replication or transcription/translation" column.

**Analysis**

4. Select one of the observations (either clue 8 or 9) from the table: *Possible clues to Copying the Code (DNA replication and transcription/translation)*. This evidence was used to understand DNA replication (DNA passing information from one generation to the next).

   Write an explanation detailing why this clue represents solid data and is not an opinion or an inference.

5. (a) Why is it sometimes difficult to tell the difference between an observation and an inference?

   (b) Which of the clues included in the table is an inference? Explain why.

   (c) Which of the clues included in the table is an opinion? Explain why.

6. Francis Crick was the first to recognize that information flows from DNA to RNA to protein. This concept is known as the Central Dogma. At the time the Central Dogma was first stated, it was an inference based on observations. Explain why.

7. Scientists bring preconceived ideas to their work. Often these preconceptions make it difficult for them to objectively interpret their data. From the information provided in the *Copying the Code* module, state one example of a preconceived idea that biased scientific thinking and slowed finding the answer to how DNA is a copying mechanism for hereditary material.

**Table:**
**Possible clues to Copying the Code (DNA replication and transcription/translation)**

| *Clues* | *Evidence supporting replication* | *Evidence supporting transcription /translation* | *Not evidence for replication or transcription /translation* |
|---|---|---|---|
| 1. When DNA from a virus is injected into a bacterium, the bacterium produces viral (phage) protein. | | | |
| 2. Protein synthesis occurs in the cytoplasm of cells. | | | |
| 3. When a gene is destroyed through exposure to radiation, its capacity to produce an enzyme stops. | | | |
| 4. Bacteria grow for many hours in a heavy nitrogen medium. | | | |
| 5. If you understand the structure of RNA then you will know how proteins are made. | | | |
| 6. RNA is a nucleic acid found in both the nucleus and the cytoplasm. | | | |
| 7. Uracil hydrogen bonds with adenine in place of thymine during RNA synthesis. | | | |
| 8. Bacteria with heavy nitrogen in their DNA, when transferred to a culture tube with lighter nitrogen, formed DNA molecules that were made of half heavy and half light nitrogen. | | | |
| 9. When DNA is removed from a cell and placed in a test tube containing the enzyme DNA polymerase and nucleotides, new copies of the original DNA are formed. | | | |
| 10. Since there is greater variety in the protein molecules than in the DNA molecules of an organism, protein must contain the genetic code. | | | |