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A Look at the Cloud Computing



Bharat Ratna



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Padma Bhushan



Dr. T. Ramasami

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On Development Communication....



Dr. R. Gopichandran

The objective of this editorial is highlight some valuable insights presented in the publication of the International Bank for Reconstruction and Development /The World Bank (2008) on development communication. It is a must read for practitioners and researchers in the field of science and technology communication. It serves as a source book and accordingly elaborates on the principles and approaches of development communication, its context specificity, and of course presents some examples of interventions of the Bank centred on these.

The Sourcebook defines the unique features of Corporate Communication, Internal Communication, Advocacy Communication, and Development Communication; since these four mutually reinforce strategies and outcome in the development interface. Importantly, the typology of participation by stakeholders has been highlighted across a continuum of passive involvement; consultation-based functional links and joint decision making with their own respective characteristics. The author also presents a snapshot of ten important points on myths about communication for development that determine consistency and effectiveness.

It is equally important to recognise the difference between communications and communication *per se*, goals and approaches of engagement and assessing situations that demand a goal – rented communication strategy. The most robust insight is about the need to go beyond the “traditional notion of behaviour change”. Communicators have to understand and articulate enabling circumstances for transitions. These include socioeconomic considerations, institutional mechanisms, risks and opportunities, scope for empowerment, and the political and social milieu through interplay of these aspects. The author helps the readers with details on the implications of participatory appraisal and action research that determine the spread and depth of communication strategies.

Going beyond the reference to the Sourcebook, I wish to mention about success of the *Rastriya Vigyan Chalchitra Mela* (RVCM) organised recently by Vigyan Prasar and the National Council for Science Museums (NCSM). Details regarding the framework including objectives and approaches can be accessed from Vigyan Prasar’s website. Importantly, the veracity of the

logical framework was re-established through the 2013-2014 edition of the *mela*. This includes such facts as: (i). A large number of enthusiastic film makers are keen to understand recent developments in the field of film-based communication, especially aligned with sustainable development. These relate to aspects of natural resources, health, fundamentals of science and technologies, and importantly, the community interface. Institutions engaged in films and other modes of communication can develop specialised modules for these enthusiasts. Vigyan Prasar and other institutions engaged in outreach can provide value-added services to embellish content and delivery systems. (ii). It will be useful to develop a repository of films that can be accessed by learners. Case examples on development and delivery can be developed for the benefit of learners.

Vigyan Prasar is grateful to the panel of experts for their exemplary diligence in assessing entries to the various contest categories and defining the opportunities stated above. Special mention must be made of the leadership provided by Shri Kiran Karnik and Ms Suhasini Mulay as Heads of the first and the second edition respectively. Vigyan Prasar and the NCSM acknowledge the efforts of eminent artists Shri Amol Palekar and Shri Nasser who led the third and the fourth editions respectively. All four panel Heads were strongly complemented by the other members of the jury. They demonstrated excellence twinning artistic insights and keen scientific temper with their own stand on values steeped in catholicity and passion. They have performed as true leaders, further educating film makers on the nuances of effective outreach. The RVCM is poised to grow in stature as an inclusive enabler of science and technology communication relevant to several sectors of development.

[Reference: Mefalopulos P 2008 Development Communication Sourcebook; Broadening the Boundaries of Communication. The International Bank for Reconstruction and Development / The World Bank, Washington DC. 266p.]

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Bharat Ratna CNR Rao

One of the World's Foremost Solid State and Materials Chemists



Dr. Subodh Mahanti

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"Science is an essential part of life. Without science I am unable to live. When I started working in science four decades ago, I did know that this would happen. I took up science as a profession and as I gradually went on working, I got addicted to it. Soon I found that science was not only running my life but was dictating its terms. There was no way I could plan my life without science"

CNR Rao in his autobiography, "*Climbing the Limitless Ladder: A Life in Chemistry*", IISc Press and World Scientific, 2010.

"Two roads diverged in a yellow wood
And sorry I could not travel both
I took the one less travelled by
And that has made all the difference".

A poem by Robert Frost quoted by CNR Rao in his autobiography to make a point that 'not following a beaten track and going after a lesser known subject in his research career has yielded dividends'.

Chintamani Nagesa Ramchandra Rao (commonly known as CNR Rao) is one of the world's foremost solid-state and materials chemists. Rao's life is a true example of a life in science. His life has evolved around science. R. A. Mashelkar, former Director General of the Council of Scientific and Industrial Research (CSIR) and presently National Research Professor says: "CNR Rao lives science and lives for science." He has amply demonstrated the fact that it is possible to do science under adverse circumstances and without much external support. M.M. Sharma, an eminent Indian scientist and educationist says: "I would compare him (Rao) to a nuclear reactor. He has produced so much output with very little input."

Rao is one of the most quoted and decorated living scientists in the world today. His research focussed on the characterisation, synthesis and design of new materials. His systematic studies on transition metal oxides led to basic understanding of novel phenomena and the relationship between materials' properties and their structural chemistry. His studies on compositionally controlled metal-insulator transitions had a profound impact in application fields such as colossal magneto-resistance and high-temperature



CNR Rao

superconductivity. He has made immense contribution to nanomaterials. He has published over 1,500 research papers, and has written over 45 books some of which have come to be regarded as classics. He is

particularly noted for his research on metal oxides, nanomaterials and graphene. He has around 44,000 citations with an h-index of 93+. The h-index (also called Hirsch index or Hirsch number), originally suggested by an American physicist Jorge E. Hirsch, attempts to measure both the productivity and impact of published work of a scientist or a scholar. A scientist with an index of h papers has published h papers each of which has been cited in other papers at least h times. To Rao 'publishing is an essential part of doing science'. Commenting on the emphasis on publishing he said: "Even now I lay emphasis on publishing papers. I am not in any race to publish. I have always had about 20 people working with me. Because I worry about them a lot, I get more papers. I don't allow my students to waste time. I worry about everything they do and I talk to them every day. Hence there is more productivity..."

He has made significant contributions to nanoscience and nanotechnology. He was the spirit behind the establishment of a Rs.1,000 crore national mission on nanoscience and nanotechnology.

After C. V. Raman, Rao is the greatest exponent of basic science in India. He has shown highest form of perseverance and commitment as a scientist. Rao's autobiography titled *Climbing the Limitless Ladder: A life in Chemistry* is worth reading by every aspiring scientist and all those interested in scientific research and education.

Rao is a remarkable institution builder. He has contributed in many ways in creating a large number of scientific institutions and agencies and strengthening the existing ones. In the 1960s, he contributed significantly towards the establishment of the Department of Chemistry of the Indian Institute of Technology Kanpur as one of the best chemistry departments in the country. Rao served as the Director of the Indian Institute of Science (IISc), Bengaluru for ten years (1984-



Chemistry Department, Banaras Hindu University



IIT Kanpur



Indian Institute of Science, Bengaluru

94). He introduced a large number of faculty members both at junior and senior levels, and established the IISc's Materials Science Centre and the Solid-State and Structural Chemistry Unit and also strengthened the Supercomputer Education and Research Centre. He is founder of the Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR) in Bengaluru. The institute was planned as part of celebration of the birth centenary year of Pt. Jawaharlal Nehru. The idea was to establish a new kind of scientific institution. The Government of India entrusted Rao to set up the Institute and it was officially inaugurated on 4 March 1995 by K. R. Narayanan, then Vice President of India. Rao has played an instrumental role in recently established Institutes of Science, Education and Research (IISERs), a series of high profile institutes. A Committee headed by Rao recommended the establishment of the National Council of Science Museums.

Rao has been a key figure in formulating and implementing many national policies on science. He has been the Chairman of the Science Advisory Council to the Prime Minister of India for several years. His role as an educationist is equally significant. He was closely involved in the preparation school science textbooks undertaken by the National Council for Educational Research and Training (NCERT). He himself has written science



Jawaharlal Nehru Centre for Advanced Research

books for school children. Rao is a great populariser of science and an inspiring orator.

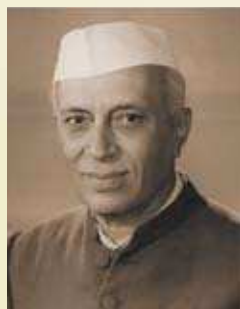
Recently Rao has been awarded Bharat Ratna, the highest civilian award given by the Government of India. He is the fourth persons working in science and engineering to be awarded the Bharat Ratna. The other three are C.V. Raman (1954), M. Visvesvaraya (1955), and APJ Abdul Kalam (1997). The provision of Bharat Ratna was introduced in 1954.

CNR Rao was born on 30 June 1934 in Basavanagudi (Bengaluru), where his maternal grandparents Belur Seshacharya and Padmavati Bai lived. His father H. Nagesa Rao worked in the Education Department of the Mysore State. His mother Nagamma was a self-educated woman. Rao was much influenced by his parents

particularly by his mother. His primary school education was under his mother's supervision. He said: "In personal life, as distinct from professional life, my mother was the most influential during my childhood. She was my teacher as I never studied in primary school; she taught everything at home." Following the advice of his father Rao studied in Kannada medium in high school. He entered Middle School at the age of six. After passing lower secondary examination in 1944 he entered the Acharya Patashala, a high school in Basavanagudi. In 1947, he passed the Secondary School Leaving Certificate

(SSLC) examination of the Mysore State in first class. In his school days, influenced by his mother, he had developed interest in reading Kannada literature. He even tried to write poems in Kannada. After completing the high school education he joined the Intermediate College at Shimoga and then shifted to the Central College, Bengaluru. He received his Bachelor's degree from the Mysore University in 1951. He obtained his Master's degree in Chemistry from the Banaras Hindu University (BHU), Varanasi in 1953 and he then went to Purdue University, USA for his PhD degree. He obtained his PhD degree in 1958.

In 1959, Rao joined the Indian Institute of Science (IISc) at Bengaluru as Lecturer. In 1963, he went to the Indian Institute Technology Kanpur as



Pt. Jawaharlal Nehru



C. V. Raman

Head of the Chemistry Department. In November 1976, he returned to the IISc at the invitation of the then Director of the Institute, Satish Dhawan. He was given the task of establishing a new department of solid state and structural chemistry. He took up the challenge in spite of the fact that, to start with, the terms and conditions of his appointment were not very attractive. He made the IISc the permanent base for his professional career.

As mentioned earlier, Rao's major contributions are in the field of solid state chemistry. Describing how he was attracted to this field, he wrote: "It was at Purdue University when I was finishing my work for the PhD degree (around 1957), that a friend of mine came to me with a sample of spectroscopically pure TiO_2 . "What is the structure of this?", he asked me. He thought that it had the rutile structure.

"Why don't we determine the structure?" I asked. He wanted me to do this for him. I took the X-ray diffraction pattern with the diffractometer in the physics department and found that it had the anatase structure which is other form of TiO_2 . We spent some time to investigate when and how pure anatase transforms to the rutile structure. This was one of the early papers on solids that I published. My interest in the subject continued as I started looking at papers of a similar nature and started publishing little notes here and there. Then I thought that I should study the chemistry of solids more..."

Rao was closely associated with the International Union of Pure and Applied Chemistry (IUPAC) for two decades (1971-1990). He became a member of the Bureau of the IUPAC in 1979, and served as Vice President (1983-85) and President (1985-87) of IUPAC. As President of IUPAC he played an instrumental role in restructuring the organisation so that it reflected modern trends in chemistry. He was associated with the executive



M. Visvesvaraya

committee of the Committee on Data for Science and Technology (CODATA) of the International Council of Scientific Unions (ICSU).

Rao has written/edited over 45 books many of which have gone into many editions and have been translated in other languages.

Rao was made Head of the Department of Chemistry of the Indian Institute of Technology Kanpur at the age of 29. He was elected a Fellow of the Indian Academy of Sciences, Bengaluru when he was 30. He was awarded the Marlow Medal of the Faraday Society of England given for outstanding contributions to physical chemistry by young scientists below 33 in 1967.

Rao has been visiting professor at Purdue University, the University of Oxford, the University of Cambridge and University of California, Santa Barbara. He was the Jawaharlal Nehru Professor at the University of Cambridge and Professorial Fellow at the King's College, Cambridge during 1983-1984.

