MAJOR RECOMMENDATIONS

Emanating from the

97th Indian Science Congress

Organized at

Kerala University

Thiruvananthapuram

January 3-7, 2010

The Indian Science Congress Association

Kolkata

Recommendation from the Address of the Hon'ble Prime Minister Dr. Manmohan Singh

"Liberate Science from shackles of bureaucratism"

1. India must chalk out strategies to achieve greater energy efficiency and a shift to renewable energy. We should plan to be among the leaders in the development of science and technology related to mitigation and also adaptation and market it to the whole world. We must plan for an accelerated nuclear power development programme.
2. It was decided to launch a Jawaharlal Nehru National Solar Mission for establishment of 20,000 MW of solar generation capacity by 2020, which provides an opportunity to the indigenous scientific institutions to contribute.
3. Water resource management is a very important area since per capita availability of water is declining as population has increased. The Ministry of Science and Technology has initiated a Technology Mission for Winning, Augmentation and Renovation (WAR) of water.
4. Strengthening food security through scientific efforts like better weather forecasting for agricultural management, Geo-spatial Technology Applications Mission to provide crop planning and monitoring as well as flood management. Developments in biotechnology present us the prospect of improving yields in our major crops by increasing resistance to pests and also to moisture stress.
5. Providing affordable health care and improving the quality of life of the elderly is another major challenge of the 21st century. We must build our scientific capabilities in a way that they can respond in real time to problems such as pandemics.
6. Revision of the value of doctoral and post-doctoral fellowships as well as the formulation of schemes that would cover all research scholars with some funding support in order to make science education outreach inclusive and affordable.
7. Redouble our efforts to attract many more talented young women to take up careers in science. A step in this direction is a new scheme available for women's universities named Consolidation of University Research, Innovation and Excellence (CURIE) which provides financial help for complete upgradation of facilities in such universities.

8. The National Science and Engineering Research Board to start functioning before March 2010. A National Policy for Data Sharing and Accessibility has been formulated. The Protection of Intellectual Property Bill, focused on sharing revenue from intellectual properties with researchers will be taken up soon.
9. Conversion of the "brain drain" of the past into a "brain gain" for the future - special effort to encourage scientists of Indian origin currently working abroad to return to India.
10. The decade 2010-2020 has been declared as the "Decade of Innovations". We need new solutions in many areas to achieve our goals of inclusive and sustainable growth - in healthcare, energy, urban infrastructure, water, and transportation, etc.,
11. The country must develop an Innovation Eco-system to stimulate innovations. Innovators must work in partnership with industry. We need to concentrate on strengthening the linkages between academia, research and industry.
12. Indian science should have a strong outward orientation; our science establishments should step up global alliances that will expose our scientists to the best in the world and enhance our competitiveness.

Recommendation from the Address of the Hon'ble Minister of State (Independent Charge) for Science and Technology and Earth Sciences; Hon'ble Minster of State in the Prime Minister's Office; Personnel, Public Grievances and Pensions and Parliamentary Affairs, Shri Prithviraj Chavan

1. Acceleration of implementation of Innovation in Science Pursuit for Inspired Research (INSPIRE) launched by the Hon'ble Prime Minister in December 2008 in order to attract the best students to science.
2. Encourage re-entry programmes for women scientists and return of Indian Diaspora in order to fill the gap of faculty in higher education Institutions.
3. Traditional Knowledge Digital Library (TKDL) will not only protect our traditional knowledge but it will be used by the European Patent Office and the US Patent and Trade Organisation for prevention of grant of patents based on traditional Indian knowledge.
4. Establishment of a state of art "Tsunami Warning Centre", Ocean observation system, weather observation and modeling capabilities, and atmospheric physics modelling.
5. International Co-operation in the field of S&T of India has grown several fold. Technology focused initiatives like Science Bridges with UK have opened up new possibilities and mechanisms to forge Academy Industry alliances and partnerships.
6. It is widely believed that 21st century will belong to China and India on account of strength of their economies and human resources. Since the next wealth creation opportunity will undoubtedly depend on science, technology and innovation, a major challenge in 21st century will be in relating the knowledge to economic outcomes and ability of science and technology system to innovate at affordable costs.
7. The grand challenges ahead are is the area of Energy security, Food security, Water, Affordable Healthcare for all and Terrorism and Internal security.
8. There is congruence between the global concern for climate change and India's concern for energy security. Answers to both lie in building capacities for alternate energy sources like solar, wind and nuclear. Also, research on clean coal technology would remain crucial for the country.
9. To address the challenges of food security, geospatial data inputs for crop planning and monitoring using special algorithms have been developed and made available to several states.

