Why Science Diplomacy is Particularly Important for Biotechnology

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Contemporary societies are characterised by unprecedented levels of material convenience, sustained by a persistent drudgery of economic productivity. The costs of this model, however, have become increasingly visible. These costs are routinely absorbed by ecosystems in the present and will be paid for, with considerable interest, by our future generations.[1,2]

Despite mounting scientific evidence and growing public awareness, global production systems remain largely misaligned with ecological limits. Incremental reforms have not matched the scale of the challenge. The structural incentives of the global economy still reward short-term output over long-term resilience.

Biotechnology offers a rare opportunity to alter this trajectory. It does not require abandoning modern standards of living; rather, it reimagines how those standards are produced. Yet, in the near term, many biotechnological solutions remain more expensive than incumbent technologies. Here lies the paradox: many of these solutions are technically viable but economically disadvantaged in the short term. They are cleaner, but costlier. They are promising, but unfamiliar. And in markets structured around immediate price competition, that difference is decisive.

Hence, biotechnology's societal impact depends on collective agreement: consensus on the seriousness of the problems it seeks to address, shared approaches to risk governance, and willingness to absorb upfront costs whose benefits may materialise only decades later. Unfortunately for biotechnology, its success requires more than mere scientific or technical merit. This is a classic collective action problem, but with uniquely high stakes.

Addressing this market failure requires sustained, proactive governmental intervention, particularly through public investment in research and development and procurement policies that deliberately privilege biotechnological alternatives. Furthermore, given the scale and transboundary nature of the challenges involved, such interventions cannot remain confined to any one nation. They instead require coordinated global action to accelerate the development and adoption of biotechnology. This makes science diplomacy not merely facilitative but structurally necessary. Without effective mechanisms for international coordination, biotechnological innovations are likely to remain limited to the laboratory, even when they offer superior long-term outcomes compared to incumbent ones.

Agreeing on the Problem

Biotechnology solutions span multiple domains. In some, the problem definition is uncontested. Gene therapies addressing unmet medical needs, for example, face little debate regarding the existence of

the underlying problem. When substitutes are absent, and suffering is visible, the political will to act is comparatively strong.

In other domains, however, biotechnology confronts a more fundamental barrier: the absence of consensus on the problem itself, or at times, on its urgency. Climate change illustrates this challenge. Although multilateral agreements such as the Paris Agreement reflect broad recognition of the need to reduce emissions, political contestation persists. Prominent leaders have publicly dismissed or minimised climate science, weakening collective resolve and signalling policy instability.[3,4] Such narratives erode investment confidence and reduce the perceived necessity of long-term transitions. When the problem is framed as exaggerated or distant, solutions that are more expensive in the present appear unnecessary, leading to policy inertia.

Why Cleaner Biotech Struggles to Compete?

Insights from behavioural and social science help explain this dynamic. Construal Level Theory suggests that problems perceived as temporally or spatially distant, such as long-term climate impacts, are evaluated in more abstract terms, thereby reducing their perceived urgency relative to immediate and tangible costs.[5] This psychological distance is reinforced by economic discounting, whereby future benefits are systematically undervalued in comparison to present expenditures.[6] Additionally, the high switching costs make it difficult for biotechnology to replace incumbent technologies. For example, transitioning from conventional jet fuel to sustainable aviation fuels produced through biomanufacturing requires retrofitting refineries, adapting fuel distribution infrastructure, securing reliable biomass inputs, and obtaining international certification approvals. In the absence of a mandate and price support, such alternatives are unlikely to appeal to innovators. Together, these mechanisms help explain why cleaner biotechnological pathways may appear insufficiently attractive when assessed through a short-term economic lens. Yet, what appears fiscally prudent today will impose vastly greater and perhaps irreversible costs tomorrow. In biotechnology, delay is not neutral. Investing in climate-resilient crops only after repeated harvest failures, or in novel antimicrobials only after resistance becomes widespread, means acting after damage has compounded. Preventive investment demands foresight; foresight demands political alignment.

Beyond the economic lens, biotechnology raises profound ethical questions that further necessitate diplomatic engagement. Technologies such as gene editing, particularly for use in humans, challenge existing norms around consent, equity, and governance.[7] As advances in synthetic biology and artificial intelligence expand what can be learned from, and changed in, biological systems, shared ethical frameworks will become essential. Disagreement over acceptable use can stall deployment just as effectively as technical or economic barriers. The responsible use of biotechnology, therefore, rests on an international alignment of values.

Science Diplomacy for a Cleaner Future: From Coordination to Commitment

Science diplomacy must move from passive coordination to active commitment. In the case of biotechnology, however, cooperation must extend beyond traditional models of assisting research collaboration and facilitating ongoing trade.

First, global assessment mechanisms focused specifically on biotechnology's role in climate mitigation, health security, and food systems should be institutionalised. Just as the Intergovernmental Panel on Climate Change has shaped climate discourse, structured assessments of biotechnological pathways could anchor negotiations in shared evidence and reduce epistemic fragmentation.

Second, diplomatic systems must embed scientific capacity. Science advisers within foreign ministries, structured Track 1.5 dialogues, and regular cross-sector forums should be institutional rather than episodic. Diplomatic literacy must keep pace with biotechnology's rapid evolution.

Third, and most urgently, science diplomacy must be used to create markets. Early-stage biotechnologies struggle because demand is uncertain and fragmented. Coordinated procurement commitments, harmonised standards, and predictable regulatory pathways can transform emerging innovations into scalable industries.

The Montreal Protocol provides a clear historical precedent. By aligning regulation, finance, and implementation timelines internationally, it transformed emerging alternatives to ozone-destroying chemicals into commercially viable technologies. The remarkable speed with which COVID-19 vaccines were researched and manufactured through the support of advanced purchase agreements is another example. Biotechnology today requires similar resolve.

Finally, science diplomacy must address governance, ethics, and inclusion. Biotechnology raises complex ethical questions, particularly around gene editing, data ownership, and unequal access, that cannot be resolved unilaterally. Diplomatic engagement is essential to develop shared norms on biosafety, ethical use, and responsible innovation. At the same time, capacity-building must be an explicit objective. Ensuring that low- and middle-income countries participate not only as consumers but as contributors to biotechnology research, manufacturing, and governance is necessary both for equity and for effectiveness. Technologies that cannot be produced, regulated, or adapted locally will fail to deliver global impact.

Conclusion: From Potential to Policy

Biotechnology holds transformative potential. But potential does not self-actualise. It depends on collective decisions about urgency, risk, cost-sharing, and ethical boundaries. Science diplomacy provides the infrastructure through which those decisions can be made coherently rather than chaotically. It aligns problem definitions, reduces uncertainty, coordinates investment, and embeds shared norms. The central question is no longer whether biotechnology can contribute to a cleaner, more resilient future. The question is whether governments are willing to coordinate before crises intensify beyond control. In a century defined by biological capability and planetary limits, inaction is not neutrality. It is a choice with devastating consequences. Science diplomacy will determine whether biotechnology remains an underutilised promise or becomes a foundation of systemic transition.

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