and the aged. Most Indian males do little to help in the household work. Many develop a cultivated incompetence for all household work, and society ridicules the males who try to share the household chores. Regarding the promotion and job policies, there are no distinctions between men and women scientists of India. In practice, however, women suffer because their problems are considered to be personal problems, and not those of the society. The handful of women scientists who do excel in such settings are usually those who possess the courage to rebel against the set traditions and conform those around them as well.

She summarized by saying that in India the attitudes are changing towards a professional career. The present-day teenaged girls are much more confident, much surer of their priorities. In many households, at least the concept of working woman and therefore sharing home responsibilities is being accepted. India has the advantage of a comparatively stable family and social life, and women should make the most of it. It is up to the women to question every tradition, to make sure that the next generation learns to question the same and learns to share all responsibilities equally.

Dr Lee started by saying that she was an oriental settled in USA, and therefore experienced a mixed sense of liberation in her life. On the one hand, she had parents staying with her, which helped her enormously during the early stages of childbearing, But that had its own traditional constraints; for example, she had to devote quite a lot of her own time for the family. She did not quite agree with Dr Gronenborn regarding the achievement of equality of both sexes in science in USA. Dr Lee specifically mentioned that in Medical Schools there was possibly an active discrimination against women, and that women had to perform much better that men for achieving the same status.

The panel discussion was attended by about one hundred and fifty odd people, 90% of whom were women. The general discussion was fairly animated. Amongst potential policy makers, Prof. Balasubramanian, the Director of Centre of Cellular and Molecular Biology (CCMB), India, remarked that every Research Organization should provide child-care facility, and that CCMB already did provide one. He also expressed the opinion that women scientists' cases should be reviewed with more flexibility for promotion, working hours, etc. Dr S. Brahmachari, Indian Institute of Science, Bangalore, however, commented that the scientific capabilities of men and women were different and that only a few women scientists were motivated enough to achieve outstanding results. Most women in the audience admitted to being suppressed in one form or another, and were of the opinion that it took much more than normal for a woman to succeed in this profession It was pointed out at the end of the discussion, by a woman in the audience, that despite the large number of women present in the audience, the participation was still dominated by men! Dr Shaila summarized that things are changing for the better, and that women must assert themselves more to excel in the existing set of norms laid out for scientists.

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Mahabaleshwar Seminar on molecular biology of plant viruses*

The 1993-Mahabaleshwar Seminar entitled 'Biology of Plant Viruses' was organized by H. S. Savithri (IISc) and M. M. Johri (TIFR) at Whitefield from November 29 to December 3, 1993. These seminars in selected areas on the frontiers of Modern Biology are organized annually, by the Tata Institute of Fundamental Research and the Indian Institute of Science. Since inception in 1975, the Mahabaleshwar Seminars have been held with minimal formalism and elegant simplicity. The selection of a venue where all participants could stay together, away from big cities, is equally important and in this respect, the placid environment at Whitefield turned out to be the right choice. At the 1993-Seminar the current status and problems of virus research in our country were discussed.

Highlights of virus research

The seminar began with a lecture by H. S. Savithri on the architecture, genome organization and replication in tymoviruses. Virion in these simple viruses consists of a single molecule of sense mRNA encapsidated in a protein shell made of 180 protein subunits. The stability of the capsid in Physalis mottle tymovirus is conferred by inter-subunit interactions and polyamines. In the absence of high resolution X-ray structure, the architecture of the virus can be probed by UV cross-linking and by use of monoclonal antibodies; these studies show that the weak RNA–protein interactions are mediated via Lys-10. For the expression of their genome, tymoviruses employ common strategies, such as use of proteolytic processing, overlapping reading frames and production of subgenomic RNA. M. R. N. Murthy described the physical principles underlying the construction of viral capsids and the methods used to study it The structure of Sesbania mosaic virus has been determined at 2.9 Å resolution by X-ray diffraction He also illustrated how the structure determination leads to insights into assembly and to design of inhibitors that block the disassembly process. These lectures were followed by a discussion on various aspects of architecture and assembly of viruses.

H. O. Agrawal (H. P. University, Shimla) reviewed the biology of bipartite viruses which have split

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genomes and the two RNA species are encapsidated individually. Simultaneous entry and multiplication of viral RNAs are prerequisites for the development of infection. M. V. Nayudu (SV University, Tirupati) highlighted the usefulness of studying mutations to understand the host–virus interactions. Such an analysis shows that the manifestation of the disease symptoms in host is a complex process and unlikely to be regulated by a unique step.

