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The Health of Indian Science*

B.K. Bachhawat and U.N. Singh

Biology today is passing through a second revolutionary phase (the first phase comprising the era of molecular biology 1953-75) with dramatic developments in the fields of genetics, immunology, cell and tissue culture, membrane biology etc. Many of these developments, based essentially on the foundations laid down during the first phase, have considerable economic potential and are poised to have profound impact on society at large. A transfer of the basic scientific knowledge to industrial and consulting units is rapidly taking place in developed countries. This has, wittingly or unwittingly, led to a delayed transfer of substantive information to developing countries until the economic gains ensuing from these researches have been fully and practically consolidated by the developed countries. Lack of vigilance on our part and failure to take cognisance of these developments have only added to the lag period. Notwithstanding the repeated assertions made by our policymakers about India ranking third in the world with reference to scientific manpower, every new conceptual breakthrough or technological innovation reported from outside continues to evoke an element of surprise from both the working scientists and the heads of various apex bodies.

Even a casual look at today's profile of biological research will convince one that unless we take a long term perspective when planning the consequences will be disastrous. India is basically an agricultural society. It is endowed with vast natural resources comprising a wide variety of plants and animals. If we fail to take appropriate steps to bring new technological innovations within our fold, we will continue to import seeds and other biological products. In addition, the country will be deprived of its legitimate share in the export market of bio-products, as has already happened in the electronic industry.

* This is based on a paper presented at the Symposium arranged by Indian National Science Academy, New Delhi, 1986.

In the health sector taking into account both humans and animals, we would be increasingly dependent on developed countries for more sophisticated and potent drugs and diagnostic reagents being made available through the recombinant DNA technology and cultured cells (Hybridomas)



Can we meet the challenge posed by an ever-increasing lag in our scientific activities with respect to those elsewhere, particularly in developed countries? In view of the piecemeal approach adopted to the whole area of biology, often shrouded in empty rhetoric and sterile polemics, we have our serious doubts. It is time that we critically analyse the needs of our scientists and the difficulties faced by them. We must realize at the outset that our long-term objective should not be restricted only to the absorption of new technological developments from outside, but to establish viable infrastructures that would be self-sustaining. The kind of infrastructure we visualise goes beyond the building edifice housing latest sophisticated equipment and theorizing on borrowed concepts and technology. It should be directed towards the development of a proper environment conducive to maximal expression of the creative faculties of

the individual. The problem of management of scientific personnel should receive the highest priority. In order to recognize the lacunae in our prevailing set-up it would be necessary to examine the present structure and the ethos of our scientists.

Scientific personnel working in the universities and various national laboratories may be broadly divided into four discernable groups. Following Independence the academic community in India had an unprecedented opportunity to come in contact with their counterparts abroad at all levels. This is in sharp contrast with the very limited avenues open to the members of this community during the preindependence period. In those days only a handful of adventurous individuals having their own resources or a few enjoying governmental patronage (often on non-academic grounds) could afford to look beyond the Indian shores. Of course, to a few like Raman, Saha or Bose who had already carved out a niche for themselves in international science, this was of no relevance. Continued interactions of Indian academic community during post independence period with its counterpart in developed countries led to the emergence of a small group of scientists (which we designate as Group I) and the establishment of a few centers of excellence, such as the IIT's. This group of scientists, nursed and nurtured by such interactions, have made outstanding contributions to science. They have been painstakingly pursuing research in their chosen areas and have made significant contributions in their respective fields when judged by international standard. They are widely recognized and respected by their colleagues outside. However, the scientists in this group remained silent and invisible on the national scene. This is largely because they have been consistently refusing to indulge in an exercise on self-deception by making false promises with unsubstantiated claims, or by climbing on the bandwagon of "fashionable" sciences in order to impress the policymakers.

As it often happens in science, an area considered to be an 'ugly duckling' today may turn into a fashionable one tomorrow. The point we wish to emphasise is that only the scientists, who have consistently maintained a certain minimal level of rigor in their areas of research, will have the potential to absorb any new developments in an alien field. The scientists in Group I fall in this category. To them an interaction with their colleagues abroad has been mutually beneficial, as they have been able to command respect as scientists by the international community on the strength of their own contributions. These scientists undoubtedly constitute the major strength of Indian Science and will continue to do so. However, they are belatedly recognized by our policymakers in India, only after their achievements have been certified by their peers in foreign countries. This delay is only indicative of our failure to devise suitable machinery for a rational assessment of true scientific merits of individuals. A recent article by Eugene Garfield appearing in current contents (April 7, 1986), which pays glowing tribute to the late Shambhu Nath De of Calcutta University for his pioneering work on cholera only underscores this point. While citing a remark made by two prominent scientists, W.F. Van Heyningen and John R. Seal - De's paper "deserves to go down as a classic in the history of cholera, and, indeed, as later developments have shown in the history of Cellular Physiology and Biochemistry" - Garfield draws a parallel between Barbara McClintock, the 1983 Nobel Prize Winner in medicine, and De in reference to their intellectual isolation. This parallel, however, ends with a strong indictment of our academic bodies - "while McClintock was elected to the National Academy of Sciences, De was never elected a fellow of any Indian Academy and never received any major award".

