

Address during the inauguration of  
15th National Children's Science Congress 2007  
Baramati

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**Creativity Leads to Great Scientific Minds :** *“When you wish upon a star,  
Makes no difference who you are Anything your heart desires Will come to  
you”*

**Dear children,**

My greetings to all the children participating in the 15th National Children's Science Congress including those coming from ASEAN countries. I was thinking what thoughts I can share with you friends. My talk will be in two parts. First one, will be need of the foundation for science which is knowledge, the beauty of science and challenging missions of science. The second part will be on three Nobel laureates particularly their childhood which led them to their achievements and Nobel prize. You will see what type of challenges they had to face during their childhood, what type of life they were blessed with, their struggle and how they achieved their goal and the inspiring story behind their lives. Hence, I will be discussing on the topic “Creativity Leads to Great Scientific Minds”. First let me talk to you about Creativity.

**Creativity:** “Learning gives creativity Creativity leads to thinking Thinking provides knowledge Knowledge makes you great”

When I see you all, I am reminded of one thought regarding inventors and inventions, discoverers and discoveries.

## **Inventors and Inventions**

Let us study important inventors and their inventions.

- The Wright brothers and the plane.
- George Eastman and film
- Thomas Edison and the light bulb
- Alexandra Graham bell and the telephone.

## **Discoverers and Discoveries**

Let us study a few Discoverers and their discoveries.

- Albert Einstein and the energy equation  $E=MC^2$
- Srinivas Ramanujan and number theory
- Chandrasekhar Subramaniam and Chandrasekhar Limit
- Sir CV Raman and Raman Effect

Now let me talk about **“What Science can give you?”**.

I see large number of aspiring scientists, I would like to share with you one question. What is the uniqueness of being a scientist?

**Magnitude of Time:** Friends, science gives you better eyes because science can remove the mental limitations and give your brain a challenge to solve many scientific problems that are yet to be solved. When people in general talk in dimensions, just less than one millimeter or few hundred thousand kilometers requirement in flight, the scientists will easily move from the behaviour of proton ( $10^{-15}M$ ) to the size of visible universe approximately  $10^{28}M$ , 43 orders of magnitude.

Most of our friends, who are not in the field of science will slice the time perhaps maximum upto one hundredth of a second. Scientists will slice the time into femtoseconds ( $10^{-15}$  Sec) which may decide a fast photo chemical reaction. When you think way back in time, it will be big bang, some 15,000 million years ago and the beginning of the life on earth, about 3800 million years ago. Again you will be ahead of 17 to 18 orders of magnitude. Science

indeed will connect you into the brains of many smart people who were there before you and who are performing some breathtaking research now . Hence, science makes you feel good to stand on the shoulders of the giants like Issac Newton, the discoverer of the Laws of Gravitational force, Albert Einstein the discoverer of general relativity theory, Stephen Hawkings the string theory originator, Sir CV Raman the discoverer of Raman effect, Chandrasekhar Subramanyam, discoverer of Chandra limit and blackhole, Srinivasa Ramanujam the number theory originator and James D. Watson, Francis Crick and Maurice Wilkins for discovery of molecular structure of nucleic acids and its significance for information transfer in living material.

**The Expanding Universe:** Science provides answers to challenging problems. Look at the southern sky with bright clouds lit by light. That is our galaxy, we belong to the milky way. Millions and millions of stars are there. We belong to a small star, what is that star? Sun. The Solar system has eight planets. Our planet earth has six billion people, and millions and millions of species. Can you imagine what science has revealed to all of us? Our galaxy and our sun and its characteristics have been identified. Exact location with respect to sun and the galaxy has been discovered. Again you ask yourself what science has done.

What scientific discoveries have led to? We know that earth rotates in its own axis in 24 hours. We get day and night. How do you get the full moon night. Earth has its own satellite, Moon, which orbits around the planet earth in 29 days. And how the moon shines? anytime have you thought, the beautiful light how do we get? How do we get the new moon ? You all know it has been discovered. It is the dynamic movement of earth, sun and the moon in the space, which decides, the full radiating moon and the dark night.

