

PSA/2004/1



**Report of Committee constituted by  
SAC-C to examine and recommend  
New Science Education initiatives  
from 10+2 onwards**

**July, 2004**

***Office of the Principal Scientific Adviser to the Government of India***

**Report of Committee constituted by SAC-C to examine and recommend  
New Science Education initiatives from 10+2 onwards**

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**1. Introduction**

In April 2003 the Scientific Advisory Committee to the Cabinet (SAC-C) constituted a Committee to look into the problems of decreasing interest in talented young students in taking up careers in basic sciences, and the consequent impact on availability of talented researchers and teachers in the coming years. The background to this step is contained in the minutes of the SAC-C meeting on 26 March 2003. Relevant parts of these minutes are given in *Appendix A*. In particular it is relevant to quote the statement of Shri Atal Bihari Vajpayee, the then Prime Minister of India.

*‘...Office of PSA to the Govt. of India should “Tackle the challenge of recruiting the best scientific talent into our research institutions and retaining them there” ’*

– inaugural speech on 31.10.2002 at BARC Founder’s Day, Mumbai.

The SAC-C minutes refer to the “Academy Paper No.1 on University Education in Science” prepared by the Indian Academy of Sciences, Bangalore, in December 1994. They also refer to several Science and Technology indicators comparing the Indian record with those of China, Japan, South Korea, Australia, UK and USA during 1995-2000 covering financial support, publications level, numbers of scientists in R & D etc. The minutes further point out that while in disciplines like engineering, management, medical sciences etc. many high quality institutions at undergraduate level already exist in the country, this is not the case in basic sciences. The minutes suggest the creation of a few ‘Indian Institutes for Basic Sciences’ (IIBS) to admit students after 10+2 and lead them to a 5 year integrated M.Sc. degree. For such new IIBS, initially the faculty may be drawn from IIT’s, IISc. and selected universities. The minutes finally state:

**“The above proposal, if implemented, besides imparting quality education right from (10+2) will provide opportunities to those young students, who are genuinely interested in pursuing a science career. This may perhaps reverse the trend of diminishing interest in a science career among young people and would also meet the aspirations of S & T policy 2003. Once quality scientific manpower with a brand like IITs is available, finding assured placements may not be a serious problem”.**

Against this background, the mandate given by SAC-C to the Committee set up by it is

**“... to look into all aspects of the matter comprehensively and make specific recommendations, taking into account the initiatives being already taken by the University Grants Commission in this context”.**

### **Constitution of the Committee**

The constitution of the Committee is as follows:

- |  |          |
|--|----------|
| 1. <b>Prof. N. Mukunda</b> , CTS, IISc., Bangalore             | Chairman |
| 2. <b>Prof. A. Nigavekar</b> , Chairman, UGC                   | Member   |
| 3. <b>Dr. S. K. Sikka</b> , Scientific Secretary to PSA to GOI | Member   |
| 4. <b>Shri V. S. Pandey</b> , Jt. Secretary, MHRD, GOI         | Member   |

At the recommendation of the Chairman, the following were co-opted as Special Invitees to cover different areas of science and science education:

1. **Prof. R. Ramaswamy**, School of Physical Sciences, JNU, New Delhi
2. **Prof. Umesh Varshney**, Microbiology and Cell Biology Dept. IISc, Bangalore
3. **Prof. A. Sitaram**, Indian Statistical Institute, Bangalore
4. **Prof. Arvind Kumar**, Director, Homi Bhabha Centre for Science Education, Mumbai
5. **Prof. Vasant Natarajan**, Physics Department, IISc, Bangalore
6. **Prof. S. Duttagupta**, Director, S.N.Bose National Centre for Basic Sciences, Kolkata

The Committee held meetings at MHRD, New Delhi on 3.9.2003, 10.10.2003 and 16.2.2004. The attendance at these meetings was as follows:

<b><u>Meeting date</u></b>	<b><u>Committee Members</u></b>	<b><u>Special invitees</u></b>
<b>3.9.2003</b>	All	Not invited
<b>10.10.2003</b>	N. Mukunda, S. K. Sikka, V. S. Pandey	R. Ramaswamy, Arvind Kumar, Vasant Natarajan