The awards received by Rao are so numerous that it is difficult to list the all. Among the awards received by him are: The Marlow Medal of the

Faraday Society (1967), *Bhatnagar prize* (1968), Jawaharlal Nehru Fellowship (1973), Centennial Foreign Fellowship of the American Chemical Society (1976), *Royal Society of Chemistry (London) Medal* (1981), *Hevrovsky Gold Medal* of the Czechoslovak Academy of Sciences (1989), Blackett Lecturership of the Royal Society

(1991), Einstein Gold Medal of the UNESCO (1996), Linnett Professorship of the University of Cambridge (1998), *Centenary Medal* of the Royal Society of Chemistry, London, (2000), the *Hughes Medal* of the Royal Society, London for original discovery in physical sciences (2000), Karnataka Ratna by the Karnataka Government

(2001), the Great Cross of the National the *Order of Scientific Merit* from the President of Brazil (2002), Gauss Professorship of Germany (2003), the *Somiya Award* of the International Union of Materials Research (2004), the title *Chevalier de la Legion d'honneur* (Knight of the Legion of Honour) by the French Government (2005), *Dan David Prize* from Tel Aviv University (2005), Honorary Fellowship of St. Catherine's College, Oxford (2007), *Nikkei Asia Prize for Science, Technology and Innovation* by Kheizai Shimbun, Inc, Japan (2008), and *Royal Medal* of the Royal Society of London (2009), Order of Friendship by the President of Russia (2009), the *August-Wilhelm-von-Hoffmann Medal* of the German Chemical Society (2010) and Ernesto Illy Trieste Prize for materials

research (2011). He received the Award for International Scientific Cooperation from the Chinese Academy of Sciences in 2013.

The Government of India has given due recognition to Rao's outstanding contributions. He was the first recipient of the India Science Award (2005). Earlier he was conferred *Padma Shri* (1974) and *Padma Vibhushan* (1985). In 2013, he has been given the highest civilian award of the Government of India, the *Bharat Ratna*.

Rao is a Fellow of the Royal Society, London, Foreign Associate of the National Academy of Sciences, USA, Foreign Member of the Russian Academy of Sciences, Japan Academy as well as the Polish, Czechoslovakian, Serbian, Slovenian, Brazilian, Spanish, Korean and African academies. He is also Foreign Member of the American Philosophical Society and

Academia Europa. He is a Foreign Fellow of the Royal Society of Canada. Rao is a member of the Pontifical Academy of Sciences.

He was invited to deliver an address at the Convocation of the Fellowship of Royal Society of London in June 2010, the main event for the 350th anniversary celebrations of the Royal Society, the world's oldest existing science academy.

Rao was the President of the Indian



Nevill Mott



Satish Dhawan



H. C. Brown



Linus Pauling

National Academy (1985-86), the Indian Academy of Sciences (1989-91), the International Union of Pure and Applied Chemistry (1985-97), the Indian Science Congress Association (1987-99). He is the Founder-President of both the Chemical Research Society of India and of the Materials Research Society of India. He was a Founder Member, Vice President and President of the Third World Academy of Sciences, later named as Academy of Sciences for the Developing World. He was first Nehru Professor of the Cambridge University (1983-84).

He was a Member of the National Committee on Science and Technology chaired by C. Subramaniam. It was NCST which had recommended the creation of the Department of Science and Technology (DST) and also the Science and Engineering Research Council (SERC). He was a Member of the Scientific Advisory Committee to the Cabinet (SACC) headed by M. S. Swaminathan. He was the Chairman of the Scientific Advisory Council to the Prime Minister Rajiv Gandhi (1985-89). He was the Chairman of the SACC under the Prime Minister I. K. Gujral. Presently he is the Chairman of the Scientific Advisory Council to the Prime Minister Manmohan Singh. He was also the Chairman of the Advisory Board of the Council of Scientific and Industrial Research (India).

Rao has received *honoris causa* degrees from over 40 universities/educational institutions including Banaras, Bordeaux, Caen, Calcutta, Delhi, Khartoum, Mysore, Oxford, Notre Dame, Novosibirsk, Purdue, Uppsala, Wales, and Wroclaw. He is on the editorial boards of 20 leading professional journals.

SASTRA University in Tanjavur, Tamilnadu has introduced an award in the name of CNR Rao as a tribute to his invaluable services to strengthen India's position in science and technology. The first SASTRA-CNR Rao Award for Excellence in Chemistry and Materials Science will be awarded to Suresh Das and Saurav Pal working in CSIR laboratories.

The CNR Rao Hall of Science at the Jawaharlal Nehru Centre and Advanced Scientific Research (JNCASR) was inaugurated by the Prime Minister of India Dr. Manmohan Singh. The Hall includes sections on the 'Chemistry of Materials Expedition', the 'Professor CNR Rao

Archives', and a Viewing Room. It is a self-contained unit for the promotion of science. The main objective of establishing the Hall of Science was to expose school/college students and teachers to the excitement of doing science and to introduce them to the current trends in various fields of science.

The following points that emerge from Rao's life and work are worth pursuing by students not only science students but all students and young people:

- One should pursue one's dreams with passion, hard work and dedication.
- One should not stop learning. The thirst to gain more knowledge should never come to end.
- One should always try to gain fresh insights.
- One should not hesitate to ask the right questions.
- One should observe leaders closely and learn as much as one can from their leadership styles.
- The journey to peaks of excellence requires a strong base camp and so one should first build a strong base.
- Keeping a balance between professional and personal life is important.

Presently Rao is a National Research Professor and also the Linus Pauling Research Professor at the Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru. Rao thinks that doing science is the greatest reward of his life. Though he has been engaged in research over six decades now but he has not been tired of it as evident from research output. Often he emphasises that he enjoys working with young students. He has worked with a large number of young students.

Among those who inspired Rao are: J.C. Bose, C.V. Raman, Linus Pauling, H.C. Brown and Nevill Mott. I would like to end this brief write-up on Rao by quoting Rao's own words: "What is wonderful is that there is no limit to scientific pursuits. This limitless world scientists belong to makes life worth living and more challenging. I have always been and continue to be thrilled by the way research areas develop as one pursues ideas. 'Great oaks from little acorns'".

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3. "Making of a leading scientist—C. N. R. Rao" (In conversation with Richa Malhotra), *Current Science*, Vol. 100, No.10, pp. 1466-1471, 2011.
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(The article is a popular presentation of the important points on the life and work of C. N. R. Rao available in the existing literature. The idea is to inspire the younger generation to know more about C. N. R. Rao. The sources consulted for writing this article have been listed. However, the sources on the Internet have not been individually listed. The author is grateful to all those authors whose writings have contributed to writing this article. The author is also grateful to the sources from which the illustrations/photographs have been reproduced.)

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An Interview with Prof. C.N.R. Rao

Prof. Chintamani Nagesa Ramachandra Rao FRS, famously known as Prof. C. N.R. Rao, is well known researcher in the field of nanotechnology. He has authored more than 1,400 research papers in journals of international repute and 45 science books. He is fellow of several academies all over the world including Royal Society, London. More than 60 universities around the globe have awarded him honorary doctorates. He is recipient of most of the major scientific awards. Recently, Government of India honoured him with Bharat Ratna – the highest civilian award of the country. Mr. Meher Wan got the opportunity to talk to Prof. Rao on various issues related to science, education and scientific and technological future of India. Here are excerpts of the interview.

MW: First of all congratulations on your recent honour – the award of Bharat Ratna – the highest civilian award of India. How do you feel now?

C.N.R. Rao: Well!! I think it's fine and very nice that's all I can say. I was not expecting anything like that, so it's nice. Many thanks for considering me for this award.

MW: So let's start with some memories of your past times, how did this journey in science begin?

C.N.R. Rao: It has been wonderful sixty and odd years, since I first started my research in Banaras University (BHU) for my M.Sc. degree, that was exactly sixty-two years ago or more than that. Since then, many things have happened. I have been a professor; in fact, member of the faculty for the last fifty-four years now. So, it has been a wonderful thing. Lots of students who have worked with me for Ph.D. and a few hundred people worked with me, so it has been wonderful.

MW: When did you realise that chemistry is your cup of tea?

C.N.R. Rao: When I was 17 years old.

MW: At that time you were in B.Sc. or M.Sc.?

C.N.R. Rao: I had just finished B.Sc. and then went to Banaras to do my M.Sc. and then I decided that I want to be a scientist. I had no attraction for IAS exam or that type of stuff, so I decided to take up science.

MW: Why did you decide to remain in chemistry?

C.N.R. Rao: Many reasons. Actually I was very much excited by science

DC, not AC. To do experiments, we had to work at night when we had to convert DC into AC. It is difficult to believe that there was no regular alternating current electricity! BHU was a very active place in science. Those days, many UP universities including Allahabad University also were quite active. BHU is no longer what it was. Aligarh was very good at one time, so it was a very nice place to work I enjoyed. But I owe a lot to BHU and I am very loyal to BHU even now.

MW: Prof. J.V. Narlikar was also a student of BHU?

C.N.R. Rao: Yeah, his father was a professor of mathematics. He is junior to me in age as well as study.

MW: How do you perceive the current condition of the university system?

C.N.R. Rao: Oh! It's terrible. Universities are in very bad shape. We don't have many universities with high standards in teaching or in research. We have to improve and have to put in a lot of effort and lot of money to improve universities and first of all get rid of the politics in universities, bureaucracy in universities. In addition we have also to improve the facilities. A lot of work has to

be done and in the meantime, of course, we can't wait for that to change. So we have to create new institutions. India requires many good institutions like this one where you are sitting (JNCASR, Bangalore), where we have outstanding facilities where young people can do very good research work. So we have to improve such things.

MW: I feel basic science education is very important and it plays a key role in development of scientific scenario in the country. How do you perceive the basic education in our country?

C.N.R. Rao: The main thing, as I told you, the teaching of science at school level itself is not very good. In spite of that many young people come up. In spite of this, it is not a happy situation in schools, and we still have to do lot more in school education. Teachers and teaching have not



*President Pranab Mukherjee presenting the Bharat Ratna to Prof C. N Ramachandra Rao at Rashtrapati Bhavan in New Delhi.
Photo: R.V. Moorthy (photo courtesy- The Hindu)*

in school, by wonderful school teachers here in Bangalore and C.V. Raman of course. I had seen him giving a lecture in our school and was very impressed. After my B.Sc., I wanted to do M.Sc. and then research. That's why I went to Banaras to do part research, part thesis, part course and things like that. There I read a very famous book of Linus Pauling – *Nature of the Chemical Bond*. That book was very important for me. Even now, in the history of chemistry, if there is one book which changed the nature of chemistry is that book. I thought I must do this kind of research and that's one reason I left Banaras and went to the United States.

MW: How do you remember the times at Banaras Hindu University?

C.N.R. Rao: Oh, fantastic! BHU was a very good university at that time. You know, electric power supply those days was

got adequate recognition and importance in India. Teaching profession is not respected. I don't have the statistics of the world about which are the countries where teachers are given very high regard. Number one country in this regard is Finland. It is very difficult to become a teacher there, but very easy to become an administrator. Here it is the opposite, anybody can become a teacher. So, I think teachers should be given importance, teaching profession should get more respect, and there should be better facilities for schools. A lot of things have to be done and if we don't do that in next five-ten years, India can no longer be expected to be a powerful nation. It won't become just by economic state; we have to improve the education. Everybody in India should get a good opportunity and for that schools and colleges become very important.

MW: Does it need political will?

C.N.R. Rao: Partly political, you know. Industries should also help. After all, all of scientific research is supported by the government. How can that be? After all, in America, South Korea, and even China industries contribute at least forty to fifty percent of the science expenditure. Private investment in education is also important. At least in this state of Karnataka we have a lot of private universities and private colleges, but they are a bit too commercial. I think we have to worry about having private universities like Harvard or Stanford. The best universities of America are private universities. Of course there are some government universities like California University which are equally good, but some of the top ones are private. Why do we not have that? Even I can mention names of some industrialists, who can easily start and easily set up private universities with no government interference. I don't know why we have not done enough of that?

MW: What is the state of industry-academia relationship in India?

C.N.R. Rao: There is not much relationship. You know, I have done extensive research publishing tons of papers for last fifty and half years, but I have never been approached by any Indian industry for help. And there is a lot of foreign interest in it, my research is being used quite a bit in industries abroad, but not in India. Because Indian industries are not quite based on hi-fi technology; they are based on technologies which do not require modern science.

They manage with some old stuff. Now things are going to change and if India is to compete with other countries then they will have to support science; they will have to support universities more. It has become the necessity of these days and I hope they will do something in this direction.

MW: You have contributed remarkably to scientific research in our country. What are the great achievements of Indian science according to you?

