



PART 3

Read the text below and answer questions 27–40.

THE CHALLENGES AND PROMISE OF A BIOMIMETIC FUTURE

Biomimicry has moved beyond the popular caricature of “copying nature” and into a more demanding intellectual programme: treating biology as a repository of testable principles. Advances in imaging, modelling, and materials science have made it possible to quantify how organisms manage friction, adhesion, heat transfer, and water movement, and to express those strategies in the language of engineering rather than admiration. This shift is philosophical as much as technical. It rejects biomorphism—looking like nature—as a sufficient aim, and insists instead on functional emulation: understanding what a system does, under what constraints, and by what mechanisms. Yet it also exposes a persistent epistemological gap between the conditions under which biological strategies evolved and the conditions under which human artefacts must operate.

One of biomimicry’s most attractive promises is thermodynamic efficiency. Many organisms synthesise complex structures at ordinary temperatures and pressures, using abundant elements and producing comparatively little waste. Shells, bones, and plant fibres demonstrate how elaborate performance can arise from modest energetic inputs, coordinated through growth rather than through high-temperature fabrication. By contrast, industrial manufacturing frequently relies on heat, pressure, and chemically aggressive pathways to achieve precision and speed. In theory, learning from nature could lower energy demand and reduce reliance on persistent chemicals. In practice, translation is not automatic. Biological performance is not simply “available” for import; it must be reconstructed within industrial constraints, which can reintroduce high energy use, specialised feedstocks, or undesirable processing steps that compromise the original sustainability narrative.

This leads to a second paradox: the maintenance problem. Living systems are not merely efficient; they are regenerative. They grow, adapt, and repair small damage through continuous metabolic work, replacing worn components and responding to changing conditions. Manufactured objects, by contrast, are expected to remain stable, predictable, and safe for years with limited maintenance. They must endure abrasion, dust, oils, ultraviolet exposure, repeated loading, and user misuse—often without the possibility of self-healing. The result is contextual obsolescence: a design that excels in a narrow test environment may degrade rapidly when confronted with the broader, messier ecology of real use. What biology achieves through ongoing repair, industry must substitute with robustness, redundancy, or service regimes, each carrying cost and complexity.



The history of biomimicry reflects an evolving understanding of where biological advantage actually resides. Early projects were frequently form-led, shaped by a reductionist fallacy: the assumption that copying an organism's visible geometry would replicate its performance. Streamlined bodies, branching patterns, ribbed shells—these shapes were reproduced as if the macroscopic outline accounted for the benefit. Later work complicated this picture. Many functional advantages depend on micro- and nano-scale features: fine grooves that modulate fluid flow, textures that control how droplets spread, or patterned surfaces that influence adhesion. In this sense, biomimicry matured from an aesthetic borrowing of morphology to a more analytical engagement with microstructure, mechanism, and boundary conditions.

These insights have indeed supported practical materials. Gecko-inspired dry adhesives can attach strongly without liquid glue because dense arrays of microscopic structures maximise surface contact and exploit intermolecular forces. Water-repellent coatings may combine chemistry with texture so droplets bead and roll away, taking dirt with them, thereby reducing cleaning and the need for temporary surface treatments. Yet the very features that enable performance can also be fragile. Laboratory success does not guarantee field reliability: a surface may behave impressively when new, but its properties can deteriorate when the texture is scratched, worn, or clogged. More broadly, biological “solutions” usually operate as integrated packages of traits tuned to a specific environment. Isolating one trait—one texture, one shape—can undermine the outcome because the original performance depended on interactions among multiple components.

System-level biomimicry therefore brings further complications. Ventilation strategies inspired by insect nests can stabilise indoor temperature through channel networks and controlled airflow, suggesting a path toward lower-energy buildings. But insects continually modify their structures in response to heat, humidity, and colony needs, while buildings must satisfy regulations and deliver predictable performance with minimal intervention. Replacing biological adaptability may require sensors, controls, and feedback loops—or extremely robust passive design—each adding expense and new failure points. The deeper lesson is not that biomimicry “fails” at the system level, but that it forces designers to confront the difference between a living architecture that evolves and a human architecture that must be certified, insured, and operated by non-specialists.