10. Science ministries have taken up several initiatives to address the challenge of water security. A Technology Mission on "Winning, Augmentation and Renovation" (WAR) for Water has been mounted by the Department of Science and Technology.
11. The Indian S&T sector should gear itself to engage in the research dimensions of National Action Plan on Climate Change (NAPCC).
12. In the area of affordable health care for all, CSIR has mounted Open Source Drug Discovery (OSDD) for infectious diseases with global participation which has identified new molecular entities for a number of therapeutic targets.
13. A "Decade of Innovations" has been articulated as the National policy. The Indian R&D sector should gear itself to fulfill the promise and deliver ***innovative technology*** solutions rather than ***technologies.***
14. There is a need to develop a suitable Science, Technology and Innovation policy framework in order to get a favorable position in global assessment of innovation industry.
15. At the end of the eleventh plan, India might need a strategy to assess and measure the economic impact of R&D and technology-led GDP growth and prepare a road map for adequate investments into the Science, Technology and Innovation during the Twelfth Plan.
16. Our future strategy should serve to:
    a. Enhance synergy among academy, research and industry
    b. Build new strategies for development of private-public partnerships in R&D and
    c. Step-up global alliances developed during the Eleventh Plan and
    d. Aim at acceleration of the pace of conversion of scientific outputs to targeted socio-economic and developmental outcomes.

Recommendations from the Presidential Address of Dr. G. Madhavan Nair, General President, Indian Science Congress Association 2009 - 2010

1. With the available scientific manpower in the country (which is the third largest in the world), the Indian Science and Technology (S&T) is bound to assume a significant role in rearing the status of the country to that of a developed nation by 2020.
2. Developments in the fields of agriculture, atomic energy, space research, Information technology, biotechnology etc., speak volumes about the capabilities of the Indian scientific community and can match international standards at all levels.
3. Enhancing agriculture productivity from 1.7 to at least 2 tonnes per hector in order to meet the requirements of the people by year 2020.
4. There is a strong need for developing alternate sources of energy. Improving the quality of generating energy from natural products is one of the challenges.
5. We need to device cost effective means to tap wind and solar energy and R&D efforts in these areas needs to be strengthened.
6. Nano-technology is yet another area which can contribute to revolutionize the future demands of agriculture, healthcare and high strength materials.
7. Emphasis on bio-science and geonome research which are going to revolutionize applications related to human health and environment security. The research in this area can lead to major achievements including work on transgenic crops with disease resistant capabilities, nitrogen fixation and production of vaccine, enzymes and recombinant proteins.
8. Conceive application programmes in the area of information technology to model physical phenomena, chemical processes, bio evaluation, etc which demand lot of efforts from young scientists and IT professionals.
9. The monitoring of climate and environment is another major area of both national and global concern and needs to be addressed adequately.
10. Advances in Medical sciences and immunization are absolutely a major priority for the highly populous India, which has an ambitious quest in prevention, early diagnosis and treatment of various diseases that affect the population, particularly the poorer sections.

11. The innovation and challenges in technology required to solve the societal problems are quite complex and demanding. In addition to massive investment in terms of infrastructure, there is a strong need for the development and identification of scientific talents.
12. Kindling scientific spirit and explorative spirit in young minds also requires equally talented scientific communicators and teachers.
13. While encouraging the youngsters to pursue advanced research schemes, there is a need for creating a cadre of scientific managers.
14. There is a need to create proper facilities and environment for research in the universities in order to do innovative work at the cutting edge of S&T as the universities act as the prime movers of scientific research and serve as feeders to the specialized laboratories.
15. Need for interdisciplinary form of science education which allows free flow of knowledge and ideas that migrate from one area to another. Students and researchers must be taught to relate what is taught in classes with real life situations early enough, from their primary classes, so to speak.