C.N.R. Rao: Well, there are a few achievements. See, for example, in India whenever we have mission-oriented science or technology project like atomic energy or space, we have done great. Whenever we have been given well-defined projects to build reactors, rockets, etc., we have done well. Where there is no new science involved or application of known science, but project-oriented or technology-oriented missions, we have succeeded fairly well. Where we have not succeeded is in real science. Real science means physics, chemistry and biology done in small laboratories, which are the ones that give progressive background. Reactors or space science is based on the concepts evolved by the ordinary people, working in small ordinary laboratories like you and me, that's the one that made science what it is today. Small lab-level science should be supported more. Big science has always been supported more, like atomic energy and space; small science in universities and other labs have not had that much of support. But now, even if you give money, our universities are not in such position to use that money to improve. There is also too much politics. On the other hand total bureaucracy and other things don't allow science to thrive in many of our education institutions, but IITs are all okay. But even among the IITs, how come one of our IITs is like MIT? They should be like MIT, but they are not. It is not just money; that's why I said, we are facing grave problems where we have to improve in a very big way. Individuals do matter. There are few individuals who are outstanding, but their number is very small. Even I can count them on my fingers.

MW: We had stalwarts like Prof. J.C. Bose, Prof. S.N. Bose, and many others. What went wrong in the mean time?

C.N.R. Rao: Don't count those names. J.C. Bose was different, he created science; he was the first great scientist of modern India. In 19th century he discovered

the coherer, he should have got the Nobel Prize. S.N. Bose and others are different; they did little research rest of their lives and they didn't do much. Personally speaking, I only respect those scientists who do science till the last day and that's why I am an admirer of J.C. Bose. Of course, Raman did wonderful physics, and Ramanujan did great mathematics but he died at a very young age. However, many others also did great works, but J.C. Bose was a scientist till his last day. All the professors with whom I have worked with very well-known people of America or UK like Nobel laureate Prof. Mott with whom I am associated. At the age of 93, he is still publishing papers. Personally, I like such people who are really dedicated. You know, I still publish papers like a young man. In fact I give a competition to young men to work and compete with me.

MW: I have seen it in your lecture a few days back at Indian Institute of Science at a union of material scientists.

C.N.R. Rao: Oh! Were you there? How did you like that?

MW: I liked your work about hydrogen generation through artificial photosynthesis for energy applications. I liked it much. If we talk about materials science we lagged behind in micro-revolution, but in nano science and technology this is not the case....

C.N.R. Rao: Yeah, in nanotechnology we are not doing too badly due to targeted funding. What actually happened is that we have funded many institutions through the "Nano Mission". Until the Nano Mission came, the only electron microscope available in the whole of eastern India was in Kolkata. Now, India is showing reasonable results in nano science and technology because in microelectronics we did nothing. But in all aspects of science, very few scientists are working on frontier areas and that's unfortunate.

MW: Much credit goes to you for the "Nano Mission".

C.N.R. Rao: Only "Nano Mission".

MW: What type of support do our scientists still need?

C.N.R. Rao: Mere money would not help. We have to create institutions. See, for example, you give a lot of money to some educational institutions, but they are not able to use that money because of local conditions, bureaucracy, and politics, whatever. I don't know, if it's the same in

all universities, but I was told it is very bad generally many places. We have to improve that part of infrastructure and everything in universities. In addition, institutions like the Indian Institutes of Science Education and Research (IISERs) we have created are outstanding. If we can create a few more good institutions like IISERs they can give us a boost and in the mean time we can improve our universities and we will do that.

MW: Media can play a very important role in highlighting the scientific achievements.

C.N.R. Rao: Yeah. Media has done almost nothing for science. You see the TV programmes and you will start getting depressed; they will show murders, rapes and this kind of stuff or politics, but very rarely science. Science figures very low in the value system of the Indian society. In Indian society science come at the bottom, I don't know why. See china is different; I just got a formal letter being induced as a foreign member of the Chinese academy. They invited me for a function; I will have to go there. Anyway, they are so organised I mean they are so proud to be Chinese and everything is so different from here. We are not so well organized; we are not so nationalistic somehow and we are paying a price for it.

MW: I feel science communicators should play an important role in this direction.

C.N.R. Rao: Of course, science communicators can, and media also. Suppose media decides to make science important people will listen to that. Look at our television; every day and night we are seeing all kinds of things, but rarely education and science. When did you see last program on science on TV?

MW: There may be reasons behind it; we teach how to do reporting on politics and crime but not how to do reporting on science? Is it so?

C.N.R. Rao: No! No! This is not the reason behind that, after all nobody teaches you how to communicate all the rotten things; many things you learn yourself. It depends on the interest. In china, are there people; who taught them? No. They give importance, the Chinese give; South Korea invited me to give a lecture in a major meeting of scientists. South Korea is fantastic, I would say in all the little countries South Korea has done best. They got the freedom

at the same time as we Indians got in 1947. Look at what they have done; see how much importance they give to education, scientific research. It is unbelievable.

MW: Sir, you are chairing the science advisory council to prime minister.

C.N.R. Rao: Yeah, we have done many things. I will give a book to read to see what we have done. There are lots of important things we are concerned about.

MW: Yes, I will surely read, please mention some important issues here, Sir.

C.N.R. Rao: It's a very large list you should read it, I can't mention all here, but IISERs were created by us, Ramanujan fellowships, and improving scholarships to research students. Again we are going to improve it, many such important things. Creation of IISERs is very obvious example; you know getting this big computing power for India. Government has just given five thousand crores to improve hyper computing facilities. In computation, you know India does not have good computing power; China has very high, America of course has very high computing power. So we want to have some computing power so that young people like you can do computing in a big way, so many such things we do.

MW: We will have highest number of youths in the world.

C.N.R. Rao: I tell you the future belongs to you. I agreed to see you because of that; otherwise I may be wasting my time. Future belongs to young people. Sixty per cent of India is below thirty and thirty-five years. Just imagine, thirty years later when Indian population become 1.5 billion there will be more young people; that is why I am concerned. We should work out a plan, a well drawn-out plan, for education, progress, and employment opportunities for young people; until we do it we will be in a very bad situation.

MW: How will we plan for it?

C.N.R. Rao: That is a very big question, I will not go deep in this question as it will need many hours to discuss here, but I have been requesting you that you should read this book and government should appoint a visionary group to think on what should be done for younger generation in the next twenty years, but they have not done anything yet. I have been telling them we should do that. You know, that question is very serious to work on; it is not like an education commission. We have to chock

out the program for the youth as soon as possible.

MW: As I have mentioned that I have listened to your lecture at IISc recently. You have shown very new research done by your group on hydrogen production through artificial photosynthesis. You are very actively engaged in research in spite of you administrative and other engagements, and your public life, how do you manage it?

C.N.R. Rao: Most of the time I do only my research. Other things are my overtime. I work very hard, I get up in 4.30 am in the morning everyday so by the normal working time, I do 2-3 hours' work. I spend much time with my students. I write papers with them, I actually sit and work with them so that we get maximum amount of research output, we optimise our effort. I write a lot, I write a lot of books, review papers. But in addition to it a little bit, I contribute to our country in various ways too. Now I am not in regular administration as before. I was president and director of Indian Society of Material Scientists, now only I am asked for advisory.

MW: Still it is a mystery to youngsters like me, how do you manage your time?

C.N.R. Rao: See, time management is an important thing, you know. Michael Faraday has a very famous statement, he said:

What is it, that can be made short or long,

What is it, that can be compressed or elongated,

What is it, that can you enjoy or detest,

What it is, that god almighty thought so precious,

to give us limited amount of it,

That is time....

You have to know how to use it. 90% of the people in the world do not know how to manage time. They waste a lot of time. I try to use it. I don't have people come to chat; you are only an exception today. I just do my work. If I don't have such work, I read something.

MW: Finally, my last question, what do you want say to youngsters?

C.N.R. Rao: I tell you, young people should be left alone to follow the path they want. They should not be forced to go in to engineering, etc. They should do

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Dr. T. Ramasami

receives Padma Bhushan

Thirumalachari Ramasami (popularly known as T. Ramasami), a highly accomplished researcher and leather scientist, has been awarded Padma Bhushan, India's second highest Civilian Honour for excellence in science and engineering. He was earlier awarded Padma Shri (2001).

Ramasami obtained his Secondary School Leaving Certificate (SSLC) from G.S. Hindu High School, Chennai, in 1963, Pre-University degree from St. Joseph's College, Trichy (1964), BTech (1969) and MTech (1972) degrees in leather technology from the Madras University. He topped in both the BTech and MTech examinations. He got his PhD degree in chemistry from the University of Leeds, England in 1976. His PhD thesis was on the chemistry of chromium. He worked at the Ames Laboratory, Iowa State University, USA (1978-80), Wayne State University, Detroit, USA (1981-83) and University of Newcastle upon Tyne (1983-84) on research areas relating to homogeneous catalysis, electron transport phenomena, and bioorganic chemistry, respectively.

In 1984, Ramasami joined the Central Leather Research Institute (CLRI), a research laboratory of the Council of Scientific and Industrial Research (CSIR), located in Chennai. The CLRI is the world's largest leather research institute. He became Director of CLRI in 1996 and served in this post till 2006. Under his leadership CLRI emerged as the global leader in leather research and development by way of original publications, IPR generation and technologies delivered. He prepared a vision document for CLRI—"CLRI Vision 2005"—and directed the Leather Technology Mission with 170 projects in 17 states of India. One of his outstanding achievements as Director of CLRI was that the Institute provided cleaner tanning technology options for a group of 764 tanneries in record time of 12 months. His contributions to the solution of environmental problems in leather sector in Tamil Nadu resulted in saving 2,50,000

jobs and an annual turnover of Rs.6,000 crores.

Ramasami's own research investigations focussed on mechanistic chemistry, industrial applications of chromium salts and "Do-ecology solutions" to industrial environment problems. Among his major research contributions are demonstration of anomalous reactivity



T. Ramasami

of chromium (III), stabilisation of unusual oxidation states of chromium, mechanistic insight into chromium induced apoptosis of human lymphocytes, understanding host-guest interactions in biomolecular systems, and development of technologies for improved tanning salts and systems for leather sector.

At least twelve technologies developed by Ramasami and his group are in commercial exploitation and many of these technologies were developed from first principle without international equivalent. Ramasami holds 37 patents including the 12 which have been commercialised. He has authored more than 220 research papers, many chapters in books, and numerous general articles. He has guided

more than 30 students for their doctoral research.

In 2006, he became the Secretary of the Department of Science and Technology (DST), Government of India. As Secretary, DST, he has initiated policies, programmes and schemes with potentials for long-term impact. Among the programmes initiated by him are INSPIRE (Innovation in Science Pursuit for Inspired Research), for encouraging talent towards science, CURIE (a programme for developing excellence in research in women in universities), and PURSE (Promotion of University Research and Scientific Excellence) for energising university research. He has prepared detailed statistics to demonstrate the publications count (quantity) and their causality to policy changes during his tenure as Secretary, DST. He has also demonstrated the performance growth with citation indices (quality). He is currently connecting causes of science with resources and public policy support.

Besides Padma Shri and Padma Bhushan, Ramasami has received numerous awards for his outstanding contributions. Among the various awards received by him are: Coleman Research Prize (1976, for the best doctoral thesis from UK), Shanti Swarup Bhatnagar Award for Chemical Sciences (1993), Vasvik Prize for Chemical Sciences (1997), Om Prakash Bhasin Award for Engineering and Technology (2000), and Platinum Jubilee Award of the Indian Chemical Society (2001). In recognition of his outstanding contributions to leather research he was invited by the American Leather Chemists Association to deliver the Arthur Wilson Memorial Lecture. He is a Fellow of the Indian National Science Academy, Indian Institute of Chemical Engineers, and Third World Academy of Sciences.

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A Look at the Cloud Computing



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Cloud computing is a transformative paradigm in information technology and may well be deemed as harbinger of the next stage in the Internet revolution.

Cloud computing promises to provide everything – from computing power to computing infrastructure, to be delivered as a service wherever and whenever required. The “cloud” in cloud computing can be defined as the set of computer processors, storage, networks, services, and interfaces that combine to deliver computing as a service.

Cloud computing should not be equated with Internet, although Internet connectivity is one of the essential requirements. It is a subscription-based service where one can obtain networked storage space and computer resources.

For an organisation, the computational requirement is not uniform at all times. To cater to the changing need with time, hardware capabilities need to be deployed based on the highest load requirement. Although the computational requirement of an organisation may increase over a period of time, it is often difficult to make a long-term investment in expensive computer hardware in the light of the uncertain future scenario with fast-changing technologies. On the other hand, incompatibility of old hardware and software set-up is often a problem, necessitating large investments on upgrading the existing computer hardware and software on a regular basis, and thus resulting in a system which is under-utilised at the time of first deployment and is redundant, insufficient, ineffective, and obsolete within a

very short time span. For businesses, this is not a cost-effective and practical option.