Friends, the earth system takes 365 days for orbiting around the sun once. The sun itself orbits around our galaxy- the milky way. It is estimated that the sun takes 250 million years to orbit around the galaxy. All the astronomical discoveries have come out of science.

**Bio-diversity in Planet Earth:** If we study the evolution of human life it is clear that science is the major link for human being to understand one self, the environment, the planet earth, atmosphere, oceans and outer space. Science has enabled understanding of many mysteries and there are several still to be understood. One major factor that affects human life is the bio-diversity of the environment and how the nature needs to be is nurtured. The current challenge all of you must be hearing on day to day basis is, how to manage the rapid deterioration of the atmosphere. I have been advocating energy independence both for energy requirements and protection of atmosphere

Earth is blessed with large bio-diversity. Particularly, India is blessed with more than 16 bio-climates which enable us to produce a variety of herbal plants, many of which are still not fully exploited. A happy combination of modern biotechnology with the rich natural diversity could produce excellent results that will extend far beyond the borders of the country.

**Human Biological System:** You take our human body. What is the human body. Science has revealed that the human body is made up of millions and millions of atoms. An average adult weighing 70 kilograms would have approximately  $7 \times 10^{27}$  atoms, that is, 7 followed by 27 zeros. This is divided into  $4.7 \times 10^{27}$  hydrogen atoms,  $1.8 \times 10^{27}$  oxygen atoms, and  $5.0 \times 10^{26}$  carbon atoms. For example, I am made up of  $5.8 \times 10^{27}$  atoms. The difference between one human being and another is determined by the sequencing of the atoms. Each human being will be unique.

The recent human genome programme reveals that human genome contains 23 pairs of chromosomes, which lie in the nucleus of every cell in the body. Each chromosome consists of a DNA double helix, that is wrapped around spool like proteins called histones. It is estimated that the human body has three hundred thousand to 2 million proteins. The characterization of each protein is the most challenging task, which is carried out by the Human Proteome Project. The unraveling of the genomic mystery will ultimately allow the bio-medical community to create a new evolutionary future for the human race. These examples show the level of mysteries continuously emerging whether you explore yourself or the environment around you. Now let me discuss the lives of Nobel laureates and understand their early childhood which will inspire us to work for excellence in science.

### **A man with a focused Mission**

Recently, I was privileged to meet Nobel Laureate Dr. John Mather at Caltech, USA and later at his laboratory in Goddard Space Centre.

Astrophysicist and cosmologist John Mather was reading biographies of Galileo and Darwin when he was a school student and earned his PhD in Physics with a perfect 4.0 grade point average at Berkeley. While doing post-doctorate work at the Goddard Institute for Space Studies, he led the team that proposed the Cosmic Background Explorer (COBE) satellite. He then spent the next two decades spearheading the project through design, construction, and fruition. In 1992, the COBE team mapped primordial hot and cold spots in cosmic microwave background radiation, and showed that the spectrum of radiation left over from the Big Bang matches the theoretical prediction. Done in collaboration with George F. Smoot of the University of California, this work essentially confirms the Big Bang theory. Mather and Smoot were awarded the Nobel Prize in Physics for this discovery in 2006.

While at school, many of John Mather's colleagues were very strong, and they excelled in at baseball and wrestling, but he was not among the athletes. John Mather was much more interested in reading everything that came his way. In addition to learning from class he developed the habit of reading original science books from library. His interest in science started quite early at the age of 6. Actually of mathematics, he realized practically that one could fill an entire page with digits and never come to the largest possible number, so he saw what was meant by infinity. His parents took him and his sister to the American Museum of Natural History in New York, after a journey of at least two hours, which seemed to him very long. The first time, Mars was very close to the Earth, and there was great excitement about whether the canals could be seen. Even with the telescope bought by his father, he could not see the canals. John Mather got started with science through the book given to him by his father *Astronomy Made Simple*. He also heard about biographies of Darwin and Galileo through his father. He liked thinking about geology and hunting for fossils in the roadside streams, as he built little dams of mud and pebbles. He didn't really appreciate what science was about yet, but it sounded very exciting, and a little dangerous in case one discovered things that were not consistent with previous knowledge, especially religious thought.