O. P. Sehgal (University of Missouri, Columbia, USA) described the phenomenon of the decline of infectivity as virions 'age' *in vivo* in case of bean pod mottle virus (a bipartite virus). A preferential degradation of one of the encapsidated RNAs seems largely responsible for this decline. Understanding the role of plant defence molecules, especially those of pathogenesis related proteins (PRPs), during early phase of infection is attracting a lot of attention. Studies in Sehgal's group show that the concentration of PRPs is 30–50 times higher in the necrotic tissue than in healthy tissue. The appearance and/or accumulation of virion usually precedes the synthesis of PRPs. Studies on the temporal and spatial distribution of PRPs do not support the idea that these proteins restrict viral movement in the host. The role of PRPs remains to be understood as yet and in transgenic plants, their expression does not confer resistance to viral infection.

Geminiviruses are a group of viruses that possess twin icosahedral virions and a single-stranded DNA genome. These viruses affect a large number of economically important plants throughout India and are therefore of enormous importance. A major problem is the correct identification of these viruses and at present the molecular probes based on the genomic components seem to offer the only approach. The molecular biology of geminiviruses is the major focus of research investigations at several institutions such as IARI, New Delhi (A. Varma and V. G. Malathi); NBRI, Lucknow (B. P. Singh and K. M. Srivastava); and the University of Agricultural Sciences, Bangalore (V. Muniyappa). Various aspects of isolation, characterization, identification and virus–vector interactions as well as breeding for resistance were discussed in detail by V. Muniyappa. The need for further research for evolving suitable methods for detection and typing of the geminiviruses of our country was evident from the discussion that followed. V. G. Malathi discussed genome organization of whitefly transmitted geminiviruses. A highly conserved coat protein gene (in DNA-A) can be used to identify the whitefly transmitted geminiviruses. Specific probes either based on common region or DNA-B can be used for characterizing specific isolates. Several strains of mungbean yellow mosaic geminivirus (MYMV) have been found to be associated with the yellow mosaic disease of mungbean and blackgram. Infectivity of a full length clone of blackgram isolate of MYMV has been confirmed by agroinoculation into blackgram and successful transmission of progeny virus by whiteflies. The genomic sequence of this virus also is nearly complete. At NBRI, efforts are being made to develop nucleic acid probes for detection and identification of geminiviruses and to generate transgenic plants resistant to tomato yellow leaf curl and cucumber mosaic viruses. The genome sequence of the former geminivirus is also nearly complete. It would be interesting to compare the two genome sequences determined in the country in order to understand host–vector-specificities.

K. Veluthambi (MKU, Madurai) discussed the role of various DNA sequences in the viral genome that are important for host and vector specificity. A difference of 4 bases leading to changes in 3 amino acids in the C-terminal portion of the C1 protein led to changes in the development of symptoms between two isolates of tomato golden mosaic geminivirus. R. Pacha (St. Xavier's College, Bombay) gave an overview of genome organization in tripartite viruses. The use of infectious *in vitro* transcripts from cDNA clones in delineating cis-acting RNA replication signals and host specificity was illustrated taking the examples of cowpea chlorotic mottle virus and brome grass mosaic virus.

D. V. R. Reddy (ICRISAT, Hyderabad) reviewed the genome organization of furoviruses which are transmitted by fungi and cause diseases in many economically important plants. He also gave an account on the current research on Indian peanut clump virus, a furovirus. With recent advances in our understanding of the molecular biology of many plant viruses, it has now been possible to develop resistance to plant virus diseases utilizing viral sequences. This topic was discussed by R. A. Naidu. This was followed by a discussion on the different strategies to control plant virus diseases relevant to our country and the merits of each technique.

Usha Ramakrishnan (MKU, Madurai) demonstrated how information from structural crystallography of viruses could be used to express animal virus epitopes on plant viral coat proteins in her talk on plant viruses as expression systems for foot and mouth disease virus epitopes. This type of work involves intimate knowledge of structure, molecular biology and immunology. P. Sreenivasulu (SV University, Tirupati) reviewed the work on caulimoviruses – an important group of plant viruses with double-stranded DNA as their genome. The peanut chlorotic leaf streak caulimovirus has been found to infect groundnut in Rayalseema area of Andhra Pradesh and it can be detected using DNA probes.

