

Questions 1–10 refer to the following passage.

The following passage is adapted from a 2016 article about single-celled organisms that was published in a popular science magazine.

¹The vast majority of living things ²are single-celled organisms. Despite ³their great numbers, our understanding ⁴of these life forms on even a basic ⁵biochemical and phylogenetic level is ⁶only a few decades old and continues to ⁷evolve.

⁸For most of the twentieth century, ⁹it was believed that all life forms could ¹⁰be broadly classified into two main ¹¹groups, called domains: eukaryotes, or ¹²organisms possessing a cell nucleus; ¹³and prokaryotes, or organisms lacking ¹⁴such a nucleus. The terms “prokaryotes” ¹⁵and “bacteria” were used more or less ¹⁶interchangeably. Only in the 1970s was ¹⁷it discovered that there are in fact two ¹⁸very distinct groups of prokaryotes, ¹⁹not any more related to each other ²⁰than they are related to the eukaryotes: ²¹bacteria and archaea. This discovery ²²was made by Carl Woese, who in ²³1990 proposed a three-domain system ²⁴based on phylogenetics, or the degree ²⁵of genetic relatedness among species. ²⁶Woese proposed separating bacteria ²⁷and archaea based on analysis of their ²⁸ribosomal RNA, genetic material that ²⁹plays an active role in the formation of ³⁰proteins. The phylogenetic branches of ³¹Bacteria, Archaea, and Eukarya form ³²the basis of the three-domain system of ³³classification still in use today.

³⁴When they were first discovered, ³⁵all archaea were believed to be ³⁶extremophiles—that is, organisms ³⁷living in extreme conditions such as ³⁸very hot, cold, or chemically caustic ³⁹environments. We now know that ⁴⁰these organisms exist in large numbers ⁴¹in virtually all habitats, including in ⁴²the human digestive tract. We also ⁴³know that most prokaryotes that ⁴⁴cause disease are bacteria, not archaea. ⁴⁵And we have an ever-improving ⁴⁶understanding of the biochemical ⁴⁷pathways employed by these two groups ⁴⁸of organisms.

⁴⁹Despite our growing understanding ⁵⁰of prokaryotes, the evolutionary ⁵¹relationships among the Bacteria, ⁵²Archaea, and Eukarya are far from ⁵³clear. A comparison of the genomes of ⁵⁴species in these three domains done ⁵⁵in 1997 showed similarities between ⁵⁶the Bacteria and Archaea in the genes ⁵⁷coding for enzymes, and similarities ⁵⁸between the Archaea and Eukarya in ⁵⁹the genes coding for protein synthesis ⁶⁰machinery. Moreover, although the ⁶¹Archaea are prokaryotes, the proteins ⁶²that give their chromosomes structure ⁶³are similar to those within the nucleus ⁶⁴of the Eukarya. In other words, the ⁶⁵Archaea seem to be related, in different ⁶⁶ways, to both the Bacteria and the ⁶⁷Eukarya. Because the Eukarya are ⁶⁸the most recent domain to evolve, it ⁶⁹has been hypothesized that the first ⁷⁰eukaryotic cell originally arose from a ⁷¹prokaryotic cell within the Archaea.

⁷²If this hypothesis is correct, there ⁷³still remains a tantalizing mystery: the ⁷⁴evolution of the eukaryotic nucleus. The ⁷⁵nucleus is a complex structure within ⁷⁶a eukaryotic cell that is encased in a ⁷⁷membrane and that contains the cell’s ⁷⁸genetic material. There are a number ⁷⁹of competing models for how this ⁸⁰structure might have evolved. Leaving ⁸¹out the most controversial of these, ⁸²which involves viruses, there are three ⁸³that have found significant support ⁸⁴within the scientific community. The ⁸⁵first is

the “syntrophic model,” which ⁸⁶states that ancient archaea slipped ⁸⁷inside bacterial cells and eventually ⁸⁸became those cells’ nuclei. The second ⁸⁹model is based on the observation ⁹⁰that certain prokaryotes have recently ⁹¹been discovered to possess a primitive ⁹²nucleus. This model suggests that ⁹³archaea might, by degrees, have ⁹⁴evolved complex chromosomes and ⁹⁵eventually also the nuclear membrane ⁹⁶encasing those chromosomes. Finally, ⁹⁷the most recent model proposes that ⁹⁸ancient archaea could have developed ⁹⁹a second external cell membrane, with ¹⁰⁰the internal cell membrane eventually ¹⁰¹becoming the nucleus. Whether any of ¹⁰²these models turns out to be correct, ¹⁰³the discovery of the Archaea as a ¹⁰⁴separate prokaryotic domain has given ¹⁰⁵rise to a fascinating field of research ¹⁰⁶into evolutionary relationships.