**16.2.2004**

N. Mukunda, S. K. Sikka,

Arvind Kumar,  
Umesh Varshney,  
Vasant Natarajan

In the present report, the primary focus will of course be on the mandate as spelt out by SAC-C. However the Committee has gone beyond a discussion on Science Education at the graduation level and upwards, since it realized that undergraduate education is part of a continuum, starting at school level and going up to research. Therefore some remarks and suggestions concerning science education at school level, and support to colleges and university departments of proven quality all over the country, have been included.

## **2. Status of Science Education and need for new initiatives**

The problems being faced by science education at school, college and university levels in the country have been the subject of innumerable discussions, reports and correspondence in scientific journals and the general media, for quite a long time. Most of these problems are very well known and appreciated, so a brief summary will suffice here.

The basic reasons for a decline in enrolments in science courses at undergraduate level are the attractions to applied and professional courses, the time and rigour needed for reaching research level in science, and the general impression created by society, family and peers of the lack of satisfying career opportunities in science teaching and research. Science education at school level onwards suffers due to lack of reasonable experimental facilities, absence of quality teachers with dedication, inadequacies in curricula, and lack of flexible subject and course combinations. Classroom demonstrations are very rare. The syllabus aimed to be covered by the end of 10+2 is too extensive, and could well be intelligently reduced by about 20% to 30%. At present the overlap with the early stages of the UG level is quite large.

There is a shortage of teachers able to convey key concepts in science effectively, and the possibility of periodic retraining of teachers to improve their skills and update their knowledge is quite weak. Teaching tends to be exam oriented, and this further stifles the joy of learning. Many senior teachers find it particularly difficult to teach newer developments. There is a lack of good quality science text books especially in Indian languages. This adds to the difficulties of self study by motivated students, and the grasping of key concepts.

As pointed out in the report of the Indian Academy of Sciences, the main damage to our science students occurs at the UG level, after they have come out of the 10+2 system. It is here that curiosity, self-confidence, enthusiasm and eagerness to learn are effectively stifled. This is so in all but a small number of colleges dotted all over the country. The task of repairing this damage at the UG level has then to be taken up at the PG and Ph.D. levels.

At the employment end, the poor pay scales for teachers in Government and aided schools is a strong disincentive to going in for a career based on science. In general, the respect accorded by society to scholarship and teaching has declined over the past few

decades. At the college and University levels the general ban on recruitments of faculty in most state-run institutions, and the dependence on temporary hired teachers, add to the problem.

As stated earlier, the problems listed above and their extensions have long been known, and various remedies have been suggested from time to time. **Here we may mention some important initiatives taken recently.**

- a) A group under the leadership of IIT-Kanpur has looked at the science curriculum at 10+2 and at UG levels. They have made suggestions for ways in which to reduce the total material so as to avoid excessive overlap. The group includes faculty from IIT Kanpur, IIT Delhi, Delhi University, St. Stephen's College (Delhi), JNU and several school teachers. The report of the group is comprehensive and quite detailed.
- b) Encouraging and enabling some amount of exposure to research at the UG level would go a long way in attracting the best minds to science research and teaching. There are some isolated, unstructured or partially-structured initiatives, albeit small, by mission-oriented agencies, national laboratories and the University System which enables this even now. This must be greatly enlarged.
- c) The UGC has recently initiated many steps for improvement of science education at all levels that come under its purview. It has identified gaps in academic infrastructure i.e. labs and library, curriculum and teacher training programmes. As a matter of strategy the UGC is trying to enhance the ambience for science education in all institutions across the country by bringing them to a threshold level, and in addition to promote excellence in a few selected institutions. A large number of colleges are part of the UGC Infonet programme, and each of them will be given support of Rs.10–15 lakhs over the next five years. In particular colleges in remote areas and those set up recently will be supported. The UGC has identified 150 colleges with potential for excellence in teaching to receive higher level support. Depending on the category to which the college belongs, support of Rs.35 lakhs, Rs.65 lakhs or Rs.100 lakhs over the next five years will be provided. Similarly, 10 universities with potential for excellence will be given support of Rs.30 crores during the 10<sup>th</sup> Plan. The Chairman, UGC, has indicated that he will pursue the matter of removal of ban on faculty recruitment in state universities with the State Governments. Finally on an All-India level, the UGC has recently announced the launching of 4 National Institutes of Science in cooperation with,

and on the campuses of, Allahabad University, Anna University, Pune University and Utkal University, at Allahabad, Chennai, Pune and Bhubaneswar respectively.