Recommendation from Public lectures

Future of Science in India

Prof. CNR Rao said that science and technology should be treated as different subjects, where technology is simply the application of science. He urged to take up study of pure sciences. He pointed out that the status in science education in India is dismal even compared to other Asian developing countries like Japan, China and South Korea.

He remarked that the educational institutions should play a constructive role in promoting science studies and scientific research.

Keep your mind open to nature: Roger Tsien

The Nobel Laureate, Prof. Roger Tsien, in his public lecture at the 97th Indian Science congress, advised young students and researchers to keep their mind open to the beats of nature.

Prof Tsien is renowned for revolutionizing the fields of cell biology and neurobiology by allowing scientists to peer inside living cells and watch the behavior of molecules in real time.

Prof Tsien stressed on teamwork by mentioning the collaboration behind his Nobel Prize winning work.

It can be done: Dr. Kalam

Dr. Kalam in his public lecture said that Indian scientists should look forward to celebrate the socio-economic development of India in 2020. He then proposed his vision of transition of Indian Science from 2020 to 2050 saying that the vision for 2050 is one of dynamic growth.

Terming Science as borderless, Dr. Kalam put forth his visualization of Global Human Civilization for 2050.

In context of Indian perspective, he said proper water management, sustainable agriculture development using organic farming practices, energy consumption and sustainability, customized healthcare for promoting enhanced longevity, balancing the greenhouse gas budget and emergence of new global leaders focusing on multi-disciplinary action are some of the key points of his visualization. He added that scientists should start considering earth, moon and mars as an economic complex for future habitat expansion of human beings.

Demystifying the Large Hadron Collider: Mr. Atul Gurtu

Mr. Atul Gurtu of TIFR unraveled the mystery surrounding the Large Hadron Collider (LHC). The eminent physicist who is India's chief spokesman of the LHC said that LHC is hailed the mother of all experiments would usher in a new era of particle cosmology.

Mr. Gurtu explained about India's involvement in this mammoth experiment. LHC will attempt to simulate the birth of the Universe by colliding protons having near light speed in a tunnel of 27km in circumference. It also hopes to find the existence of the hypothetical “Gods particle” called Higgs Boson.

Dr. MGK Menon's talk explained about the birth of meson physics.

Recommendations from Children Science Congress

1. Children Science Congress (CSC) 2010 was organized from 4 – 6, January 2010, hosted by Indian Space Research Organization (ISRO) and University of Kerala, Thiruvananthapuram, with the objective to stimulate creativity and create interest in science in the young minds.
2. The Congress encourages children and teachers to visualize the future of the nation and to pursue their natural curiosity, thus unleashing a wave of creativity and scientific temper.
3. CSC provides a platform for children across the country to interact with eminent scientists and enhance their knowledge and ideas.
4. Dr G Madhavan Nair, General president, ISCA presided over the function. In his address, Dr Madhavan Nair stressed the “need to have passion for science cultivated from very young age”. He exhorted the youngsters to pursue science, learn and observe the nature and thus solve the mysteries of science and thereby improve the quality of life of the fellow beings. He urged the students to derive inspiration from great scientists like Sir C.V Raman who were deeply committed to science.
5. Dr. A P J Abdul Kalam, former President of India inaugurated CSC – 2010 on January 4, 2010. In his inaugural address, Dr. Abdul Kalam said that Earth, which was rapidly exhausting its resources, would not remain an independent entity in the future, but form a 'single economic entity' with the Moon and Mars as a single economic and strategic entity. This will be possible by developing scientific knowledge in a very unique solution to the crisis of water, energy, infrastructure faced by humanity in different parts of the world. Detection of evidences of water on the Moon for the first time through the Chandrayaan-1 mission, ISRO had found an answer to an issue that was evading the collective scientific wisdom of all the space-faring nations for the last five decades. He urged the CSC delegates to follow the example and use science to prove other impossible things possible.