Cloud computing promises to provide everything – from computing power to computing infrastructure, to be delivered as a service wherever and whenever required.

The same situation may happen in public utility services provided by public enterprises. As the number of services increase and more and more people are connected to avail of services like online reservation, utility bill payments, registrations, etc., more computing and storage requirement is inevitable. These services are independent most of the time, handled by different

organisations and managed by independent third party service providers. Resources are often under-utilised initially and by the time demand increases those become obsolete and insufficient. Under-utilisation of costly hardware resources reduces overall efficiency and incurs cost. There are also significant loss of electricity and under-utilisation of space and manpower.

Cloud computing is not only capable of handling the above situations effectively, it promises to deliver better-than-ever services in terms of Quality of Service (QoS) and adaptive service delivery mechanism based on customer feedback.

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to multiple organisations (Cloud Users or CUs). State-of-the art technologies like virtualisation of servers, multi-tenancy and scalability ensures that CUs request services from CSPs as per the requirement and pay only for the services that they have utilised.

One easy way to visualise cloud computing in action is to consider our experience with web-based email account, be it in *gmail*, *yahoo*, *rediffmail*, or any other email service provider. These service providers take care of housing all of the hardware and software necessary to support our personal email accounts. When we want to access our email, we open web browser, open the website of the service provider and log in. Our emails and all attached documents

One of the major advantages in cloud computation is that software solutions are mostly based on open source and not proprietary driven.

are not housed in our physical computer; we access it through a service provider. With an Internet connection we can access it anywhere and anytime. A CU is similar to an email user, except instead of accessing just email, one can choose different kinds of services like storage of large amount of data, computation, query based retrieval, etc.

Open source framework

One of the major advantages in cloud computation is that software solutions are mostly based on open source and not proprietary driven. A number of open source developers work together for a common goal. Software is released under open source licensing agreement that allows anyone to improve upon the existing software coding and subsequently the next version is released. This is more like a community driven approach where software developing community work together and no licensing fee is to be paid by the end users.

Open source framework enables deployment of the software in commonly available hardware infrastructure, supplied

by multiple vendors. In a traditional distributed platform or in High Performance Computing (HPC) environment, specialised and customised software is required to work on specialised hardware set-up. This limits the scalability. Customised hardware and software are normally supplied and supported by a single organisation. Hence dependency increases and any up-gradation involves huge expenditure.

A CSP can establish data center with multiple servers at multiple locations running on open source software. As the demand increases, CSP can simply add more servers. As CSP uses open source framework in the cloud infrastructure, no extra expenditure in terms of licensing is required. As a result CUs get the services at a cheaper rate.

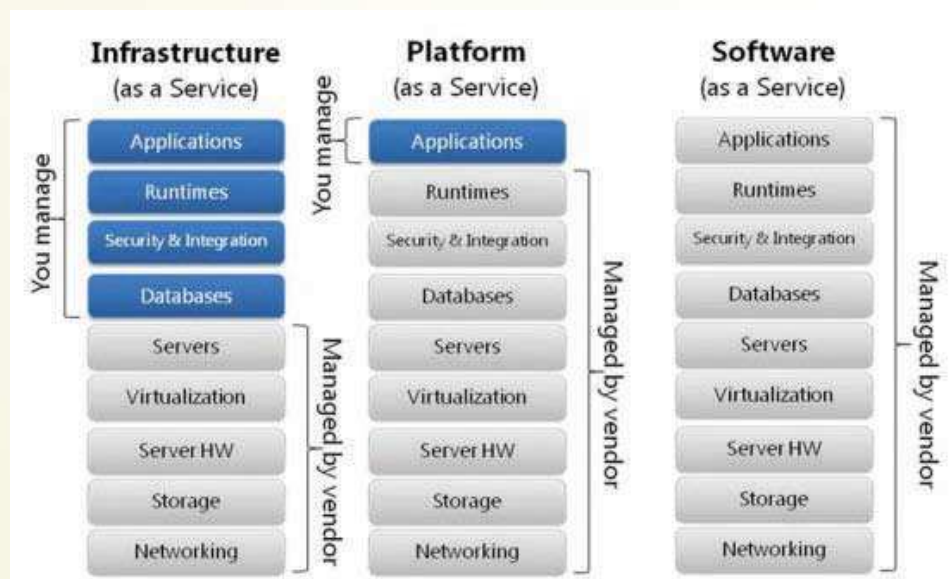
In case of increased demand, a CU can simply request more resources from CSP, even for a particular duration. In any case cloud resources are dynamically allocated. In most cases, CUs prefer 'pay-as-you-go' model. Hence there is no possibility of under-utilisation of resources.

Historical development of cloud computing

Cloud computing is not a new technology – it is a new service delivery model. Many of the underlying technologies that form the foundation of cloud computing have existed for quite some time now.

During 1960s, large-scale mainframe computer resources used to be shared by different user groups. The mainframe's colossal hardware infrastructure was costly. Multiple users were able to access the mainframe via "dumb terminals" – stations whose sole function was to facilitate access to the mainframes. Due to the cost of buying and maintaining mainframes, it was not possible to provide a mainframe for each user. It became a practice to allow multiple users to share the same software applications and central processing unit (CPU) power. Similar to mainframe computer, cloud computing is also all about resource sharing. One need not invest in costly hardware and software for information technology related services like data storage and computation.

During 1970s, IBM released an operating system called VM that allowed mainframe systems to have multiple virtual systems, or "Virtual Machines" (VMs) on a single physical computer. The VM operating system took the 1960s application of shared



access of a mainframe to the next level by allowing multiple distinct computing environments to exist in the same physical environment. Most of the basic functions of any virtualisation, one of the key computing techniques of cloud computing, can be traced back to this early VM Operating System. Virtualisation became a technology driver, and it became a huge catalyst for some of the biggest evolutions in communications and computing.

With the boon of information technology, more and more services became dependent on fast computing power of computers. From accounting to railway reservation, everything became dependent on computers. At the same time more and more people started using computers. In an organisational set-up, client-server architecture became popular, where all the computers, called nodes are connected with a common server. In a client-server scenario, the server has high computation power and storage capacity compared to nodes. All the nodes share resources from the server.

As more and more data started generating at a faster-than-ever rate, processing large volume of data became a challenge. More and more computation power and processing of large amount of data demanded more powerful servers. With ever increasing demand of fast computation and a variety of services, servers were virtualised

into shared hosting environments, Virtual Private Servers, and Virtual Dedicated Servers. High Performance Computing (HPC) and High Throughput Computing (HTC) became a reality. Data centres, having a large numbers of servers to store and process extremely large volume of data, were conceptualised.

Amazon played a key role in the development of cloud computing by initially renting their data center to external customers.

By installing and configuring software called a hypervisor across multiple physical nodes, a system would present all of the environment's resources as though those resources were in a single physical node. To help visualise that environment, technologists used terms like "utility computing" and "cloud computing". In these cloud computing environments, it became easy to add resources to the "cloud": Just add another server to the rack and configure it to become part of the bigger system.

Amazon played a key role in the development of cloud computing by initially renting their data center to external customers. In 2006, they launched Amazon EC2 (Elastic Cloud Computing) as a utility computing platform. After that several major vendors, including Google, IBM, Sun, HP, Microsoft, Yahoo released cloud solutions. Since 2007, the number of trademarks covering cloud computing brands, goods and services has increased many folds.

At the same time, cloud computing is also a much favoured research topic addressing the challenges of large-scale distributed computing. In 2007, Google, IBM and several universities announced a research project, the Academic Cloud Computing Initiative (ACCI). Since then, several open source projects have come up. For example, Eucalyptus, OpenStack, OpenNebula are application interfaces for deploying cloud computing facility.

In July 2010, HP announced the SiteOnMobile for emerging mobile cloud. Several mobile network operators have started offering cloud computing services.

In March 2011, the Open Networking Foundation, which consists of 23 IT companies, was founded by Deutsche Telecom, Facebook, Google, Microsoft, Verizon, and Yahoo. This non-profit organisation supports a new cloud initiative called software-defined networking, an initiative which is meant to speed up innovations through programmable networking, wireless networks and data centres. These initiatives will ensure easy deployment of hardware and better services in a cloud environment.

Cloud characteristics

Cloud computing provides ICT resources in a dynamic and scalable manner over a network. It allows consumers and businesses to use applications without investing in costly hardware and software. The technology allows efficient computing in terms of storage, memory processing and bandwidth.

As a general resource-provisioning model, cloud computing integrates a number of existing technologies like grid computing, utility computing, service oriented architectures, internet of things etc.

Some of the qualitative aspects of cloud computing are:

Elasticity: It allows cloud users to request services dynamically as per their requirements. Provisioning of service by the cloud provider is adaptable and cloud users pay as per the usage. Performance is

Grid versus Cloud Computing

Both cloud computing and grid computing involves massive computer network infrastructure. However, conceptually cloud is different from grid computing.

Grid systems are designed for collaborative sharing of resources. It can also be thought of as distributed and large-scale cluster computing. A grid utilises processing capabilities of different computing units for processing a single task. The task is broken into multiple sub-tasks; each machine on a grid is assigned a sub-task. Computing centres are distributed across different sites, countries and continents. Grid computing is more associated with research collaborations with multiple organisations.

Clouds computing enable access to leased computing power and storage capacity from shared servers. Data centres, owned by the cloud providers, are often centralised in a few locations with excellent network connections. Unlike grid, cloud users can request for more resources and different services anytime from cloud service providers and pay as per the usage of services.

However, both grid and cloud computing are based on resource sharing, thereby ensuring better utilisation and increased efficiency.

monitored and consistent.

Availability: It refers to specific requirement of the outsourced services made available by cloud service provider. Quality of Service (QoS) is measured in terms of response time and throughput.

Reliability: It represents the ability to ensure constant system operation without disruption.

Agility: It is a measure of cloud providers' ability to adapt online to changes in resource demand.

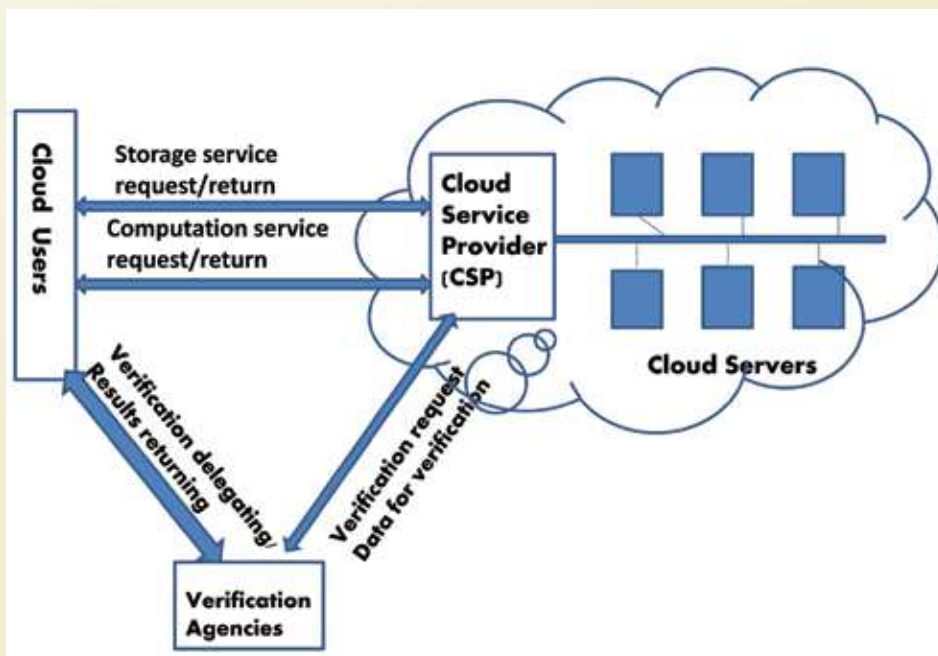
Service models

Since a cloud is an underlying delivery mechanism, computing ability can be provisioned on three levels: software, platform and infrastructure.

Software as a service (SaaS): It is a delivery model in which applications are accessed by users using a simple interface like web browser. The users are not concerned with the underlying cloud infrastructure including network, servers, operating systems, storage or platform. This model also eliminates the need to install and run the application on the local computer. Now SaaS has become a common delivery model for many business applications such as social media, online games, including accounting, collaboration and

management. Facebook, NetSuit, Google Docs, Web Mail are a few examples of SaaS model.

Platform as a Service (PaaS): It offers a high-level integrated environment to build, test, deploy and host customer created or acquired applications. Customers of PaaS do not need to manage the underlying infrastructure, but need to have control over the deployed applications and their hosting environment configurations. Typical examples of PaaS are Google App Engine,



Windows Azure and Force.com.