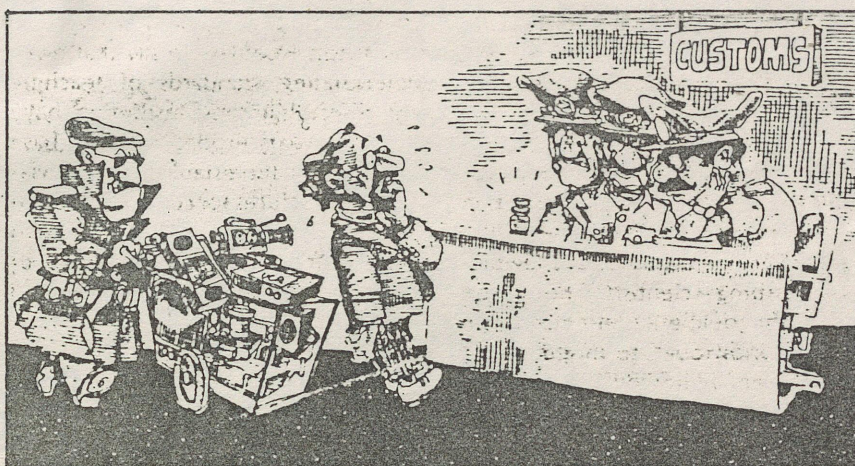
Scientists in the Group II, however, exploited recent developments in biology in a very different way. They have successfully exploited their social contacts with prominent scientists abroad in impressing upon our policymakers to give an overmuch importance to such interactions as a means to achieve self-reliance. This led to the establishment of new centres and insti-

tutes with annexure guest houses offering four star comforts to the visiting scientists from abroad. No serious efforts were made to improve the working conditions of the local scientists or to modernise their training programmes. Sophisticated equipments in these institutions lie idle most of the time, only to be displayed as showpieces to visiting scientists. The reason behind this deliberate attempt made by a few individuals to misguide our policymakers is not difficult to find. Many scientists in this category have no *locus standi* in international science as judged by their own contributions. Their survival in science depended on their continuing social interaction with their mentors outside, preferably with those involved in more fashionable areas of the day. Indeed, to these scientists sociology has become a saviour of their science.

In the third category (Group III) we include scientists who seem to have literally strayed into this profession accidentally. They are engaged in research and teaching in a very superficial manner. Most of them neither had an opportunity to be exposed to international science nor they have the motivation or aggressiveness of the scientists in Group I to get out of the rut they find themselves in. They work under very adverse circumstances with meagre facilities and the little they do is often of no relevance. But what is really more disturbing is that they feel content about it - with much of their energy to spare for non-academic pursuits. This is particularly true of a large number of scientists occupying high positions in the universities and professional (medical and agricultural) colleges in the country. Many of them manage to climb up the hierarchical order in these institutions merely through seniority, and have little to show by way of any tangible scientific achievement. A few talented ones among them, particularly the new entrants, soon get frustrated or demoralized in the milieu created by their seniors and become a part of the rut. This state of affairs in the older universities (which once enjoyed the distinction of being the premier institutions in the country) and the professional colleges is even worse. Our newer universities, on the other hand, have often displayed more dynamism and have

been more receptive to new concepts and ideas. Needless to say that ever-deteriorating standards of teaching and research in these institutions have over the years eroded the very base required for the establishment of viable infrastructures for continuing scientific research of international standard in the country. The performance of our universities as regards to their two-fold objective of (i) dissemination of knowledge and (ii) creative contributions to knowledge has left much to be desired. Indeed, the poor performance of our national institutions can be traced back to the non-performance of our universities. There is a need to realize that post-graduate education (particularly in the field of biology) can not be viewed in isolation from good research-oriented departments and unless positive steps are taken to improve the conditions in the universities, our so-called premier institutions will continue to remain the temples of science with idle instruments as reigning deities.