By the time he was in fourth grade, he started liking scientific and engineering things, including electronics. For Christmas he got a one-tube radio kit, and then he saved his allowance for a 5-tube shortwave Heathkit radio that he put together to listen to exotic languages and broadcasts from far-away places. He participated in the School Science Fair when he was in 4th grade with 4 little projects. Hardly anyone else at the school was much interested in science at the time, but he had one friend who walked several miles to come visit him at his house and talk about science. He used a mobile

library to borrow scientific books and started reading books on optics. He saved money from allowance and ordered some lenses from Edmund Scientific and assembled small refractor telescopes. Mather's parents sent him to participate in the Science Fairs. He wanted to do a science fair project with a "robot" that he designed with vacuum tubes and remote controls. It never worked but he got a lot of experience, and now looking back he recognizes that his parents contributed a substantial research grant when he was only about 11. So he had an opportunity to learn science, even in his very rural setting

He had some excellent teachers in science, math, and English and was very fortunate to have the opportunity to go away to summer schools. When he was in 11<sup>th</sup> grade, he went for a summer Physics program, where he was introduced to Quantum Mechanics, Special Relativity, Optics, Nuclear Physics, and Cosmology. After coming from this programme, he was convinced that he could have a future in science. His father taught him statistics and learnt calculus himself through self study. This was another way of getting ahead of his colleagues when he got to the college. The childhood of Nobel laureate John Mather indeed is very inspiring, he was preparing himself during his school days for a great mission. Let us now discuss another Nobel laureate who got the Nobel Prize in 2007 for Medicine.

### **Birth of Creativity in a difficult situation**

Mario Capecchi had a difficult and challenging childhood. For nearly four years, Capecchi lived with his mother in a chalet in the Italian Alps. When World War II broke out, his mother, along with other Bohemians, was sent to Dachau as a political prisoner. Anticipating her arrest by the Gestapo, she had sold all her possessions and given the money to friends to help raise

her son on their farm. In the farm, he had to grow own wheat, harvest, take it to miller to be ground. From the flour, he made bread dough, which he took to the baker to be baked. He also remembers helping to make wine. Then, the money which his mother left for him ran out. He began four years of wandering. He was four and a half years old.

He headed south, sometimes living in the streets, sometimes joining gangs of other homeless children, sometimes living in orphanages and most of the time hungry. He spent the last year in the city of Reggio Emilia, hospitalized for malnutrition that would never be cured, since he, like the other children, was given only one cup of coffee and a small crust of bread every day. He wanted desperately to escape. Scores of beds lined the rooms and corridors of the hospital, one bed touching the next. No sheets, no blankets. That was where his mother found him on his ninth birthday after a year of searching. Within weeks, the Capecchi and his mother sailed to America to join his uncle and aunt. His mother had a psychological set back due to her life in prison and her subsequent search for Capecchi. The day after he arrived, his uncle and aunt sent him to the third grade, although he'd never before been to school. Nor did he speak English. The teachers allowed him to play with paints and make murals, enabling him to learn socialization and the language

Capecchi became very active in sports, playing on four varsity teams: football, baseball, soccer and wrestling, where he was team captain. Capecchi says that sports are important from a psychological point of view which enables you to learn about human psychology, things that you later transfer to relationships: perseverance, pushing yourself beyond certain limits. The sense of social responsibility permeating the atmosphere at school also influenced him. There was a cognizance of world problems. It wasn't taught, but it was felt that one should do something to make this a better world. This



led Capecchi to take up the study of political science. But after one political science class, Capecchi found there wasn't anything to bite on. There was little science in politics. He switched to science and math, graduating in 1961 with a double major in Physics and Chemistry.

Capecchi never took a Biology class; he learned about biology in the labs. For his practical experience, he worked several terms at the Massachusetts Institute of Technology (MIT). Once, he worked with Charles Pop Kettering, a very curious man who dismantled an experimental machine Capecchi had worked three months to construct. Incredulous, Capecchi watched, later admitting that it was fun watching Kettering and his excitement at seeing how it worked. Although he really liked Physics its elegance and simplicity, Capecchi realized from his lab experience that everything we learned [in Physics] was only up to the 1920s. It was still classical education. Physics lacked the excitement in his time that Capecchi sensed in a new science being developed: molecular biology. He knew he would switch to molecular biology in graduate school, on the advice of James D Watson. Watson taught him that he should not be bothered about small things, since such pursuits are likely to produce only small answers.