Infrastructure as a Service (IaaS): It offers processing, storage, networks and other fundamental computing resources to users. IaaS users can deploy and run any application, software and operating systems on the infrastructure that can be scaled up dynamically based on the resource needs. The infrastructure is virtualised, flexible, scalable and manageable to meet user needs. Examples of IaaS include Amazon Elastic Compute Cloud (EC2), IBM Blue Cloud, Eucalyptus, Rackspace cloud etc.

Deployment models

Cloud can be deployed in different fashions, depending on the usage scopes. There are four primary deployment models:

Public cloud: It is the standard cloud computing paradigm, in which service provider makes resources, such as application and storage, available to the generic public over the internet. Service providers charge the users based on the usage. Examples of public cloud include Amazon Elastic Compute Cloud (EC2), IBM Blue Cloud, Google App Engine and Window's Azure Service Platform.

Private cloud: It provides proprietary computing architecture that provides services to a limited number of people on internal networks. Organisations that need accurate control over their data will prefer a private cloud so that all the characteristics of a public cloud, like scalability, agility, etc., are guaranteed and at the same time total control of data is ensured. HP CloudStart and eBay provide private cloud deployments.

Hybrid cloud: A hybrid cloud is a combination of public cloud, private cloud and even local infrastructures. The strategy is proper placement of workloads depending upon cost, operational and compliance factors. Users can deploy an application hosted on a hybrid infrastructure, in which some nodes are running on real physical hardware and others on virtual cloud server.

Community cloud: A community cloud overlaps with grid computing to some extent. It refers to several organisations in

Big Data

Big data is a popular term used to describe a large and complex dataset that is difficult to process using standard data processing software. Big data is the result of exponential growth and availability of data, both structured and unstructured along with the processing need. More data lead to more accurate analyses. More accurate analyses lead to greater operational efficiency, cost reductions and reduced risk in a socio-economic scenario.

Many factors contribute to the increase in data volume. Data collected during transactions, unstructured data streaming from social media, data collected through sensors (RFID tags, sensors and smart metering) and many more. Scientists regularly encounter limitations due to large data sets in many areas, including meteorology, genomics, physics and biological and environmental research. Analysis of extremely large data set is one of the major research interests. Traditional data processing techniques are ineffective as processing time will be large. Massively parallel software running on tens, hundreds, or even thousands of servers are required to analyse Big Data. In 2004, Google published a paper on a process called MapReduce that used such architecture. MapReduce framework provides a parallel processing model and associated implementation to process huge amount of data. Other popular Big data processing software are MongoDB and Splunk.

a private community sharing the cloud infrastructure. The organisations usually have similar mission, policy and data security requirements.

Foundation of cloud computing environment

Technical characteristics are the foundation of cloud computing that promises to change the service delivery mechanism of information technology. Some of the key concepts are:

Virtualisation: It refers to the act of creating a virtual version of computer hardware platform, operating system (OS), storage device, or computer network resources. The term "virtualisation" traces its roots to 1960s mainframes, during which it was a method of logically dividing the mainframes' resources for different applications.

Virtualisation is a way of improving the efficiency of hardware. It involves employing specially designed central processing unit (CPU) and hardware components that help improving the performance of a guest environment. The usual goal of virtualisation

is to centralise administrative tasks while improving scalability and overall hardware-resource utilisation. With virtualisation, several operating systems can be run in parallel on a single CPU. This parallelism tends to reduce overhead costs and differs from multitasking, which involves running several programs on the same OS. Using virtualisation, an enterprise can better manage updates and rapid changes to the operating system and applications without disrupting the user. Ultimately, virtualisation dramatically improves the efficiency and availability of resources and applications in an organisation. Instead of relying on the old model of "one server, one application" that leads to under-utilised resource, virtual resources are dynamically applied to meet business needs without any excess expenses and clients pay for only what is needed.

Multi-tenancy: It allows sharing of resources and cost across multiple users. Multi-tenancy ensures better utilisation and efficiency. Multi-tenancy also ensures high peak-load capacity.

Data security

Security is the largest concern for adoption of cloud computing. As data are stored and managed by cloud service providers, integrity and availability of data is one of the concerns among cloud users. One of the options is to use services of trusted third party authenticators (TPA). TPAs will ensure security of data in cloud environment and issue necessary certificates to CSPs. It is similar to third party authentication when we do financial transaction over the Internet. Financial transactions are not only encrypted while it is sent through payment gateways, organisations who are doing the financial transactions are certified by certifying agencies, like VeriSign to do financial transactions.

Security is the largest concern for adoption of cloud computing.

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Neurotransmitters – The chemical messengers of the body

Ms. R. Vathsala E-mail: vathsalarangachari@gmail.com

- You are sitting in the garden. Suddenly you smell the fragrance of a flower. It is an exotic and unusual smell. You have already experienced it a very long time ago. You start thinking and suddenly you are able to remember the fragrance. It is from a magnolia flower. How are you able to recollect this?
- You hear a melodious film song. Immediately you recollect that the singer is Lata Mangeshkar and also the name of the film.
- You see a face in the crowd. The face looks familiar. The other person also keeps on looking at you. Suddenly both of you recognise one another. He was your schoolmate!
- While walking barefooted in your garden, you step on a thorn. You feel the pain, shout “ouch”, squat on the ground and remove the thorn.

How do these happen? Have you ever thought about such happenings?

We all know that the food we eat gets digested and we get the energy to do work. We breathe in air and it reaches the lungs and the used air comes out through the nose. So, every one of us have a vague idea about the various physiological functions occurring in the body. But how many of us really know about the brain, the spinal cord, and the nerves?

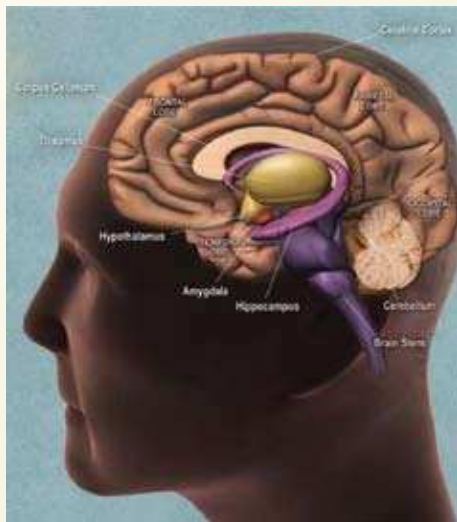
We all have a vague idea that the nerves and the brain in our body are responsible for the various sensations, movements and also memory. But not many of us really know about the amazing capacity of the brain.

We are all fascinated by the latest computers and their capacities. But let me assure you, no modern computer can compare with the tremendous capacity of the human brain.

The brain is enclosed in the skull; it continues down the backbone as the spinal cord, and we have millions of nerves distributed all over the body. The nerve cells are called neurons. They are branched cells and the branches are connected with one

another forming a continuous cable system. The brain, the spinal cord and the nerves together form the nervous system.

The transmission of a nerve impulse along a neuron from one end to the other occurs as a result of electrical changes across the membrane of the neuron. The electrical changes are brought about two ions, which are electrically charged particles. The two ions involved are sodium and potassium



ions. Sodium ions enter the nerve fibre and potassium ions come out of it. For this process to occur the permeability of the membrane of the nerve needs to be altered. This change in permeability is brought about by substances called neurotransmitters.

Let us first understand what a nerve impulse is.

A nerve impulse is an electrical signal that travels along a nerve fibre and makes us feel pain, move our hands or feet and also utter sounds like ‘ouch’ and talk. When we accidentally step on a thorn, the nerve fibres in the affected area are brought into action. The message is sent to the brain. The brain issues a series of commands. All these actions occur within a few seconds. In all these processes the messages and commands pass to and fro along the nerves and from one nerve ending to the next one.

Each nerve tract consists of millions of neurons. The endings of a nerve fibre are connected to the nerve endings of another nerve fibre. This meeting point is called

a ‘synapse’. In a synapse there is no actual contact between the nerve endings, but there is a minute microscopic gap of about 20 to 40 nanometres (nm).

Neurotransmitters

Neurotransmitters are the brain chemicals that help in the passage of nerve impulses through the gaps. The brain uses neurotransmitters to tell our heart to beat, our lungs to breathe, and our stomach to digest. They can also affect mood, sleep, concentration, weight, and can cause adverse effects when they are out of balance. Neurotransmitter levels can fall in many ways. Stress, poor diet, neurotoxins, genetic predisposition, drugs (prescription and recreational), alcohol, and caffeine usage can cause these levels to deviate from the optimal range.

Otto Loewi was a German-born pharmacologist whose discovery of the neurotransmitter acetylcholine helped enhance medical therapy. The discovery earned for him the Nobel Prize in Physiology or Medicine in 1936, which he shared with Sir Henry Dale. He has been referred to as the “Father of neuroscience”.

Acetylcholine was the first neurotransmitter to be identified. It is used by nerve cells that control the heart, muscles, and lungs. It is also used by neurons in the brain involved in memory functions. Acetylcholine is released at the junction between nerve and muscle cells. This release signals calcium ions to begin muscle contraction.

There are two kinds of neurotransmitters – Inhibitory and excitatory. Excitatory neurotransmitters stimulate the brain. Neurotransmitters that calm the brain and help create balance are called inhibitory. Inhibitory neurotransmitters balance mood and are easily depleted when the excitatory neurotransmitters are overactive.

How are neurotransmitters released?

Neurotransmitters are signalling molecules which are released by a kind of neurons called pre-synaptic neurons, and bind to and activate the receptors of another kind of neurons called the post-synaptic neurons.

Neurotransmission usually takes place at a synapse, and occurs when a nerve ending is stimulated resulting in a change in its permeability. This allows the entry of sodium ions into the neuron and the impulse is carried along the nerve fibre.

When a nerve impulse arrives at the synapse, it releases neurotransmitters, which influence another cell, either in an inhibitory way or in an excitatory way. Excitatory neurotransmitters stimulate the nerves and inhibitory neurotransmitters suppress the action of another neurotransmitter or nerve.

Inhibitory neurotransmitters

Serotonin is an inhibitory neurotransmitter; that is, it does not stimulate but sedates the brain. Adequate amounts of serotonin are necessary for a stable mood and to balance any excessive excitatory neurotransmitter stimulating the brain. About 80% of our body's total serotonin is in the gut, where it regulates intestinal movements. The rest is synthesised in the central nervous system.

If you use stimulant medications or caffeine daily, it can cause a depletion of serotonin. Serotonin also regulates many other processes such as craving for carbohydrates, sleep cycles, pain control, and proper digestion. Low serotonin levels are also associated with decreased immune system function.

Serotonin plays an important part in the regulation of learning, mood, sleep and vasoconstriction (constriction of blood vessels). Alterations in serotonin levels in the brain may affect mood. Some anti-depressant medications affect the action of serotonin. A study carried out at Oxford University found that serotonin influences the way we rate intimacy and romance. Research has shown that serotonin levels are lower during winter. This explains why some people feel miserable during winter.

Scientists have shown that the brain's serotonin systems in males and females are different. They think they might have found one of the reasons why more women are affected with depression and chronic anxiety than men.

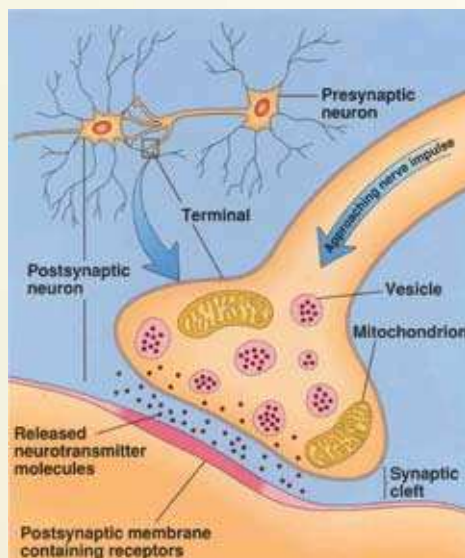
GABA (gamma-aminobutyric acid) is an amino acid that functions as an inhibitory neurotransmitter in the brain. GABA is synthesised in the brain from the amino acid called glutamic acid. In the body, GABA is concentrated in the hypothalamus region of the brain and is known to play a role in the

overall functioning of the pituitary gland – which regulates growth, metabolism, reproductive processes, and temperature regulation.