Eight point Oath

1. Science is a lifetime mission. I will work, work and work and succeed.
2. Wherever I am, a thought will always come to my mind. That is what I can innovate, invent or discover.
3. I will always remember that “Let not my winged days, be spent in vain”.

4. I realize I have to set a great scientific goal that will lead me to think high, work and persevere to realize the goal.
5. My greatest friends will be great scientific minds, great teachers and great books.
6. I firmly believe that no problem can defeat me; I will become the captain of the problem, defeat the problem and succeed.
7. I will work and work for removing the problems faced by planet earth in the areas of water, energy, habitat, waste management and environment through the application of science and technology.
8. My National Flag flies in my heart and I will bring glory to my nation.

Recommendations from Science Communicators Meet

(3rd Vigyan Sancharak Sammelan)

3rd Vigyan Sancharak Sammelan (Science Communicators Meet) was organised during January 4-5, 2010 in concurrence with 97th Indian Science Congress (ISC 97) at Thiruvananthapuram, Kerala. This is a forum for science communicators and journalists to exchange their views, expertise and experience in the field of science communication through media, press etc., The focal theme of the sammelan was ***Advances in Science Journalism – Role of Space Science and Technology***. This is the third in the series with the last two having been very successful.

Inaugural Session

In his inaugural address, Dr. G Madhavan Nair expressed the importance of Science Communication. He stressed that Science communicators should focus more on work within the laboratories where the real development of science is going on. He added that science communicators should convey the achievements of science to the common people. These days many awards are given to scientists, which indicates that the people have started recognizing the contribution and the significance of science.

In the presidential address, Prof A Jayakrishnan, Vice Chancellor, University of Kerala stressed upon the qualities of Science Communications.

General Sessions

There were five general sessions and one student session. Each session had a lead paper by the expertise followed by 5 - 6 presentations. The major topics covered under the general sessions were around the focal theme, *Advances in Science Journalism – Role of Space Science and Technology*. Overview of Satellite Communication, Need for Science Communication, Role of Space Science and Technology in Science Journalism, Science Communication and Emerging Challenges, Issues of Science Communication, Shortcomings in the present system, Recognitions of Science Journalism, Science Communication through various Media, Modern tools like Internet, Blogging, Online News etc., Importance of Space Technology, Contents of Science News, Trends in Science Journalism starting from ancient, medieval to modern era and Vision for the future Science Journalism etc.,. were discussed in detail.

Students' Session

The students' session chaired by the Head of Department, Communication and Journalism, University of Kerala, as part of the science communicator's meet

gave a good opportunity for the students to discuss on various topics connected with science/space journalism.

The Sammelan made the following general observations:

- Much of scientific knowledge is confined to a small minority of scientists. Regular science coverage in the media is absent and only occasional and sensational science news appears in print and electronic media.
- Science and technology journalism has progressively developing in India, in terms of quality and quantity, but is still far behind the desired level, (estimated around 3 % against a desired level of 15%.)
- Department of Science and Technology (DST) through Rashtriya Vigyan Evam Prodyogiki Sanchar Parishad has supported the Vigyan Sancharak Sammelan thorugh the Indian Science Congress. The support is strongly recommended in future also since it has provided a platform for students, journalists and researchers to share their research. This inter-disciplinary field needs recognition by researchers in traditional areas of science. ISCA Chapter Conveners need to be continually sensitised about the theme and the selection process.

Following recommendations were considered and approved at the plenary:

- Teacher educators have the potential to spread awareness and literacy among the next generation. Schemes to enhance their skills may be developed and introduced.
- Research scholars may be encouraged to give presentations about their research in third year to scholars from other disciplines. This would develop an appreciation about the research in other disciplines and would improve communication skills of the scholars. Universities can introduce this with internal resources.
- Plagiarism in science communication or in any type of serious communication should be avoided.
- Case studies elaborating research methodologies in science communication should be presented.
- Science communicators should be more committed and sincere about the news they disseminate; wrong or incomplete scientific information should not be communicated through that could mislead the viewer or reader. Proper checks and balances need to be provided by the science communicators through responsible journalistic principles.

