

Science

TURK TALK

An interplanetary scientist shares his experience of participating in the Mars One programme

EXPERT EYE

Risk and food management are crucial for improving the country's food security

IN SIGHT

India and UK team carry out joint research for better monsoon predictions in South Asia



{ By Invitation }



G P S Raghava

Head, Bioinformatics Centre,
Institute of Microbial Technology,
Chandigarh

FOURTH PARADIGM

One of the major reasons behind India's tremendous economic growth is the boom in information technology (IT). In the past few decades, IT-based companies and jobs have flourished at an exponential rate. Due to technical advances in every field of science, there has been unprecedented growth of data over the past few years. Thus, managing and mining this big data is one of the major challenges in this era. Big data mining will provide a golden opportunity for Indian youths in the coming years. To take full advantage of this new challenge, we need to understand issues pertaining to big data mining.

There has been a continuous paradigm shift in science over the years. Earlier, science was mainly based on observations or small experiments. This era of science was called the first paradigm. The past few centuries witnessed the second paradigm in science where major emphasis was on the development of generalised principles and formulation of models. In the past few decades, however, major importance was given to computer simulations where modelling/simulation of complex processes was performed using computers. The past few years have seen exponential growth in the size of data which has led to "data intensive scientific discoveries" or the fourth paradigm in science. In summary, the four paradigms in science are based on (i) observation, (ii) the theo-

retical approach, (iii) computer simulation and (iv) data mining. This article focuses on issues related to the fourth paradigm, particularly applications in biological sciences.

► MANAGE BIG DATA

Traditionally, data is collected and compiled from various sources and maintained in the form of a database. These traditional databases allow users to retrieve, modify and delete data using database management systems (DBMSs). In the past, DBMSs such as MySQL, PostgreSQL and Microsoft SQL Server were developed. However, these traditional DBMSs are not suitable for handling big data produced by various sources. For example, Facebook generates massive content every day, Google has data in petabytes, and Twitter generates data in tetrabytes every day. Developers are now working on alternative data management software/ techniques (eg MangoDB, CouchDB and Hadoop) to manage big data. This field is underdeveloped for users and, thus, it is important to update the knowledge and develop smart software so that users may manage their data effectively.

Though various sources are generating billions of documents daily, more than 80% data is unstructured. To extract meaningful inferences from this raw data, there is a need to convert this unstructured

data into structured data. In biological sciences, there are a number of dedicated scientific journals, like *Databases*, that publish papers on biological databases. In India, we have trained manpower in the field of IT that can be used to convert this raw data into finished products using manual and automatic (software-assisted) curation. This field may provide a golden opportunity for Indian researchers to use their talent. Our group has developed a large number of biological databases which are heavily used by communities worldwide.

In the past, various standalone and web-based software have been developed to cluster, analyse and classify data. Traditional data mining tools are suitable for mining data of reasonable size but not for huge data. In a bid to manage big data, new modules have been developed under existing systems. However, there is a need to develop new systems. The commonly used packages for mining big data are Mahout, R modules (RprotoBuf, RHadoop), MOA (Massive Online Analysis), H2O, Orange, RapidMiner and Knime. This is an open field for IT professionals to develop efficient and effective software.

► PERSONALISED MEDICINE

The first human genome was sequenced in 2003. It took nearly 13 years, and many countries were involved in this project worth billions of dollars. Today, thousands of human genomes have been sequenced and sequencing of the whole genome is possible in a few hours at a reasonable cost (less than Rs 1 lakh). There will be a time when sequencing of the whole genome will become a routine medical test, like a blood test. Sequencing of the human genome is important to understand the genetic make-up of an individual because every individual is different and the genome mutates with age. So, there is a need to introduce personalised medicines. At present, we treat all patients with the same drug for a particular disease. However, this often leads to drugs becoming toxic for a few individuals. Like humans, all strains of pathogens responsible for infection have variations in their genomes. Due to these variations, drug-resistant bacteria and viruses have emerged. These cannot be eliminated with existing drugs. Due to advancement in next-generation sequencing (NGS) techniques, sequencing of a bacterial genome is now possible in a few thousand rupees. In the present era, sequencing of the human genome is not a problem but the major challenge is how to manage and mine genomic data.

► DRUGS FOR CANCER

Cancer is a global health issue and a leading cause of mortality worldwide. Both developed and developing

countries are in the grip of this deadly disease. For cancer patients, chemotherapy remains the principal mode of treatment, which mainly includes cytotoxic drugs, and kills fast proliferating cells, a common feature of all cancer types. There are numerous reasons “why we do not have effective drug against cancer”. Among these reasons is the fast mutation in genes. For faster drug discovery to combat diseases like cancer, attempts have been made to develop QSAR (quantitative structure activity relationship) models for designing drugs.

Due to advances in sequencing technologies and high-throughput screening, a large number of cancer cell lines (different types of cancer) have been sequenced and various drugs have been tested against these cell lines. There is a need to develop independent models for each cell lines for predicting drugs, which can fight different types of cancer. Recently, we developed a web server which allows users to design/ discover drug molecules effective against different pancreatic cancer cell lines. This field is wide open, and requires more and more software packages that may provide assistance in discovering new drug molecules against various types of cancer. The informatics community can play a vital role in the development of chemo-informatics tools for combating diseases like cancer.

► COLLABORATIONS

Due to the growth of information in different fields (like medicine, biology, and chemistry), a number of interdisciplinary fields have emerged in the past few decades like bioinformatics, cheminformatics and pharmainformatics. To address the important challenges such as drug discovery, one requires knowledge of various related subjects. It is difficult for a researcher to gain expertise in more than one discipline. Thus, collaboration is required to address the issues important to the community — particularly between IT and subject experts.

► OPEN SOURCE RESOURCES

Open-source-based resources are important for the growth of a community, particularly for Indian users, as it is difficult for them to afford commercial software. In addition, open source or free software allows users to use these to build their software packages. Recently, opensource-based projects have gained popularity. For example, an open source drug discovery project has been initiated by CSIR (www.osdd.net).

(Raghava is on Thomson Reuters' 'The Worlds' Most Influential Scientific Minds 2014' list)

BANSAL CLASSES PVT. LTD.

The Legend in IIT JEE Coaching



9325

Total selections in
JEE MAIN (AIEEE)
Since 2012

18528

Total selections in
JEE ADVANCED (IITJEE)
Since 1984

289

Total selections in
MEDICAL (AIPMT/AIIMS)
Since 2013

Only institute to produce AIR-1 four time from regular classroom program in IITJEE



Nitin Gupta
AIR-1 (Yr. 2000)



Dugararam Choudhary
AIR-1 (Yr. 2002)



Achin Bansal
AIR-1 (Yr. 2007)



Shitikanth
AIR-1 (Yr. 2008)

Admission open for IITJEE (Main & Advanced) & Pre-Foundation 2014-15

For Students Appearing class VII to IX	For Students Appearing class X	For Students Appearing class XI	For Students Appearing class XII
Octagon Course (Class 8th) Pearl Course (Class 9th) Zenith Course (Class 10th)	Apex Course and Bull's Eye Course	Nucleus Course	Sterling Course
Direct Admission Course Commencement Date 6th April, 2015	Entrance Test Date & Time 18th January, 2015 Timing : 03:00 PM to 06:00 PM	Entrance Test Date & Time 27th March, 2015 Timing : 03:00 PM to 06:00 PM	Direct Admission Course Commencement Date 27th April, 2015

The above schedule is for Kota center only. | For details regarding Course / Date contact respective center. | For any further details visit our website www.bansal.ac.in

How to get Application form

◆ **Apply online:** You can visit www.bansal.ac.in to apply online for the courses offered. ◆ **By Visiting Our Office:** You can visit our Kota office or other centers and obtain the application form by paying Rs. 1000 (for Engineering or Medical) & Rs. 500 (for Foundation). ◆ **By Post:** Send demand draft of any nationalized bank for Rs. 1000 (for Engineering) & Rs. 500 (for Foundation) in favour of "BANSAL CLASSES PVT. LTD.", payable at "KOTA (RAJ.)". Write your name, father's name, address, contact number, course applied for and class in which studying (as on date) at the back side of Demand Draft.