Excitatory neurotransmitters

Dopamine is a special neurotransmitter because it is considered to be both excitatory and inhibitory. When dopamine level is either elevated or reduced, it may lead to disturbances in focussing such as not remembering where we put our keys, forgetting what a paragraph said when we just finished reading a book, or simply daydreaming and not being able to stay on the task we were just then working on.

Dopamine is also responsible for our drive or desire to get things done; that is, motivation. Stimulants such as some



medications and caffeine cause dopamine to be pushed into the synapse so that focus is improved. Unfortunately, stimulating dopamine consistently can cause a depletion of dopamine over time.

Brain dopamine systems are involved in motor control (control of movements) and in controlling the release of several important hormones. Many important diseases of the nervous system are associated with dysfunctions of the dopamine system. Parkinson's disease, a degenerative condition causing tremor and motor impairment, is caused by loss of dopamine-secreting neurons in the midbrain area. There is evidence that schizophrenia is caused by altered levels of dopamine activity.

Outside the nervous system, dopamine functions in several parts of the body as a

local chemical messenger. In the blood vessels it inhibits release of the hormone norepinephrine and acts as a vasodilator (causes dilation of blood vessels); in the kidneys it increases sodium excretion and urine output; in the pancreas it reduces insulin production; in the digestive system it reduces gastrointestinal movement and protects intestinal mucosa; and in the immune system it reduces the activity of lymphocytes.

A variety of important drugs work by altering the way the body makes or uses dopamine. Dopamine itself is available for intravenous injection: although it cannot reach the brain from the bloodstream, its peripheral effects make it useful in the treatment of heart failure or shock, especially in new-born babies. The chemical L-DOPA (DOPA is an acronym for 'dihydroxyphenylalanine'), the metabolic precursor of dopamine, does reach the brain and is the most widely used treatment for Parkinson's disease.

Epinephrine and norepinephrine are excitatory neurotransmitters which regulate heart rate and blood pressure. These two hormones act very similarly. They are associated with vigilance and the fight-or-flight response. Their activity stimulates the sympathetic nervous system, preparing the body to face danger or run away from it. If a bull suddenly starts chasing, you either grab the bull by the horns if you are a matador or run away, as most of us do.

Epinephrine is released into the bloodstream when dangerous circumstances occur in an emergency requiring immediate action, and in stressful situations or environments. In the bloodstream, epinephrine rapidly prepares the body for action. It increases the supply of oxygen and glucose to the brain and muscles while suppressing other non-emergency bodily processes (like digestion).

Epinephrine increases heart rate and stroke volume, dilates the pupils, and constricts thin arteries in the skin and gastrointestinal tract while dilating thin arteries in skeletal muscles. It increases breakdown of glycogen to glucose in the liver thereby elevating the blood sugar level. At the same time, epinephrine begins the breakdown of lipids in fat cells. Like some other stress hormones, epinephrine has a suppressive effect on the immune system.

Endorphins

Why do we have a sense of satisfaction after a hearty meal? Scientists believe that it is due to the release of a group of chemical substances in our body called endorphins (endogenous morphine) which give the pleasant feeling. Endorphins are a set of neurotransmitters – endogenous (produced within the body) opium-like peptides that function as neurotransmitters. They are produced by the pituitary gland and the hypothalamus in vertebrates during exercise, excitement, pain, consumption of spicy food, love and orgasm, and they resemble the opiates produced by plants in their abilities to produce analgesia and a feeling of well-being.

Endorphins naturally relieve pain. They resemble morphine in their chemical structure. In addition to their analgesic, or pain-relieving, effect endorphins are believed to be involved in controlling the body's response to stress, regulating contractions of the intestinal wall, and determining mood. They may also regulate the release of hormones from the pituitary gland, notably growth hormone and the sex hormones.

The term "endorphin rush" has been used in popular speech to refer to feelings of exhilaration brought on by pain, danger, or other forms of stress, supposedly due to the influence of endorphins. When a nerve impulse reaches the spinal cord, endorphins that prevent nerve cells from releasing more pain signals are released. Immediately after injury, endorphins allow animals to feel a sense of power and control over themselves that allows them to persist with activity for an extended time and keep fighting.

Regular exercise has been known to improve and maintain physical fitness, as well as help prevent diseases such as high blood pressure, heart disease, and diabetes. Now it is discovered that exercise is also great for our mood.

Exercise increases release of endorphins. Endorphins are the body's natural feel-good chemicals, and when they are released through exercise, they boost our mood naturally. Along with endorphins, exercise also releases adrenaline, serotonin, and dopamine. These chemicals work together to make you feel good.

The endorphins produced during exercise can be so powerful that they actually mask pain. Physically active people recover from mild depression more quickly and physical activity is strongly correlated with good mental health as people age.

Neurotransmitter deficiencies can occur due to various reasons. They include: depression, irritability, sleeplessness, anxiety/panic, stress, etc.

Factors responsible for neurotransmitter deficiency include:

- Genetic: A person's genetic makeup is responsible for low, high or balanced levels of neurotransmitters from birth.
- Stress: Stress depletes neurotransmitters. Lack of sleep, mental and emotional problems or poor health, deplete endorphins, resulting in a reduction of transmitters needed for sleep, as well as for pain blocking.
- Diet: The specific amino acids that our brains use to manufacture

neurotransmitters are frequently not supplied by our modern diet. As stress further depletes supplies it is difficult, if not impossible, for the brain to restore necessary amounts to proper levels.

How to restore proper levels of neurotransmitters?

Major neurotransmitters are manufactured inside neurons (brain cells) and then used as needed. Neurons specifically use two key amino acids – phenylalanine and glutamine – as precursors, or building blocks, to make neurotransmitters from. By supplying the brain with a ready daily supply of these two amino acids, neurotransmitter levels can be maintained.

Cheese, meat, grains, soya meals are rich in phenylalanine. Foods rich in glutamine include dairy, meat and eggs along with vegetables like cabbage, beets, celery, kale, Brussels sprouts, spinach, and carrots.

As we age, our bodies produce fewer hormones and hormones regulate neurotransmitter production. This throws off the delicate balance and exposes us to physical problems. Imbalances are also caused by day-to-day stress and by the choices we make regarding our diet. A correct lifestyle, suitable environment, proper medication, a good wholesome diet and adequate exercise will ensure the secretion of adequate quantities of neurotransmitters.

Ms R. Vatshala has been a teacher in a Chennai school for 17 years and is at present engaged in developing educational software for school children in a software firm.

Continued from page 40 (An interview with Prof. C.N.R. Rao)

whatever they like; they want to be a poet, an economist, a scientist or doctor, whatever they want, but they should not give up their passion. At least a few of them should have high level of passion; they are the ones who save India. We don't need a lot of them; 5-10 % of the population is enough. Unfortunately that is not happening, people are forced to go to engineering. Everybody in Bangalore goes to engineering; science colleges are being closed down. This is bad, very few goes to economics, etc., only the leftovers go for that. We should not be like that, all professions need very good people, As India needs to come up in all areas, young

people should not listen to bad advice of people like me and they should do what they think is best with full passion. Even I have done that way; my parents allowed me to go BHU very far from here to do M.Sc., they never told me do this or that. Wonderful parents I had. I owe a lot to them because this freedom of thinking and freedom of working is very important for young people. Second, I think three important qualities should be retained by youngsters inside – doggedness, perseverance and tenacity, a little intelligence is also useful, but that comes afterwards. You must not give up after all.

MW: It is very nice to talk to you Sir. Thanks a lot to you for such visionary words.

C.N.R. Rao: Same here; Best wishes to you too.

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Nature's engineering masterpieces - Living double-decker bridges



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Mother Nature is a great enchantress, applying her magical tricks to create even engineering wonders. Examples of Nature's extraordinary ingenuity are unique double-decker bridges built entirely of roots of an indigenous rubber tree. Such root-bridges can be found in the forests of North-east India, near 'Cherrapunji' in Meghalaya state, which is known to be wettest place on Earth. These bridges are not built by humans, but grow naturally by growth of secondary roots of the Indian rubber tree '*Ficus elastica*', which has an incredibly strong root system. These living root-bridges were first alluded to in the *Journal of the Asiatic Society of Bengal* by one Lieutenant H. Yule in 1844, but after that these creations were almost forgotten. The root-bridges were rediscovered by Denis P. Rayen, a local of Cherrapunji about nine years ago. There are many such bridges situated in the hills of Meghalaya, but the most famous is the double-decker root-bridge of Nongriat village in Cherrapunji, best known as "Umshiang double-decker root-bridge". Another single bridge is located at Riwai village, near Mawlynnong. These *Ficus elastica* root-bridges are incredible in many biological and technical aspects too. In Khasi language these are called "jingkieng deingiri" meaning 'bridge of the rubber tree'.

Indian Rubber Tree (*Ficus elastica*)

Ficus elastica, commonly known as rubber tree, rubber bush or Indian rubber bush is native of the Northeastern region of India and the southern part of Indonesia. It belongs to the banyan group of figs. The height of this plant may vary from 30 to 40 metres with a thick-bodied trunk of diameter of 2 metres. Aerial and buttress roots develop from the trunk which help anchor the plant in soil and provide support to its bulky branches. Leaves of *Ficus elastica* are broad, oval in shape and shiny.

Rubber plants do not necessarily produce conspicuous, colourful and scented flowers; these are the characters which are

eminently found in plants which require external pollinators for their pollination to be carried out. This genus of plant bears a unique mode of reproduction. Each and every species of *Ficus* possess a closely associated family of tiny wasps called agaonid wasps. Also known as fig wasps, they develop



*Double-decker root-bridge of Umshiang
formed by *Ficus elastica* roots*

and spend most of their lives inside figs and help the plant in pollination. The fruit of the plant is called fig or syconium. Their fruits are tiny, oval shaped, yellowish green in colour. The fruit is barely edible, but it contains viable seeds where the associated wasps resides and lay their eggs.



*Foot path embellishment on
the bridge by locals*

Milky white latex is secreted from the trunk of *Ficus elastica*, which is a complex emulsion of alkaloids, tannins, resins, gums, etc. This latex can be used to make rubber. This latex might be fatal if taken orally; it is also an irritant to the eyes and skin.

Bioengineering techniques of *Ficus elastica*

The Indian rubber tree with its strong root systems flourishes in the hills Meghalaya, which receive heavy rainfall. These plants produce secondary root series from the higher parts of its trunk and can luxuriously grow along the riverbanks and even across rivers. An indigenous tribe of Meghalaya known as "War-Khasis", long ago noticed these trees and found an opportunity to use its robust roots as bridges in crossing the rivers easily. Thus whenever and wherever their need arose they simply grew the tree and manipulated the growth of its long roots over the rivers. For growing the roots in right direction, they usually use betel nut trunks with their middle region sliced down and hollowed, for creating a guidance system for root growth. The betel nut trunks prevent the rubber tree root system from fanning out and make them grow straight.

After growing in this way, when the roots reach the other side of the river they easily get soil for extending their root systems. Enough time must be given for a sturdy living bridge to be produced. Some bridges formed like this extend over 30 metres and it may take ten to fifteen years to evolve into fully functional structure. These bridges are quite strong to support the weight of more than 50 people at a time. Because they are alive and in a state of continual growth, they gain more strength with time; and there are some of the ancient living bridges around Cherrapunji aged well over 500 years and are still being used daily by village people.

One big advantage of these root-bridges is that they can withstand high level of soil erosion during monsoon rains unlike artificial manmade structures. Besides, being living material, they are resistant to the attack of termites which often destroys wooden manmade bridges.

Arpita Das Choudhury is involved in Silico research in drug designing in collaboration with Bioinformatics centre, Assam University.

Iron Deficiency Anaemia— All You Want to Know About



Dr Yatish Agarwal
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Iron deficiency anaemia is the most common type of anaemia — a condition in which blood suffers from a deficiency of the oxygen-carrying pigment haemoglobin in red blood cells.

Iron is an essential component of haemoglobin in the production of blood. Without enough iron, your body can't produce enough haemoglobin. This defect affects the oxygen-carrying capacity of the blood negatively. As a result, sufficient oxygen is not transferred into the blood from the lungs and the body tissues receive insufficient oxygen iron, leaving you tired and short of breath.

You can usually correct this situation with iron supplementation. Sometimes, however, especially if you're bleeding internally, you may require specific treatment to weed out the basic cause.

Symptoms

Initially, iron deficiency anaemia can be so mild that it goes unnoticed. But as the body becomes more deficient in iron and anaemia worsens, the signs and symptoms intensify.

