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"Shared research spaces and translational hubs allow scientists to engage with industry"

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A few weeks ago, Infosys Science Foundation (ISF) announced the winners of the Infosys Prize 2025 in six categories—Economics, Engineering and Computer Science, Humanities and Social Sciences, Life Sciences, Mathematical Sciences, and Physical Sciences, where Dr Anjana Badrinarayan, Associate Professor at the National Centre for Biological Sciences, Bengaluru, emerged as the winner of the Infosys Prize 2025 in Life Sciences, for her pioneering contributions to understanding mechanisms of genome maintenance and repair. To find out more about her research and its relevance to the life sciences sector, BioSpectrum spoke in detail with Dr Anjana.

Could you explain your award-winning research in simple terms? How is it relevant for the life sciences sector in India?

At the most basic level, my research asks a simple question: *how do cells protect and repair their DNA?* DNA carries the instructions for life, but it is constantly damaged by normal cellular processes and environmental stresses. Cells must therefore repair this damage efficiently to survive, grow, and pass on accurate genetic information. If this damage is not repaired correctly, it can lead to mutations or cell death and is the underlying cause for many pathologies.

My lab studies how microbes detect DNA damage and repair it with remarkable efficiency. By watching these processes in real time inside living cells, we have uncovered new mechanisms that cells use to find and fix broken DNA. These are fundamental findings that are relevant across all forms of life.

For India's life sciences sector, such fundamental knowledge is essential. It forms the conceptual foundation for applications in health, biotechnology, and environmental science. Strong basic research also trains skilled scientists and creates ideas that later drive innovation and industry.

You discovered new ways in which microbial cells repair DNA. Why is this important, and what made this work challenging?

DNA repair is essential for survival, yet many of its steps happen extremely fast and inside crowded cells. We discovered that cells actively *move* repair machineries across the cell to efficiently locate broken DNA and fix it. We also found that DNA Repair can occur in previously unconsidered contexts, shedding light into novel routes for dormant cells to gain new mutations.

This is important because it changes how we think about genome organization and repair - not as passive processes, but as highly dynamic and regulated ones. Such insights help explain how cells maintain genetic stability under stress and how errors can arise when these systems fail or can be programmed when cells need to adapt.

The main challenge was technical. These events occur at very small scales and over seconds to minutes. Capturing them required developing new quantitative live-cell imaging approaches and genetic approaches, as well as integrating biology with physics and computation, often pushing existing methods beyond their limits.

Live-cell imaging played a big role in your findings. How is this technique changing the way scientists study cells?

Live-cell imaging allows scientists to observe biological processes as they occur inside living cells, rather than inferring them from fixed or disrupted samples. This shift has fundamentally transformed cell biology. It is akin to an ecologist observing the natural environment to infer relations and the dynamics of a complex ecosystem. We can now ask '*when does a protein move, how fast, and in response to what signal?*' We can also appreciate how heterogenous biological cells are.

In the context of DNA repair, live-cell imaging made it possible for us to track how repair proteins move, interact, and respond to damage over time. Many crucial steps in repair are transient and would be invisible in static images. By following single cells, we could also see how different cells respond differently to the same stress.

More broadly, live-cell imaging enables researchers to study dynamics, timing, and variability - features that are central to how biological systems function. As imaging technologies become more quantitative and accessible, they are allowing scientists to ask deeper questions about cellular decision-making, coordination, and robustness that were previously hidden, and in ways that were not possible even a decade ago.

How might your fundamental discoveries help future research in areas like antibiotic resistance, ageing, cancer, or neurological diseases?

Many human diseases, including cancer, neurodegenerative disorders, and aspects of ageing, are linked to failures in DNA repair and genome maintenance. While my research focuses on microbes, the core principles governing DNA repair are conserved across evolution. Understanding these principles in tractable systems often reveals mechanisms that apply more broadly.

In bacteria, DNA repair pathways are also central to the development of antibiotic resistance. These pathways allow bacteria to survive stress and generate genetic diversity, enabling rapid evolution. By understanding how repair is regulated and mobilized, we gain insights into how resistance emerges and how it might be slowed.

Fundamental discoveries provide the conceptual framework for future therapies. They do not translate overnight, but they define *what is possible* - for example, identifying new targets, predicting resistance mechanisms, or understanding why certain cells survive damage while others do not. They shape the questions that applied researchers ask. They identify new targets, reveal vulnerabilities, and provide frameworks for understanding why some cells survive damage while others do not, which is critical across many areas of medicine.

What does winning the Infosys Prize mean to you personally and professionally?

Personally, winning the Infosys Prize is deeply meaningful. Fundamental research is often slow, uncertain, and driven by curiosity rather than immediate outcomes. Recognition for this kind of work is both affirming and motivating.

Professionally, the prize reflects the collective effort of students, postdoctoral researchers, collaborators, and mentors over many years. It also reflects the importance of the scientific environment that enables the work. In that NCBS is a truly special place for fundamental science. Scientific discoveries are rarely individual achievements, and this award acknowledges the ecosystem that made the work possible.

The prize also brings visibility to basic research being done in India and reinforces the idea that globally impactful science can emerge from Indian institutions. For early-and mid-career researchers, this kind of support strengthens confidence and helps build a culture where risk-taking and originality are valued. For younger scientists and trainees, it sends an important message that pursuing deep, mechanistic questions is valued and supported. I hope it contributes to building confidence in long-term, discovery research as a cornerstone of India's scientific future.

How does support from the Infosys Science Foundation help scientists in India, especially those working in advanced areas of biology?

The Infosys Science Foundation plays a critical role by recognizing excellence in fundamental discovery research. Such recognition sends a powerful signal - that deep, long-term scientific questions matter. This kind of support is particularly important in advanced areas of biology, where progress often requires long timeframes, sustained funding, and intellectual freedom.

Such recognition helps scientists gain visibility, attract talented students and collaborators, and pursue ambitious ideas that may be considered risky. It also strengthens confidence in the value of fundamental science, which is essential for building a robust research ecosystem. This is especially important in a rapidly developing scientific landscape like India's, where balancing immediate societal needs with investment in discovery-driven research will determine the country's ability to lead in science and innovation over the coming decades.

Are there any ongoing collaborations with the industry to take your work forward into the life sciences market?

My lab is primarily focused on fundamental discovery. However, many discoveries in science are serendipitous, and one such serendipity led to the formation of a start-up from some of the research from my lab. This has provided me a unique window into the industry side of research, which is very exciting. I want to highlight that historically; many transformative technologies including antibiotics and genome editing emerged from basic discovery research. Our primary goal will always be to build the knowledge base that can eventually enable such applications.

What are your thoughts on the current gaps that exist between industry and academia, and how can those be bridged?

One of the biggest gaps between academia and industry is the difference in timescales and incentives. Academic research is often driven by long-term questions and open exploration, while industry must focus on deliverables and scalability. Bridging this requires better interfaces - shared research centres, flexible funding models, and people who can move between both worlds. Equally important is mutual understanding. When industry engages early with fundamental science, and academia appreciates real-world constraints, collaborations become far more productive. But it is important to note that this is not an either/ or situation - there is incredible value to both sides of research, and each must be nurtured and sustained. Having had the opportunity to experience both spaces, I see the importance of structured interfaces between the two. Shared research spaces and translational hubs allow scientists to engage with industry without compromising scientific integrity.

Dr Manbeena Chawla