Some recommendations relating to these initiatives are given in Section 4 of this Report.

### **3. History of support to Engineering, Medicine and Management education**

The history of the establishment of national institutions of UG level engineering education of high quality goes back to about half a century. It is the vision, sustained support and maintenance of a rigorous and respected student-selection process that has led to the 'I.I.T.' brand name being respected worldwide as a synonym for quality today. Over this same period of time, nothing comparable has been done for science education at UG and PG levels nationally.

According to figures obtained from MHRD and quoted in Current Science (vol. 86, no. 3, p.369, 10 February 2004), the average annual support under Non-Plan and Plan to the five 'original' IIT's at Delhi, Kanpur, Kharagpur, Mumbai and Chennai have increased in the decade 1993-94 to 2002-03 as follows (in crores of Rupees):

Non Plan (annual average)		Plan (annual average)	
<u>1993-94</u>	<u>2002-03</u>	<u>1993-94</u>	<u>2002-03</u>
24.90	69.65	3.42	20.00

The two 'newer' IIT's at Guwahati and Roorkee are also receiving substantial support under both Non-Plan and Plan.

The 18 Regional Engineering Colleges have recently been elevated to the status of National Institutes of Technology, with significant added support from Government. In addition, there have been some indications that half a dozen more IIT's are likely to be set up in the near future.

In the medical and management areas as well, there has been significant support from Government at the national level. To the existing national-level medical institution AIIMS New Delhi, it is proposed to add 6 more similar institutions. The chain of 6 IIM's at Ahmedabad, Kolkata, Bangalore, Lucknow, Indore and Kozhikode has also achieved an international reputation for quality education through careful selection procedures and high-class teaching.

Returning to the engineering scene, the average expenditure incurred per student per year at the IIT's is around Rs.1.3 lakhs; at the REC's (now NIT's) it is around Rs. 60,000.

Compared to the above, and repeating the statement made earlier in this Section, it is clear that there have been no successful efforts at all over the decades since independence to set up any family of national level institutions to impart UG and PG education in the sciences. It is true that large chains of national research institutions – under CSIR, DAE, DST, DBT, ISRO, DRDO – have been built up steadily; however there seems to have been no sustained planning and support in the area of sciences within the education sector to create institutions with brand names like the IIT's, IIM's, to cater to the most talented students who come out of our 10+2 school system and could be attracted to careers in science.

It is in this context that the recent initiative of the UGC to set up 4 National Institutes of Science assumes enormous importance. This effort of the UGC has been briefly mentioned in Section 2, and some remarks relating to it are also given in the next Section 4.

#### **4. Suggested new initiatives – recommendations to SAC-C**

In the light of the information presented briefly in the two previous sections (more details can be found in a large number of reports prepared by various bodies), the Committee wishes to make several specific as well as general recommendations to SAC-C. The implementation, if accepted, would have to be under taken by appropriate wings of Government.

##### **A. Setting up of new institutions**

We recommend the setting up of national institutions devoted to a combination of research and UG + PG student training in the sciences. To begin with, 2 or 3 such institutions could be set up in close collaboration with leading scientific research institutions like IISc Bangalore and TIFR Mumbai, to take advantage of the existing ambience for research at these institutions. There is a definite need for such institutions, in addition to the 4 NIS's being set up by UGC. Some important aspects of this idea are spelt out below.

