



PART 3

Read the text below and answer questions 27–40.

SYNTHETIC BIOLOGY: ENGINEERING LIFE FROM SCRATCH

A

Synthetic biology is an effort to make living systems easier to design, build, and predict. Rather than merely altering a single gene in an existing organism, practitioners assemble genetic “circuits” from standardised components, redesign metabolic pathways, and sometimes propose minimal genomes that perform a defined set of tasks. The underlying ambition is to treat biology as an engineering medium: modular, testable, and scalable. In reality, however, engineering metaphors collide with the fact that cells are adaptive, historically evolved systems, so the field is shaped by both technical ingenuity and epistemic uncertainty about how complex life will behave outside controlled settings.

B

One major strand focuses on DNA synthesis and genome writing. As the cost and speed of synthesising long DNA sequences have improved, researchers can construct extended genetic programs and insert them into cells to create new metabolic capabilities. This enables microbes to manufacture medicines, fragrances, or industrial enzymes by redirecting metabolic flux toward a desired product. Yet writing long DNA is not the same as controlling behaviour. Cells regulate gene expression through layered feedback, and engineered pathways can interact unpredictably with native networks. Even when a new pathway functions in early tests, it may burden the cell, trigger stress responses, or behave differently as conditions change, reminding researchers that “design” does not automatically translate into stable control.

C

A second strand centres on genetic circuits that sense inputs and generate outputs, such as activating a therapeutic gene only when a disease marker is detected. In principle, these systems could reduce side effects by acting only where needed. In practice, circuits are exposed to stochasticity: biological noise in gene expression, mutation that alters circuit components over time, and cell-to-cell variation that makes identical designs behave differently inside different cells. As a result, circuits do not behave consistently “once designed,” and they typically require redundancy, tuning, and extensive testing across conditions to approach reliability. This vulnerability is not merely a nuisance; it is a structural constraint on claims that programmable cells can be treated like deterministic machines.



D

Environmental and agricultural applications are expanding alongside medical ambitions. Engineered microbes may fix nitrogen more efficiently, potentially reducing fertiliser demand, while others are designed to break down pollutants or capture carbon. These possibilities raise ecological questions about competition and persistence: how engineered organisms will fare against wild counterparts, whether genes might transfer to other species, and what happens if an organism spreads beyond its intended setting. Because retrieval is difficult once organisms disperse, many proposals emphasise biocontainment strategies and credible “off-switches,” as well as monitoring plans that can detect unexpected outcomes early. The central concern is not only whether a design works, but whether it can be contained and, if necessary, removed.

E

Biosecurity is a persistent concern because tools that lower the barrier to building organisms also create a dual-use dilemma. Techniques intended for legitimate research can be misused, intentionally or accidentally, to produce harmful agents or risky experiments. This has led to calls for screening DNA orders, monitoring high-risk research, and embedding safety features into organisms and workflows. However, screening systems are uneven globally, and definitions of what counts as “high-risk” can vary across jurisdictions, creating weak links in an international chain. Differences in capacity, incentives, and regulation mean that governance cannot be assumed to be uniform, even when the scientific methods are widely accessible.

F

The field also faces an intellectual and practical challenge: standardisation meets biological complexity. Genetic parts that appear to be “plug-and-play” often behave differently depending on context, including the host organism, growth conditions, and interactions with other inserted components. This context dependence makes results hard to reproduce across laboratories, even when teams follow similar protocols. Researchers respond by developing shared measurement standards, characterisation libraries, and open repositories, hoping to turn idiosyncratic findings into reusable knowledge. Yet these efforts must compete with proprietary knowledge incentives and rapid commercial timelines that discourage full disclosure, reinforcing the sense that synthetic biology advances through negotiation between openness, competition, and the stubborn variability of living systems.

G

Ethical questions extend beyond immediate safety. Synthetic biology can concentrate power in organisations that control patents, datasets, and production infrastructure,



allowing a small number of actors to shape which products reach markets and which problems are prioritised. Bio-based manufacturing may disrupt livelihoods if it replaces traditional agriculture or extraction industries, shifting value from land- and labour-intensive sectors to capital-intensive bioprocessing. These distributional effects can be difficult to see in early technical discussions, but they matter for legitimacy. Advocates argue that biological manufacturing could reduce environmental damage by replacing petrochemicals, yet critics note that “cleaner” production does not automatically imply fairer outcomes.

H

Public acceptance depends on trust and transparency, particularly when applications involve environmental release rather than contained medical use. Communities often demand visible oversight, clear accountability, and meaningful participation in decisions that affect local ecologies and economies. Past debates over genetically modified crops suggest that technical risk assessment does not settle value conflicts about who benefits and who decides. Many analysts therefore argue that governance may determine whether benefits outweigh risks: standards, monitoring, and accountability can help translate engineering power into socially acceptable practice, while weak governance can amplify inequality, ecological risk, and distrust. The likely trajectory is cautious iteration rather than sudden revolution, with progress shaped as much by institutions and norms as by scientific capability.

Questions 27–31

The text has eight paragraphs, **A–H**. Which paragraph contains the following information? Choose the correct letter, **A–H**.

- 27** The passage points out that standardised biological parts may perform differently depending on context, making results hard to reproduce.
- 28** The text warns that global screening practices are uneven and that definitions of “high-risk” research differ between jurisdictions.
- 29** A concern is raised that engineered circuits may not behave reliably because of biological noise, mutation, and cell-to-cell variation.
- 30** The passage notes that inserting long DNA sequences does not necessarily mean researchers can control how a cell behaves.
- 31** The text highlights ecological worries about releasing engineered organisms, including gene transfer and the difficulty of retrieval if problems occur.

Questions 32–36



Choose the correct heading for each paragraph.

List of Headings

- i Biosecurity controls and uneven screening regimes
- ii Patents, power concentration, and potential livelihood disruption
- iii Environmental releases raise competition, gene flow, and retrieval challenges
- iv How genome writing enables new industrial manufacturing
- v Why governance may determine whether benefits outweigh risks
- vi Standardisation meets context-dependence and conflicting incentives
- vii Why contained medical use avoids public controversy

32 Paragraph D

33 Paragraph E

34 Paragraph F

35 Paragraph G

36 Paragraph H

Questions 37–40

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.

37 The passage suggests synthetic biology aims to make biology more like engineering by using modular, testable systems.

38 The passage states that once designed, genetic circuits behave consistently and do not require extensive testing across conditions.

39 The passage reports that environmental-release applications of synthetic biology have already been widely banned in many countries.

40 The passage suggests that if standards, monitoring, and accountability keep pace, synthetic biology could deliver benefits while limiting risks.

Answer Key

27. F



28. E

29. C

30. B

31. D

32. iii

33. i

34. vi

35. ii

36. v

37. TRUE

38. FALSE

39. NOT GIVEN

40. TRUE