Many viruses are known to infect sorghum under natural conditions. V. R. Mali (Parbhani) discussed their symptoms, detection methods and the management practices being followed in India. These viruses can be detected and classified using rather simple methods without having to resort to molecular techniques. Potyviruses are one of the largest group of plant viruses that infect a number of plant species in India. K. M. Srivastava discussed the genome organization, diagnostics and the biology of this group of viruses and the efforts that are being made for characterization, diagnosis and management of plant viruses at NBRI. B. P. Singh reviewed the mechanisms involved in host–virus interactions and gave an overview of the genes that have been characterized from resistant varieties. It was clear that the development of virus resistance through conventional breeding continues to be a promising strategy. At the same time, the genes responsible for resistance also need to be characterized so that they could be used in future. It is necessary to characterize the gene responsible for resistance for future insertion into sensitive varieties.

Problems of plant virus research in India

The problems of working in the field of plant virology in India were discussed at

length. Between 20 and 25 institutions (universities, state agricultural universities and ICAR's commodity institutes) seem to be involved currently in virus research. Except for a few academically viable groups in virology (for example those at IARI, CPRI, NBRI, ICRISAT, IISc, BCKVV, UAS, Lucknow University and SV University), trained persons and facilities are lacking at other institutions. At several institutions, the work on the isolation and characterization of viruses has just begun and their services (or output) and accomplishments could be vastly improved if funds are provided to employ one or two well-trained personnel and upgrade the facilities. The administrators develop interest in viruses only at the time of crisis, when there is massive crop failure due to viral infection. Based on the response from participants, the following additional points emerged:

Virology as a multidisciplinary discipline

As the ideas, approaches and techniques of molecular biology have been incorporated in all the disciplines of modern biology, including virology, a close interaction between classical virology, biochemistry and(or) molecular biology has become inevitable. In some cases complimentary interests at inter-institutional level are also desirable. At the majority of the Institutions inter-disciplinary interactions have not yet emerged. Good work is being done by a few research groups independently but the results are not commensurate with the talents, resources and potential available in the country as most of the groups are sub-critical. Due to lack of Institutions with comparable standards, the mobility of individual scientists in our country is very limited. We feel that unless a few multidisciplinary groups are rapidly organized, it will be virtually impossible to compete with the best and leading groups in the world. The lack of mobility among scientists is something unique to Indian science and appears to be common in all faculties including physical and biological sciences.

Education and training in virology

At present virology is offered as a separate subject at the post-graduate level by the Indian Agricultural Research Institute, some of the State Agricultural Universities and traditional Universities. There is a need to have a fresh look at the syllabi of various Universities. As modern plant virology can offer many exciting opportunities, a greater emphasis on molecular virology is needed and the syllabi need to be modified accordingly. Besides improvement in teaching, refresher courses and workshops in basic virology and laboratory techniques also need to be organized more frequently for training the persons who wish to alter their research emphasis by incorporating some of the modern techniques.

Type culture collection and database in virology

There is an urgent need to develop a National Type Culture Collection for plant viruses so that authentic cultures of viruses are made available to various workers. At present no organized facility of this sort exists in the country. We suspect immense biodiversity among viruses in our country and some of them could be useful for developing new vectors for genetic engineering, besides fundamental studies. Access to the information about indigenous viruses or to the broad areas of virology research in different labs in our country is rather limited. A strong need for a centralized source providing this information has been felt for many years. A database on viruses had been envisaged at Palampur but most of the investigators did not know about it or the type of services rendered by it. A need was strongly felt to have another database with easy accessibility and visibility.

Supplemental financial support

Except for the few Institutions, the availability of funds in most places is insufficient or even subcritical to sustain the existing research and to provide any services to end users Several groups have successfully prepared polyclonal antisera against some of the viruses, but due to lack of funds, find it difficult to produce the antisera in bulk and make it available to other investigators. The funding agencies should consider providing supplemental funds to such groups to facilitate antisera production on a large scale for distribution to end users.

Need for service oriented regional centres

As the demand for antisera increases (e g., for virus indexing by Hybrid Seed and Plant Tissue Culture or Biotechnology Companies or Plant Introduction and Quarantine Departments), the Type Culture Collection should have a few separate Regional Centres. Such Centres could undertake, on a limited scale, work on the isolation and characterization of locally-important viruses and produce antisera and probes for the detection of viruses. These Centres need not have a large infrastructure of manpower and financial outlay but should have a clear and well-defined mandate (such as identification of economically important viruses of particular groups) and also be provided seed money for a period of ten years. By then the Centres should have diversified their services to a point that they could generate enough resources of their own (e.g., by providing the user-oriented services and undertaking contractual research). The notion of end users supporting the services needed by them, must be incorporated or built-in right from the beginning. Additionally, progress made at these centres must be reviewed periodically and continuation of funding should depend on the progress achieved.

