

Kalyan Banerjee (1937–2021)

‘Life is no brief candle to me. It is a sort of splendid torch which I have got a hold of for the moment, and I want to make it burn as brightly as possible before handing it on to future generations.’

– George Bernard Shaw

These words aptly describe the philosophy of the world-renowned virologist Dr Kalyan Banerjee, who in his 50 years of work in the field of Virology not only conducted pioneering research, but also motivated many to carry further his legacy of hard work, integrity and courage.

Banerjee having completed his MBBS degree from Calcutta university, began his career in the field of virology in 1961. He joined the then Virus Research Centre (VRC, Pune), later renamed as National Institute of Virology (NIV) for a Ph.D. degree under the guidance of Charles Anderson of Rockefeller Foundation, Yale University, Connecticut, USA. In the early ‘70s, Banerjee was also awarded the prestigious D.Sc. degree from Yale University, USA. In Yale, Banerjee worked with the Nobel laureate Max Theiler, who remained a life-long beacon of light for Banerjee’s scientific quest.

Banerjee’s early research focused on various aspects of arboviruses. He was a unique scientist – a dexterous field worker as well as a diligent laboratory person. In a chapter in *Virus Ecology*¹, he wrote ‘The term arbovirus connotes a very heterogeneous group of viruses. It is essentially an epidemiological concept’. He conducted extensive epidemiological work in areas affected by dengue, Japanese encephalitis (JE), chikungunya and West Nile viruses. He spent weeks and months in places like Bankura (West Bengal), Dibrugarh (Assam), Muzaffarnagar (Uttar Pradesh), Kolar (Karnataka) and Kerala, gathering epidemiological data on these viruses. Banerjee isolated several strains of JE virus in India and conducted cross-neutralization studies for the demonstration of strain variation of JE virus, a feature commonly associated with RNA viruses. Alongside, he also discovered three new arboviruses, viz. Barur virus (a rhabdovirus) isolated from Karnataka, Chobar Gorge virus (an Orbivirus) from Nepal and Sripur virus (a rhabdovirus) from West Bengal.

Banerjee’s field surveys were backed by several laboratory studies that included

methods for the growth and quantitation of dengue group of viruses, identifying genetic markers of dengue viruses and mathematical relationship between dose and survival time with different strains of dengue and chikungunya viruses. He was the first to show the formation of persistently infected mosquito cell cultures.



Banerjee was always sanguine and passionate about the dire necessity of basic studies and constantly encouraged his students to conduct in-depth research on virus ‘behaviour’. He guided his students on varied topics such as phylogenetic analysis and protein-based strain variation of JE virus. Under his guidance, work was conducted on the generation of attenuated strains and immune-stimulating complexes (ISCOMs) of JE virus as vaccine candidates as well as the generation of monoclonal antibodies to chikungunya and dengue viruses. Banerjee worked further towards the development of cell cultures like fish cell line, retinal culture and brain cell culture. The growth of JE virus and changes in the morphology of the cells of nervous tissue origin were shown in neurons as well as in astrocytes.

Banerjee’s phenomenal expertise in arbovirus studies automatically led him to take interest in the entomological aspects of viruses, especially susceptibility of mosquito species to virus infection and spread. He demonstrated the involvement of *Culex bitaeniorhynchus* mosquito in the bird-mosquito-bird cycle and the involvement of *Culex vishnui*, *Culex tritaeniorhynchus* and several other species of mosquito in the natural cycle of JE virus in India. His

work elucidated the role of peri-domestic vertebrates and bats in the epidemiology of JE virus. These protracted epidemiological surveys and studies scientifically necessitated the setting up of field stations. Hence, after Banerjee assumed charge as the Director of NIV, the Gorakhpur Field Station in eastern Uttar Pradesh was set up for the study of JE virus and acute encephalitis syndrome (AES). The next step was the emergence of field stations in the Andaman & Nicobar Islands for conducting haematophagous arthropod survey and surveillance.

One of his pioneering works was on the Kayasanur forest disease virus, discovered by NIV scientists during an outbreak in Sorab taluka of Shimoga district, Karnataka, recognized by an unusual heavy monkey mortality followed by a febrile epidemic in the adjoining villages. Banerjee’s endless trips to Sagar in Shimoga district by way of field studies and surveys of monkeys, ticks, humans and the forest ecology, were accompanied with deft laboratory studies. His work encompassed elucidating the basic virological aspects of the virus, the entomological and epidemiological understanding of its spread, to developing an effective ‘inactivated vaccine’ against the disease. He was instrumental in establishing the vaccine manufacturing processes and conducted multiple clinical trials of the vaccine. What can be more rewarding for a virologist than to see that the vaccine developed by him is saving the lives of hundreds of at-risk people even today in Karnataka.

