AP® BIOLOGY
2016 SCORING GUIDELINES

Question 6

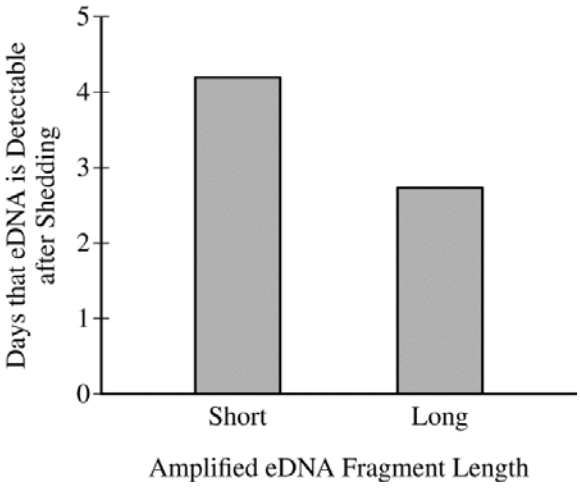

Figure 1. Detectability of eDNA fragments of varying lengths

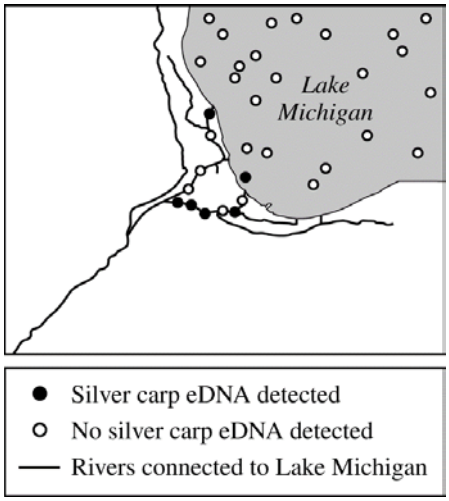

Figure 2. Map of the waterways that connect a nearby river system to Lake Michigan

Living and dead organisms continuously shed DNA fragments, known as eDNA, into the environment. To detect eDNA fragments in the environment, the polymerase chain reaction (PCR) can be used to amplify specific eDNA fragments. eDNA fragments of different lengths persist in the environment for varying amounts of time before becoming undetectable (Figure 1).

To investigate whether silver carp, an invasive fish, have moved from a nearby river system into Lake Michigan, researchers tested water samples for the presence of eDNA specific to silver carp (Figure 2).

(a) **Justify** the use of eDNA sampling as an appropriate technique for detecting the presence of silver carp in an environment where many different species of fish are found. **Propose** ONE advantage of identifying long eDNA fragments as opposed to short fragments for detecting silver carp. **(2 points)**

Justify (1 point)

- eDNA allows detection of the fish without visual identification/catching the fish.

Proposed advantage (1 point)

- Longer fragments indicate more recent presence of fish.
- Longer fragments are more likely to contain a sequence that is specific to silver carp.
- Longer sequences/more base pairs may increase accuracy/specificity/confidence that the eDNA is from a silver carp and not a related species.

(b) The researchers tested a large number of water samples from Lake Michigan and found eDNA specific to silver carp in a single sample in the lake, as indicated in Figure 2. The researchers concluded that the single positive sample was a false positive and that no silver carp had entered Lake Michigan. **Provide reasoning** other than human error to support the researchers' claim. **(1 point)**

Reasoning (1 point)

- eDNA entered the lake by means other than the fish (e.g., river flow, boats, waste from predators).

