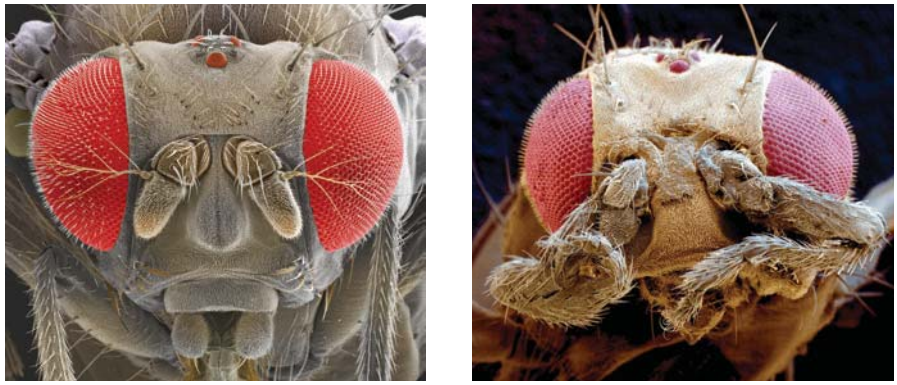
Lesson Self-Check

CAN YOU EXPLAIN IT?

FIGURE 12: A normal wild-type fruit fly (left) and a mutant fruit fly (right).



Hox genes code for transcription factors that play an important role in the development of body structures. In the developing embryo, these transcription factors help initiate and regulate cell differentiation, cell adhesion, and cell migration. Controlling the order and timing of these events is critical for proper body development. As a result, these genes are very similar, or conserved, among many different species.

A mutation in a homeobox gene leads to the development of a body structure in the wrong position. For example, the effect of a mutation in the gene *Antennapedia* determines whether an insect body segment will grow antennae or legs. In the wild-type fruit fly, antennae develop normally. In the fly with a mutation in this gene, legs develop where the antennae should be. However, the rest of the fly develops normally. Although the misplaced legs look normal in structure, they do not work properly. Flies with these mutations usually do not live very long.

Explain Refer to the notes in your Evidence Notebook to explain why a mutation in *Hox* genes results in structural malformations such as the one shown in Figure 12. In your explanation, answer the following questions:

1. How do transcription factors regulate gene expression in eukaryotes? Create a model to illustrate the process, and write an explanation to accompany your model.
2. Why does a mutation in the *Antennapedia* gene affect body development in this way? How is this change in structure related to the regulation of gene expression?

CHECKPOINTS

Check Your Understanding

1. Which statement best explains why gene expression can be more complex and sophisticated in eukaryotic cells than in prokaryotic cells?

- **a.** Eukaryotic cells use a more complex genetic code.
- **b.** Eukaryotic cells use double-stranded DNA and single-stranded RNA.
- **c.** Transcription and translation are separated in time and space in eukaryotic cells.
- **d.** Gene expression in eukaryotic cells involves both transcription and translation.

2. Scientists have concluded that gene expression is responsible for the differentiation of the cells of a multicellular organism. Which two observations together most strongly support this conclusion?

- **a.** All cells produce the enzymes needed for energy metabolism.
- **b.** The DNA in all body cells of an organism is essentially identical.
- **c.** Gene expression can be regulated by a wide variety of mechanisms.
- **d.** Enzymes needed for digestion are produced only by cells lining the digestive tract.

3. Which of the following is an example of mRNA processing?

- **a.** non-coding segments of RNA are added to the beginning of an mRNA sequence
- **b.** double-stranded RNA initiates reactions that break apart RNA strands
- **c.** enzymes break down newly synthesized proteins
- **d.** RNA polymerase attaches to a promoter near a gene cluster

4. Draw a Venn diagram to compare gene expression in prokaryotes and eukaryotes.

5. The role of introns in newly transcribed mRNA has not yet been determined. How might introns help increase genetic diversity without increasing the size of the genome?

6. Use these terms to complete the statement below:

promoter, gene, transcription factors, RNA polymerase

A section of DNA which codes for a protein is called a _____. An enzyme called _____ reads along the DNA and produces mRNA in a process called transcription. Special proteins called _____ help this enzyme bind to a segment of DNA called the _____. When the correct factors are present in the nucleus, RNA polymerase can begin transcription.

7. Which would be the best mechanism for maintaining homeostasis when conditions suddenly change in the cell? Pre-transcriptional, transcriptional, or translational regulation? Explain your reasoning.

8. Which would most likely affect the structure and function of a protein, a mutation in an intron or a mutation in an exon? Explain your answer.

MAKE YOUR OWN STUDY GUIDE

In your Evidence Notebook, design a study guide that supports the main ideas from this lesson:

Gene expression is responsible for the differentiation of cells.

Gene expression is regulated differently in prokaryotic cells and eukaryotic cells.

Remember to include the following information in your study guide:

- Use examples that model main ideas.
- Record explanations for the phenomena you investigated.
- Use evidence to support your explanations. Your support can include drawings, data, graphs, laboratory conclusions, and other evidence recorded throughout the lesson.

Consider how the structure and function of DNA, RNA, and proteins make regulation of gene expression possible. Explain how alterations in these processes make mutations in organisms possible.