Ideal for Scholars

CORPORATE OFFICE: A-10, "Gaurav Tower", Road No.1, IPIA, Kota-324005 (Raj.)

Tel: 0744-2423738/39, 2421097, 2424097 ◆ Fax: 0744-2436779

SMS: BCPL <SPACE> ENQ to 56161 ◆ E-mail: admin@bansal.ac.in

Website.: www.bansal.ac.in ◆ www.bansaltestprep.com

Helpline No.: Engineering : 80030-45222, 80030-46222, 80030-32222 ◆ Medical: 80030-12222 ◆ Pre-Foundation: 80030-38222

{ **TURK TALK** }

THE UNIVERSE

LIFE ON MARS

Joseph Roche

Assistant Professor of STEM Education,
School of Education,
Trinity College Dublin (TCD), Ireland

I have never dreamed of being an astronaut. When I was a child there was no job that I could imagine an older, future version of myself doing for the rest of my life. There were times when I wanted to be an artist or a palaeontologist or a farmer. My eternally patient parents advised me to pursue my interests rather than trying to follow a specific career path. I grew up to be indebted to this advice because the top careers in the world right now (most of them in STEM areas — science, technology, engineering and maths) did not even exist when I was a child. I could never have planned for them. I give the same advice to anyone in school thinking about a career in STEM. By focussing on the subjects that they are passionate about, without worrying about jobs, young people can explore all opportunities open to them and trust that this path will lead them to a career that they will enjoy.

My love of science took me to Trinity College Dublin where I studied physics and astrophysics. Astrophysics is the study of the processes that govern our universe. At a basic level, like any branch of science, it involves

observing the world around us and trying to make sense of it. That remains the lure of science for me — the relentless quest to try and understand more about who we are and why we are here, how we came to be and what will become of us. Although astrophysics does not have all the solutions, the pursuit of the answers to those questions is equally challenging and satisfying. After my degree, I embarked on a PhD in astrophysics which led me to use the Hubble Space Telescope to observe dying stars and to work with world-renowned solar physicist, professor Peter Gallagher. Professor Gallagher also arranged for me to go to NASA to gain some practical experience.

▶ **THE JOURNEY**

Working at NASA was an eye-opener for me. It gave me a chance to see what it might be like to be completely immersed in a research career. Like any job, it comes with advantages and disadvantages. However, the joy of being able to concentrate solely on one area of research is tempered by the lack of job security. A full-time astrophysics researcher depends on winning competitive short-term research grants. I realised that one of the most important skills an astrophysicist (or any scientist) needs is the ability to clearly communicate their science and inspire the public with their ideas. Only then are scientists likely to be funded regularly. The ability to communicate was my biggest weakness. Hence, I started working part-time in public engagement at the Science

SCIENCE



THE RELENTLESS QUEST TO TRY AND UNDERSTAND MORE ABOUT WHO WE ARE AND WHY WE ARE HERE, HOW WE CAME TO BE AND WHAT WILL BECOME OF US REMAINS THE LURE OF SCIENCE FOR ME

ADMISSIONS
2015-16



Knowledge Without Borders

Envisioned as a centre of excellence, the South Asian University was established and is funded by the governments of the eight SAARC nations. It was modelled as a research and post graduate focussed university with an aim to build a culture of understanding and regional consciousness. Pursue a degree in this international university that is recognised in all the member nations of SAARC and experience a new dimension in learning.

Applications are invited for admissions in **Masters** and **M.Phil./Ph.D.** Programmes in the following areas:

Applied Mathematics | Biotechnology | Computer Science | Development Economics | International Relations | Legal Studies | Sociology

Apply by: **9 March, 2015**
Entrance Test on: **5 April, 2015**
Session starts: **26 July, 2015**

For details on online / offline application procedure, test centres and other information, log on to www.sau.ac.in

Campus: Akbar Bhawan, Chanakyapuri, New Delhi - 110021, India.
For further information, write to admissions@sau.ac.in

Highlights:

- **Globally-recruited faculty**
- **Well-equipped laboratories**
- **Excellent library**
- **Scholarship and financial aid schemes**
- **Wi-Fi enabled campus**
- **Hostels**
- **Medical facilities**
- **Multiple entry SAU Visas**
- **Reserved seats for students from each SAARC country**
- **Highly subsidized tuition fee**



SOUTH ASIAN UNIVERSITY

(Jointly established by SAARC Nations)





POINT TO NOTE

WAY OF THINKING is the most important skill that a scientist can possess. It is the ability to observe and research the world around us — to propose experiments to test and model nature. However, to be a successful scientist in today's world, more skills are required. These include the ability to work as part of a team, to collaborate, to research, to be creative and to be able to communicate ideas clearly

Gallery at TCD in an attempt to improve my communication skills.

The Science Gallery is a public space that tries to engage visitors in conversations about art and science. It has become one of the top tourist attractions in Ireland and, thanks to some seed funding from Google, is in the process of becoming a global network with Science Galleries due to open in London, New York, Bangalore and Melbourne by 2020.

When I heard about Mars One, I was working as the education and learning manager for Science Gallery (another job that I could not have planned for as a child — the gallery is only six years old).

The Mars One Foundation, a not-for-profit Space Exploration Organisation, declared that if the challenges associated with the return leg of a potential manned-mission to Mars were removed, then they could send people to Mars much sooner than anyone expected. This was the first time the world had heard of a one-way mission to Mars. Mars One also announced that they needed volunteers for the mission and I knew immediately that I was going to be one of them.

After spending more than a decade trying to understand our place in the universe, I could never turn down the opportunity to be one of the first interplanetary scientists. My family and friends were not surprised when I volunteered. The likelihood of my selection is quite small and the mission itself faces a number of obstacles that we hope can be overcome but could scupper my chances at any stage. My family members are rational and would never worry about such a drastic scenario as my leaving the planet unless it began to look likely.

▶ THE APPLICATION

The application process itself was straight-forward and consisted of a form and a short video. More than 200,000 people volunteered. Mars One chose just over 1,000 candidates to progress to the second round of the selection process where it invited

us to undertake some basic medical examinations to ensure we are physically capable of the trip at present, even though the mission itself would not launch for at least 10 years. Of those that passed the medical tests, there are currently 663 of us waiting to be interviewed.

The interviews will take place over the months ahead and a small group of candidates will then be picked to start eight years of astronaut training. Mars One has designed the mission using the existing technology that already works on earth. Robotic rovers would build an outpost in the years preceding the manned-mission. Essential support modules have been designed to reclaim water from the soil and create a breathable atmosphere inside an inflatable living component covered with several metres of Martian soil to protect the inhabitants from radiation. Mars is a cold, inhospitable planet, but humankind has already demonstrated its ability to survive in some of the most remote regions on earth.

This is why some of the Mars One mission training would take place in Antarctica — to simulate the isolation the astronauts would have to endure on Mars. Food would consist of plants, algae and mushrooms all of which can be produced with little maintenance. Communication with earth would be possible through a satellite in Martian orbit. A three-and-a-half minute delay in communications would rule out any live conversation but the colonists would have access to the internet and could keep in touch with loved ones through video messages, email and SMS.

▶ THE RATIONALE

People often assume I spend a lot of my time dreaming of being an astronaut and imagining life on Mars. They are sometimes disappointed to learn that I treat my participation in the Mars One project just like everything else in my life — with scientific rationale. It has no impact on my life other than the fact that I probably spend a little more time speaking about Mars than I do other topics in astrophysics. I see my involvement with Mars One as an exciting hobby that I am honoured to have. I am sure my friends, family and colleagues are tired of hearing me speaking about it and as a consequence, I do not mention it anymore unless people explicitly ask me about it. I find it endlessly fascinating and I think I always will, regardless of my involvement in the mission, but I do not think it should define me. I never dreamed of being an astronaut as a child and I still do not. I think it is a fantastic career and if I were selected for the mis-



“MY MISSION IS TO MAKE ICAI WORLD’S TOP CMA INSTITUTE”

What has been your career journey so far? Where have you worked before and what have been the up and downs of it?

