



PART 3

Read the text below and answer questions 27–40.

PLANETARY PROTECTION: ETHICS IN THE FINAL FRONTIER

A

Planetary protection refers to the policies and practices intended to prevent harmful biological contamination during space exploration. The concern runs in two directions. Forward contamination occurs when terrestrial organisms are transported to other worlds; back contamination describes the possibility that extraterrestrial material—returned intentionally or accidentally—could pose risks to Earth’s biosphere. While the probability of dramatic outcomes is debated in the scientific community, most space agencies treat contamination control as essential, partly to protect public safety, and partly to preserve the credibility of research in environments where evidence may be fragile and hard to interpret.

B

The scientific case for forward contamination control begins with epistemology: life-detection is vulnerable to false positives. Spacecraft inevitably carry some bioburden—microorganisms that survive cleaning, assembly, and launch. If those microbes reach a target environment, they could colonise protected niches, persist long enough to be detected, or leave chemical signatures that mimic biological activity. Even if long-term flourishing is unlikely, short-term survival in shaded cracks or transient brines could confuse instruments and distort conclusions. The risk is amplified by the fact that many proposed “biosignatures” are indirect and probabilistic. A single ambiguous signal can drive years of follow-up, so the cost of contamination is not only biological but interpretive.

C

Back contamination is most frequently discussed in relation to sample-return missions. Rocks or soils brought from Mars or other bodies are widely expected to be low risk, yet they are not risk-free in principle: they may contain unknown chemical hazards or biological entities outside current experience. Responsible planning therefore emphasises layered containment, quarantine procedures, and specialised facilities designed to prevent accidental release while still enabling scientific analysis. The goal is not to dramatise danger, but to acknowledge uncertainty. In public debate, back contamination is often framed as a binary—either catastrophe or nothing—whereas the real issue is managing low-probability, high-consequence possibilities without paralysing exploration.



D

Ethical arguments extend beyond safety into questions about how humans ought to behave in unfamiliar environments. Some philosophers reject a purely anthropocentric framework and propose that other worlds may possess intrinsic value independent of human use. On that view, irreversible contamination could be a moral harm even if no life is assumed to exist elsewhere, because it damages environments we do not understand and forecloses future knowledge. Others defend a stewardship ethic: exploration can proceed, but only with humility, restraint, and an obligation to avoid preventable harm. These positions differ in emphasis, yet both treat planetary protection as a matter of moral responsibility rather than merely technical hygiene.

E

Commercial activity complicates governance because incentives shift when timelines are tight and objectives are profit-driven. States can regulate companies under their jurisdiction, but competitive pressures can encourage “flag of convenience” behaviour, in which operators seek licensing regimes with the least restrictive requirements. In practice, this can resemble regulatory arbitrage: firms may engage in jurisdiction shopping to secure faster approvals, lower compliance costs, or weaker oversight of sterilisation protocols. The challenge is that contamination is not contained by national borders; a single poorly controlled mission can affect shared scientific interests. International coordination is therefore crucial, yet difficult, because it requires aligning enforcement capacity and commercial incentives across multiple legal systems.

F

A further dispute concerns proportionality. Strict sterilisation standards can raise mission costs, constrain hardware choices, and create barriers for smaller organisations that cannot afford elaborate clean-room infrastructure. Critics argue that requirements should be calibrated to realistic risk, not worst-case speculation, and that excessive caution can slow the accumulation of knowledge. Others reply that the downside is asymmetric: even if the probability is low, irreversible contamination would be a permanent loss for science and for future generations, because it could erase the very conditions needed to test whether life ever existed independently elsewhere. This disagreement is not simply technical; it reflects different tolerances for uncertainty and different views about what counts as an acceptable trade-off.



G

Technology offers partial solutions but not absolution. Improved clean-room practices, better bioburden monitoring, DNA sequencing for microbial audits, and advanced sterilisation methods can all reduce contamination risk. Yet no method is perfect, and overconfidence in technical fixes can create blind spots—particularly when complex supply chains, schedule pressure, and human error interact. For that reason, transparency about remaining risk is not optional. Maintaining records of cleaning procedures, microbial surveys, and mission histories allows later investigators to interpret ambiguous findings responsibly. In planetary protection, accountability is as much about traceability and openness as it is about hardware performance.

H

Public trust matters because planetary protection is a collective choice about shared risks and shared scientific heritage. Sample-return projects, for example, can face political backlash if they are perceived as secretive, careless, or captured by private interests. Conversely, transparent oversight, independent review, and clear communication can build legitimacy—even among societies that weigh exploration benefits and environmental risk differently. Looking ahead, planetary protection will likely become more complex as missions multiply, actors diversify, and technologies enable more intrusive activities. The aim is not to halt exploration, but to ensure it remains scientifically credible and ethically defensible. Achieving this will require standards that adapt to new capabilities, coordination across nations and companies, and a commitment to accountability when plans change.

Questions 27–31

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 describes planetary protection as addressing both contamination of other worlds and potential risks to Earth.

28 The passage suggests that even short-term survival of Earth microbes could interfere with later attempts to detect life.

29 The passage states that material returned from Mars is more hazardous than material collected from all other celestial bodies.

30 The passage suggests that stricter sterilisation standards can increase costs and restrict some mission designs.



31 The passage implies that technological improvements alone can remove the need for openness about residual risk.

Questions 32–35

Select the correct answer.

32 Why can forward contamination create difficulties for scientists searching for extraterrestrial life?

- A** It may allow terrestrial microbes to produce misleading biological signals.
- B** It prevents spacecraft from collecting any samples.
- C** It makes all forms of microbial survival permanent.
- D** It removes the need for later scientific investigation.

33 According to the passage, why are layered containment and quarantine procedures proposed for sample-return missions?

- A** Because returned material could contain unknown hazards
- B** Because agencies expect dramatic biological outcomes to be likely
- C** Because strict containment is needed mainly to protect commercial assets
- D** Because sample-return missions are intended to avoid scientific analysis

34 What complication is raised by the growth of private missions?

- A** Private organisations are prevented from operating in space by international law
- B** Commercial operators generally face stricter requirements than national agencies
- C** Private missions remove the need for international coordination on standards
- D** Enforcing planetary protection rules may become harder when profit pressures and short timelines apply

35 What does the passage suggest is one reason public trust affects planetary protection policy?

- A** Public engagement tends to reduce scientific scrutiny of risk
- B** Political support depends mainly on keeping sample-return methods confidential
- C** Perceived secrecy or carelessness can trigger backlash against missions
- D** Trust matters only when extraterrestrial life has already been confirmed

Questions 36–40

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



36 The prediction that standards will need to adapt as exploration activity increases.

37 The view that moral duties may apply even if no life is assumed to exist elsewhere.

38 The warning that excessive confidence in technical fixes can create new weaknesses.

39 The suggestion that companies may seek the least restrictive licensing environment.

40 The argument that irreversible contamination could be a permanent loss despite low probability.

Answer Key

27. TRUE

28. TRUE

29. NOT GIVEN

30. TRUE

31. FALSE

32. A

33. A

34. D

35. C

36. H

37. D

38. G

39. E

40. F