In the fourth category (Group IV) we may classify an increasing number of young scientists who have either returned to India or aspire to do so. Some of them are well trained in modern biology, and have valuable contributions to make to Indian Science by bringing in their expertise. In view of their training and exposure to the work-culture of the West they are generally found to be enthusiastic and motivated. However, faced with the sluggish bureaucratic system in the country including universities and research institutions these new comers often find themselves at a loss. We would like to cite a recent example of how bureaucrats bungle the hopes and promises arising out of major governmental policy changes affecting scientific research in India. In 1986-87 budget proposals, scientists noted with great enthusiasm that for governmentally funded research programmes, import of necessary chemicals and supplies were exempt of duty free. Visions of not having to wait days and may be weeks outside the customs enclosure for release of perishable materials made many of us euphoric. We were about to send off letters of congratulations to the Prime Minister and the Finance Minister for this singular act that might help Indian Science



in a positive way. But one of our cautious colleagues found out that what this largely meant was more paper work that would mean even longer waits.

Being unable to cope with the rapid pace of developments in their respective fields abroad they become fossilized within a few years and join the rank of scientists in the third category. Many other follow the soft option and go back to post-doctoral positions abroad.

Let us analyse the total picture of the scientific communities in the country, with particular reference to their ethos and *modus operandi* as outlined above. We must devise means to rectify the ills of the various groups.

The scientists in the first category barring a few aberrant individuals, will continue to play an increasingly vital role in sustaining a high standard of scientific activities. There is, however, a need to impress on these scientists to be a bit more outward looking and be conscious of their obligations towards an enrichment of the academic fibre at the national level. Their laboratories in India must not become merely a training ground for future migrants. Their endeavour to foster interactions with their colleagues abroad only to promote their own career may prove to be counter-productive in the long run as regards to our national objective of self-reliance. The scientists in this group by temperament will probably continue to pursue doggedly their choice of research. They have the necessary resilience to survive in adverse circumstances. Apart from extending due recognition to these scientists and providing generous

financial support towards their work, means must be devised to include them in the advisory capacities in the modernization of teaching and research programmes of sister institutions. They should be persuaded to organise short-term courses and workshops for post-graduate students.

Scientists (or pseudo-scientists) in the second category have long been the spokesmen of our national science policy over the past two decades or so. They have attained this dubious distinction by operating at a socio-political level. In the local context they have been the "political weather cock" giving the politicians what they want - empty slogans and unsubstantiated claims to cure all the ills of our society. At the international level they have their mentors, who, with their patronizing attitudes towards scientists from developing countries (a hangover from colonial past), have not hesitated in compromising their objectivity and high standard of science in their own work in lending support to the latter. If we have to give a little more than lip service to our policy of self-reliance, then we should be ready to make a radical departure from the past, particularly from the policy projected by Group II. We must realize that self-reliance is not a commodity that can be imported nor can it be viewed in isolation from self-development. Interactions of our scientists with their counterparts abroad should be looked upon as a means towards achievement of self-reliance, and not as a goal in itself, as has been the case with the scientists in the second category.

Our relatively better performance in the field of atomic energy is a point in

order. Faced with severe restrictions imposed by International Atomic Energy Agency with heavy political undertones on the transfer of technical knowhow, our atomic scientists have stood up to the challenge with remarkable achievements to their credit.

The community of scientists in the third category during the past three decades have grown to an alarming proportion. Although many of them have not been a part of the decision-making processes at the national level, they have come to wield enormous powers at the local level in various universities and professional colleges. With their negative attitude towards anything academic they have frustrated all efforts to modernise teaching and research in these institutions. A few talented ones among them with academic motivation must be identified before they slide deep into the morass and are irretrievably lost. Encouragement and generous support must be extended to them. The scientists in Group I have a vital role to play in this regard by extending moral and material (laboratory facilities) support to such individuals. At the same time steps must be taken to neutralize the negative attitude of many others in these institutions towards introduction of new concepts and ideas.

Establishment of the so-called advanced centers in the universities, which essentially involved a quantitative (not qualitative) upgrading of existing departments was no solution to the problem. Indeed, it has proved to be an ill-conceived move and only led to a further tightening of bureaucratic strangle-hold and accentuation of internal power-politics. A rational approach will be to set up administratively independent units in these institutions comprising new entrants from Group IV. They should receive direct support from various national agencies without interference from the prevailing bureaucratic organization operating in these institutions.

The fourth category must be carefully nurtured. Quite a few of them return to India, because after a number of years of stay abroad they have realized the need of developing their own research programmes in order to be able to make any mark in the international science. We must provide them proper environment. They are the pio-

neers of our new generation of scientists. This will require proper academic environment which provides them freedom to pursue their chosen field of work. Once they have acquired necessary confidence, they would be able to interact with other scientists in their respective areas at the international level. It is, or course, assumed that they should also be evaluated on the basis of their attainments.