Finance has been my forte all through my life. With over 37 years’ experience in Financial Management and Cost Management in variety of industries which includes Financial Advisory Services, strategies and business development for small and medium industries and providing cost management systems and MIS systems for large number of units. I worked in different capacities for ten years and later turned to Entrepreneurship in 1987.

The journey with the institute has been for nearly 30 years now. I entered in the year 1985 and next year I will be completing 30 years. I have been associated with the Hyderabad Chapter in different capacities and then elected to Southern Regional Council and as the Chairman of SIRC during the year 2000. I was elected to the Central Council in 2004 and has been with the council since then. There are lots of challenges currently facing the profession and I am confident that with the support of my colleagues and our members, will be able to wither all challenges.

How do you propose to train Indian Cost Accountants according to the global environment as financial standards are evolving?

The CMA profession is unique as it draws continuously from global best practices in financial and management accounting aspects and retunes them according to the Indian environment taking into account the domestic concerns. Apart from strengthening the Indian CMA’s on financial reporting standards the impact of these benchmarks into performance reporting is an area our institute is looking at. It is also well integrated into the cost accounting standards which are evolved by the institute.



**CMA Dr A S Durga Prasad, President
The Institute of Cost Accountants of India**

The institute is also conducting series of capacity building training programmes through class room trainings, seminars, webinars and conferences. In addition, Special projects such as CMA Labs, which is planned, give focused hands-on-training on the four pillars of the CMA syllabus which are Finance, Reporting, Regulatory and Strategy. Although India is well connected to the global economy, to a major extent, we have to identify and nurture domestic strong points on cost competencies to build them into the cost competitiveness of Indian economy. We believe in prioritizing the global practices in a way that it does not have an adverse impact on the domestic economic environment.

What is your vision as the President, ICAI?

My vision for the institute is that we should be the number one CMA institute in the world. Looking at the vast resources available and the young generation in India it won’t take us much time to achieve this goal. My vision is to set same standards and competencies which any other country has for the cost and management accountants, I visualise the same and see that we should be at the top of the world. My goal is to draw a roadmap to ensure the necessary

competencies are built amongst the young members.

How do you see the Companies Act? How does the new law seek to improve corporate governance?

The Companies Act, 2013 has evolved from a major metamorphosis which prepares the corporate world with a futuristic outlook on the tenets of accountability, fairness, transparency and disclosures. The onus on corporate governance is also put on the shoulder of the Independent Directors, Audit committees, Auditors and KMP’s in order to boost the investors’ and other stakeholder confidence, at the same time, ensuring proper and ethical governance of the corporate world. My personal feel is that any new legislation like The Companies Act, 2013, which has departed from the past to a major extent, requires to be tested over a reasonable period of trial period before getting implemented. This has been the refrain in many such instances in the past, and why not this time also?

Any words of wisdom for aspiring Cost Accountants?

In this globalised connected world, organizations require professionals who have specialised knowledge on business strategy and value creation. The Cost and Management Accounting being the foundation on which the enterprises are built, the specialised education and training the institute provides should make them perfectly fit the requirement. The current business environment requires not only strong foundation in Cost and Management Accounting, but also on using the IT capabilities to deliver faster and online information based on best CMA practices. The motto of our institute is, ‘Behind every successful business decision there is always a CMA’, this should be the fulcrum on which the aspiring cost accountants should weave their career. ■



sion, I would relish the opportunity, but for the moment I love being a scientist on earth and I am firmly concentrating on my life here.

▶ A WAY OF THINKING

Reflecting on my career up to this point makes me believe that being a scientist is, like most careers, about acquiring a set of skills. One of my idols, astrophysicist Carl Sagan, once said: "Science is more than a body of knowledge, it's a way of thinking." That "way of thinking" is the most important skill that a scientist can possess. It is the ability to observe and research the world around us — to propose experiments that test and model nature. However, more skills are required to be a successful scientist in today's world. These include the ability to work as part of a team, to collaborate, to research, to be creative and to be able to communicate ideas clearly.

These key skills are now an area of my research

in Trinity's School of Education, where I have taken up a role as an assistant professor of STEM Education (yet another job that did not exist when I was a child). This position was created due to an ongoing collaboration between Google and Trinity College. I am also a course co-ordinator for a new Trinity/Google Postgraduate Certificate in 21st Century Learning that aims to provide teachers with the tools needed to improve STEM education in Irish schools. I have had the opportunity to teach STEM workshops in places as diverse as Bangalore and Seoul and the one thing that is constant is the passion that students have for their subjects when they are taught in a style befitting 21st century learning. When young people acquire skills in the classroom that will benefit them in any future job, we hope it will allow them to focus on the subjects they are learning, without having to worry about their eventual careers on this or any other planet.

SCIENCE



INDIA'S MISSION

WITH THE MANGALYAAN

spacecraft slipping into the orbit around Mars after a 10-month voyage in September 2014, India became the first country to successfully reach the planet in its first attempt. But the most notable distinction was the mission's shoestring budget — at a cost of only \$74 million, India's space agency put the satellite into orbit for a fraction of what other nations have spent.

"The Mars mission created curiosity not

just about the mission but also about the technology used; it which was developed indigenously. It has also opened up areas of research in technology like on-board autonomy, deep space communication, navigation, mission planning and management. Putting together these aspects, it will encourage more people to join this area. This will enable the trial of further space exploration and testing of newer technologies," says M Annadurai, programme director, Mars Orbiter Mission, Indian Space Research Organisation (Isro).

According to him, when it comes to

training, science students who are interested in knowing more about planetary systems and space travels should be able to decipher the data as well as the science behind it, and cull out useful information.

"From a multidisciplinary perspective, space exploration has scope for students. There are people from diverse backgrounds such as instrumentation engineering, communications, mechanical engineering, electrical engineering, among others, working together to make a programme successful," adds Annadurai.



SUBJECT WISE

ASTRONOMY

REACH FOR THE STARS

SCIENCE

Do you enjoy gazing at the stars at night? Does the very idea of space and celestial objects fascinate you? If so, a course in astronomy is ideal for you.

But what is astronomy about? And why do people study the subject?

Says professor G S D Babu, director, M P Birla Institute of Fundamental Research, Bangalore, "Perhaps the most important reason to study astronomy is that it seeks to satisfy our fundamental curiosity about the world we live in, and answer questions like 'How was the universe created? Where did we come from? Are there other intelligent life forms?' The discovery that the basic elements that we find in stars and the gas and dust around them are the same that make up our bodies has further deepened the connection between us and the cosmos. This connection and the awe it inspires touches our lives. Astronomy is breaking new records every day, establishing the farthest distances, most massive objects, highest temperatures

and most violent explosions. Even the satellites in space, space travel and most of the communication systems, for example, are all the outcome of the understanding of aspects related to astronomy."

► CAREER PATHWAYS

There are organisations like Indian Institute of Astrophysics, Raman Research Institute, Inter-University Centre for Astronomy and Astrophysics, National Centre for Radio Astronomy, Physical Research Laboratory and Aryabhata Research Institute of Observational Sciences (ARIES), which can lead to career opportunities in astronomy. "Various planetariums take in people with training in astronomy. Some universities, colleges and schools have astronomy programmes as a part of physics courses, where those who have pursued a course in astronomy can become faculty. There is also a possibility of entering space-oriented programmes," he adds. However, in India, careers in astronomy are somewhat limited.



MY CHOICE

KRISHNA KUMAR KOUSHIK, who studied physics, mathematics and electronics at the BSc level, just completed his postgraduate course in physics from Jain University, Bangalore. He now plans to apply for higher studies in astronomy in US. He says, "The courses helped me a lot because I learnt how to focus on research"

The situation abroad is much better. Several universities offer astronomy courses at undergraduate and postgraduate levels, where a prior course in astronomy is given substantial weight in admissions. In addition, there are many astronomical organisations all over the world where good career opportunities are available. There could be a few chances of joining NASA, according to Babu.

