

# answers

## Discussion Questions to Consider about Artificial Life and Evolution of Digital Organisms

*Note to teacher:* The questions in this handout and the suggested answers (in red, below) are meant **to guide discussion, more than be an assessment**. It is recommended that students answer the questions to the best of their abilities as preparation for conducting the associated activity, where these same questions are asked and answers are evolved by students as they learn.

### Discussion Questions to Consider about Artificial Life and Evolution of Digital Organisms

1. Compare and contrast the digital organisms in the Avida environment to biological organisms in the natural world. In what ways are digital organisms similar to computer viruses?

*Example answer:* Digital organisms in Avida have an instruction set similar to the genetic information that biological organisms have in their DNA. Like biological organisms, the instructions set codes for “traits” of an organism as well as replication instructions for reproduction. The genetic information can also be changed by random mutation. Digital organisms are similar to computer viruses because they are short, self-replicating computer programs.

2. What do biologists mean when they use the word “evolution”?

Can we observe evolution?

Can we experiment with evolution?

What are potential causes of evolution?

Explain your answer and give examples from the article or prior knowledge.

*Example answer:* Evolution refers to change in a population over time (many generations). Modern biologists are specifically referring to change in gene frequencies over generations (whereas Darwin focused on changes in frequencies of traits in a population). We can observe evolution in biological organisms, especially organisms that replicate quickly such as bacteria and many simple plants and animals. The development of antibiotic resistance and the evolution of viruses are important examples. There are many causes of evolution such as environmental factors. The reason a certain gene is passed down is to help that species survive and flourish in their habitat. We can experiment with evolution using biological organisms, but we can also use software models such as Avida. The article gives many examples of evolutionary questions that Avida has addressed such as the study of the origin of complex features, the origin of sexual reproduction, and the future course of evolution.

3. What makes AVIDA a useful tool for biologists?

What are the strengths and limitations of such an approach?

*Example answer:* Avida has been summarized as “an instance of evolution in a modeled environment.” Avida is less complex than biological systems and can be manipulated in ways that biological organisms cannot. All of the requirements for evolution by natural selection are present: variation (random mutation), inheritance (replication), selection (differential fitness), and time (many generations). Because digital organisms replicate much faster than biological organisms, data for many generations can be gathered quickly. In addition, the software makes it much easier to track changes in the “genetic” code of digital organisms than in biological ones. The same mechanisms are at work in Avida and in biological organisms, but the actual organisms and the environment are very different.