Iron deficiency anaemia symptoms may include:

- Extreme fatigue
- Pale skin
- Weakness
- Shortness of breath
- Headache
- Dizziness or light-headedness
- Cold hands and feet
- Irritability
- Inflammation or soreness of your tongue
- Brittle nails
- Fast heartbeat
- Unusual cravings for non-nutritive substances, such as ice, dirt or starch
- Poor appetite, especially in infants and children with iron deficiency anaemia
- An uncomfortable tingling or crawling feeling in your legs (restless legs syndrome)

Causes

Iron deficiency anaemia occurs when your body doesn't have enough iron to produce haemoglobin. Haemoglobin is the part of red blood cells that gives blood its red colour and enables the red blood cells to carry oxygenated blood throughout your body. If you aren't consuming enough iron, or if you're losing too much iron, your body cannot produce enough haemoglobin, and iron deficiency anaemia will eventually develop.

Causes of iron deficiency anaemia include:

Blood loss

Blood contains iron within red blood cells. So if you lose blood, you lose some iron. Women with heavy periods are at risk of iron deficiency anaemia because they lose blood during menstruation.

Slow, chronic blood loss within the body — such as from a peptic ulcer, a hiatal hernia, a colon polyp, or colorectal cancer — can cause iron deficiency anaemia. Gastrointestinal bleeding can result from regular use of some over-the-counter pain relievers, especially aspirin. Hookworm infestation in the bowel is another major cause, especially in such areas where public hygiene is poor.

A lack of iron in your diet

Your body regularly gets iron from the foods you eat. If you consume too little iron, over time your body can become iron deficient. Examples of iron-rich foods include meat, eggs, leafy green vegetables and iron-fortified foods. For proper growth and development, infants and children need iron from their diet, too.

An inability to absorb iron

Iron from food is absorbed into your bloodstream in your small intestine. An intestinal disorder, such as celiac disease, which affects your intestine's ability to absorb nutrients from digested food, can lead to iron deficiency anaemia. If part of your small intestine has been bypassed or removed surgically, that may affect your ability to absorb iron and other nutrients.

Pregnancy

Without iron supplementation, iron deficiency anaemia occurs in many pregnant women because their iron stores need to serve their own increased blood volume as well as be a source of haemoglobin for the growing foetus.

Risk factors

The following groups of people tend to be at an increased risk of acquiring iron deficiency anaemia:

Women

Since women lose blood during menstruation, women are at a greater risk of developing iron deficiency anaemia. This is particularly liable to happen if a woman has shortened menstrual cycle or suffers from excessive bleeding during menstruation.

Infants and children

Infants, especially those who were low-birth-weight or born prematurely, who don't get enough iron from breast milk may be at risk of iron deficiency.

Children also need extra iron during growth spurts. If your child isn't eating a healthy, varied diet, he or she may be at risk of anaemia.

Vegetarians

People who don't eat meat may have a greater risk of iron deficiency anaemia if they don't eat other iron-rich foods.

Complications

Mild iron deficiency anaemia usually doesn't cause complications. However, left untreated, iron deficiency anaemia can become severe and lead to health problems, including the following:

Heart problems

Iron deficiency anaemia may lead to a rapid or irregular heartbeat. Your heart must pump more blood to compensate for the lack of oxygen carried in your blood when you're anaemic. This can lead to an enlarged heart or heart failure.

Problems during pregnancy

In pregnant women, severe iron deficiency anaemia has been linked to premature births and low-birth-weight babies. But the condition is easily preventable in pregnant women who receive iron supplements as part of their prenatal care.

Growth problems

In infants and children, severe iron deficiency can lead to anaemia as well as delayed growth and development. Additionally, iron deficiency anaemia is associated with an increased susceptibility to infections.

When to see a doctor

If you or your child develops signs and symptoms that suggest iron deficiency anaemia, see your doctor. Iron deficiency anaemia isn't something to self-diagnose or treat. So see your doctor for a diagnosis, rather than taking iron supplements on your own. Overloading the body with iron can be dangerous because excess iron accumulation can damage your liver and cause other complications.

Tests and diagnosis

Your doctor may run a number of tests to diagnose iron deficiency anaemia and look for its cause:

Red blood cell size and colour

With iron deficiency anaemia, red blood cells are smaller and paler in colour than normal.

Haematocrit

This is the percentage of your blood volume made up by red blood cells. Normal levels are generally between 34.9 and 44.5 percent for adult women and 38.8 to 50 percent for adult men. These values may change depending on your age.

Haemoglobin

Lower than normal haemoglobin levels indicate anaemia. The normal haemoglobin range is generally defined as 13.0 to 17.5 grams (g) of haemoglobin per decilitre (dL) of blood for men and 12.0 to 15.0 g/dL for women. During pregnancy, a value of 11.0 g/dL is also acceptable. In children, the normal ranges vary depending on the child's age and sex.

Ferritin

This protein helps store iron in your body, and a low level of ferritin usually indicates a low level of stored iron.

Supplementary tests

If your blood test indicates iron deficiency anaemia, your doctor may order additional tests to identify an underlying cause, such as:

Endoscopy

Doctors often check for bleeding from a hiatal hernia, an ulcer or the stomach with the aid of endoscopy. In this procedure, a thin, lighted tube equipped with a video camera is passed down your throat to your stomach. This allows your doctor to view your oesophagus — the tube that runs from your mouth to your stomach — and your stomach to look for sources of bleeding.

Colonoscopy

To rule out lower intestinal sources of bleeding, your doctor may recommend a procedure called colonoscopy. A thin, flexible tube equipped with a video camera is inserted into the rectum and guided to your colon. You're usually sedated during this test. A colonoscopy allows your doctor to view inside some or all of your colon and rectum to look for internal bleeding.

Ultrasound

Women may also require a pelvic ultrasound to look for the cause of excess menstrual bleeding, such as uterine fibroids. Your doctor may order these or other tests after a trial period of treatment with iron supplementation.

Treatments and drugs

To treat iron deficiency anaemia, your doctor may recommend you take iron supplements. Your doctor will also treat the underlying cause of your iron deficiency, if necessary.

Iron supplements

Your doctor may recommend iron tablets to replenish the iron stores in your body. To improve the chances that your body will absorb the iron in the tablets, you may be instructed to:

- Take iron tablets on an empty stomach. If possible, take your iron tablets when your stomach is empty. However, because iron tablets can upset your stomach, you may need to take your iron tablets with meals.

- Take iron tablets with vitamin C. Vitamin C improves the absorption of iron. Your doctor might recommend taking your iron tablets with a glass of orange juice or with a vitamin C supplement.

- Iron supplements can cause constipation, so your doctor may also recommend a stool softener. Iron may turn your stools black, which is a harmless side effect.

Iron deficiency cannot be corrected overnight. You may need to take iron supplements for several months or longer to replenish your iron reserves. Generally, you'll start to feel better after a week or so of treatment. Ask your doctor when you need to return to have your blood rechecked to measure your iron levels.

Treating underlying causes of iron deficiency

If iron supplements don't increase your blood-iron levels, it's likely the anaemia is due to a source of bleeding or an iron-absorption problem that your doctor will need to investigate and treat. Depending on the cause, iron deficiency anaemia treatment may involve:

- Medications, such as oral contraceptives to lighten heavy menstrual flow
 - Antibiotics and other medications to treat peptic ulcers
 - Surgery to remove a bleeding polyp, a tumour or a fibroid
- If iron deficiency anaemia is severe, blood transfusions can help replace iron and haemoglobin quickly.

Prevention

Choose iron-rich foods

You can reduce your risk of iron deficiency anaemia by choosing iron-rich foods. Foods rich in iron include:

- Beans
- Dark green leafy vegetables, such as spinach
- Dried fruit, such as raisins and apricots
- Eggs
- Iron-fortified cereals, breads and pastas
- Peas
- Poultry
- Red meat
- Seafood

The human body absorbs more iron from meat than it does from other sources. If you are a vegetarian, you may need to increase your intake of iron-rich, plant-based foods to absorb the same amount of iron as someone who eats meat.

Choose foods containing vitamin C to enhance iron absorption

You can enhance your body's absorption of iron by drinking citrus juice or eating other foods rich in vitamin C at the same time that you eat high-iron foods. Vitamin C in citrus juices, like orange juice, helps your body to better absorb dietary iron.

Vitamin C is also found in:

- Broccoli
- Grapefruit
- Kiwi
- Leafy greens
- Mangoes
- Melons
- Oranges
- Peppers
- Strawberries
- Tomatoes

Preventing iron deficiency anaemia in babies

To prevent iron deficiency anaemia in infants, feed your baby breast milk or iron-fortified formula for the first year. Cow's milk isn't a good source of iron for babies and isn't recommended for infants under one year. Iron from breast milk is more easily absorbed than the iron found in formula.

Continued from page 35 (A Look at the Cloud Computing)

Research on cloud computing

One of the frontier research areas in computer science and engineering is cloud computing. Besides initiatives by enterprises, academic researchers across the globe are addressing wide ranging challenges on cloud computing such as standardisation, security and more open source solutions in cloud platform.

The volume of data in cloud storage is enormous and is growing exponentially. These enormous data is called 'BigData'. Some of these data are structured while remaining are unstructured. Analysing the whole data is a major challenge. Traditional data processing techniques are ineffective as processing time will be large. Massively parallel software running on tens, hundreds, or even thousands of servers are required to analyse BigData. Cloud computation is perhaps the only solution to handle such massive scale operation.

One of the frontier research areas in computer science and engineering is cloud computing.

Cloud computing is going to have a huge impact on all sectors.

Data handling in a cloud platform is one of the current research topics.

Conclusion

Cloud computing is an evolving service provision model, where software, platform, infrastructure, data and hardware can be directly delivered as a service to the end customers. This ensures better utilisation of resources, increased efficiency and reduced operational cost. Cloud computing has become a new trend in the information and communication technology domain and has gained significant commercial success over past years. As smart mobile phone users are increasing rapidly, mobile cloud computing has also become a potent trend. Challenges like data security and standardisations are foundation for future research and development. As of now, it can be said that cloud computing is going to have a huge impact on all sectors. No

one can deny that cloud computing will play a pivotal role in the next decade.

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Recent developments in science and technology



Biman Basu

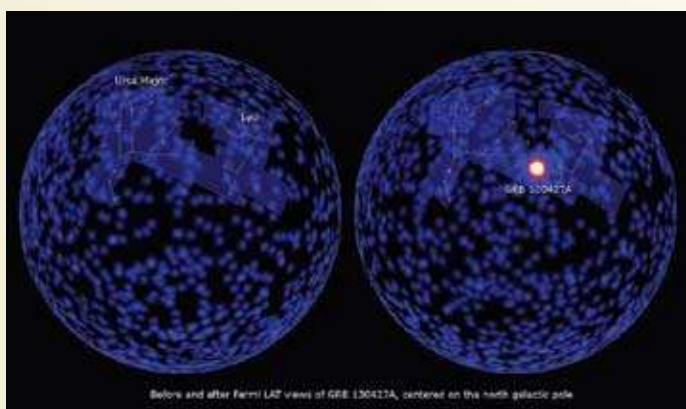
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Brightest ever gamma-ray burst observed

The universe is home to numerous exotic and beautiful phenomena, some of which can generate almost inconceivable amounts of energy. Gamma-ray bursts (GRBs) are such energetic cosmic events that produce flashes of gamma rays by extremely energetic explosion of massive stars. They are the brightest electromagnetic events known to

extremely bright supernova.

The blast, named GRB 130427A, was observed by several space- and ground-based telescopes, and the data was analysed by dozens of astronomers around the world. The *Fermi Gamma-ray Space Telescope* was the first to detect the event, and it quickly began monitoring the flood of radiation using its Large Area Telescope (LAT), the principal scientific instrument on the *Fermi*



GRB 130427A, before (left) and after (right) the gamma-ray burst, as recorded by the LAT of Fermi Gamma-ray Space Telescope. (Credit: NASA/DOE/Fermi LAT Collaboration)

occur in the universe. Bursts can last from a few milliseconds to several minutes. Recently, for the first time ever, an international team of researchers have observed an unusually powerful gamma-ray burst in the relatively nearby universe – a monster gamma-ray burst from near the constellation Leo. It has now been confirmed as the brightest gamma ray burst ever observed. Information about the gamma-ray burst has been published in five papers (*Science*, 3 January 2014 | DOI: 10.1126/science.1242279, 1242302, 1242316, 1242353, and 1248522).

