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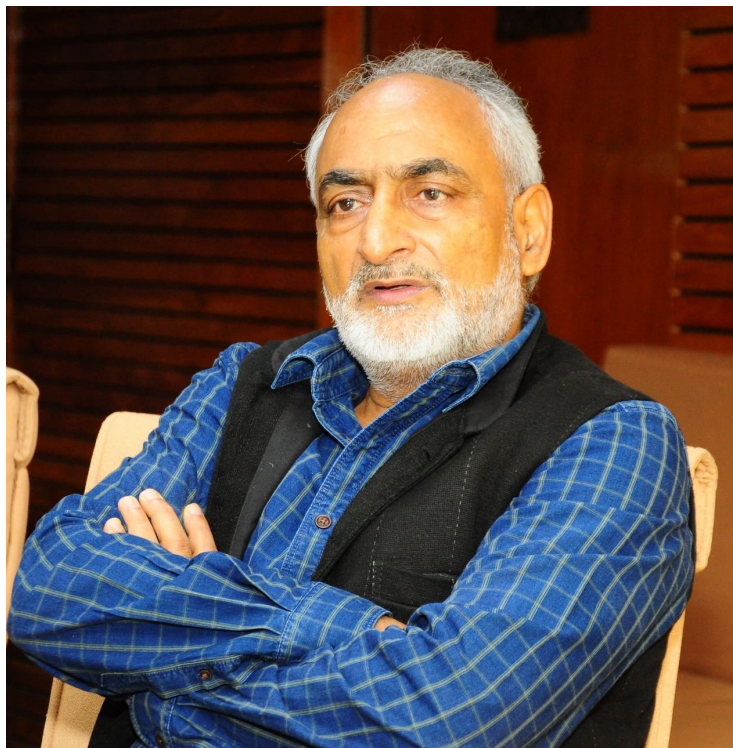
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"We want to make mRNA technology affordable to our society"

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A unique initiative of the Tata Trusts with a mission to support the application of cutting-edge science to solve societal problems, Bengaluru-based Tata Institute for Genetics and Society (TIGS) is deepening its efforts towards developing science-based solutions to prevent diseases and improve access to affordable and quality diagnostics and therapeutics in the country. During an exclusive interaction with BioSpectrum, Dr Rakesh K Mishra, Director, TIGS, spoke about the recent advancements in genetics and genomics that have the potential to solve some of the most complex challenges in healthcare and create significant societal value in India.



What were the unique highlights and achievements at TIGS in 2025?

Research programmes at TIGS are focused on three broad areas: infectious diseases, rare genetic disorders and crop improvement. We made noticeable progress in building affordable, multi-pathogen diagnostic and surveillance platforms. By optimising multiplex RT qPCR and next-generation sequencing workflows, TIGS enabled the simultaneous detection of respiratory, enteric, vector-borne, vaccine-preventable, and oncogenic pathogens. Our diagnostics portfolio now supports comprehensive pathogen profiling at a scale and cost aligned with public health needs.

TIGS further strengthened its leadership in environmental surveillance, particularly wastewater-based monitoring. We finalised standardised end-to-end frameworks- from sampling and laboratory workflows to data interpretation, sentinel site selection, and city-scale network design.

Our partnership with the Indian Council of Medical Research (ICMR) under the National One Health Mission expanded significantly in 2025. By scaling wastewater surveillance across the nation through the Viral Research and Diagnostic Laboratory network, TIGS enabled pan-India metagenomic monitoring and surveillance of antimicrobial resistance, supported by focused training and capacity-building efforts.

In rare genetic disorders, we advanced the validation of novel, affordable diagnostic assays. A major milestone was TIGS being designated the nodal centre for ICMR's Centre for Advanced Research on Neuromuscular Genetic Disorders (CAR-NMGD), catalysing integrated efforts across natural history studies, diagnostics, preclinical models, and therapeutics.

Our mRNA therapeutics platform matured further, now progressing from target identification to patient trials, with two lysosomal storage disorder candidates entering preclinical validation.

Central to these outcomes is our strengthened Technology Implementation pipeline. In 2025, all TIGS-developed assays and kits underwent rigorous evaluation, with multiple technologies progressing toward transfer and deployment. Expanded engagement through workshops, conferences, and outreach programmes reinforced our national footprint and commitment to capacity building.

What are your views on the growing burden of AMR in the country, and how are you addressing it?

Antimicrobial resistance (AMR) continues to escalate as a serious public health threat, particularly in India, where antibiotic overuse and under-regulated prescribing practices in human medicine, livestock production, and environmental discharge

contribute significantly to the rapid emergence and spread of resistance.

