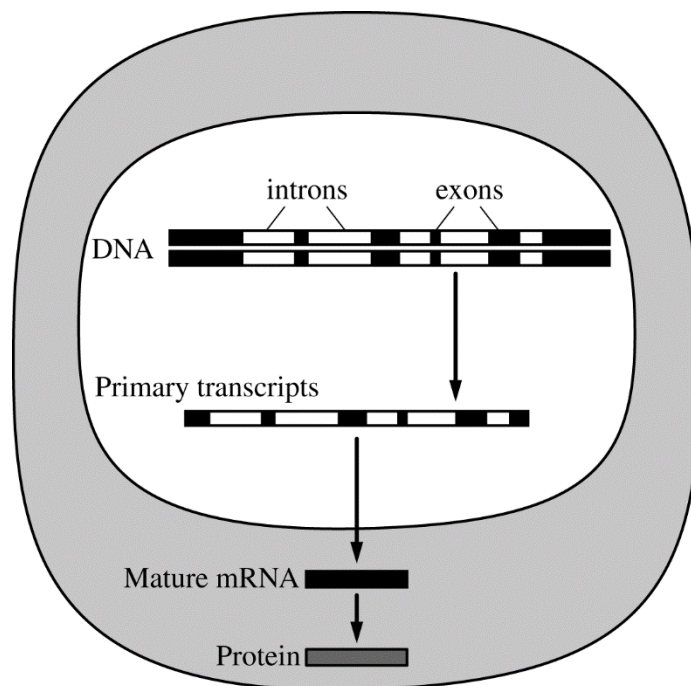


AP[®] BIOLOGY
2016 SCORING GUIDELINES

Question 4



The figure represents the process of expression of gene *X* in a eukaryotic cell.

- (a) The primary transcript in the figure is 15 kilobases (kb) long, but the mature mRNA is 7 kb in length. **Describe** the modification that most likely resulted in the 8 kb difference in length of the mature mRNA molecule. **Identify** in your response the location in the cell where the change occurs. **(2 points)**

Describe process (1 point)

- Removal of introns
- RNA processing

Identification (1 point)

- Nucleus

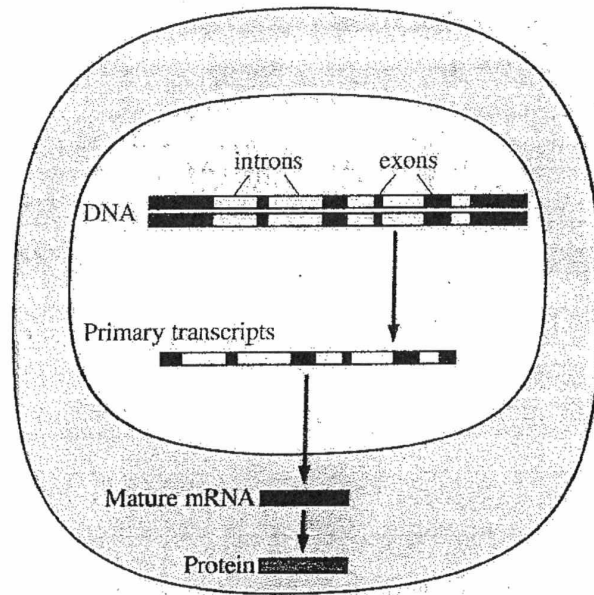
- (b) **Predict** the length of the mature gene *X* mRNA if the full-length gene is introduced and expressed in prokaryotic cells. **Justify** your prediction. **(2 points)**

Prediction (1 point)

- 15 kb
- Longer than the mature mRNA in the eukaryote

Justification (1 point)

- mRNA processing typically does not occur in prokaryotes



4. The figure represents the process of expression of gene X in a eukaryotic cell.
- The primary transcript in the figure is 15 kilobases (kb) long, but the mature mRNA is 7 kb in length. Describe the modification that most likely resulted in the 8 kb difference in length of the mature mRNA molecule. Identify in your response the location in the cell where the change occurs.
 - Predict the length of the mature gene X mRNA if the full-length gene is introduced and expressed in prokaryotic cells. Justify your prediction.

PAGE FOR ANSWERING QUESTION 4

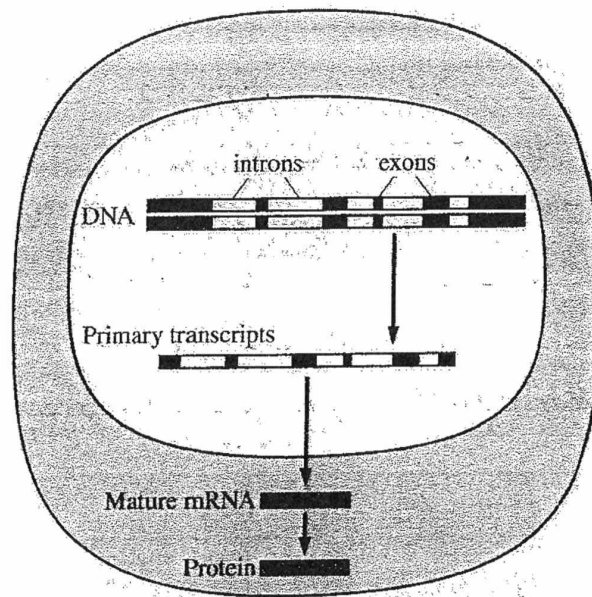
a. Primary transcripts, also known as pre-RNA, include introns in the raw DNA complementary code. In order to achieve the finished product, mRNA, the pre-RNA must go through RNA processing in the nucleus itself. A 5'-cap of modified guanine is added to the pre-RNA to help it bind to the ribosome for translation. A poly-A tail is added to the 3'-end, in order to protect the RNA from degradation by hydrolytic enzymes and to help the RNA be ejected from the nucleus and into the cytoplasm. ^{Most importantly,} ~~then~~ in