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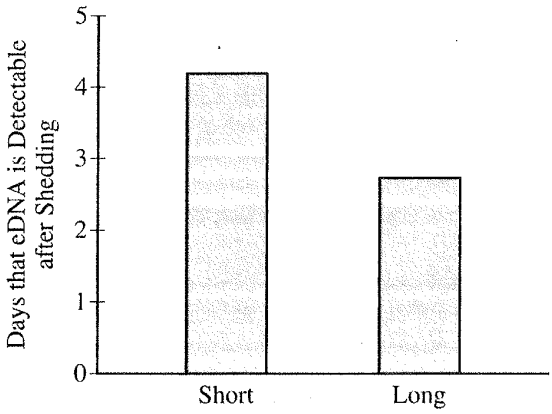

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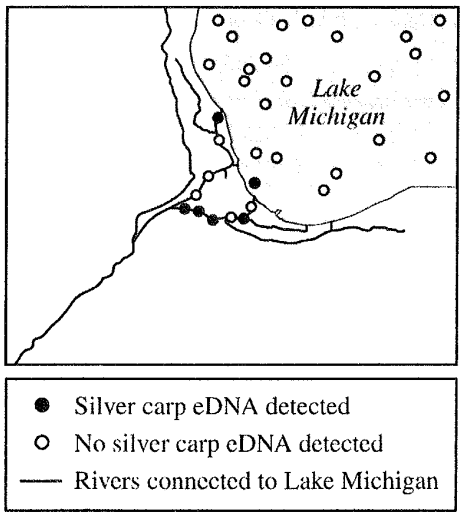

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a.) eDNA is an appropriate technique to identify the presence of silver carp because through PCR, scientists can attribute different lengths of eDNA of different species of fish, including dead ones. So while one may not physically see silver carps,

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the identification of its eDNA will provide evidence that the carp head moved on.
The advantage of identifying long eDNA fragments is that the eDNA had to have been shed more recently, or within 2½ days. Finding long eDNA can then help scientists estimate how many silver carp there are in the area

b.) The sample could be a false positive because water from the streams that contained silver carp could carry their eDNA into the lake.

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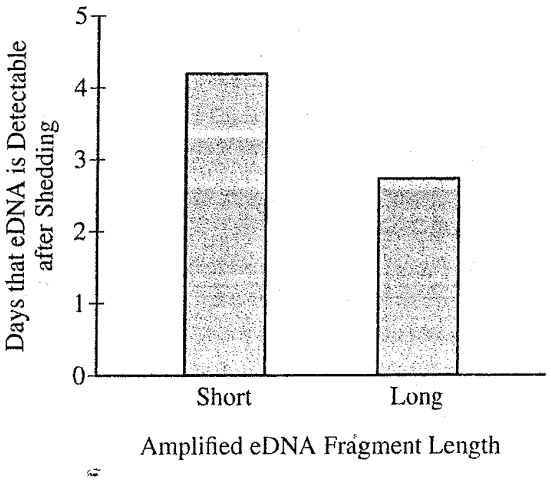

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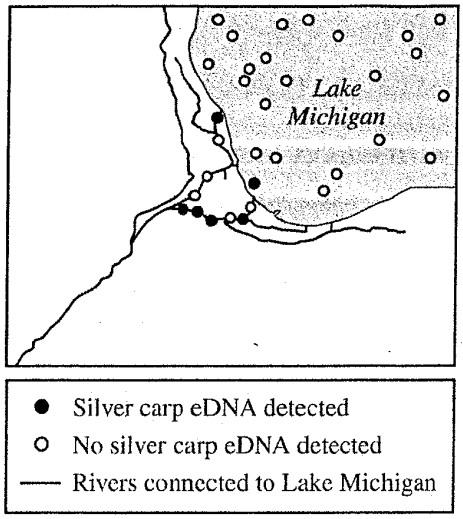

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a. If silver carp shed eDNA into their environment, then their ~~[illegible]~~ presence is detectable in that environment because their eDNA is specific to their species. If long eDNA is found, it can be concluded that a

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silver carp was there very recently, because long eDNA fragments persist for a shorter amount of time than short fragments.

b. Because the eDNA was found in a sample so close to the mouth of a river, it can be reasoned that some silver carp eDNA had flowed from the river (where silver carp were present) to the lake (where silver carp were not present).