- Developing countries should upload more than they download from the Internet. Social participation and successful local/regional development stories involving science and technology need to be brought to the forefront.
- Use of local language and idiom to reach larger populations is recommended.
- Students had put good efforts in their presentation. However, they need to concentrate on accuracy, brevity and language skills. It is suggested to continue the student session in future too; however, it was recommended to invite the science journalism students from all over the country.

3rd VSS was funded by DST through Rashtriya Vigyan Evam Prodyogiki Sanchar Parishad and co-ordinated by Ms. Padmavathy A S, Scientist, ISRO.

Recommendation of Sectional Committees

Recommendations as received from Sectional Presidents

Agricultural and Forestry Sciences

Indian agriculture is facing the tremendous challenges of reduced farmers' income, water scarcity and labour shortage. Climate change has added another dimension to the already complex challenge. Problem of drought, flood, abrupt rise in temperature and events of heavy rainfall have intensified in recent years. To face these challenges, Indian agriculture has to be reoriented and rejuvenated. It needs to be diversified and made income-oriented for food and nutritional security of the emerging India. The following research and policy strategies need to be adopted for achieving the goal.

- **Climate change mitigation and adaptation:** Greenhouse gas emission from agriculture can be mitigated by adopting technologies such as growing aerobic, direct-seeded rice and use of nitrification inhibitors. Technologies such as conservation agriculture and crop diversification will be very useful for adaptation. Sequestration of carbon in soil would provide a good opportunity for climate change mitigation and adaptation. Government should promote these technologies and provide incentives to farmers adopting the same.
- **Crop improvement:** Crop cultivars for tolerance to biotic (pest and diseases) and abiotic (drought, flood, nutrient) stresses for different agro-climatic zones of the country using biotechnology and molecular tools should be developed. Recently developed flood tolerant (Swarna sub1, sub2) and drought resistance varieties should be promoted.
- **Crop management**: Conservation agriculture including the technologies of laser-aided land leveling and zero tillage is useful for increasing input-use efficiency. Alternate cropping and crop diversification (cereal-legume, agro-forestry, rice-fish culture) should be developed, refined and promoted in different agro-climatic zones.
- **Soil management**: Site-specific nutrient management using soil testing, remote sensing and GIS tools will be required for increasing crop yield and combating micronutrient deficiencies. Research on soil biotechnology and nanotechnology should be encouraged for enhancing nutrient use efficiency.
- **Water management**: Water scarcity is the biggest problem for the farmers. It is going to be more severe because of climate change. Promotion of water harvesting and water-saving technologies (drip and sprinkler, laser-aided land leveling, bed planting) should be given high priority.

- **Crop protection**: Technologies for identification and control of existing and emerging pests and diseases using molecular tools should be developed. Surveillance system and simulation models should be developed for forecasting pest outbreak and their timely control. Integrated pest management strategies should be promoted.
- **Promotion of new, unconventional crops**: High value, low volume crops including medicinal and essential oil bearing crops should be promoted. Some of these crops can be grown even in waste and marginal lands with minimum input and maximum income.
- **Micronutrient fortified crops**: For eradicating nutrient deficiencies and malnutrition, nutraceuticals should be developed introducing molecular tools and efficient management of micronutrients.
- **Utilization of agri-residues for energy**: Technologies should be developed for utilization of crop residues and agricultural wastes for energy generation. Efficient strains of crops such as sweet sorghum should be developed for bio-fuel.
- **Increasing research fund**: More funds should be allocated for agricultural research to address the problem faced by the farmers constituting 65% of Indian population.
- **Upgrading agricultural education**: Students and young researchers to be encouraged to take up agricultural research as their career through providing fellowship, research grants and more job opportunities.