ADDITIONAL PAGE FOR ANSWERING QUESTION 4

~~There~~ There, snRNPs and spliceosomes remove introns from the pre-mRNA, resulting in mature mRNA's smaller size.

b. If this gene was expressed in prokaryotic cells, the mature RNA would be just as long as the original gene, 15 kb, because prokaryotic cells lack the ability to remove eukaryotic introns.

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 - Predict the length of the mature gene X mRNA if the full-length gene is introduced and expressed in prokaryotic cells. Justify your prediction.

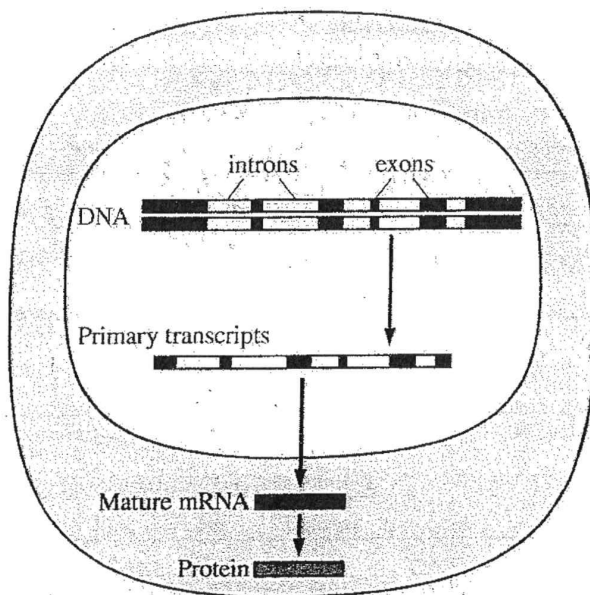
PAGE FOR ANSWERING QUESTION 4

The change in length of the mature mRNA molecule is due to the cutting out of introns. Introns are not expressed, only exons are. So, snurps which recognize introns, combine with other proteins to cut out the introns and stitch together exons. This is why the length is shorter. The change occurs within the nucleus to prepare for the mRNA to leave the cell. I predict that if the full-lengthed

ADDITIONAL PAGE FOR ANSWERING QUESTION 4

gene is expressed in prokaryotic cells, the mRNA will be 15 kb in length.

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4. The figure represents the process of expression of gene X in a eukaryotic cell.
- (a) The primary transcript in the figure is 15 kilobases (kb) long, but the mature mRNA is 7 kb in length. **Describe** the modification that most likely resulted in the 8 kb difference in length of the mature mRNA molecule. **Identify** in your response the location in the cell where the change occurs.
- (b) **Predict** the length of the mature gene X mRNA if the full-length gene is introduced and expressed in prokaryotic cells. **Justify** your prediction.

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The cause of the 8 kb difference in length of the mature mRNA molecule is was most likely deletion. This modification occurs in the nucleus of the cell. If the full-length gene is introduced and expressed in prokaryotic cells, then the length of the mature gene X mRNA would be 15 kb long. This is because the primary transcript was 15 kb long.

AP[®] BIOLOGY

2016 SCORING COMMENTARY

Question 4

Question 4 was written to the following Learning Objectives in the AP[®] Biology Curriculum Framework: 2.14, 3.21, 3.4, and 4.2.

Overview

This question focused on the process of gene expression. Students were given a diagram representing the expression of a gene in a eukaryotic cell. Students were asked to describe the modification that most likely results in the mature mRNA being shorter than the primary transcript, and to identify the location in the cell where the modification occurs. Students were then asked to predict, with justification, the length of the mature mRNA if the same gene were expressed in a prokaryotic cell.

Sample: 4A

Score: 4

The response earned 1 point in part (a) for describing the modification as RNA processing. The response could have earned 1 point in part (a) for describing the modification as the removal of introns from pre-RNA, but the point had already been earned. The response earned 1 point in part (a) for identifying the nucleus as the location in the cell where the modification occurred. The response earned 1 point in part (b) for predicting that the *gene X* mRNA would be 15 kb. The response earned 1 point in part (b) for providing the justification that prokaryotic cells are unable to remove introns.

Sample: 4B

Score: 3

The response earned 1 point in part (a) for describing the modification as the cutting out of introns. The response earned 1 point in part (a) for identifying the nucleus as the location where the change occurred. The response earned 1 point in part (b) for predicting that the *gene X* mRNA would be 15 kb.

Sample: 4C

Score: 2

The response earned 1 point in part (a) for identifying the nucleus as the location in the cell where the modification occurred. The response earned 1 point in part (b) for predicting that the *gene X* mRNA would be 15 kb.