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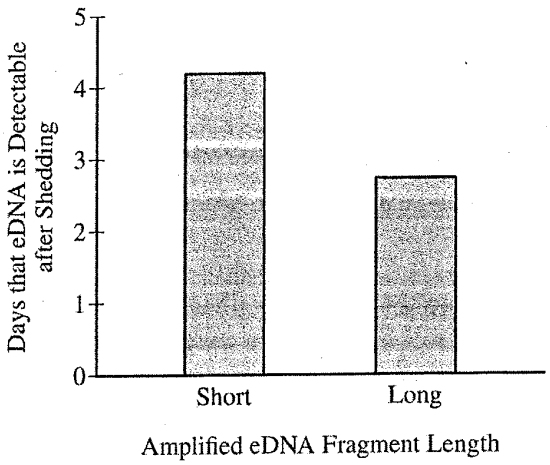

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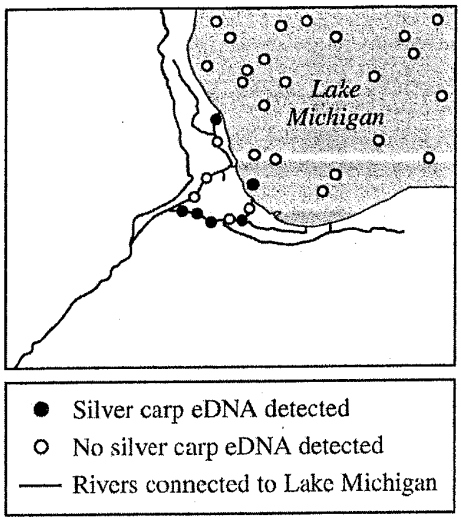

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No Every organism DNA is different in some way. There are millions and millions of variations in DNA sequences. Although fish have similar phenotypes, their genotypes are very different and so are their genes. eDNA is an appropriate

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technique because the DNA of silver carp is different from other fish and can easily be distinguished. The advantage of identifying long eDNA fragments that short is because the more nucleotide bases there are, the more of a difference a person can prove that the DNA is from a silver carp. Some DNA might be the same between silver carp and other fish and a short eDNA can probably be inaccurate. Long eDNA can help solidly identify that the DNA found is from a silver carp.

As stated before, the eDNA used to identify the silver carp could have been short eDNA. The eDNA aquired may not be long enough to accurately identify it as from a silver carp.

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AP® BIOLOGY
2016 SCORING COMMENTARY

Question 6

Question 6 was written to the following Learning Objectives in the AP® Biology Curriculum Framework: 2.23, 4.11, 4.15, 4.19, and 4.3.

Overview

This question focused on using DNA fragments shed from organisms into the environment (eDNA) to detect the presence of silver carp, an invasive species of fish. Students were given a graph showing the length of time that short or long fragments of eDNA can be detected after being shed from the organisms. Students were also given a map of Lake Michigan and a connected river system with sampling sites indicating whether eDNA from the silver carp had been detected. Students were asked to justify the use of eDNA for detecting silver carp in a community with many different species, and to propose an advantage of identifying long fragments rather than short fragments of eDNA. Students were then asked to provide reasoning to support a researcher's claim that the detection of eDNA at a single sampling site in Lake Michigan is a false positive.

Sample: 6A
Score: 3

The response earned 1 point in part (a) for justifying that the fish can be detected without physically seeing them. The response earned 1 point in part (a) for proposing that detecting a long eDNA fragment would indicate that a silver carp had been there more recently. The response earned 1 point in part (b) for reasoning that the eDNA had been carried from the stream containing silver carp to the lake.

Sample: 6B
Score: 2

The response earned 1 point in part (a) for proposing that detecting a long eDNA fragment would indicate that a silver carp had been there more recently. The response earned 1 point in part (b) for reasoning that the eDNA had flowed into the lake from the river where silver carp were present.

Sample: 6C
Score: 1

The response earned 1 point in part (a) for proposing that long eDNA fragments have more nucleotides, which may give a more accurate identification.