A further challenge is the knowledge-transfer problem. Databases that translate biological strategies into engineering language can accelerate brainstorming and help teams move from curiosity to candidate mechanisms. However, they can also encourage shallow matching: selecting an attractive analogy while neglecting the ecological context that made the strategy effective. Decontextualisation is tempting because it offers speed. Yet it



risks substituting labels for understanding—treating “lotus effect” or “gecko adhesion” as plug-and-play answers rather than as phenomena whose performance depends on scale, environment, and maintenance. Moreover, attention can cluster around charismatic or well-studied organisms, leaving less obvious but potentially valuable strategies under-explored simply because they are harder to observe, less marketable, or absent from popular repositories.

Finally, biomimicry is not automatically sustainable or ethically uncomplicated. Replicating a biological structure may require high heat, rare materials, or toxic solvents, and “nature-inspired” branding can obscure these trade-offs behind the halo of the natural. Similarly, patents and ownership disputes can arise when multiple teams adapt the same biological idea, raising questions about who is entitled to profit from principles that were not invented but discovered. Critics also warn that biomimicry can reproduce older patterns of unfair benefit-sharing when biological knowledge is sourced from biodiverse regions or indigenous communities without appropriate credit or reciprocity. A responsible biomimetic future therefore demands more than clever analogy: it requires transparent claims, institutional accountability, and interdisciplinary collaboration that integrates biology, engineering, ethics, and policy.

The promise of biomimicry remains real, but it is best understood as a disciplined method rather than a guarantee. Its ambition is to narrow the epistemological gap between living and manufactured systems—not by pretending that industry can become biology, but by translating what is learnable while respecting what is irreducibly contextual. The most credible pathway is rigorous: life-cycle evaluation that tests environmental claims, iterative experimentation that anticipates degradation, and governance norms that treat the biological idea as a shared inheritance rather than a marketing asset. If these conditions are met, biomimicry can become less a romantic slogan and more a practical philosophy of innovation under constraint.

Questions 27–32

Choose **TRUE** if the statement agrees with the information given in the text, choose **FALSE** if the statement contradicts the information, or choose **NOT GIVEN** if there is no information on this.

27 The passage suggests that biomimicry is increasingly treated as a source of testable principles rather than decorative imitation.

28 The passage claims that adopting biological manufacturing strategies will always reduce the use of persistent chemicals.



29 The passage indicates that manufactured objects are expected to function reliably over long periods with limited maintenance.

30 The passage suggests that early “form-led” projects often assumed overall shape accounted for most advantages.

31 The passage suggests that a biomimetic surface may lose performance when its texture is scratched or clogged.

32 The passage states that biomimicry databases are now used by most major manufacturing companies.

Questions 33–37

Select the correct answer.

33 According to the passage, one major difference between living systems and manufactured objects is that living systems can

- A** heal small damage and adjust to changing conditions
- B** meet building regulations without modification
- C** avoid exposure to dust and oils in the environment
- D** maintain performance only in laboratory conditions

34 Early biomimetic design is described as “form-led” because it often

- A** rejected geometry as irrelevant
- B** relied on databases instead of observation
- C** copied visible shapes as if geometry alone explained the benefits
- D** focused mainly on micro- and nano-scale textures

35 The passage suggests that real-world performance can decline because surfaces may

- A** expand in size when exposed to sunlight
- B** be scratched or clogged, altering their properties
- C** stop interacting with water completely
- D** become more effective after repeated use

36 When applying insect-nest ideas to buildings, designers may need sensors or controls because buildings

- A** are rebuilt every season
- B** can change their shape without cost
- C** do not require stable indoor temperatures
- D** must deliver predictable performance with minimal intervention



37 The author's concern about biomimicry databases is that they may

- A** encourage shallow matching that ignores ecological context
- B** contain too many examples to be usable
- C** prevent patents from being granted
- D** remove the need for interdisciplinary work

Questions 38–40

Complete the sentences below. Choose **ONE WORD ONLY** from the text for each answer.

38 Replicating a biological structure may require high heat, rare materials, or toxic

39 Ownership disputes can occur when different teams adapt the same biological

40 The most credible pathway includes evaluation to test environmental claims.

Answer Key

27. TRUE

28. FALSE

29. TRUE

30. TRUE

31. TRUE

32. NOT GIVEN

33. A

34. C

35. B

36. D

37. A

38. solvents

39. idea

40. life-cycle