- i. It has already been mentioned that exposure to research at the UG level would go a long way in attracting the best minds to science research and teaching. Therefore, the research component in these institutions would be crucial. It would set the standard and provide the ambience for the teaching activity right from the UG level. The standards aimed for and the section of the student body targeted would correspond to Tier 1 of the 1994 Paper of the Indian Academy of Sciences (reproduced in Appendix B). Whereas the Academy paper had mentioned seven such institutions being set up, in view of the recent UGC initiative and to supplement it, the Committee for the present has felt that a beginning could be made with 2 or 3 institutions.
- ii. The dependences on IISc, Bangalore and on TIFR, Mumbai would be at the highest Council levels, and at the levels of academic planning and teaching. A possible model may be for the proposed new institutions to be named, say, 'IISc College' and 'TIFR College', or 'IIBS at IISc' and 'IIBS at TIFR', and being governed by the IISc and TIFR Councils respectively. The healthy conventions and traditions of the parent institutions with respect to faculty recruitment, evaluation, promotion, etc., generally regarded as enlightened and progressive, would be imbibed by the new institutions. However the new institutions would have to create their own laboratories, teaching facilities, student facilities, library, computing centers etc. apart from administrative and other buildings. While they would have to build up their own faculties, the academic inputs from the 'parent' institutions (IISc/TIFR) would come in some part of the teaching being done by faculty from the parent body, in addition to inputs in curriculum development and periodic updating. It is not intended that these new institutions should lead to increased pressures on laboratory and research facilities of the parent institutions, though library and computer center facilities could be offered to a reasonable extent. The kind of relationship to IISc and TIFR described above may be more acceptable than otherwise to these established and highly reputed institutions, and this kind of link would lend the 'brand names' of these institutions to the new ones.
- iii. Students graduating from the new institutions would not be automatically eligible for the Ph.D. programmes of the parent institutions. If they are interested in pursuing their Ph.D.'s at the parent institutions, they would have to compete with other students under the existing selection norms of these institutions. The parent

institutions would have to set up suitable academic and administrative procedures to guide students for the Ph.D., if necessary jointly, etc.

- iv. In addition to the two new institutions specifically linked to IISc, Bangalore and TIFR, Mumbai, for the future some other possibilities such as the following may be kept in mind: Kolkata (in association with S. N. Bose National Centre for Basic Sciences, SINP, VECC); Delhi (in association with JNU) or Chandigarh (in association with Punjab University); Hyderabad (in association with Central University). The institution proposed in Mumbai could in fact be linked to both TIFR and BARC, and be located in Navi Mumbai.
- v. The basic programme would be an Integrated 5-year M.Sc. programme in science, with a Bachelor degree being available at the end of the 3<sup>rd</sup> year. An added entry point could be at M.Sc. 1<sup>st</sup> year. This would be followed by Ph.D. programmes of the highest quality, suitably dovetailed with the existing Ph.D. programmes at the parent institutions. The curriculum content of each year can be worked out in detail, following the structure suggested in Appendix B. Specialisation in subjects should be available only after the 1<sup>st</sup> year, and interdisciplinary combinations of courses with ample flexibility should be available. The contents of the first 3 years may be like a good quality B.Sc. Honours programme but without specialization in Physics, Chemistry, Biology, etc. The true specializations could occur at the M.Sc. level in years 4 and 5 of the integrated course.
- vi. The student intake per institution per year could be in the 100-150 range, so that in a few years' time the total student strength may be around 700-800 (including Ph.D. level students) in each institution.
- vii. The faculty to students ratio should be about 1 to 7, with the average teaching load on each faculty member being one course per semester. This would be consistent with faculty being actively involved in research at a level comparable to, say, IISc/TIFR and high-quality universities in the U.S. system. In addition to a core faculty strength of around 75, there should be provision for about 50 adjunct/visiting faculty from R & D laboratories, parent institutions, industries with research laboratories, etc. The problem of recruiting high-quality core faculty may not be as severe as one may initially imagine, given the number of Ph.D.'s being produced in science by the existing best institutions in the country. Indeed, as

many of these Ph.D. students go abroad for their post-doctoral work, these institutions will help bring them back to the country. This is provided they are offered excellent facilities for work and attractive salaries.

