

## **“Xenobots”, living machines designed by an evolutionary algorithm**

**(1) Meet the xenobots:** Tiny living robots have been created using cells taken from frog embryos. Each so-called xenobot is less than a millimeter across, but one can propel itself through water using two stumpy limbs, while another has a kind of pouch that **it** could use to carry a small load.

**(5) Okay, but ... why?** The early research, published in [Proceedings of the National Academy of Sciences](#), could help the development of useful soft robots that can heal **themselves** when damaged. Because they are made of living tissue, they also decay once they stop working. The researchers, from Tufts University, the University of Vermont, and the Wyss Institute at Harvard, hope **(10)** such living robots could one day be used to clean up microplastics, digest toxic materials, or even deliver drugs inside our bodies (although this is obviously still all a long way off).

**How are they made?** The robots are constructed from heart cells, which spontaneously contract and relax like tiny pistons, and skin cells that provide **(15)** more rigid structure. Once it is set loose, a robot’s cells have enough energy to keep it wriggling and squirming for up to 10 days.

**Intelligent design:** The xenobots were created using an evolutionary algorithm, which mimics natural selection by generating potential solutions and then repeatedly picking and mutating the most promising ones. The algorithm **(20)** conjured thousands of random configurations of between 500 and 1,000 skin and heart cells and each one was tested in a virtual environment. Many were useless lumps. But those that showed potential—such as being able to move—were tweaked and used to seed the next generation. After running this process 100 times, the researchers built the best designs out of living cells.

**(25) Are there ethical concerns?** This first crop of xenobots are very basic. But future versions could be made with nervous systems and sensory cells— even rudimentary cognitive abilities—which would allow them to react to their environment. It is far from clear whether we should treat such robots as machines or living creatures.

*Adapted from [www.technologyreview.com](http://www.technologyreview.com)*

### **[1] BRIEFLY ANSWER THE FOLLOWING QUESTIONS ACCORDING TO THE TEXT, ONLY WITH THE DATA REQUIRED (NOT A WHOLE SENTENCE).**

1.1 The sentence “*while another has*” (line 3) the word ‘*another*’ refers to...

1.2 The sentence “*that it could use...*” (line 4) the word ‘*it*’ refers to ...

1.3 In the sentence “*that can heal themselves when damage*” (line 7) the word ‘*themselves*’ refer to...

1.4 In the sentence “*have enough energy to keep it ...*”(line 16) the word ‘*it*’ refers to...

1.5 In the sentence “*the most promising ones...*”(line 19) the word ‘*ones*’ refers to...

1.6 In the sentence “*It is far from clear...*”(line 28) the word ‘*it*’ refers to...

1.7 What two things can xenobots do?

1.8 What would they be used for?

**[2] ARE THE FOLLOWING STATEMENTS TRUE OR FALSE? INDICATE THE LINE.**

2.1 Xenobots are formed by heart cells and skin cells.

2.2 They live up to ten days.

2.3 The process was carried out between 500 and 1,000 times.

**[3] CHOOSE a), b) OR c). ONLY ONE CHOICE IS CORRECT ACCORDING TO THE TEXT.**

a) The algorithm was based on natural selection.

b) The xenobots have cognitive abilities.

c) Xenobots are inanimated machines.

**[4] VOCABULARY.**

**4.1 Find one word in the text for each of the following definitions (0.2 each):**

a) a bag, sack, or small container, esp. one for small articles or quantities

b) imitates or copies something

c) pieces or mass of solid matter without regular shape

**4.2 Find synonyms in the text for each of the words below (0.2 each):**

c) to impel, drive forward or onward.

d) short and thick

**4.3 Give a synonym, definition or explanation to show the meaning of these words, which appear in the text.**

a) load:

b) decay:

c) wriggling and squirming:

d) conjured:

e) tweaked

**[5] WRITE ABOUT THE FOLLOWING TOPIC USING BETWEEN 120-150 WORDS (4 POINTS).**

Do you think there should be limits on how science is used to manipulate living things? Why or why not?