

• Advanced Critical Reading - Biomimetics

Biomimetics is the billion-dollar industry which draws inspiration from nature to solve problems in engineering, medicine, and other fields. While human beings have always had a natural propensity to observe and try to copy the ingenuity of nature, it is only recently that biomimetics has taken off as a field of its own.

5 The Renaissance genius Leonardo da Vinci dedicated himself to observing and recording natural phenomena half a millennium ago. His superb graphic renditions of plausible flying machines are based on his direct observations of birds in flight. His renowned Codex Atlanticus, along with smaller codices, includes renderings of animal musculature, revealing a fascination with movement. His erudite studies of flowing hair and water manifest his contemplation of the
10 movement of waves in nature. However, without modern technology, early inventors like da Vinci were unable to implement their biomimetic insights.

 On the other hand, contemporary biomimeticists have access to the technology and nanotechnology essential to the industry. One tool of enormous utility to today's biomimetics is the electron microscope. Being able to see and comprehend the nanoscale construction of natural
15 structures is crucial to synthesizing those miniscule formations.

 One person who has taken on the challenge of biomimetics is Robert Fearing, a professor of electrical engineering at the University of California, Berkeley. A modern-day echo of da Vinci's work, Fearing's current challenge is to create a bio-robotic fly which is small, swift, and maneuverable enough to deploy on surveillance or rescue missions. Fearing does not aspire to
20 replicate the fly. Rather, he hopes to isolate the enigmatic natural structures which give it flight, and perhaps find a simpler solution than the 20 muscles which power a fly's wing. Those 20 muscles allow it to make a 90-degree turn from straight-line flight in under 50 milliseconds, something even the most advanced planes are not able to accomplish. "Some things are just too mysterious and complicated to be able to replicate," says Fearing.

25 Engineer Anthony Brennan, professor in the University of Florida's Materials Science and Engineering Department, learned that the pattern of miniscule diamond shapes on shark's skin inhibit the growth of algae and other organisms. He created a surface nanotechnology comprised of billions of microscopic diamond-shaped bumps which repel bacteria and other microorganisms. His biomimetic plastic wrap is being used in hospitals on typically bacteria-
30 laden surfaces such as light switches.

 According to MIT chemical engineer Robert Cohen, "The natural structure provides a clue to what is useful in a mechanism. But maybe you can do it better." Cohen recently utilized nanotechnology to mimic the scales of a desert lizard to produce a water collection device. In a
35 National Geographic interview, Cohen says, "Looking at pretty structures in nature is not sufficient. What I want to know is, can we actually transform these structures into an embodiment with true utility in the real world?"

 Leonardo would have met today's technologies with a receptive mind. In his own time, he was heralded primarily not as an artist, but as an engineer. His orientation as a biomimeticist might be summed up in his own quotation concerning nature: "Human subtlety will never devise
40 an invention more beautiful, more simple or more direct than does nature because in her inventions nothing is lacking, and nothing is superfluous."

Questions

1. According to the passage, how do today's biomimeticists differ from Leonardo da Vinci?
 - I) Leonardo did not have the technology to construct his machines when he envisioned them.
 - II) Today's biomimeticists aspire to improve upon nature, whereas Leonardo considered nature to be ultimately better than any man-made invention.
 - III) Today's biomimeticists have conceived of replacing many natural structures with man-made structures.
 - A) I only
 - B) II only
 - C) III only
 - D) I and II only
 - E) II and III only
2. How is Fearing's current challenge an echo of da Vinci's work?
 - A) Fearing is attempting to create a flying machine based on a natural structure.
 - B) Fearing hopes to improve upon the fly's movement mechanism.
 - C) Fearing aspires to create a miniscule technology.
 - D) Fearing hopes to simplify modern flight technology.
 - E) Fearing is working on electricity.
3. In line 20, *enigmatic* most closely means
 - A) discrete
 - B) strategic
 - C) pragmatic
 - D) inscrutable
 - E) determinate
4. Based on the passage, which modern biomimeticist holds views most similar to those of Leonardo as exemplified in lines 39–41, and why?
 - A) Robert Fearing — because he wants to simplify the natural structures that give the fly flight
 - B) Robert Fearing — because he believes that some things are too complicated to be able to replicate
 - C) Anthony Brennan — because he replicated a structure found in nature
 - D) Anthony Brennan — because he created a surface technology
 - E) Robert Cohen — because he says, “maybe you can do it better.”

Answers and Explanations

1. The correct answer is **D**.
 - I) Correct. Leonardo did not have the technology to construct his machines when he envisioned them.
 - II) Correct. Today's biomimeticists aspire to improve upon nature, whereas Leonardo considered nature to be ultimately better than any man-made invention.
 - III) Incorrect. Today's biomimeticists have not conceived of replacing many natural structures with man-made structures.
2. The correct answer is **A**.
 - A) Correct. Fearing is attempting to create a flying machine based on a natural structure, just as Leonardo wanted to build a flying machine based on the flight of birds.
 - B) Incorrect. Fearing hopes to improve upon the fly's movement mechanism, however da Vinci did not hope to improve on nature.
 - C) Incorrect. Fearing aspires to create a miniscule technology, but da Vinci did not aspire to create a small technology.
 - D) Incorrect. Fearing hopes to simplify the fly's natural flight mechanism.
 - E) Incorrect. There is no mention that Fearing is working on electricity. Fearing is an electrical engineer.
3. The correct answer is **D**.
 - A) Incorrect. *Discrete* means separate. Since Fearing hopes to isolate the structures, or make them separate, *discrete* cannot be correct.
 - B) Incorrect. *Strategic* means planned. Since Fearing hopes to isolate these structures, he does not yet know whether or not they are planned, so *strategic* cannot be correct.
 - C) Incorrect. *Pragmatic* means practical. Since Fearing hopes to simplify these structures, he seems to believe they are not practical or *pragmatic*, so *pragmatic* cannot be correct.
 - D) Correct. *Inscrutable* means puzzling. Fearing is hoping to isolate the structures, so he seems to believe they are puzzling, so *enigmatic* is correct.
 - E) Incorrect. *Determinate* means distinct. Since Fearing hopes to isolate the structures, or make them *determinate* or distinct, *determinate* cannot be correct.
4. The correct answer is **C**.
 - A) Incorrect. Robert Fearing — because he wants to simplify the natural structures that give the fly flight, whereas da Vinci believed that nature had the simplest answers.
 - B) Incorrect. Robert Fearing — because he believes that some things are too complicated to be able to replicate, whereas da Vinci believed that nature had the simplest — not complicated — answers.
 - C) Correct. Anthony Brennan — because, like da Vinci, he replicated a structure found in nature
 - D) Incorrect — There is no mention that Leonardo created a surface technology.
 - E) Incorrect. Robert Cohen — because he says, “maybe you can do it better,” whereas da Vinci thought nature had the best answers.