▶ WHAT TO STUDY?

Various institutes in India offer courses and facilities up to the PhD and post-doctoral levels. There are courses for enthusiasts and the general public as well. Accordingly, the syllabus varies. For example, an MSc-level course in solar astronomy might include techniques of observing the sun, structure of the sun's interior, solar atmosphere, solar activity and magnetic fields, transient events, solar wind and high-speed plasma streams, solar-terrestrial relations and so on.

In a specialised radio astronomy course with an MSc-level syllabus, you would focus on the fundamentals of radio astronomy, varieties of radio telescopes, antenna details, radio interferometry and aperture synthesis, mechanism of radio emission from celestial objects, radio sources in the sky, the sun as a radio source, pulsars, extragalactic radio studies, etc.

A specialised course in astrobiology and astrochemistry with an MSc-level syllabus could include life on other planets of our solar system, general conditions for the existence of life, probability of life on Mars, the origin of life, evolution of intelligence, information biomolecules, biogenetic carriers, extinction of dinosaurs, panspermia, building blocks of life in deep space, SETI update, impact of global warming, Kyoto Protocol, super eruption, and the like.

Introductory courses in cosmology usually include introduction to theories and models for the origin and evolution of the universe

along with topics like the Big Bang model and its comparison with Steady State and other models. The recent explosion of observational evidence for dark matter and dark energy are included as well as exciting current issues in cosmology, such as string theory, worm holes and so on.

An introductory course in space astronomy would deal with topics such as history of space flight, elementary space dynamics, design of a space experiment, lunar and interplanetary missions, astronomy missions, and more.

Besides, summer schools are organised for schoolchildren to become aware of stars, galaxies and the universe. They focus on co-ordinate systems used in astronomical observations, constellations of stars and naked eye astronomy, physical parameters of the celestial objects, evolution of stars, interstellar matter, galaxies and the cosmological aspects related to the origin of the universe.

Apart from these, there are also basic astronomy courses for the general public. Most of these are available at the M P Birla Institute of Fundamental Research.

▶ ROAD AHEAD

Babu emphasises the importance of astronomy by quoting the famous astronomer, Carl Sagan, from his book, *Pale Blue Dot: A Vision of the Human Future in Space*, "It has been said that astronomy is a humbling and character-building experience. There is perhaps no better demonstration of the folly of human conceits than this distant image of our tiny world. To me, it underscores our responsibility to deal more kindly with one another, and to preserve and cherish the pale blue dot, the only home we have ever known."

He adds, "Every advance in astronomy moves society closer to being able to answer the most elemental questions about the origin of life. With advanced technology, we have peered into the distant, early universe, searched for habitable worlds, and come to the conclusion that we, ourselves, are stardust. Astronomy constantly reminds people of two seemingly contradictory things. First, that the universe is infinite and we are of but the tiniest fraction of importance. And second, that life is rare and precious. A home as beautiful and unique as earth does not come often. We must protect it."

– Geetha Rao

STUDENT SPEAK

JOY OF DISCOVERY

Kanika Jain
PhD candidate,
Department of Chemistry,
Central University of Rajasthan

When I was a child, my choices on what I would like to do in life covered a range of possible careers: science, medicine, arts, law and almost everything else. While I was initially more attracted to fine arts, I decided to study science mainly because I was good at it in school and had a certain amount of curiosity.

The colours of compounds always fascinated me and made me think about their origin and cause. During my Master's in chemistry at Central University Rajasthan, I came across the research work of Raghu Chitta, assistant professor in the chemistry department. I was enthused by the coloured compounds synthesised in his research laboratory and was excited by the utilisation of these dyes in trapping solar energy. I later had the opportunity to pursue my PhD under his guidance and was fortunate to win the Inspire Fellowship under the Assured Opportunity for Research Careers (AORC) for my research proposal on 'solar energy harvesting.'

My research topic focuses on addressing the world's energy problem. As natural fossil fuels diminish day by day, producing clean and green energy is the way forward for the world's future

energy requirements. In this regard, silicon-based solar cells emerged as efficient alternative technologies to create energy from sunlight. These cells have achieved power conversion efficiencies of ~24%. However, the high cost and tedious fabrication limit their use for general purpose.

Dye-sensitised solar cells (DSSCs) stand out as viable alternative solutions for application in solar-energy harvesting, due to their low cost, ease of fabrication and large-scale production. DSSCs have a theoretical maximum energy conversion efficiency of 33%. However, due to technical constraints, the actual energy conversion efficiency of a DSSC is closer to 11%, which is less than half of the crystalline silicon-based solar cells' efficiency. Improving DSSC efficiency is critical to widespread adoption of this technology. As part of my research project, I designed and synthesised a multiple chromophore (dyes) system that can capture solar energy efficiently and enhance the performance of solar cells.

I believe that incorporation of such systems into the DSSC will drastically reduce its cost, increase efficiency and make this technology reach the masses. What motivates me to work in this field is that the outcomes of my research can provide potential solutions to various energy problems we face by creating new, clean sources of energy.

In my one-year experience as a PhD scholar, I have learnt that laboratory work often involves setbacks and negative results. Yet, success in making a new observation, however small, is exciting. When you discover something new, even a small thing, you are on cloud nine for days. That is what delights me.

It is only through practice, the stimulating atmosphere of the laboratory and an inspiring mentor that I slowly grew to realise that I have become involved in one of the most creative and exciting areas of research. For me, research is a unique opportunity to make unexpected observations. Science is invigorating and I am grateful for the opportunity to be in this stream.

WHAT MOTIVATES ME TO WORK IN THIS FIELD IS THAT THE OUTCOME OF MY RESEARCH CAN PROVIDE POTENTIAL SOLUTIONS TO VARIOUS ENERGY PROBLEMS THAT WE FACE



SEED TO MARKET

S Ayyappan
Director-General,
Indian Council of Agricultural Research

Changing economies at macro-level (global or national) as well as at micro-level (household) are significantly affecting people's taste and food preference. Consequently, the consumption pattern of Indians is changing significantly. This has diversified food demands towards products such as fruits and vegetables, fish, milk and meat, to name some. This is likely to put pressure on agriculture to increase resource allocation among competing commodities.

Fresh food, be it fruit or fish, is highly perishable and spoilage occurs during storage. It has been suggested that associated micro-organisms be monitored as a measure of food quality. This is crucial as demand for ready-to-eat food is going up with the changing consumption habits. Meanwhile, risk management decisions should take into account the whole food chain from primary production to consumption, and need to be implemented in the context of appropriate food safety infrastructure, for instance, regulatory enforcement, food product tracing and traceability systems.

In the food processing chain, risk management should be based on scientific knowledge of microbiological hazards. It should also be based on the understanding of primary production, processing and manufacturing technologies and handling during food preparation, storage and transport, retail as well as catering. As well as food security, nutritional security is of paramount interest because anaemia is increasingly engulfing rural India due to iron deficiency.

Vitamin A and zinc deficiency, too, are becoming common in India. This scenario has provided us a lot of opportunities for crop diversification and integrated farming systems to translate mundane agriculture into remunerative agriculture; to embark on secondary agriculture minimising production losses through effective post-harvest technology and to conduct good agribusiness. To meet the challenges of the 21st century, particularly concerning feeding the swelling population of our country, heavy investment to develop requisite infrastructure and other areas of agriculture is required to create linkages from 'seed to market' and for efficient 'lab-to-land' transfers. These steps can help meet the ends of the National Food Security Act, 2013.

To enhance productivity, cutting-edge research in science and technology development in India's agricultural sector has been internationally acknowledged. In the years to come, ICAR is implementing (a) consortia research platforms on select thematic areas, (b) a farmer FIRST (Farmer Innovation Resources Science Technology) approach to achieve indigenous linkages in agri-sector development, (c) a student-READY (Rural Entrepreneurship and Awareness Development Yojana) approach to capacitate agricultural students to develop entrepreneurial skills and ARYA (Attracting and Retaining Youth in Agriculture) to attract rural youth to agriculture, to harness the potential of 80% of the population in the age group of 25-49. Researchers, policymakers and farmers are updated about the problems of growth and sustainability in the agriculture sector. This can be rectified through a mix of technological development and appropriate agricultural policies and synergising them with the dynamism of the farming community.