Animal, Veterinary and Fishery Sciences

- With a view to conserve biodiversity emphasis on strengthening of Classical Zoology in the syllabus of under graduate (UG) and post graduate (PG) programmes be given, as it is not reflected in the new UGC syllabus.
- Bioresources are the wonderful gift of the nature to the mankind, whose sustainability can be effectively linked to rural livelihood and economic development, so science education should aim at attracting talent for proper management and sustainable utilization of bioresources.
- Ensuing dangers of climatic changes to biodiversity be recognized and mitigating measures be undertaken on priority.
- Premier institutions dealing with research on animals, veterinary and fishery should be linked academically for collaborative utilization and sharing infrastructure facilities, expertise and experience for bioprospecting the food security, rural development and economy.

- Programmes needed to be initiated for the exploration of other less known potential varieties of life forms with a view to ensure livelihood and food and financial safety.
- Multivoltine race of silkworm Bombyx mori should be tested under different agro climatic zones of India for proper evaluation of their improved efficiency.
- Through selective breeding, sex limited yellow colour cocoon can be achieved in silkworm breed M12W which will reduce the production cost of the fibre.
- Various disease problems in Aquaculture and their management measures are to be worked out in detail to ensure safety of highly nutritious food resources.
- Mangroves, important shelters of marine animals of high food values and source of livelihood of coastal people, should be declared as Natural Reserves. Interactive group should be established involving Animal Science, Fisheries, Agricultural Science (mainly Soil Science) to ensure Mangrove Conservation.
- Ecosystem approach should be used for holistic and sustainable development of Fisheries production.
- Application of molecular tools for wildlife (endangered species) conservation, and nanotechnological tools in rural health and livelihood be given importance.
- National funding agency should provide sufficient funding for research on Animal Taxonomy. Classical taxonomy has gone on backfoot during last 2 decades and proper identification of species of biodiversity importance has become a problem for young researchers.
- Biotechnological tools should be used for the conservation and management of habitats.
- Injudicious use of Pesticides affects the aquatic and terrestrial environment and animal resources. Efforts should be made through Public-Private partnership to mitigate these problems. Also eco-friendly remedial measures should be developed.
- 100% eradication of dengue causing Aedes mosquito is possible with the introduction of zooplankton, cyclopoid copepods. Its utilization can be introduced with some precaution. Culture of Makhana (a wetland cash crop which increases zooplankton density) be encouraged which can be utilized for freshwater culture in the wetlands of Bihar.

- Ecological and Molecular Parasitology of Helminths should be incorporated in the university curriculum and researchers should be encouraged to take up research in the frontier areas of Helminthology.
- New tools in molecular endocrinology should be applied to activate the specific resistant genes so as to combat the changing scenario of climate for aquaculture boost.

Earth System Sciences

- Reorganization of India's Earth Sciences institutions is needed.
- India, process of geophysical surveys has to be enhanced substantially.
- Mineralization potential of the Deccan Trap and Himalayan belt needs very serious reassessment.
- India's Uranium potential needs reassessment of intensive exploration. The meeting enclosed with vote of thanks the chair.

Engineering Sciences

- Green technology should be encouraged. Program on harnessing of solar energy should gather more momentum on priority basis.
- System should design and encourage modern comfortable Public Transport system.
- Energy efficient technology has to be developed. Emphasis must be given to the design of devices which will reduce energy consumption yet be efficiently functional to do a given job.
- Outsourcing concept should be phased out step by step with genuine assessment of the actual requirements.
- Adequate attention has to be paid on the Scientific Storage system of food grains and edible. Mere increase in production of agricultural items cannot go on increasing because of the shrinking of agricultural land due to industrialization.
- Awareness should be created to discourage wastage of resources like electricity and water encourage the culture of cleanliness of ambience. Emphasis should be given on the culture of Waste management. This is important not only for aesthetic cause but also for economic benefit.

- Science & Engineering community have contributed more than other professionals but paradoxically the contributions of the real Scientists and Engineers are not visible in the society due to lack of due recognition. And that is why Young students are now-a-days opting for subjects devoid of science and Engineering to build up career. Mere distribution of few fellowships will not solve the problem unless the science and engineering profession is respected socially.