- viii. The selection process should be completely merit based, and common to all the new institutions that may be set up. While in the longer term it may be necessary to evolve a complete new and separate selection process, initially one may make partial use of the existing engineering and medical examinations being held at the end of 10+2 stage. One can explore the possibility of using the results of the IIT Joint Entrance Examination (JEE) in Physics, Chemistry and Mathematics, and of the corresponding AIIMS examination in Physics, Chemistry and Biology, as **preliminary filters**. As an example, those in the top 3500 of JEE rankings could be treated as automatically eligible for **possible admission** to the proposed institutions. The final selections could be based on a written examination plus interview to a selected set of about 5000 students. In the long term, one should aim for a written examination model that is not a one-time examination but can be taken many times during the year, like the SAT in the US.
- ix. The details of funding support needed for the setting up and running of the proposed new institutions could be worked out by MHRD. However, based on the figures given in Section 3, and as an approximate guide, we suggest that each new institution would require about Rs. 500 crores over the initial 5-year period for setting up and creation of basic facilities, and an annual operating budget of the order of Rs. 50-70 crores (in comparison with and after scaling down the figures for each IIT given in Section 3).
- x. The Committee feels convinced that if science education after 10+2 up to M.Sc. of the quality we have suggested is made available, there will be no shortage of talented students who will come forward to take advantage of such opportunities and to go for such a 'brand name'. Equally, with many private industries and multinationals setting up R&D centers (about 25 in the past year), and with the growing needs of existing R&D institutions, employability of such well-trained students should not be a problem at all. In addition, there is a void of good science teachers at all levels, which these scientists will be able to fill.

## **B. National Institutes of Science under UGC**

The UGC's recent initiative to set up 4 National Institutes of Science has already been mentioned in the previous Sections. The outlay for these institutions over the next 8 years, as planned by the UGC, is of the order of Rs. 225 crores each. The present Committee would like to stress the importance of this initiative within the otherwise dismal scene of science education in the country at UG and PG levels, and would urge that additional needed financial support be given to UGC by MHRD for these 4 institutions.

## **C. Additional Initiatives to Improve Science Teaching**

There is a need for programmes at 10+2 as well as UG and PG levels in science to improve and redesign curricula, laboratories, text books and libraries in institutions across the country. Quite often, curricula at UG and PG levels may be quite extensive but training and retraining of teachers is a major problem. For some of these activities, an approach may be made to the National Science Academies of the country to seek their advice, help and involvement.

In a recent UGC report, special measures to assist about 150 colleges of proven quality and potential for excellence have been described. We recommend that these measures include the following, with support coming from MHRD as well as science departments of the Government:

- i. A programme for selected teachers from colleges to spend extended periods (say up to 6 months) at national research institutions and R&D laboratories to learn new subjects, improve their teaching methodologies etc. with suitable contingency support being given to the host institution.
- ii. Funds to support visits of scientists from national laboratories to colleges for a reasonable length of time (at least few weeks) as adjunct faculty, with permission being granted by the scientist's parent institution.
- iii. A UGC supported and funded programme to enable senior/retired scientists to visit colleges for a term at a time as Visiting Professors, to teach and inspire young students. This programme should avoid using such scientists as substitute teachers, and ensure that only scientists of proven quality and track record are chosen as Visiting Professors.
- iv. A reliable and transparent mechanism to identify such colleges of quality and potential, on a continuing basis, to be set up, possibly under NAAC of UGC.

- v. A source of research funding exclusively for teachers from such colleges, similar to that operated by the National Science Foundation (NSF) in the U.S.A. The support for this could be contributed by agencies like DST, DBT, DAE, ISRO, DRDO and CSIR. The scale of research support could typically be about Rs. 20–25 lakhs for a 2 or 3 year project. This can enable talented students already at UG level to start getting exposed to research activity at a possibly modest scale, to experience the excitement of research and the creation of new knowledge.
- vi. In a recent issue of the magazine 'India Today', dated May, 17<sup>th</sup>, 2004, the following colleges in the country have been ranked as the top ten in science education:

- (1) Presidency College, Chennai
- (2) St. Xavier's College, Kolkata
- (3) Loyola College, Chennai
- (4) Hindu College, Delhi
- (5) St. Stephen's College, Delhi
- (6) St. Xavier's College, Mumbai
- (7) Presidency College, Kolkata
- (8) Madras Christian College, Chennai
- (9) Mount Carmel College, Bangalore
- (10) Hans Raj College, Delhi

This listing could be taken as starting point and if necessary after further discussion at suitable level these and some other carefully selected colleges could be considered for direct support to enhance their programmes in science education.