(The author won the GM Modi award for science and technology 2014)

As well as food security, nutritional security is of paramount interest because anaemia is engulfing rural India

INDIA ENERGISED

R Velraj

Professor and Director,
Institute for Energy Studies,
Anna University, Chennai

It is well known that the basic needs of living beings are water, food, clothing and shelter. However, in recent years, energy has also become an essential factor which is directly related to the holistic prosperity of any nation.

Adequate supply of clean energy is linked to global stability, economic prosperity and quality of life. Finding energy sources to satisfy the world's growing demand has been one of society's foremost challenges in recent years. The importance of this problem and the perplexing technical difficulty of solving it require an intensive national effort, marshalling our most advanced scientific and technological capabilities.

Fortunately, scientists and researchers around the world are formulating new methods and technologies to generate, store and transmit energy in a secure, sustainable and eco-friendly way. It is vital to tackle the energy crisis through sensible utilisation of copious renewable resources, such as wind, biomass and sunlight.

Recent universal events, such as the oil spill in the Gulf of Mexico in 2010 and the impact of natural disasters on the Fukushima nuclear plant in Japan in 2011, highlight the importance of continu-

ing to develop cost-competitive, new and renewable sources of energy.

More recently, in December, an oil tanker collided with an empty cargo vessel at the Sunderbans, the world's largest mangrove forest spanning across the Indo-Bangla border. It spilled oil into the Sela river, threatening the survival of multiple species of flora and fauna.

► ECO-FRIENDLY ENVIRONMENT

Securing 'sustainable renewable energy for all' involves the development of systems that support the optimal use of energy resources in an equitable and socially supportive manner while minimising environmental impact. Most European countries have shifted their focus to sustainable and clean energy resources. They have framed policies to promote and increase the use of renewable energy.

The European Union Emissions Trading System coined the term 'carbon credit' to develop an eco-friendly environment and to minimise the emission of hazardous effluents, particularly to shift the attention of developing nations towards the utilisation of renewable energy. These promotional and encouraging activities by international organisations may turn into enforcement in the form of a 'carbon tax,' which is a serious threat for all developing nations.

► POWER POTENTIAL

There is huge potential for renewable energy in India. It has been estimated that India's renewable energy potential amounts to a total of more



SECURING 'SUSTAINABLE RENEWABLE ENERGY FOR ALL' INVOLVES THE DEVELOPMENT OF SYSTEMS THAT SUPPORT OPTIMAL USE OF ENERGY RESOURCES IN AN EQUITABLE AND SOCIALLY SUPPORTIVE MANNER WHILE MINIMISING ENVIRONMENTAL IMPACT. MOST EUROPEAN COUNTRIES HAVE SHIFTED THEIR FOCUS TO SUSTAINABLE AND CLEAN ENERGY RESOURCES



than 1,00,000 MW. The present renewable energy contribution in India is about 29,900 MW which is approximately 11% of the total power generation in the country. The development of wind power in India, started in the 1990s, has significantly increased in the past few years. At present, India is one of the world's leading countries in wind power generation and as of March 31, 2014, its installed capacity of wind power was 21,136 MW.

In the biomass scenario, the concept of cogeneration in sugar mills became popular during the past two decades. There is considerable power generation utilising the large quantity of bagasse available in sugar mills. Further, based on a detailed survey on the availability of various biomass resources throughout the country, carried out by the Ministry of New and Renewable Energy (MNRE), in 2005, several small capacity biomass-based power plants were established in the country. At present, biomass-based power generation has exceeded 4,000 MW.

Of late, due to promotion by various countries, solar energy is taking the lead and the Indian government, too, launched the National Action Plan on Climate Change on June 30, 2008, under which eight missions were envisaged.

The Jawaharlal Nehru National Solar Mission (JNNSM), one of the eight missions launched in 2010, promotes development in infrastructure, entrepreneurship, skilled manpower and research and development (R&D) activities in solar energy. This resulted in phenomenal growth in solar power installations in the past two years, and as on January 2014, the installed grid-connected

solar power is 2,208 MW. Several states in India have evolved their policies to further promote solar power.

► RENEWABLE RESOURCES

Though renewable resources are infinite, they are seasonal and intermittent. The variability of these sources, particularly with large installations for small capacity power generation, has created big technical issues in the stability of the electrical grid, hence, the concept of a 'smart grid' evolved. The success of the 'smart grid' concept requires research and technological advancement in the field of cloud computing, monitoring and control, hybrid energy generation and energy storage. Realising this urgent need, the government is promoting many research activities in universities and research organisations through the Department of Science and Technology (DST), Ministry of Human Resource Development (MHRD), University Grants Commission (UGC) and MNRE.

In realisation of the potential development of solar energy in India, the Institute for Energy Studies (IES), an autonomous centre at Anna

University, has launched a postgraduate programme in solar energy, the first-of-its-kind in India, in addition to the existing postgraduate programme in energy engineering. Under the patronage of the Tamil Nadu Energy Development Agency (TEDA) and the UGC, a lot of workshops and training programmes on solar energy utilisation and energy storage are being conducted to create awareness and

for human resource development among faculty from academic institutions and other stakeholders involved in solar activities.

IES is nurturing the student community and fostering research and development in solar, wind and energy storage technologies. With such strong potential in universities, organisations like the Confederation of Indian Industry (CII) and Federation of Indian Chambers of Commerce and Industry (FICCI) should promote networking of academic institutions and industry, to turn the need-based new and innovative technological ideas into a reality.

Having said that, India's energy crisis could instead be transformed to make the country energy-surplus through greater awareness and, promotion of renewable energy technologies. This is possible by way of skilled manpower development, promotion of technological innovations and by bringing research ideas into the market via industry-academia networks.

It is vital to tackle the energy crisis through sensible utilisation of copious renewable energy resources, such as wind, biomass, and sunlight

{ YOUNG ACHIEVER }

POISED FOR GROWTH

Ravi Maruthachalam
School of Biology,
IISER - Thiruvananthapuram
(DuPont 2014 Young Professor Awardee)

After a successful post-doctoral experience at the University of California, Davis, I joined the faculty of the School of Biology, Indian Institute of Science Education and Research, Thiruvananthapuram (IISER-TVM). Our broad areas of research include plant genetics, reproductive biology and agricultural crop biotechnology. More specifically, I continue to work on haploids in *Arabidopsis*.

Haploid plants are an important crop improvement tool to expedite plant breeding. They can be generated through tissue culture or through simple breeding using the haploid-inducing strain discovered by us. The system can be improved to make it more efficient. However, we have demonstrated its success only in the model plant, *Arabidopsis*.

The power of haploid genetics has been mainly realised only in model yeasts and related microbes. Now, it can be realised in plants, especially in advancing basic genetics studies. Though haploids in plants can be produced through tissue culture, they were mainly used for hybrid seed production. Using our method, it is now possible, at least in *Arabidopsis*, to generate a population of haploids with less space, labour and money in a short time.



THE LONG-TERM IMPACT OF OUR RESEARCH WILL BE THAT WE CAN DEVELOP NOVEL HYBRIDS AND VARIETIES IN PLANTS IN A SHORT TIME

We use a combination of genetics, molecular, cell biology and bioinformatics methods to address the events that take place during artificial haploid induction in plants. Most of our research findings have been demonstrated only in the plant model, *Arabidopsis thaliana*, which is a weedy relative of cultivated brassicas (mustard, cauliflower and cabbage). The challenge is to extend our haploid production method to crops of economic and agricultural importance in India. We plan to collaborate with national institutes to translate our research discovery from *Arabidopsis*. IISER-TVM has generously supported me in the establishment of a research lab and other infrastructure.