Environmental Sciences

- It has been realized that different institutions should come together and a system be received to share the knowledge.
- On each subject area, concerned Central and State Government Department should make position to receive findings of various researchers and utilize them appropriately.

Information and Communication science and Technology (including Computer Sciences)

- Focus of ICT should be switched to mobile phone technology so as to widen up the scope of the field and make it reachable for common men. More and more applications related to mobile concepts should be encouraged.
- Thrust on research to be aligned with the millennium challenges for solving the 'famous' unsolved problems.
- The scope of science should be cinemascoped so as to reach everybody. The popularity generating outlook should be expanded to cover the non-science community of the country.
- Sectional programs should be more centric towards the applicability and sustainability of the subject.
- Plenary sessions may be well publicized to the local people, specially in the academic and industrial communities.
- Research scholars have to be given a special platform with a view to generate more inter-disciplinary interest to be nurtured.
- A separate track for the presentation of research scholars who have recently (in the last one year) submitted their Ph.D. thesis selected through a review process.
- An award also could be given to best Ph.D. thesis.

Materials Science

- Materials Science community must reorganize its resources, manpower and focus on development of materials for energy (traditional and alternative), health (drug delivery, prosthesis, body-implants), green technology (environment, structure, effluent treatment) and efficient use of the natural resources (coal, minerals, water). A national level initiative is absolutely essential to harness solar, wind and atomic energy and develop commercially viable and portable devices (photovoltaic and fuel cells). A similar effort is also required to develop a policy document for production of key engineering materials like steel, cement, petroleum, rayon, fibre, etc.
- While funding for new or novel material development (synthesis and characterization) is needed, unambiguous focus and commitment on the true scope of application, realistic prediction of feasibility and success (milestones, targets), and well defined targets and deliverables with quantifiable index are essential for achieving breakthroughs in Materials Science and Technology.
- Reallocation of funds and manpower is desired to boost research to above threshold level and achieve landmark success (plant, product, machine, device) in material and technology development in key (automobile, micro-electronic, sensor) and strategic (energy, space, defence, water) sectors.
- While applied research will bring accountability, fundamental research should not be ignored but pursued in centres of excellence of proven credentials.
- Research in Materials Science and Technology must receive a boost with larger number of fellowships, research projects, pilot plant level (start up) grants, and incentives for mentors or supervisors. Number of doctorates in India is far too low in India than that in China, Japan or USA. The country also faces an acute shortage of technical manpower to run sophisticated equipments, processors, devices and facilities. We should extend grants and encouragements to private institutions with proven credentials and should not be confined only to Government Institutions. Above all, appointment of fresh and young scientists and engineers should be promoted instead of ad-hoc appointments of retired personnel.
- Sponsored projects must be properly and routinely monitored and evaluated. Continuation must be linked to transparent and objective assessment in reasonable intervals.
- Characterization and testing of materials is a major bottleneck for larger participation of research community in high-end and strategic areas of research. Sophisticated equipments, gadgets or facilities are prohibitively expensive both in terms of capital investment and maintenance. As a results,

these privileges lie only with large and major institutions (IISc, IITs, Central Universities and National Laboratories), and that too, only to certain groups and individuals. For larger participation and contributions from the entire research community, we need to create central and regional centres for characterization and testing of materials and components. These facilities must be manned by trained and paid technicians and not scientists with active career interests. The users must pay booking charges and the equipments must be run, manned and maintained from such booking charges. The Regional Instrumentation Centres created in the past were mooted with this very objective, but they have failed to live up to the desired level. The Government must take a fresh look at this problem.

- Indiscriminate proliferation of institutes and courses in the garb of advanced materials, nano-technology or materials science should not be allowed, Instead, a nation wide exercise is needed to develop a common curriculum on Materials Science and Engineering with room for specialization through electives and minor subjects so that both traditional sectors like steel, aerospace, plastics and semiconductors, as well as advanced areas like nanotechnology, bio-technology or energy science can be equally addressed and served.
- Career in Materials Science and Technology should be as attractive as that in banking, finance and information technology areas so that the best students willing to pursue career in Materials Science do not leave their academic pursuit or research career prematurely or in between.
- The key components or challenges that the materials community should immediately address in right earnestness are solar and fuel cells, sensors, light weight composites, auto grade steels, advanced ceramics, etc.

