

Indian research can shape the world

People fret about the buses India has missed in its technological growth. The list is familiar: aircraft, advanced weapons, new materials, and biotechnology. In each, we look at what others built decades ago and ask why we did not. There is value in this introspection, and there is danger. The value is that it forces us to ask whether our systems can be streamlined and enabled. Catching up is not a bad thing. Much of the world's industrial history is a history of catching up. The danger is that catch-up-itis can become a habit. If our ambition is always defined by what someone else has already done, we will always arrive late, pay for licences and know-how, and build on foundations laid elsewhere. The costs of technological catch-up are a heavy burden, and they recur with every new wave.

There is a better question to ask, and it arises from a tectonic change in the relationship between science and technology. By science, we mean discovery, curiosity, the effort to explain the universe, and the development of abstract ideas in mathematics. By technology, we mean the development of tools that enable humans to transform the world. For much of history these were treated as separate enterprises, with technology following science at a distance, sometimes by a century.

However, over the past 50 years or so we have increasingly seen fundamental research and application sewn together at the hip. Much of our understanding of how genes are regulated came from studying viruses that infect bacteria. More recently,



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studying how bacteria defend themselves gave us CRISPR technology within just a few years, which has an extraordinary range of applications. Today, the distance and time from curiosity to application are short. This shift lets thinking and training lead, and it shows that investing in fundamental research will enable leading than playing catch-up. The bus we need to board is the next one, and it has not yet left.

Get on the bus first

For science from India to have global impact by developing transformative technologies, four things need to be addressed.

First, invest in high-quality education at scale. The features of AI that democratise access to learning allow us to reach millions of students poorly served by our moribund institutions, and to bypass those institutions where necessary. But learning science requires doing science. Hundreds of experimental "foundries" in engineering, physics, biology, chemistry and math should be created; places where young people work with real instruments on real problems.

Second, national laboratories need to be liberated from insularity. The bulk of our national labs are currently poorly accessible to researchers, students and companies outside their walls. This can easily change, benefiting both labs and universities. All national labs need to be organised around three zones: green for open interaction, amber for collaboration, and red for strategic work. Much of what India's labs do belong in the green and amber zones.

Third is flexibility. Many

say we are a low-trust society and that our regulators should trust our research system more and be more flexible. The response to this is to point out that trust is low because compliance with guidelines is poor, necessitating onerous rules. However, India does have many high-quality islands of excellence in universities, institutes and laboratories. These institutions do comply with the rules and regulations, and should be freed from the weight of General Financial Rules compliance, a weight few other countries place on their scientists. Accountability should be measured by outcomes, and not by procedure at every step. Flexibility can allow these institutions to leap ahead.

Fourth, our regulatory system still needs much reform. Approvals for research with biological materials and for clinical trials remain slow and unpredictable. The more hoops companies and researchers must jump through, the less likely small and medium-sized institutions are to succeed, since only those with deep pockets can afford the time and costs. Thus, high-quality, speedy regulation is important.

None of this is beyond us; they can be achieved step by step. Many are already doing so in pockets. What is missing is the decision to make those pockets the norm, and a few who dedicate themselves to this task. How long will it take to become a science-driven nation with global impact? If we improve just 10% in each sector, field, and every year, we will be nearly seven times better in 20 years.