After earning his doctorate in biophysics in 1967, Capecchi was a junior fellow at Harvard for two years. The next four years, he spent on the Biochemistry faculty at the Harvard School of Medicine, but realized that science was losing something. While in search for new topics, Capecchi found University of Utah in Salt Lake City to provide the right atmosphere to work on projects whose outcome may take 10 years. The main strength of Capecchi was his focus in science. He also wanted to know where his work fits in.

From then on, his objective was to do gene targeting. The experiments started in 1980, despite NIH's refusal to fund the work. By 1984, Capecchi had clear success. Three years later, he applied the technology to mice. In 1989, he developed the first mice with targeted mutations. The technology created by Doctor Capecchi allows researchers to create specific gene mutations anywhere they choose in the genetic code of a mouse which was considered not worthy of pursuit by National Institute of Health. It may seem like science fiction, but by manipulating gene sequences in this way, researchers are able to mimic human disease conditions on animal subjects. What the research of Mario Capecchi means for human health is nothing short of amazing, his work with mice could lead to cures for Alzheimer's disease or even Cancer. The innovations in genetics that Mario Capecchi achieved won him the Nobel Prize.

**Value of Science:** When I see experienced scientists, teachers and young scientists, I thought of sharing with you how value of science have to be recognized and put into action. Let me share the experience in the life of Sir CV Raman. Raman was in the first batch of Bharat Ratna Award winners. The award ceremony was to take place in the last week of January, soon after the Republic Day celebrations of 1954. The then President Dr. Rajendra Prasad wrote to Raman inviting him to be the personal guest in the Rashtrapati Bhavan, when Raman came to Delhi for the award ceremony. Sir CV Raman wrote a polite letter, regretting his inability to go. Raman had a noble reason for his inability to attend the investiture ceremony.

He explained to the President that he was guiding a Ph.D. student and that thesis was positively due by the last day of January. The student was valiantly trying to wrap it all up and Raman felt, he had to be by the side of the research student, see that the thesis was finished, sign the thesis as

the guide and then have it submitted. Here was a scientist who gave up the pomp of a glittering ceremony associated with the highest honour, because he felt that his duty required him to be by the side of the student. It is this unique trait of giving value to science that builds science

**Conclusion:** Friends, as you grow up, you will have the challenges and opportunities for solving many problems faced by humanity as well as discovering new phenomena in outer space and under the sea. You will also have challenges in bringing back a clean environment by replacing fossil fuel based fuels to renewable energy from sun, wind, nuclear systems. The following are some typical great challenges, as we foresee today:

- (a) Increasing the agriculture production from the existing 200 million tones to 340 million tones with reduced land availability from 170 to 100 hectares, reduced water availability and reduced number of people working in farming.
- (b) Evolution of clean atmosphere by replacing the fossil fuel by the cost effective renewable energy system.
- (c) Exploring the human body, particularly gene characterization through the proteomics project for developing gene based drugs
- (d) Accurate weather prediction and earth quake prediction
- (e) Evolution of a convergence system for the multi-media application for meeting the needs of communication in office, home and on the moon using high bandwidth mobile wireless.
- (f) Evolution of unified field theory which may be the ultimate of Physics revealing how the universe is born and how we are born.
- (g) Evolution of earth, moon, mars complex and to bring back to the earth new material like helium 3 and generates solar power.
- (h) Evolution an alternate habitat for the mankind,

With these words, I inaugurate the 15th National Children's Science Congress 2007 and my best wishes to all the participants from different countries success in their mission of

“nurturing nature for our future through bio-diversity”. Let me also take this opportunity to wish you all a happy and prosperous New Year 2008.

**Message to aspiring Scientists on Courage**

*Courage to think different,  
Courage to invent,  
Courage to discover the impossible,  
Courage to travel into an unexplored path,  
Courage to combat the problems and Succeed, are the unique qualities of the  
youth.  
As a youth of my nation, I will work and work with courage to achieve success  
in scientific discoveries.*

May God bless you.

Dr. APJ Abdul Kalam,  
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