Mathematical Sciences (including Statistics)

- Because of better facilities and no retirement age a large number of Indian Mathematicians is settled abroad. The credit of their research contributions goes to other countries and not to India. This is not good in the national perspective. To curb this menace the following are suggested.

    a. As at the entry level NET clearance is required, similarly at the age of 55-66, there should be a national level screening and based on the academic record one should be granted further extension irrespective of the affiliation (Universities/central universities/IITs).

    b. To prevent senior mathematicians from settling abroad, Research Professorships with reduce teaching load should be created. This will also benefit the young researchers as their supervisors will be able to give more time to them.

- Clearance of at least two advance courses after M.Sc. (Called Pre-Ph.D. courses) and at least two publications in refereed journals should be made mandatory for the submission of the Ph.D. thesis.

- The infrastructure facilities, expertise and experience available at mathematics research centers like TIFR, Mumbai, MATSCIENCE, Chennai and HRI, Allahabad should be shared and utilized by a wider section of the mathematics community. For this sabbatical leave rules should be liberalized.

- Industry/Government should provide more research opportunities to attract the young talents.

    - Steps (such as training from primary level) should be taken to improve the performance of the Indian team in the International Mathematics Olympiad.

- In the CSIR-UGC NET scheme for JRF and Lectureship ‘Statistics’ is made a part of ‘Mathematical Sciences’, while ‘Computer Science and Applications’ enjoys independent stature. In the question papers there are more questions form mathematics and very few questions from statistics. There is a lot of freedom of choice for the students with basic degree in mathematics but NOT for those who have degrees in Statistics. It is therefore recommended that as in the UPSC list of subjects for Civil Services Examination where statistics and mathematics figure as different subjects, similarly in the JRF and Lectureship Mathematics and Statistics should be considered as two different subjects.

- Ramanujan Birthday (December 22) should be declared as a “National Mathematics Day” programmes like seminars, paper presentations, quiz

competitions should be held in all Mathematics Research Institutes/Universities/Colleges on this day.

Medical Sciences (including Physiology)

- More emphasis on Research on Basic Medical Sciences
- Improvement of science by Public Private Partnership (PPP) model and setting of uniform rules & controlling body.
- Accommodate and acclimatization of impact of Globalization issue on health sector.
- Stoppage of Medical Scientist migration and encourage the persons who has been migrated to come back i.e., brain drain to brain gain.
- Evidence based learning – provisions & budgetary allocations.
- To gain trust towards a torture free world.

New Biology (including Biochemistry, Biophysics & Molecular Biology and Biotechnology)

- Launch New Biology Initiative to
    1. Accelerate the growth of the New Biology
    2. Achieve solutions to societal challenges in food, energy, environment, and health
- Develop interdisciplinary curricula, graduate training and educator training to create and support New Biology
- Develop the information sciences and technologies that will be critical to the success of the New Biology
- Develop Entrepreneurs by
    1. setting up more technology incubators in universities and research institutions
    2. encouraging partnership with industry
    3. setting up funds at state level to support and nurture new ideas for commercialization for societal benefit

Physical Sciences

- It was resolved that the National sensor laboratory may be established, especially in under developed areas of the country (e.g. Bihar), as the work

on different sensors is reported from the various physics departments of Universities in Bihar.

- The number of young scientist prizes and poster awards may be increased.
- Steps should be taken to attract good students for graduate and postgraduate courses in Physics.

Plant Sciences

- Priority should be given to document the plant wealth of the Hot Spots of the Country.
- Documentation of Indigenous knowledge and use of Botanicals, their validation and value addition for shaping them into medicines should be given emphasis so as to make plant sciences much more attractive and valuable to the Society. Interface between Biotechnology, Molecular Biology and Pharmacology can be created to achieve this goal.
- Plant Science learning and teaching should be made more attractive through unified syllabi and curricula both at the Graduate and Post-Graduate levels.