1. The main purpose of the passage is to
 - A. describe the discovery of the Archaea domain and its implications.
 - B. suggest that the three-domain system of classification should be more widely adopted.
 - C. refute the idea that bacteria are the most ancient life forms.
 - D. argue for the inclusion of eukaryotes in the Archaea domain.
2. Based on information in the passage, it can be reasonably inferred that ribosomal RNA
 - A. has improved our biochemical understanding of single-celled organisms.
 - B. determines whether or not a single-celled organism has a nucleus.
 - C. serves as a marker of how closely different species are related to one another.
 - D. exists only in archaea that prefer extreme environments.
3. Which choice provides the best evidence for the answer to the previous question?
 - A. Lines 2–7 (“Despite... evolve”)
 - B. Lines 8–14 (“For most... a nucleus”)
 - C. Lines 21–25 (“This discovery... species”)
 - D. Lines 34–39 (“When... environments”)
4. In line 30, “branches” most nearly means
 - A. boughs.
 - B. offices.
 - C. chapters.
 - D. groupings.
5. The author presents the idea that the Eukarya evolved from the Archaea as
 - A. conclusively proven.
 - B. plausible but not definitively established.
 - C. unlikely at best.
 - D. convincingly disproved.
6. Which choice provides the best evidence for the answer to the previous question?
 - A. Lines 30–33 (“The phylogenetic... today”)

- B. Lines 45–48 (“And we... organisms”)
- C. Lines 49–53 (“Despite... clear”)
- D. Lines 92–96 (“This model... chromosomes”)

7. The third paragraph serves mainly to

- A. note a common misconception about the Archaea.
- B. present new information about extremophiles.
- C. draw a contrast between the Bacteria and the Archaea.
- D. provide examples of the improved understanding of prokaryotes.

8. According to the passage, the genetic similarities between the Archaea and the Eukarya are significant primarily because

- A. they imply extremophilic origins for the Archaea.
- B. they suggest an evolutionary origin for the Eukarya.
- C. they undermine the belief that the Bacteria are of more ancient origin than the Archaea.
- D. they make it impossible to consider more than three phylogenetic domains.

9. In line 79, “models” most nearly means

- A. ideals.
- B. hypotheses.
- C. examples.
- D. figurines.

10. According to the passage, the syntrophic model of the evolution of the eukaryotic nucleus posits that

- A. the first eukaryotes arose from a fusion of archaea and bacteria.
- B. viruses played a role in producing the first eukaryotic cells.
- C. the first eukaryotes developed directly from archaea.
- D. a second cell membrane was involved in its development.

1. **A**

Difficulty: Easy

Category: Global

Strategic Advice: If all the choices begin with verbs, use the author's tone to quickly eliminate choices.

Getting to the Answer: The tone of this passage is descriptive, not persuasive, so you can immediately eliminate (B), (C), and (D). The passage discusses the discovery of a new domain of one-celled organisms, the Archaea, confirming that **(A)** is the correct answer.

2. **C**

Difficulty: Medium

Category: Inference

Getting to the Answer: A small detail like "ribosomal RNA" may not be in your passage map, but three capital letters like "RNA" should stand out if you have to skim over the passage. Once you find it, read carefully and match the information in the passage to the choices. "RNA" appears in line 28. Woese used analysis of ribosomal RNA to separate the Bacteria from the Archaea. The preceding sentence says that Woese proposed his three-domain system based on the "degree of genetic relatedness among species" (lines 24–25). So ribosomal RNA must be a way of determining how related species are to each other. This matches **(C)**.

(A), (B), and (D) are distortions of the information in the passage. Although ribosomal RNA did improve scientific understanding of the types of single-celled organisms, the text does not connect ribosomal RNA to the *biochemistry* of single-celled organisms, so (A) is incorrect. Ribosomal RNA is used to distinguish between the two types of one-celled organisms that do *not* have nuclei, not between those that have nuclei and those that do not, so (B) is incorrect. Although archaea were originally believed to be extremophiles, this view was discounted; moreover, it was never connected to ribosomal RNA. Eliminate (D).

3. **C**

Difficulty: Medium

Category: Command of Evidence

Getting to the Answer: The support to the previous question comes from the two sentences in lines 21–30. Choice **(C)** cites the first of these sentences and is thus the correct answer.

(A) and (B) have no connection to ribosomal RNA. (D) introduces the early thinking about archaea and again has no connection to ribosomal RNA.