As regards to the kind of infrastructure needed for doing good and meaningful science we can only offer a few guidelines which are primarily based on heuristic considerations. It is important to bear in mind that (i) an atmosphere of academic and intellectual freedom is a basic pre-requisite. This essential derives from the contention that scientific research like many other creative endeavours of mankind tends to be highly individualistic. Further (ii) much of the activities in modern biology are essentially interdisciplinary in nature, and therefore require involvement of scientists from various alien disciplines such as chemistry, biochemistry, physics, mathematics, engineering etc. organised into a team. It is this dichotomous situation arising from the necessity of team work without stifling individualistic aspirations of the members, or the promotion of multidisciplinary activities against an increasing trend towards specialization that calls for special qualities in scientific leadership. A leader of scientific team must be able to command respect of the rank and file on the strength of his or her own contributions, and not demand by virtue of the position he or she occupies in the hierarchical order. Indeed, much of the malaise that plagues our scientific institutions at the grass root level can be traced to this lacuna in our organizations.

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High Temperature Superconductivity Need for National Effort

High Temperature superconductivity had remained a dream for scientists ever since the discovery of superconductivity in mercury at 4.2K by Kamerlingh Onnes in 1911. This unusual property of metals to lose their electrical resistivity at the ultra-low temperature was recognised to be of immense importance in technology and the search for it at high temperature began right from the early days after its discovery. The target set was 77K at which this property could be obtained at liquid nitrogen temperatures and would not require economically prohibitive liquid helium refrigerators. Sustained efforts for the last seventy five years yielded the highest superconducting transition temperature of nearly 23K in alloys of niobium and germanium.

Crossing the 'technological' and 'psychological' barrier of 77K appears to be one of the greatest achievements in science in recent years (reported in February 1987). The most important breakthrough in the field appeared in 1986, when Bednorz and Muller, from the IBM Zurich Research Laboratory reported superconductivity at a significantly high temperature of 30K in a sintered sample of barium, lanthanum and copper oxide. It is interesting to note that superconductivity, in this case, was recorded in an oxide, which are generally considered to be unlikely candidates for superconductivity. The replacement of lanthanum by strontium produced a further enhancement in the superconducting transition temperature to 36K and the final triumph of crossing 77K came with a sample in which lanthanum was replaced by Yttrium.

Note must be taken of the commendable success in this area of Indian scientists at the Indian Institute of Science, Bangalore and T.I.F.R and B.A.R.C in Bombay. Their attempts mainly focus on standardisation of the sample preparation and physical characterisation of the material to understand the mechanism of superconducting transition. The group in I.I.Sc., has identified the pure (perovskite) oxide phase responsible for high temperature superconductivity; the oxide shows 100% Meissner effect. The effect is found to be confined to

about 3K around the transition temperature which is around 90K. (Zero resistance is seen at 90K). Efforts are now underway to attain superconductivity at still higher temperatures.

The scale of activity that the recent discoveries have generated can be exemplified by the fact that a recent meeting on the subject (vide New York Times 20.3.1987) was attended by over two thousand physicists from three continents. Considering the support given to superconducting research by the pillars of multinational industries (eg. IBM, Bell Labs, Westinghouse, G.E.C.) the pace of research is likely to increase and greater secrecy would certainly be exercised in publication of the progress in future.

While the induction of high investment by the big companies into the project would stiffen the challenge to Indian science. It would be detrimental to our national interests if we allow the initiative to slip from our hands. The scientists of I.I.Sc., have already identified specific areas like SQUID technology where they can step in immediately. The point is to accelerate the pace. It would require inputs from physics, chemistry, electronics, metallurgy, electrical technology, power engineering, nuclear engineering etc. No single institute in the country is equally developed in all the fields and hence there is no alternative to a combined national effort.

The future applications of superconductivity appear to be vast. A major input would be in the area of electronics and computer science, where resistance free conductors would allow us to construct circuits with faster response. Consequently areas such as remote sensing, radar technology would get great impetus. Another area to benefit would be those of energy generation and transmission. Attainment of high magnetic fields with superconducting magnet would facilitate research in MHD and fusion reactions, areas in which the scientists at the plasma physics project, Ahmedabad and the Saha Institute of Nuclear Physics, have plans to embark on frictionless railway carriages using levitation can be realised by using superconducting devices. Preliminary trials appear to be encouraging.