In addition, I received a grant support from DBT-Ramalingaswami Fellowship and more recently the DuPont Young Professor grant.

The main challenge is to transfer the method to commercial crops of interest especially because those haploid production methods do not exist. If this becomes a reality, then it will drastically reduce the time required to develop inbred plants and hybrid seeds by conventional plant breeding. I believe the long-term impact of our research will lead to the development of novel hybrids and varieties in a short time.

In India, another challenge we face in terms of manpower is to obtain highly motivated PhD students and post-doctoral scholars to contribute to the research project. Most talented intellectual young minds prefer to move abroad, so we are at a disadvantage. However, I believe this scenario will change in future.

(Maruthachalam is also a recipient of the UC Davis Award for Excellence in Postdoctoral Research, an early career award from the American Society of Plant Biology and currently, a Ramalingaswami fellowship, awarded by the Department of Biotechnology, government of India. He was one of the top 10 international young faculty members to be recognised by DuPont)

– Aaditi Isaac

SCIENCE



A GOOD CATCH

A Gopalakrishnan

Director &

K Sunil Mohamed

Principal Scientist and Head,
Molluscan Fisheries Division,
Central Marine Fisheries
Research Institute, Kochi

The Ashtamudi estuary, covering an area of 61.4 sq km, is the second largest wetland ecosystem in Kerala. *Paphia malabari-*ca, the short-necked or yellow-foot clam, is the dominant clam species exploited in the Ashtamudi estuary. It is a benthic filter feeding, bivalve mollusc found in estuarine habitats on the east and west coasts of India. Up to 1,000 fishers in the area rely on this clam resource for livelihood. They paddle dug-out canoes from nearby villages to the shellfish beds. Divers dislodge the clams from the seabed with their hands and feet or a team of two or three fishermen use a hand-dredge from the canoe. On a good day, a fisherman can gather as much as 200kg over four-five hours. Another 3,000-4,000 people are involved in cleaning, processing and trading the clams. The fishery has sustained catches of around 10,000 tonnes a year for the past decade. The value of the clam fishery in the Ashtamudi estuary is close to US\$1 million, with the catch being in good demand in Southeast Asia and Japan.

The growth of Ashtamudi's commercial clam fishery was driven by demand from Japan, Vietnam, Thailand and Malaysia in the '80s and '90s. By 1991, the catch peaked at 15,000 tonnes a year, but declined 50% in 1993 due to unsustainable practices and over-fishing. Scientists of Central Marine Fisheries Research Institute (CMFRI) carried out a study

and recommended a number of measures to rebuild clam stocks in the estuary. A closed season and mesh size restriction for nets were introduced, along with a minimum export size and a prohibition on mechanical clam fishing. These measures showed immediate effects, reviving the clam fishery. This development resulted in a sense of trust between fishermen and scientists.

► CLAM SANCTUARY

Further, CMFRI came out with a clam fisheries management plan which recommended a clam sanctuary for protection of clam brooders and a council-based participatory governance system. This led to the creation of a 20-member Ashtamudi Clam Governance Council (ACGC) headed by the district collector and with adequate representation of all stakeholders and scientific representatives. Although initially the council was viewed with scepticism by fishers, it eventually became a body with teeth, taking collective decisions on managing a natural resource by the users themselves, with scientific advice. This process, an essential prerequisite for the Marine Stewardship Council (MSC) certification, was aided by the involvement of WWF-India. In India, fisheries are generally characterised by poor regulations and management as well as the lack of fisher involvement in the management



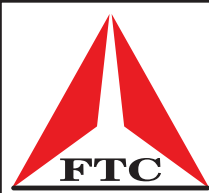
process, if any. The Ashtamudi estuary short-neck clam fishery proved to be an exception. This ultimately earned it the certificate and global recognition in November 2014.

In total, over 240 fisheries are MSC-certified and another 100 under full assessment across the world. Together, fisheries already certified or in full assessment record annual catches of close to 10 million metric tonnes of seafood. This represents over 11% of the annual global harvest of wild capture fisheries. Worldwide, more than 25,000 seafood products, which can be traced back to the certified sustainable fisheries, bear the blue MSC ecolabel. There is growing interest among global seafood consumers in choosing labelled fishery products. Invariably, these products are sold at a premium (estimated roughly as 20-30%). The benefits of this price premium are expected to reach the producer or the fisher, ultimately leading to higher living standards. Maintaining the label also means that fishing is done in a sustainable manner, which even-

tually leads to a steady income for them.

Going forward, the Ashtamudi estuary short-neck clam fishery will also undergo a chain-of-custody certification in early 2015, protecting it from trade malpractice or mislabelling. Ashtamudi not only leads the way for other fisheries in India, but also across the developing world, because it is only the third fishery in Asia to achieve the MSC certification. Worldwide, seafood is one of the most traded food commodities and has a greater economic importance in the developing world than other commodities such as coffee, tea, bananas, cocoa, rice and rubber.

CMFRI and WWF-India are jointly looking at other well- and self-managed small-scale fisheries such as the trap fishery for lobster in Kanyakumari, the gill-net fisheries for sardines in central Kerala, the blue crab fisheries in Tamil Nadu and pole-and-line skipjack tuna fisheries of Lakshadweep as potential places to go for certification. As a prelude, a fishery improvement programme (FIP) is already underway for some of these fisheries.



Face The Challenge Academy™
for Civil Services – IAS, IPS, IRS, IFoS

L-71, 2nd Floor, Malviya Nagar,
New Delhi-110017
Tel: 011-64645364
Mob: 8527559420

facethechallengeacademy@gmail.com | www.facethechallengeacademy.com

THANKS FOR YOUR TRUST ON US

The weekend (Sat.-Sun.) batch has started successfully from 3rd January, 2015, for Civil Services Pre-cum-Mains-2015 module for 40 weeks. We are thankful for the overwhelming response.

Optional Subjects for C.S. (Main)-2015 Exam

Fresh batches for Political Science and Geography starting from 11th Feb. (two lectures of 90 minutes each every Wed.-Thurs.) for 34 weeks. Fees ₹ 35,000/-, 25% discount for early birds. Only 60 seats are available.

Free one day interview workshop for Indian Forest Service

To be held on 17th & 18th Jan. 2015 by Mr. Vijay Kumar IRS, Commissioner of Income Tax & ex Indian Forest Service, and his colleagues from IFoS. Please send email giving your Name, Roll No. of IFoS exam 2014 and choice of one date.

Free one day workshop for interview of Civil Services

To be held in Feb. & March 2015 for candidates of C.S. (Main) Exam-2014. Watch out for the dates on our website or remain in touch on telephone.

New Mon.-Tues. Batch from 2nd February for C.S. (Pre-cum-Mains) 2015

A fresh Mon.-Tues. batch including G.S., CSAT, Essay, Qualifying Hindi & English and Interview starting from 2nd Feb. (Mon.) 2015 for 38 weeks, fees ₹ 90,000/-, 25% discount for early birds. Registration starts from today (Pay ₹ 15,000/- and rest in instalments). Only 60 seats are available.

Chief Advisor
Sh. Vijay Kumar IRS,
ex Indian Forest Service

Dean
Er. K. K. Sharma
BE, LLB, MBA

{ **FIELD WORK** }

SEISMIC STUDIES

NATURAL DISASTER

Ravi S Jakka

Assistant Professor,
Department of Earthquake Engineering,
Indian Institute of Technology (IIT), Roorkee

Earthquake is one of the worst natural disasters, causing a huge loss of human lives and destruction to structures around the world. India has a long history of devastating earthquakes, primarily because the Indian plate continues to drive into the Eurasian plate. Earthquakes can neither be predicted nor prevented. However, the severity of the damage can be minimised by proper infrastructure planning based on seismic hazard studies (viz seismic microzonation and/or site-specific studies), and by following appropriate construction procedures according to the earthquake-resistant design guidelines.