Career prospects and opportunities

Despite a vast diversity of viruses in our country, the job opportunities and the availability of trained persons with proven track record are rather limited at present. The two are related and hopefully, in a few years as plant virology acquires more important and flourishing stature, the career opportunities for trained virologists should also improve. The unwillingness of some of the trained persons to move to another city is yet another social-dimension of this problem.

Finally, it must be realised that on the international front with increasing restrictions on the exchange of biological materials and also limited or no access of nucleic acid sequences (due to Intellectual Property Rights), there is no

alternative but to develop our own expertise in the field of plant virology. Time is really ripe and what is needed is a strong leadership to provide much needed dynamism *to transform the concern into action*. At present, the major research emphasis in plant virology continues to be on the characterization of genome and proteins mainly because of the widespread usage of techniques that make the handling of these macromolecules far more amenable than the host genes. As the expression of viral infection involves an interaction between the host and viral genes, it is only in the last few years that with the incorporation of techniques like RFLP and RAPDS in combination with mendelian genetics, that it is becoming possible to isolate a few of the host genes that play a role in viral infection. A study of these genes undoubtedly offers yet another viable strategy to produce virus resistant plants.

Ample opportunities, particularly in terms of adequate funds and rapid communication with international labs, need to be provided to our scientists in India to take advantage of rapid developments in the field of plant virology. A rapid flow of data and knowledge coupled with a global network are immediately needed and the tempo of decision making and implementation should be speeded up.

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COMMENTARY

Central Research University for Science and Technology (CRUST) – A proposal

T. R. Anantharaman

Indian Science is today at cross-roads. The scientists have begun to feel that they are not getting enough support, encouragement and recognition from Government and Industry. There is at the same time a growing feeling in some government circles and also industrial organizations that scientists have not been able to deliver the goods despite all possible encouragement and support since India's Independence in 1947, particularly from India's first Prime Minister, Pandit Jawaharlal Nehru, during 1947–1964. According to articles appearing in the media in the recent past, Indian Science has had very little success so far in developing indigenous technology and transferring the same to industry profitably. Further, since Independence, Indian Science has not been able to throw towering personalities like Ramanujan, Raman, Bose, Saha and Sahni as it did during the more difficult and less prosperous preindependence days. Except in a few areas here and there, Indian Science has also not been able to make any significant impact on the global scene. There have been complaints against many senior scientists that they are more inclined to pursue power than to seek Truth with devotion and dedication.

There are obviously many reasons that have gradually led to the dismal scenario of today as described above. One of them has been the low morale and inadequate motivation among young scientists and technologists entering the fascinating world of scientific research. Their expectations with regard to emoluments, working conditions, library facilities, supervisory guidance, boarding and lodging arrangements etc. are rarely fulfilled and they tend to become disappointed, cynical and frustrated in no time. The pursuit of Excellence in Scientific Research has thereby been adversely affected, causing already incalculable damage to the growth of healthy traditions in our Universities and Research Institutions like those of Council of Scientific and Industrial Research (CSIR), Defence Research and Development Organization (DRDO), Department of Science and Technology (DST), Indian Council of Agricultural Research (ICAR), Indian Council of Medical Research (ICMR) and the Departments of Atomic Energy and Space (DAE and DOS).

The present proposal is concerned with the many, many hundreds of our bright young scientists and technologists who are associated with well over one hundred well-equipped R&D Establishments, have started their research careers and wish to do their Ph D as quickly as possible. Most of them face different types of registration problems and have often to get affiliated to distant and not so well-known universities with outdated, stringent and meaningless procedures, made even more trying by the callous attitude of bureaucrats and petty officials in their Academic Sections. Registration can be done only *TWICE* in the year, say February and August, in most Universities. External Registration is generally frowned upon and definitely discouraged by difficult and often almost impossible course or residence requirements, apart from the need for the so-called 'local' supervisor. The supervisors in the R&D units, often more qualified and better recognized professionally than the academics in Universities, are made to feel inferior to the local guides since they are not designated as Professors and have to depend heavily on the latter for the smooth progress in research of their wards.

Taking all the above facts into account, it is now proposed that the Union Ministry of Human Resource Development (HRD), in consultation with the University Grants Commission (UGC) and other concerned Departments/Agencies, may establish through an Act of Parliament an Institution of National Importance to be called 'Central Research University for Science and Technology (CRUST)' and