As virus research became more varied and complex, NIV, under Banerjee’s stewardship expanded and diversified beyond arbovirus studies. He thus initiated rigorous research and surveillance of poliomyelitis, influenza and measles viruses. Appreciating the role of viruses causing hepatitis in humans, he took keen interest in expanding outbreak investigation and encouraged laboratory studies on hepatitis.

In the 1990s, Banerjee along with Dr Robert Bollinger, submitted India’s first NIH–US Human Immunodeficiency Virus (HIV) research proposal. The first ‘AIDS cell’ was established in NIV under Banerjee’s meticulous planning and execution. This helped in the ‘Preparation for AIDS vaccine evaluation programme’, leading to the construction and establishment of the state-of-the-art National Aids Research

Institute (NARI) in Pune under Banerjee's indefatigable and inspiring leadership.

Over the years, Banerjee and many other scientists at NIV felt the need to establish a laboratory where microorganisms of highly infectious nature could be handled and stored. They believed that this would help equip NIV and in turn India to monitor and combat the periodic national outbreaks and pandemics. Thus, the idea of high-containment laboratory called 'Microbial Containment Complex (MCC)' was born. Banerjee along with being a visionary leader, recognized that it was going to be an uphill task to convince policy-makers and Government agencies to allocate the required land and funds for this project. After considerable persuasion and follow-up, a land of approximately 28 acres was finally allocated to NIV for the development of MCC by the Government of Maharashtra. This was a happy moment for all and as Y. D. Sabale (Civil Engineer, NIV) recalls, was celebrated by NIV scientists visiting the residence of Dr C. G. Pandit, the founder member of NIV. After becoming the Director of NIV, Banerjee along with his colleagues made special efforts for establishing this new Institute. He was extremely happy to lay the foundation stone for the construction of the basic laboratory. The soaring MCC complex standing today in Pashan, Pune, with its BSL-3 and the recent addition of BSL-4 laboratories that played a pivotal role in the development of diagnostics and vaccine for COVID-19 is a testament to his far sightedness.

Since the early 80s, Banerjee was inducted as one of the prominent members in WHO's Advisory Committee on communicable diseases. From 1990s onwards, he became a crucial participant in WHO on the Smallpox Advisory Committee on Variola Virus Research. Since then till 2012, Banerjee worked side by side with the stalwarts of the world smallpox eradication programme like F. Fenner, D. A. Henderson, I. Arita, Z. Jezek, and I. D. Ladnyi, who authored the magnum opus: *Small Pox and its Eradication* (WHO, Geneva). Banerjee with his incisive and imperturbable mind, always opposed the plans to continue to hold live virus stocks in the US and Russia. During one of the WHO meetings in 2011 (The Wall street Journal Bio-terror Fears Prompt U.S. to Keep its Smallpox Cache by Betsy McKay, updated 18 January 2011, 12:01 am ET), he had said 'To put it bluntly, it is the same logic by which the superpowers continue the

possession of nuclear weapons; they wish to hold on to the smallpox virus as a super bio-weapon'. Dr Niteen Wairagkar, then a WHO member, recalls how Banerjee with his pragmatic approach would navigate complex discussions in these committees and put forward a strong perspective from developing countries. He was a bridge and guiding force in these committees and represented a generation who witnessed the horrors of smallpox and worked hard to eliminate it.

For Banerjee, the word 'retirement' had no meaning and he continued his work in the field of virology in various capacities even after his superannuation as the Director of NIV. He first worked in the Research Unit of KEM Hospital, Pune, for about two and a half years as a research consultant. At KEM Hospital, Banerjee in the capacity of a consultant, contributed immensely to the study on understanding prevalence of reproductive tract infections (RTIs) and sexually transmitted infections (STIs) and HIV/AIDS in an outreach clinic in rural Maharashtra. He also contributed significantly in preparing the Health Education Package to address this issue in rural Maharashtra.

Subsequently, Banerjee became associated with the Maharashtra Association for the Cultivation of Science (MACS), the apex body of Agharkar Research Institute (ARI), as a life member. He took keen interest in the research activities of MACS-ARI and inspired the Institute to venture into cutting-edge science that could be of societal relevance and make the best use of its R&D infrastructure. In consistence with this thinking, he initiated an All-India Coordinated Programme in Viral Taxonomy and established a Virology Lab at MACS-ARI. With the recognition of Indian Council of Medical Research, the laboratory actively contributed to the SARS-CoV-2 testing by RT-PCR assay during the COVID-19 pandemic. Banerjee also contributed to the MACS administration as Secretary, Vice President and President in various capacities, and MACS immensely benefited from his adroit guidance.