Seismic hazard studies require detailed field investigations to characterise a large volume of the ground. Conventional geotechnical methods are expensive and tedious. Geotechnical investigations are best suited to small areas, where site-specific hazard estimation is needed. Geophysical methods are a better alternative to geotechnical methods for carrying out seismic site characterisation, where it is not possible to drive a borehole or to conduct other geotechnical tests.

Successful seismic hazard estimation requires experts from geotechnical engineering, seismology and geophysics. Seismic site characterisation, in particular,

requires a competent site investigation agency with trained personnel in addition to the experts just mentioned. Difficulties arise mainly from inadequate knowledge of proper use of geophysical methods. The lack of trained personnel for carrying out field investigation, limited funding to use more advanced equipment and unavailability of detailed guidelines and codes sometimes hinder investigations as well.

There is wide scope for development in this area. Seismic site characterisation requires development of new technologies and methods to minimise the limitations and shortcomings of the various existing techniques. Nowadays, surface wave methods (MASW) are widely used for dynamic site characterisation. New

developments in this area, such as the combined use of active and passive wave tests, joint fitting of the active test with a horizontal-to-vertical ratio, use of ground-penetrating radar and seismic stress ratio, can explore deeper and generate more detailed information about soil stratification. Active research is going on in this direction.

Seismic microzonation studies, which, as of now, are only confined to megacities and a few big cities, can be extended to smaller cities to ascertain the safety of rapid urbanisation. Development of high-performance materials at lower costs, improvement of guidelines for earthquake-resistant design, and retrofitting of old structures need to be taken care of with the help of advanced research.

As it is not possible to predict the next earthquake, at least an advance warning can be sent out if an early warning system is created.

Earthquakes can neither be predicted nor prevented. But severity of damage can be minimised by proper infrastructure planning

{ **TECH TATTLE** }
BIOMATERIALS

REGROWING BONE

Bruce Milthorpe

Dean,
Faculty of Science,
University of Technology, Sydney

In the past few years, my research has been focusing on biomaterials — looking at materials for repair of ligaments and tendons, and more recently, looking at substances that help regrow bone. These are largely materials that are based around calcium phosphate in a form known as hydroxyapatite. Hence, what we have been looking at is how to make calcium phosphate particles of the right pore size so as to encourage more expedited growth by the host bone. A scaffold of calcium phosphate and other such materials along with some cells not only help the bone grow quickly but also facilitate rapid healing of the bone.

For example, if someone has bone cancer and they lose a large amount of bone, what surgeons generally do is amputate because there is no whole bone and whatever remains has to be saved. But regrowing the bone involves inducing the right material into the bone so as to best replicate its natural composition. The idea is not just to replace but replace to regrow, almost naturally.

The emerging trends lie in the area of the source of materials that could be used in different parts of the body to allow the growth of appropriate cells and tissues. For instance, in bone, we use calcium phosphate particles in a variety of sizes because they are well-tolerated by the body. However, if you are making a soft tissue for an organ like the liver or kidney, you need to work on the entire structure of the organ and that becomes much more complex. The latest trends involve using various kinds of polymers which can be tolerated by the body, and using fibres in a way where cells are grown on them. The fibres are then implanted. This works to some extent in cases of cartilage or a breast tissue, if only fillers are needed.

But if an entire organ were to be recreated, it

requires one to go to the next level — which is effectively bioprinting wherein a scaffold of cells is printed with a sophisticated inkjet printer. One can build different intricacies and create cells on different spots with the printer. Building a three-dimensional organ with a bioprinted tissue is the most sophisticated that we can get as of now.

Research on bioprinting is still continuing, and, there are limitations here as well. The primary challenge is to ensure that the cells remain alive while printing and that they are printed in a matrix with compatible chemicals that retain the water content during the printing process. The chemicals, apart from keeping the cells alive, also help replicate an environment similar to that of the human body. This allows these cells to thrive in a conducive environment. The cells must feel that they are at home and they recognise the chemicals in that sense, be it collagen, elastin or other, less well-known chemicals.

Further, it can take hours to print a relatively small amount of tissue. Ordinary printers that use paper as the base deliver a single layer print; even an inkjet printer is supposed to be single layer. The printers used for this purpose follow the principle of rapid prototyping where you first print what is on the first layer and then you print the second layer and so on. Each layer is roughly only 10 microns thick, and one will need about 100 layers to make a millimetre. Say, one wants to print something with a thickness of 20mm — this would take nearly 2,000 print cycles to achieve the desired result. Needless to say, this is a time-consuming process but efforts are on to improve the technology so that we not only print faster but are also able to obtain printing sizes and resolutions that are closer to the human body's actual make-up.

We are learning newer insights about cells with the focus on stem cell research. Even though many are working with embryonic stem cells these days, adult stem cells are the best bet right now for potential clinical application. We can recreate bone, cartilage, muscle, nerve, and to a certain extent, blood vessels. The next problem to be tackled is not having enough sources of stem cells.

– Sarah Zia

SCIENCE



WEATHER REPORT

Hugh Coe

Team Head,
Drivers of Variability in the South Asian
Monsoon Research Programme &

G S Bhat

Professor,
Centre for Atmospheric and Oceanic Sciences,
Indian Institute of Science (IISc), Bangalore

Asia, the UK and India are joining forces to undertake research projects aimed at better projections. The work is set to begin in 2015 under the Drivers of Variability in the South Asian Monsoon research programme announced in August 2014, with total funding of around £8 million from the UK's Natural Environment Research Council (NERC), India's ministry of earth sciences and the UK Met Office. To be run for three to five years, the joint programme seeks to improve monsoon prediction by furthering our knowledge of the way the land surface responds to heating and rainfall and feeds back on the atmosphere; assessing the heating of the ocean and its impact on monsoon development; and by quantifying the role pollution and dust particles in the air play in affecting the heating of the surface and the atmosphere in the advance of the monsoon. Enhancing our understanding of these key processes over the Indian region and using this knowledge to improve the models of weather and climate predictions will improve our ability to predict monsoon rainfall.

Few things or phenomena affect the lives of more than a billion Indians the way the monsoon does. In India, the summer monsoon is a key event, on which not only the farmer but also those who occupy the corridors of power are dependent because 80% of the annual rainfall in the country is monsoonal. Though the well-being of India's economy is so intricately tied with it, prediction of its onset and development remains poor.

At present, India's capability to model the monsoon and to make forecasts on scales from more than five days to the season ahead is limited by large errors that develop quickly. A lack of detailed observations of the land, ocean and atmospheric parts of the monsoon system, on a range of temporal and spatial scales, prevents a more thorough understanding of processes involved in the development and propagation of monsoon convective clouds on the land surface, which eventually decide the spatio-temporal distribution of rainfall over India.

Given the importance of the monsoon in south

► CLIMATE PROJECTIONS

India has supported a major science programme to understand the monsoon through its ministry of earth sciences, which is bringing together scientists from across the country to conduct a wide range of measurements and modelling studies. The UK has significant capability to add to this excellent programme. The British team has been supported by the UK NERC to bring its large research aircraft, a BAe-146, fitted as a flying laboratory, to India to provide a unique data set. The UK will use an Indian research ship to launch a



THE INDO-UK JOINT PROGRAMME SEEKS TO IMPROVE MONSOON PREDICTION BY FURTHERING OUR KNOWLEDGE OF THE WAY THE LAND SURFACE RESPONDS TO HEATING AND RAINFALL AND FEEDS BACK ON THE ATMOSPHERE. THE PROJECT WILL LEAD DIRECTLY TO IMPROVEMENT IN MONSOON FORECASTS

SCIENCE

number of oceanic gliders to investigate ocean temperatures and will add surface measurements to the Indian network. These measurements will help constrain both UK and Indian climate and weather models, including the UK's Met Office weather/ climate model to improve future monsoon prediction.

The UK Met Office weather/climate model, installed at the National Centre for Medium Range Weather Forecasting (NCMRWF), Noida (Uttar Pradesh), has been used for weather forecasts. This so-called unified model can be used for a very short range (few hours) to climate runs (years). As part of the joint collaboration, measurements over India and the adjacent oceans by the UK's research aircraft, along with intensive ground-based observations on land and over the ocean, will be made. New observations of the land surface, the boundary layer structure on land and over the ocean, and atmospheric profiles will be made, and the information will feed directly into the UK model at the met office in Britain and at NCMRWF in India.