The unusually bright GRB was observed on 27 April 2013 by NASA's *Swift* satellite and new research has found this to be a result of an extremely powerful stellar explosion. This explosion produced a jet of matter moving close to the speed of light, which was formed when a massive star collapsed to make a black hole at its centre. As a result, a blast wave caused the rest of the star to expand outwards, producing a glowing shell of debris observed as an

extremely bright supernova. The blast, named GRB 130427A, was observed by several space- and ground-based telescopes, and the data was analysed by dozens of astronomers around the world. First, its light travelled 3.6 billion years before arriving at Earth – less than half the distance at which gamma-ray bursts have previously been seen. This closer

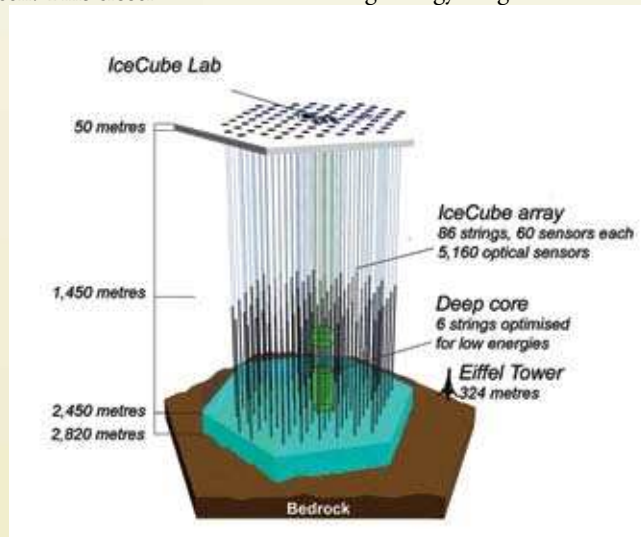
proximity to Earth allowed astronomers to confirm for the first time that one object can simultaneously create a powerful GRB and a supernova explosion. The record-setting 20 hours that the LAT observed gamma rays was longer than any other observed GRB. And, in addition to being the brightest GRB ever witnessed, it was also one of the most energetic. The LAT recorded one gamma ray with an energy of at least 94 billion electron volts (GeV), or some 35 billion

times the energy of visible light, and about three times greater than the LAT's previous record. Scientists believe that there may be a common driving force between GRBs detected now and those that happened early in the universe following the Big Bang.

First solid evidence for cosmic neutrinos found

Scientists have found the first solid evidence for cosmic neutrinos, ghostly particles created in violent events in the far reaches of the universe. Neutrinos are one of the fundamental particles which make up the universe. They are also one of the least understood. In the past five-and-half decades since the neutrino was first discovered, scientists have been searching for these ghostly particles from outer space, and now they have finally found them. In the latest study, researchers detected 28 neutrinos at the IceCube detector, built under the thick ice of the South Pole (*Science*, 22 November 2013 | 10.1126/science.1242856).

The existence of neutrino was first postulated by the German physicist Wolfgang Pauli, who in 1930 predicted a hypothetical particle to explain the fact that energy and momentum did not appear to be conserved in certain radioactive decays. Pauli suggested that this missing energy might be carried



The IceCube Neutrino Observatory (Diagrammatic)

off, unseen, by a neutral particle which was escaping detection. The discovery of a particle fitting the expected characteristics of the neutrino was announced by American physicists Clyde Cowan and Fred Reines in 1956. (Reines was jointly awarded the 1995 Nobel Prize in Physics for discovering neutron.)

Particle physicists originally believed that neutrinos were massless. But in the 1990s, a team of Japanese scientists discovered that they actually have a tiny mass – about 10,000 times less than that of electron. This tiny bit of mass may explain why the universe is made up of matter, not antimatter. If neutrinos have mass, they also interact gravitationally with other massive particles, but gravity is by far the weakest of the four known forces. That's why they almost do not interact with matter.

From what we know today, a majority of the neutrinos floating around were born around 15 billion years ago, soon after the birth of the universe. Since this time, the universe has continuously expanded and cooled, and neutrinos have just kept on going. Theoretically, there are now so many neutrinos that they constitute a cosmic background radiation whose temperature is 1.9 Kelvin (-271.2°C). Other neutrinos are constantly being produced from nuclear power stations, particle accelerators, nuclear bombs, general atmospheric phenomena, and during the births, collisions, and deaths of stars, particularly the explosions of supernovae.

The IceCube Neutrino Observatory, an international project set up some two kilometres underground in Antarctica at the South Pole, is the world's largest neutrino detector, encompassing a cubic kilometre of ice. It is a powerful tool to search for neutrinos, and could reveal the new physical processes associated with the enigmatic origin of the highest energy particles in nature. IceCube is focussed on seeing high-energy neutrinos, which can help us understand where cosmic rays come from and learn more about gamma ray bursts and supernovae, the identity of

dark matter, and the ability of neutrinos to oscillate, or change type.

Since they do not interact with anything, the cosmic neutrinos found at IceCube are useful to scientists because they point in straight lines to where they came from, although the few they detected are not enough to pinpoint any location in particular. But, according to the researchers, the IceCube team will look for further detections in coming years, "like waiting for a long exposure photograph", to fill in their emerging picture of the faraway cosmos.

Hyper-velocity stars observed escaping our Galaxy

In astronomy, it is widely accepted that most stars are born within molecular clouds known as stellar nurseries. The stars formed within such a cloud compose open clusters containing dozens to thousands of members.



Side view of the Milky Way galaxy shows the location of four of the new class of hyper-velocity stars. These are Sun-like stars that are moving at speeds of more than 1.6 million kilometres per hour relative to the galaxy – fast enough to escape its gravitational grasp. (Credit: European Southern Observatory)

Over the course of centuries, stars in the sky appear to maintain nearly fixed positions with respect to each other, so that they form the same constellations over historical time. However, precise long-term observations show that the constellations change shape, albeit very slowly, and that each star has an independent motion called proper motion. This motion is caused by the true movement of the stars relative to the Sun and solar system through space.

Recently, an international team of astronomers led by Vanderbilt University (Tennessee, USA) graduate student Lauren Palladino has discovered a surprising new class of "hyper-velocity stars" – solitary stars

moving fast enough to escape the gravitational grasp of the Milky Way galaxy. Palladino and her team were working on a project called Sloan Digital Sky Survey, when they chanced upon the new class of stars. The survey aims at studying stars and galaxies covering a quarter of the sky. According to astronomers, the new stars are relatively small – about the size of the Sun – and the surprising part is that none of them appear to come from the galactic core (*Astrophysical Journal*, 1 January 2014 | doi:10.1088/0004-637X/780/1/7). Astronomers have discovered more than a dozen such stars that move fast enough to escape the gravitational grasp of the Milky Way galaxy.

Astronomers of the Smithsonian Astrophysical Observatory had found the first hypervelocity star in 2005. Two more castaway stars were discovered in 2006. In 2010, astronomers using NASA's *Hubble Space Telescope* reported detecting HE 0437-5439 – a hyper-velocity star that had sped away from the galaxy at a speed of 2.5 million kilometres an hour. Now, the Vanderbilt University team has found 20 new hyper-velocity stars while scanning the sky. The newly discovered stars travel at over 1.6 million kilometres per hour.

But how can a star escape the gravitational pull of the Milky Way galaxy? According to the astronomers, the most commonly accepted mechanism for doing so involves interaction with the supermassive black hole at the core of the galaxy. It is known that the Milky Way's central black hole has a mass equivalent to four million Suns, which produce a gravitational force strong enough to accelerate stars to hyper velocities. Primarily, it would involve binary pairs of stars that get caught in the black hole's gravitational grip. As the pair is sucked in by the hole, while one of the stars spirals towards the core, the other one receives a huge kick and is thrown out of the galaxy. However, in that case the hyper-velocity stars should emerge from the centre of our galaxy. But none of these hyper-velocity stars come from the centre, which

implies that there is an unexpected new class of hyper-velocity star, one with a different ejection mechanism. The scientists say they are working to solve the conundrum.

Artificial bone marrow for treatment of leukaemia

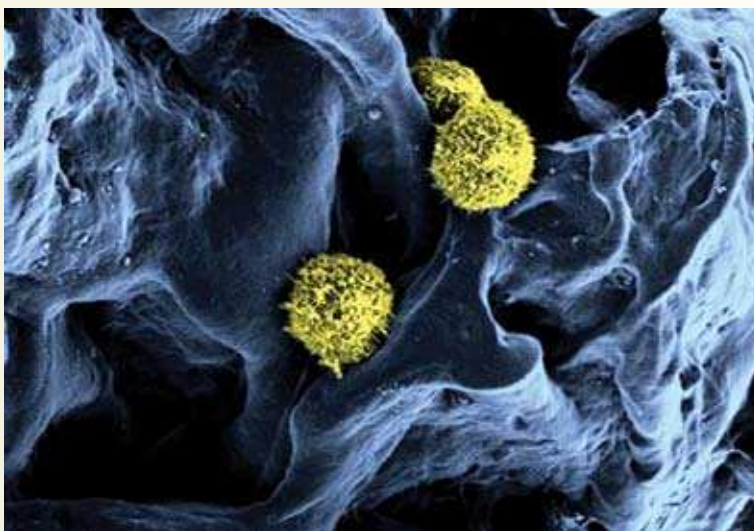
Leukaemia is cancer of blood-forming cells. Leukaemia usually causes large numbers of white blood cells to be made. These abnormal cells usually cannot carry out the normal functions of white blood cells. They crowd the bone marrow and spill into the blood and may then spread into organs such as the liver, spleen, lungs and kidneys. Sometimes, they may also spread into the fluid around the brain and spinal cord. Because there are so many abnormal white cells crowded into the bone marrow, the marrow sometimes cannot make enough normal red blood cells, white blood cells, and platelets.

In the body, blood cells are continuously replaced by new ones supplied by blood-forming stem cells located in specialised areas of the bone marrow. Blood-forming stem cells can be used for the treatment of blood diseases, such as leukaemia. For treatment, the affected cells of the patient are replaced by transplanting healthy blood-forming stem cells of an eligible donor. The donor cells can be taken from another person's bone marrow or bloodstream, or from preserved umbilical cords and placentas. But finding a matching donor can be difficult, and the amount of stem cells harvested from the donor may not always be enough to meet the needs of the patient.

Moreover, not every leukaemia patient can be treated in this way, as the number of appropriate transplants is not sufficient. Recently, researchers of the Karlsruhe Institute of Technology, the Max Planck Institute for Intelligent Systems, Stuttgart, and Tübingen University in Germany have created a prototype for an artificial kind of bone marrow that can function as a stem-cell nursery and could eventually make it easier to treat leukaemia (*Biomaterials*, January 2014 | doi: 10.1016/j.biomaterials.2013.10

.038).

The areas in the bone where blood-forming stem cells are formed are highly porous and similar to a sponge. This three-dimensional environment does not only accommodate bone cells and blood-forming stem cells but also various other cell types. Moreover, the space among the cells has a matrix that ensures certain stability and provides the cells with points to anchor.



Scanning electron microscope photo of stem cells (yellow) in a scaffold structure (blue) serving as a basis for the artificial bone marrow. (Credit: C. Lee-Thedieck/KIT)

The cells are also supplied with nutrients and oxygen. Bone marrow nurtures both red blood cells and white blood cells, with healthy people producing more than 500 billion red and white blood cells every day. But when bone marrow is damaged by a disease like leukaemia, or by radiation or chemotherapy drugs, the supply of blood

cells drops, leaving a person at risk for fatal infections.

The researchers used a simple, porous polymer to mimic a sponge-like structure for the base of their artificial bone marrow. They added proteins similar to ones found in bone marrow to act as docking points for the blood stem cells, and added other cells to help ferry necessary molecular messages and materials back and forth. When blood-forming stem cells from cord blood were introduced to the artificial environment, they thrived much better than in standard cell-culture systems. Subsequent breeding of the cells took several days. Analyses with various methods revealed that the cells really reproduce in the newly developed artificial bone marrow. Compared to standard cell cultivation methods, more stem cells retain their specific properties in the artificial bone marrow.

According to the researchers, the newly developed artificial bone marrow that possesses major properties of natural bone marrow can now be used by scientists to study the interactions between materials and stem cells in detail at the laboratory. This will help to find out how the behaviour of stem cells can be influenced and controlled by synthetic materials. This knowledge might contribute to producing an artificial stem cell niche for the specific reproduction of stem cells and the treatment of leukaemia in ten to fifteen years from now.

Articles
invited

Dream 2047

Vigyan Prasar invites original popular science articles for publication in its monthly science magazine *Dream 2047*. At present the magazine has 50,000 subscribers. The article may be limited to 3,000 words and can be written in English or Hindi. Regular columns on i) Health ii) Recent developments in science and technology are also welcome. Honorarium, as per Vigyan Prasar norm, is paid to the author(s) if the article is accepted for publication. For details please log-on to www.vigyanprasar.gov.in or e-mail to dream@vigyanprasar.gov.in

