India in the Emerging Scientific Scenario

Three key features will revolutionize science in the future- integrative, fast and small. Scientists will need to think out of the box and explore unknown domains. As science becomes more and more complicated they will need to search for solutions in fields other than theirs. The biggest discoveries will be made through collaborations at the interface of science.

Though genomics caused the gold rush in the earlier half of this decade, it fails to capture the complete picture. Scientists have come to recognize that genetic information is not of much use unless one can understand the workhorses of the cells- the proteins. The proteins are modified by sugars or the glycome, which forms the microenvironment of the cells. To get to the root of a disease and to develop newer and safer approaches of treatment it will be necessary to understand how the information flow between transcriptome, the proteome and the glycome is altered during disease. Furthermore, this needs to be integrated with the clinics using a clinical informatics approach. This will enable early diagnosis and tailoring the therapy to the patient. This in turn will need more engineers, computer scientists, biologists, mathematicians to enter the domains of biology and medicine and work in tandem with biologists and clinicians. Together they will push the boundaries of an emerging field called systems biology.

Major developments, mainly in the training of excellent manpower and the accessibility to advanced technology has defined that India can move to a position of strengths in this emerging area. Significant milestone are being achieved by Indian scientists in this field. For example, Prof. Vijay Pande’s group at Stanford is using a concept called distributed computing to figure out the three dimensional folding of a protein. The conformation of a protein is a vital element in its proper function, and alterations can often lead to diseases such as Alzheimers. Without his approach, it would have taken years to model the folding of a protein that happens in nanoseconds. However, there is still a need for faster computing capabilities, and this can again be achieved through the contributions of another Indian Scientist.

Way back in the 1920s, Prof. Satyendra Nath Bose made theoritical framework of what came to be known as the Bose-Einstein condensates. Recently, scientists at Harvard University are using this concept to demonstrate that ultra-cold atoms can be used to freeze and control light to form the core or the CPU of an optical computer, smashing the intrinsic speed limit of the silicon technology. These technologies will help unravel the secrets of biology in the future.

Another area that is emerging is regenerative medicine, enabled by the advances in stem cell biology. These pluripotent cells have the capability to differentiate into any cell type, and the goal is to harness this capability to generate specific organs for transplantation. An interesting question to ask is – why the same cell forms neurons in the brain and cardiac cells in the heart? Is it that the microenvironment controls the outcome, and if so can we engineer artificial microenvironments that will enable us to generate the desired tissue? These are some of the questions that we are asking in our laboratory at Harvard Medical School and Brigham and Women's Hospital, and can be addressed by chemists and biologists working in tandem.

Hybrid nanotechnology will revolutionize medicine. Our laboratory recently developed a novel nanoscale device that packages multiple anticancer agents into a small packet and releases these inside the tumor only when required, increasing their anticancer effect while reducing side effects. Another invention from Prof. Ajay Sood's laboratory at Indian Institute of Sciences, Bangalore, shows that electricity is generated when liquids flow through carbon nanotubes. The day is not far off when these can be harnessed to generate implantable sensors for early detection of diseases or to power a pacemaker without the need for replacing a battery.

This is an exciting time for science. India, and we as Indians, have the capability but we needs to realise that revolutions in science or in any field cannot be brought about by individual efforts but through working as a team. We need to shake of the individualistic mentality and break down the boundaries between fields. Its only through seamless transition of technology that we can emerge as the leaders of innovation in science.

About the author:

Shiladitya Sengupta completed his undergraduate and postgraduate studies at the All India Institute of Medical Sciences, where he received the Geeta Mital Gold Medal and also the Shakuntala Amir Chand Prize for excellence in medical research from the Indian Council of Medical Research. He completed his PhD at Trinity College, University of Cambridge as a Nehru Scholar, and his postdoctoral training at MIT. He then joined Harvard Medical School, Brigham and Women's Hospital and MIT as a joint Assistant Professor of Medicine and Assistant Professor of Health Sciences and Teechnology. He has been awarded many times by the American Society for Pharmacology and Experimental Therapeutics, and recently was awarded the Coulter Foundation Career Award in Bioengineering. He received the prestigious TR35 under 35 Innovator award from the Technology Review Magazine in 2005, and was selected as one of the Thought Leaders by India Today Magazine and the NRI of the Year by Hindustan Times in 2005. He has also started two companies and has been a winner at the Cambridge University and Wharton University Business Plan Competitions, and is currently involved with the Government of India in promoting entrepreneurship within Indian academia.