One of the biggest challenges faced by the medical community is the quick diagnosis of the AMR profile of the disease-causing organism. Conventional methods to identify pathogens and their antibiotic susceptibility take several days, during which patients can only be treated with broad-spectrum antibiotics, which may not have any effect on the specific infection. This is not only dangerous for the patient but also contributes heavily to increased ineffective antibiotic usage and the resultant AMR problem.

All efforts must be made to diagnose infectious agents early, along with the ability to predict which antibiotics would be best for treatment. To enable this, we are using multiple approaches for AMR diagnostics and therapeutics. We are building an ASO-directed AMR therapeutic platform to provide a solution towards rapidly evolving resistance patterns. In diagnostics, we are investigating the use of known chemical probes that report on the form and function of the bacterial plasma membrane. We seek to establish reliable fluorescence signatures from the probes that could help distinguish resistant microbes from susceptible ones, under specific antibiotic exposure. We are developing qRT-PCR-based assays for rapid, accurate, and low-cost detection. Next-generation sequencing (NGS) approaches are also being employed to understand the changing AMR landscape.

Additionally, we have initiated work towards understanding the prevalence of AMR by detecting the pathogens, crucial biomarkers and antimicrobial resistant genes (ARGs) from environmental and clinical samples. Our ongoing efforts with ICMR VRDL centres, over 65 centres for AMR signatures using wastewater and a metagenomics approach, aim to strengthen AMR preparedness and improve access to high-performance diagnostics through cost-effective and scalable molecular testing solutions.

What has been your action plan toward increasing the diagnosis of rare diseases and eventually treating them?

The diagnosis of rare genetic disorders (RGDs) is challenging not only due to a lack of awareness but also due to genetic heterogeneity and a variety of overlapping symptoms seen in patients.

We are working towards developing affordable, rapid, indigenous diagnostic solutions that are accurate and cater to the Indian RGD community. Our diagnostic assays are being designed keeping population-level screening and compatibility with carrier and newborn screening in mind.

For instance, we have developed a digital PCR-based diagnostic assay using saliva samples of patients in collaboration with the Centre for Cellular and Molecular Biology (CCMB) and Centre for DNA Fingerprinting and Diagnostics (CDFD), Hyderabad and CureSMA Foundation of India, for Spinal Muscular Atrophy (SMA), an autosomal recessive neurodegenerative disorder.

Additionally, we have developed NMPhenogen, a comprehensive database for genotype–phenotype correlation in neuromuscular genetic disorders. We have also built a blood-based diagnostic test for Monoamine neurotransmitter disorders using Liquid Chromatography–Tandem Mass Spectrometry that is multiplexed, rapid, minimally invasive, and cost-effective.

In the coming five years, we are aiming to develop preclinically validated mRNA-based therapeutic candidates for the three lysosomal storage disorders (LSDs)- Pompe disease, Fabry disease, and Gaucher disease. We would set up cGMP-compliant synthesis of mRNA-based drugs and conduct preclinical toxicity studies for mRNA-based biotherapeutic candidates, in collaboration with industry partners.

In terms of our effort to develop single-shot therapy for rare genetic disorders, in the upcoming five years, we would strive to develop preclinically validated mRNA-based gene editing/therapy candidates for muscular dystrophies and hepatic-related rare genetic disorders.

Which new technologies have the potential to advance scientific research in India, and why?

mRNAs are a fast-emerging class of biotherapeutics. mRNA therapies offer a new opportunity for targeted treatment of challenging diseases and flexible manufacturing, as demonstrated by the rapid development of mRNA vaccines against COVID-19.

For cancer, in the coming five years at TIGS, we want to develop clinically validated mRNA-based antibody candidates for the treatment of breast cancers and mRNA vaccines for the most prevalent cancers in the Indian population. For infectious diseases, we intend to finish preclinical trials alongside challenge experiments for the mRNA vaccine candidates developed

for Leptospirosis and Tuberculosis and in collaboration with industry partners, we want to begin clinical trials for the same.

On the other hand, induced pluripotent stem cells (iPSCs) derived from patients enable lab-based disease modelling that closely replicates human disease phenotypes, and are overcoming limitations of animal models. These iPSC-derived cells are valuable for understanding disease mechanisms and drug screening. However, ethical concerns and limited access to patient samples, as well as the need to study common disease variants, motivate the use of gene editing to generate specific disease models. At TIGS, CRISPR-Cas genome editing has been leveraged to develop a versatile stem cell-based therapeutic platform that supports modelling of diverse diseases.

Also, cutting-edge technologies like digital PCR, isothermal amplification methods (such as LAMP and RPA), and next-generation sequencing (NGS) have huge potential in the future to provide affordable and reliable diagnostic solutions for a wide range of diseases, from common infections to rare genetic conditions.

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