One of the main objectives of this study is to compare high-resolution model outputs with obser-

vations, and identify where the major differences between the two occur, look for the physical causes and correct them in the model. The model will be run at different spatial resolutions, including at an extremely high, 100-metre scale. By comparing the results at different resolutions, it will be possible to describe the key processes controlling the monsoon rainfall, and to indicate how these need to be represented in different applications, such as weather predictions or climate predictions, which are run at coarser resolutions of tens of kilometres.

Through model evaluation at a range of scales, the development of a theoretical understanding of the rainfall processes, and working with Indian and UK groups responsible for operational model improvement, the project will lead directly to improvements in monsoon forecasts. By improving rainfall prediction, we expect the work to have an economic impact in India and internationally.

(Coe is a professor of atmospheric composition at the University of Manchester and Bhat is among the researchers from India taking part in the bilateral project)



AMITY UNIVERSITY

SPEAK TO ANY OF OUR STUDENTS AND YOU WILL END UP BEING ONE!

ADMISSIONS 2015 OPEN

INTERNATIONAL CREDIBILITY

RICS - world's leading professional qualification since 150 years, with presence in 146 countries. **Amity University** - India's leading research & innovation driven University. Opportunity to study one semester at **University of Salford** - UK's leading school of built environment.

JUMPSTART WITH BEST EMPLOYERS

Industry led institution where placements & internships are committed by **top employers** in this fast growing real estate, construction & infrastructure sector - **set to be 3rd largest in world by 2020** like · Shapoorji Pallonji · L&T · Leighton India Contractors · Turner & Townsend · Tata Housing · DLF · Unitech · Lodha Group · Hines · Bharti Realty · Sobha Developers · Embassy · K Raheja · Mahindra Lifespaces · JLL · CBRE · DTZ · Knight Frank · Cushman & Wakefield · Colliers · HDFC · IDFC · Kotak Realty · Birla Sunlife · KPMG and many more.. **-85% of first MBA batch placed within 2 weeks** in some of these firms.

RETURN ON INVESTMENT

Expect to **recover your full education fee with first year** salary. First MBA batch placed at **average CTC of Rs. 6.7 lakh** - higher than education fee. Upto 100% Scholarship on need & merit basis with extra incentives for girls.

Specialised MBA and BBA degrees supported by 200+ top companies

2 YEAR MBA
in Real Estate and Urban Infrastructure
with specialization in Investments & Finance or Marketing

2 YEAR MBA
in Construction Project Management

2 YEAR MBA
in Construction Economics & Quantity Surveying

2 YEAR MBA
in Infrastructure Management

3 YEAR BBA
• in Real Estate and Urban Infrastructure
• in Construction Management

To download application forms, visit us: www.ricssbe.org; www.amity.edu/rics ricssbe@rics.org

+91 965 078 4445, +91 813 065 4445 | **RICS School of Built Environment, Amity University, Block F2, Sector 125, Noida**

video is here



{ SCHOLAR TALK }

A SCIENTIFIC TEMPER

Pavani Praveen Nadiminti

PhD candidate,
School of Life and Environmental Sciences,
Deakin University, Australia

I got interested in research when I started my Master's in biotechnology in India. Since then, I have wanted to pursue research as my career. When I discussed my career plans with my parents, they were supportive, though finances were a concern. Being from an average middle-class family, I depended on an education loan but taking it from an Indian bank was not easy.

In 2009, I attended an Australian education fair in Hyderabad. When I came across the Master of biotechnology programme offered by Deakin University, I was impressed with its curriculum and focus on research. With my goal to ultimately pursue a PhD, the degree seemed the best fit.

I applied through the university's India office and was counselled and supported through the process. Luckily, my application was successful and I enrolled in Deakin. While my Master's was still on, I approached one of my professors, David Cahill, for a possible PhD supervision and nomination for a scholarship. He was sup-

portive of my application and recommended that I apply for a PhD under his supervision. He also encouraged me to apply for full funding under Deakin Scholarships for Higher Degrees for Research, which provides research students a 100% tuition fee award and a handsome stipend to cover living expenses. My application was approved and I commenced my research studies.

My PhD project investigates the use of nano-particles as next-generation agrochemical delivery vehicles to plants. Three years of research experience while studying in India and at Deakin had prepared me well to deal with puzzling questions. Undoubtedly, research is

highly challenging. Therefore, a strong passion at heart, hard work, scientific thinking and

zeal to work in a team are some of the important prerequisites. Deakin has provided me a fantastic platform

for research and installed rigorous checks throughout the PhD candidature. These checks have driven me towards quick and successful completion of my PhD.

I hope to be able to add the title 'Doctor' to my name after graduation in March 2015.

Australia is a beautiful country. People are warm and friendly and, of course, kangaroos are exciting. The best days of my life have been spent Down Under.



SCIENCE



UNDOUBTEDLY, RESEARCH IS HIGHLY CHALLENGING. THEREFORE, A STRONG PASSION AT HEART, HARD WORK, SCIENTIFIC THINKING AND ZEAL TO WORK IN A TEAM ARE SOME OF THE IMPORTANT PREREQUISITES FOR IT

RESEARCH ROUNDUP

CLIMATE CHANGE

BETTER FARMING

A RESEARCHER IS DEVELOPING GUIDELINES FOR FARMERS TO ENCOURAGE THE GROWTH OF NATURALLY OCCURRING, METHANE-CONSUMING SOIL MICROBES

Methane is expelled by cows and other ruminant livestock through flatulence. It is a potent greenhouse gas which contributes to climate change. In an attempt to control it, a New Zealand-based researcher is developing a set of guidelines for farmers to encourage the growth of naturally occurring, methane-consuming soil microbes.

Sally Price, senior researcher, Faculty of Agriculture and Life Sciences, Lincoln University, who has been undertaking periodic research over the past 15 years into the role the microbes play, notes that it is the root systems of trees and shrubs that help break up the soil and allow the methane to travel down to the microbes. Minimising compaction of the soil and incorporating organic residues can also make a difference to the microbial communities and increase methane consumption.

Price says that while work to understand the animal's digestive processes is important and ongoing, the focus has to be on other measures as well. Climate change is a reality and the guidelines will help farmers do their bit, as well as provide them benefits.

"Many factors influence the effectiveness of soil methane bacteria, with the soil water content, aeration and disturbance being the greatest variables." Price says these factors are also vital to the maintenance of soil health, so following the guidelines will encourage microbe growth and methane consumption will lead to better soil.

The measures could include putting land aside for planting trees and shrubs without putting animals on it. Soil methane uptake

rates had shown signs of improvement approximately 10 years after the introduction of shrubland into unimproved pasture. Afforestation with quick-growing pine trees had shown substantial methanotrophic activity could be restored in about 30 years.

In future, it could be regulated as part of efforts to meet targets to reduce greenhouse gas emissions, Price says, but for now, it could just mean a mind-shift for farmers. "It is important that land managers become aware of how to enhance this natural yet important process to aid reductions in anthropogenic (human-caused) methane emissions," she adds.

Methanotrophs prefer drier environments. Methane oxidation rates can be high in dry soils (on a global scale) in India. As India has approximately half of its land under agriculture, an awareness of soil microbiology/ soil health and, hence, soil methane consumption can help improve the rates of methane removal by the soil.

In the NZ context, Price hopes to educate farmers to better look after their soil microbes, specifically in relation to the type of land management that they are employing, for example, arable, grazing — high-quality pasture or grazing on low-quality pasture. She also aims to encourage them to plant indigenous vegetation or set aside unproductive land to let it revert to its original condition with native species.

Today, farmers have to know a lot about science in their role but they should also take in account what is happening on the microscopic scale. "They (the microbes) are actually driving the farm," sums up Price.

— Malini Sen