4. **D**

Difficulty: Easy

Category: Vocab-in-Context

Getting to the Answer: Return to line 30, read the sentence it contains, and predict a word or phrase to replace “branches” that retains the original meaning of the sentence. That sentence says, “The... branches... form the basis of the... system of classification,” so “categories” would be a good prediction. This matches **(D)**, the correct answer.

(A), (B), and (C) are alternative definitions of “branches” that do not make sense in the context of the passage. The text is not discussing branches of trees (“boughs”), branches of a business (“offices”), or branches of a club (“chapters”).

5. **B**

Difficulty: Hard

Category: Inference

Getting to the Answer: The evolutionary relationships among the three domains are discussed in paragraph 4, which begins with the sentence “Despite our growing understanding of prokaryotes, the evolutionary relationships among the Bacteria, Archaea, and Eukarya are far from clear” (lines 49–53). The paragraph ends with the hypothesis that the Eukarya evolved from the Archaea, but that first sentence announces the author’s opinion of that hypothesis: it hasn’t been conclusively established. Eliminate (A). The author does seem to think that the stated hypothesis has evidence to support it: the Archaea are related to the Eukarya, and the Eukarya evolved later. Eliminate (C) and (D). The correct answer is therefore **(B)**.

6. **C**

Difficulty: Hard

Category: Command of Evidence

Getting to the Answer: The evidence for the answer to the last question comes from several sentences in paragraph 4. The first sentence shows that the author thinks the hypothesis is not proven; that is found in lines 49–53, which corresponds to choice **(C)**, the correct answer.

(A) is concerned with the three-domain system. (B) is about biochemistry, not genetic relatedness. (D) might be tricky: these lines describe one of the models of the evolution of the eukaryotic nucleus, and according to that model, the Eukarya evolved from the Archaea. But the author states no opinion in that sentence.

7. **D**

Difficulty: Medium

Category: Function

Getting to the Answer: Review your passage map and determine how the third paragraph contributes to the author's overall purpose. A good map would note that the third paragraph provides information on the new domain of one-celled organisms, the Archaea. Archaea are defined in lines 16–21 as prokaryotes, so **(D)** is correct.

(A) is too narrow. Although the paragraph does note, and correct, the original thinking about archaea, it continues to provide other examples of new knowledge about prokaryotes. (B) is a subtle distortion of information in the passage. Although archaea were originally considered to be extremophiles, the text corrects that error. (C) is a faulty use of a detail from the passage. A contrast is drawn between bacteria and archaea, but this discussion is presented in the second paragraph, not the third.

8. **B**

Difficulty: Hard

Category: Detail

Getting to the Answer: This question contains two clues. First, the question refers to the similarities between the Archaea and Eukarya. Consult your passage notes to find that this clue sends you to the fourth paragraph. Second, the question asks why those similarities are important, so scan the fourth paragraph for the similarities between the Archaea and Eukarya and look for a word or phrase indicating a reason. The similarities are mentioned in lines 60–64, and the reason is introduced by the keyword “Because” (line 67). The similarities are important because they indicate there may be an evolutionary connection between Archaea and Eukarya. Therefore, **(B)** is correct.

(A) is a distortion of information presented in the passage. Although archaea were originally thought to be extremophiles, the passage does not connect extreme environments to the *origins* of archaea. (C) and (D) are not discussed in the passage at all. The similarities between archaea and eukaryotes are not connected to the origin of the Bacteria, as in (C), nor to any limitation of the number of domains, as in (D).

9. **B**

Difficulty: Medium

Category: Vocab-in-Context

Getting to the Answer: Lines 78–80 refer to “a number of competing models for how this structure might have evolved.” Substitute a different word that would make sense and use that word as your prediction. *Ideas* or *theories* would be good predictions. Choice **(B)** is a match and the correct answer.

(A), (C), and (D) are alternative definitions of “models” that do not fit the context. (A) might be tricky. The word “ideals” indicates a high standard to be aimed at; it does not have the same meaning as “ideas.”

10. **A**

Difficulty: Easy

Category: Detail

Getting to the Answer: The eukaryotic nucleus is discussed in the last paragraph. A quick skim shows that the “syntrophic model” is mentioned in line 85. The sentence states that according to this model, “archaea slipped inside bacterial cells and eventually became those cells’ nuclei” (lines 86–88). So the eukaryotic cell arose from the two types of prokaryotic cells according to this model, making **(A)** correct.

(B) is incorrect because the theory that involves viruses is the controversial one that the author chooses not to describe. (C) refers to the second and third theories that are described, not the syntrophic model. Similarly, (D) refers to the third theory, not the syntrophic model.

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