2. Prof. Dr. A. Nigavekar                      Member  
Chairman  
University Grants Commission.
3. Dr. S. K. Sikka                                Member  
Scientific Secretary  
to the PSA to GoI
4. Shri V. S. Pandey                            Member Secretary  
Jt. Secretary  
Ministry of Human Resource  
Development, GoI

The committee may co-opt other experts as required to deliberate on specific issues. Members of the SAC-C were requested to send their suggestions to the Chairman or other Members of the Committee.

***Measures to attract young brilliant Scientists and their retention in National Research Labs/ Institutes/ Universities.***

Hon'ble Prime Minister while delivering his inaugural speech on the 31<sup>st</sup> of October, 2002, the founders day of BARC, observed that Office of PSA to the Govt. of India, should :

***“Tackle the challenge of recruiting the best scientific talent into our research institutions and retaining them there”.***

2. Some of the Science and Technology indicators of India are compared with those for the other countries in Table 1 (Annexure). These indicators show that the scientific manpower and publications are stagnant or decreasing (this has been also pointed out by Dr. S. Arunachalam, of M. S. Swaminathan Research Foundation in a recent Current Science article) compared to the case of South Korea and China. Among others, this has been attributed to lack of interest of young people to opt for careers in Science. This issue is of national concern and has attracted attentions at higher level for appropriate policy action. **Hon'ble Minister of Human Resource Development** in his inaugural speech in Golden Jubilee Year of the University Grants Commission, New Delhi also expressed his concern in this context and observed as under:

***“The undergraduate education in pure sciences is a matter of serious concern. We are going to face shortage of good researchers in a few years time particularly in our premier research institutes in the field of Atomic Energy, Space, Bio-technology, Energy, Oil exploration, Communication and so on. We will have to focus at 10+2 level and “catch them young” for integrated 5 years teaching programme with a possibility of exit after three years”.***

3. The **S&T policy 2003** has laid great thrust on basic research and recommended new funding mechanism for basic research. This mechanism includes creation of new structures/strengthening existing ones to create world-class facilities to meet the global competitiveness in identified areas. The policy also recommends simplification of administrative and financial procedures for efficient operation of research programmes on basic research across the country.

4. Many disciplines like engineering, management, medical sciences, etc., have already quality institutions in the country for imparting high class education to undergraduate students. No such school or institute exists for basic sciences, though

there are some excellent post-graduate Science Departments in the university system. In order to fill this gap, one solution that has been suggested in various forms is that one or more Indian Institutes for Basic Sciences (**IIBS**) be created in India.

Broad description of the proposed institutes could be as follows:

- The above IIBS will admit students after (10+2) and lead them to a 5 year integrated M. Sc. Degree. The products of these will hopefully find assured careers in national laboratories and universities. For example, many like BARC Training School induct MSc's, followed by absorption in DAE. Most of them acquire Ph. D degrees while working.
- The mode of selection for admission will be an entrance examination. One can adopt the existing IIT entrance examination as this already tests the students for Physics, Mathematics, Chemistry and English skills. At present, more than 2,00,000 students appear for IIT examination and only about 2500 get admission. Thus, there is plenty of scope for selecting bright students for the new institutes.
- For the new institutes, initially, the faculty may be drawn from IITs, IISc, Bangalore and selected universities, as well as from National laboratories. It has been suggested that national laboratories could be closely involved in developing proximate centers of excellence in basic sciences. The teachers may hold adjunct positions till new talented persons can be appointed. These faculty members should also be funded to create research facilities so that the new institutes become both high-class research and teaching ones.

