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Ruling the Roost in Biomanufacturing

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With India poised to be among top 5 global biomanufacturing hubs by 2025, as stated by Dr Jitendra Singh, Union Minister of Science & Technology, the biotech industry has been rapidly responding to this sector.

Based on this response, the Department of Biotechnology is working on a national project to foster high performance biomanufacturing, as an integrated approach towards promoting circular economy, which will establish world-class expertise, facilities, and skilled workforce in synthetic biology-based sustainable manufacturing methods.

Biomanufacturing, an old technique, is the engine by which innovative bio-products can be brought to commercial scale. Recent transformative advances in fundamental biotechnology, including gene editing, CAR-T and other cell therapies, metabolic engineering and synthetic biology, and mRNA vaccines are creating enormous new opportunities to grow the global bioeconomy.

For instance, the world's response to COVID-19 depended on the rapid production of new vaccines through biomanufacturing, but biomanufacturing is not only about vaccines or gene therapies. It also includes alternative proteins, plant-based oils and biofuels, bioplastics and innovative products such as bio-concrete, etc. For instance, methane-based biomanufacturing has the potential to improve the economic viability of biosynthesis.

According to market reports, artificial intelligence (AI), machine learning, and augmented reality, among other advanced technologies, are continuously being used in biomanufacturing processes across the globe, taking it to the next-generation level. Reports also suggest that the global next-generation biomanufacturing market which was $20.08 billion in 2021, would soar to $42.58 billion by 2029, with a projected CAGR of 9.85 per cent.

With next-generation biomanufacturing, we can develop upstream and downstream processing protocols such as low-cost, cell-free expression to generate portable bio-factories; sustainable manufacturing of protein purification substrates; and engineered strains to automate bioprocessing. We can merge machine learning, protein engineering and low-cost device design for testing in low-resource labs and healthcare environments.

Undoubtedly, the development of a next-generation biomanufacturing process can allow for the production of biological medication for the treatment of many crucial ailments. However, huge capital expenditure, associated unpredictable costs, lack of skilled professionals, operational complexity and compatibility challenges are hindering the growth of this sector.

One approach being explored by India, to excel in this space is the establishment of biofoundries. The biofoundries can contribute to the development and strengthening of a Design-Build-Test-Learn approach for developing new high-throughput biological solutions using cutting-edge automation technologies such as robotics, AI algorithms, high-throughput analytical equipment and software, etc. Biofoundries can rapidly develop tools and datasets to enable and improve rational strain improvement in biomanufacturing.

Apart from adequate financial and technical resources, establishing and running a biofoundry requires integrating physical and digital infrastructures and taking care of the organisational and operational issues. Nevertheless, biofoundries with appropriate automation and equipment are especially well-suited for designing vaccines.

Although technology can offer a big support to the biomanufacturing sector, the field needs investment in human capital. Besides keeping up with the latest biology and engineering technologies, the technicians and leadership in biomanufacturing need to understand and use new advances in automation and data science. And this requires constant contribution from the government, industry and academia to build a strong workforce for the biomanufacturing sector, thereby contributing to the bioeconomy of the country.

Ultimately, the ability to translate the many promising biotechnologies from lab to a manufacturing relevant scale requires a strong and technically advanced biomanufacturing base; a skilled and diverse workforce at every level; and shared infrastructure that can support development of different bioprocesses.

Developing capacity to rapidly manufacture bio-engineered solutions in all areas of the world, including diagnostics, vaccines, materials and industrial catalysts, has the potential to revolutionise the global bioeconomy. India must bring all stakeholders together to emerge as a leading player in biomanufacturing by 2025.

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