One of Banerjee's major contributions was in the National Certification for Polio Eradication (NCCPE) since its inception in 1998. He was a member of the Committee tasked with certifying the eradication of polio. Between 2009 and 2015, the International Clinical Epidemiology Network (INCLIN) Trust established a comprehensive North Indian setting entitled 'SOMAARTH' Demographic, Develop-

ment, and Environmental Surveillance Site (DDESS) in a rural North Indian setting (Palwal district, Haryana). As a surveillance platform, DDESS aimed to allow monitoring and interpretation of synergetic and complex relationships between the environment, society, regional development, economics and health status of the population over time. 'SOMAARTH' is a Sanskrit word meaning synergy between economic development and health, and according to Dr N. K. Aurora (Executive Director, The International Clinical Epidemiology Network) was coined by Banerjee himself. Banerjee had a reputation of being circumspect in investigating claims of no polio activity and his diligence in cross-evaluating surveillance indicators was well known. At the age of more than 65 years, he had once accompanied a field worker on foot to a remote village of 12-15 huts just to check proper implementation of the polio vaccination programme. He would say 'If you don't look for it, you won't find it. Give me the proof that you have looked everywhere and you didn't get it'. A perfect perspective for a certification guy.

Banerjee was a member of the National Bio-security Committee for two years and a sagacious critique of unwarranted recombinant virus studies. He opposed research involving gain-of-function studies (manipulating viruses to impart added functionalities so that those could be studied), even in the best of biosecurity laboratories. His views are still relevant when laboratory leak or deliberate creation of SARS-CoV-2 theories are making the rounds.

Needless to say, Banerjee was the recipient of several prestigious awards, including the Shakuntala Amirchand Award (1970), Dr P. N. Raju Oration Award of ICMR (1982), Dr Gharpure Memorial Award of Haffkine Institute (1991) and J. B. Chatterjee Medical Award of the School of Tropical Medicine, Kolkata (1993). In 1995, Banerjee was presented with the Jubilee Medal '100 Years of Virology' by the D. I. Ivanovsky Institute of Virology, Russian Academy of Medical Sciences, Moscow. In 1996, he received the famous Om Prakash Bhasin Award for Science and Technology. Banerjee was a Fellow of the Indian Academy of Science; Indian Virological Society and National Academy of Medical Sciences. He was also a member of the New York Academy of Sciences, USA.

In addition to his scientific interests and immense achievements in the field of virology, Banerjee had a mastery over Sanskrit

PERSONAL NEWS

and a keen interest in ancient Vedic literature. His very philosophy of life was influenced by the all-embracing knowledge available in Sanskrit hymns (shlokas), which he could recollect and recite easily. Dr Hemant Apte (KEM Hospital) fondly remembers when Banerjee, on a field trip to a tribal region in Jawahar taluka, Maharashtra, on a sunny day after the rains had just stopped, sitting at the edge of a cliff had recited and explained to him the verses from *Raghuvamsa*, the epic poem by Kalidasa.

Banerjee was a person of strong conviction and many have experienced his stern behaviour as a guide and Director of NIV. However, he had a sweet, humorous, compassionate and fatherly side to his perso-

ality. A word of appreciation from Banerjee was no less than a huge award and would call for celebration among his students. Additionally, for his students and all those who were keen to learn, he was a wonderful teacher and used to take classes in his chamber after office hours. He nurtured a generation of virologists at NIV and later at ARI. On rare occasions, he would talk about his personal experiences. I vividly remember once when he had narrated a hilarious incidence related to the hysterical behaviour of a drunken celebrity sitting next to him during an international flight to Mumbai.

Banerjee dedicated his life to the betterment of society and science, and will always be respected and admired. My

heart pains at the thought that our beloved and most respected guide left for heavenly abode on 14 April 2021 at the age of 83 years. However, his intense character has left behind a huge legacy of wisdom and also shown that being true to your field of work never goes out of fashion.

-
1. Banerjee, K., Emerging arboviruses of zoonotic and human importance in India. In *Virus Ecology*, South Asian Publ., New Delhi, 1984, pp. 109–121.
-

LEENA R. YEOLEKAR

*Serum Institute of India Pvt Ltd,
Hadapsar,
Pune 411 028, India
e-mail: leena.yeolekar@seruminstitute.com*