5. The above proposal, if implemented, besides imparting quality education right from (10+2) will provide opportunities to those young students, who are genuinely interested in pursuing a science career. This may perhaps reverse the trend of diminishing interest in a science career among young people and would also meet the aspirations of S&T policy 2003. Once quality scientific manpower with a brand like IITs is available, finding assured placements may not be a serious problem.

Appendix B – Extract from “Academy Paper No 1: University Education in Science”, Indian Academy of Sciences, Bangalore, December 4, 1994, Section 3, pages 8-10.

*a) Planning Commission initiative [4]*

A Working Group to suggest ways and means of improving university science education, especially at the undergraduate level, was set up by the Planning Commission in 1989. This Group prepared a detailed proposal, expressing the hope that the action suggested would be taken starting August 1990. Though this has not happened, the proposal itself is still worth scrutiny. This proposal, or possibly some suitable variant of it, would be a good starting point to reverse the many undesirable trends in the present situation.

The proposal involves working at three tiers, each aimed at a particular segment of the student population. They may be briefly described as follows:

**Tier I:** This is aimed at the highly talented group of students, the number per year being estimated at about 700 (i.e., 0.5% of the total of about 1,50,000 students entering undergraduate science courses each year).<sup>\*</sup> The proposal is to introduce a very carefully planned five year Integrated M.Sc. programme in a few institutions (structured like the family of I.I.T.'s). They could be independent institutes, or alternatively the UGC could choose a few Centres in existing institutions, say 3 Centres to cater to Physics and Chemistry, 2 to cater to the Life Sciences, and 2 to the Mathematical Sciences. With seven such Centres, each could admit 100 students per year based on merit alone, through a common entrance test conducted nationwide. The courses in Year 1 would be common to

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*\* These and subsequent figures in this Section are estimates made by the Planning Commission Working Group, and refer to 1989.*

all streams, ensuring that the foundations of each major subject are properly covered. Years 2 and 3 would be like a B.Sc. (Honours) programme, involving one main subject leading up to the M.Sc., and two subsidiary subjects. At the end of Year 3, a successful student could either leave with a B.Sc. (Honours) degree, or proceed to M.Sc. Years 4 and 5 should bring the student to the threshold of research.

Every student should acquire basic levels of proficiency in mathematics, computers and electronics; and the entire programme should be challenging and flexible enough to permit combinations of subjects like physics and biology, mathematics and biology etc. Students should be provided with reasonable scholarships to finance their education; and major agencies such as DAE, ISRO and CSIR should be persuaded to assure career opportunities to the most successful students coming out of this course.

**Tier II:** This is aimed at the next segment of the undergraduate science student group numbering about 24,000 per year (about 16% of the students entering each year). The purpose is to raise the general level of undergraduate science teaching at a large number of selected institutions spread all over the country. The UGC may select 20 colleges each year over a five year period – thus ultimately reaching a total of 100 colleges. Financial assistance should be provided to such colleges to formulate and introduce 3 year B.Sc. degree courses of high academic quality and content. Each college would admit 240 students per year, based on a locally conducted entrance test. Year 1 of the course would have a curriculum common to all students, while Years 2 and 3 would cover one main and two subsidiary subjects. By the time 100 colleges introduce such programmes, the annual admissions would reach 24,000.

**Tier III:** Tiers I and II together would cater to almost 25,000 students, out of the total of 1,50,000 entering undergraduate science each year. The remaining 1,25,000 (constituting 84% of the total) form such a large group that in order to improve matters for them it becomes essential to go beyond conventional systems and methods. Most of these students study in affiliated colleges, many of which have indifferent faculty and inadequate infrastructure. To cope with the vast numbers involved, one has to employ new methods of communication and distance education such as video taping of lectures by outstanding teachers, preparing entire courses of lectures on tape, periodic teacher training programmes at nearby universities etc.

The financial estimates made in 1989 by the Working Group for a full five year programme were as follows: Tier I - 25 crores, Tier II - 60 crores, Tier III - 30 crores.