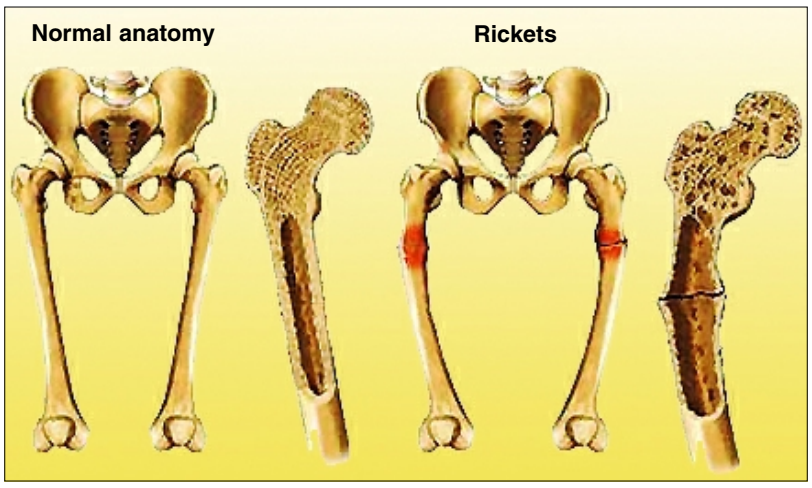
Not just bones, arteries too

Vitamin D has also been found to benefit blood vessels and reduce heart disease, says s ananthanarayan



THE essential biochemical agent that allows the intestines to absorb calcium from food and directly promotes health of the skeletal system, Vitamin D was first discovered for its role in preventing rickets, a disease of the softening of the bones that mainly afflicts undernourished children. It is now routinely added to processed food and prescribed to treat bone disease in adults, particularly the elderly.

Ibhar Al Mheid, a cardiovascular researcher at Emory University School of Medicine, presented hard data at the annual meeting of the American College of Cardiology in New Orleans to show that Vitamin D also positively reduces loss of elasticity, or stiffening, of the arteries, which is a major factor in high blood pressure and heart disease.

When rickets, a disease affecting bones, became a public health issue some time in the 1700s, scientists began to search for the specific additions to diet that could prevent the scourge – inh the way that citrus fruit had helped control scurvy and unpolished rice had helped with beri beri. It was soon found that cod liver oil was an effective remedy and preventive. It was also found that simply exposing the body to sunlight was equally effective – in fact, even just some foods that had been exposed to sunlight.

The effective agent in control of rickets was identified as Vitamin D in the 1920s and now there are methods to recover and package it to supplement common foods or for the treatment of acute deficiency. The name "vitamin" is used when the organism itself cannot synthesise the substance from its components and depends on diet or external sources, which was true for humans and Vitamin D. And what is a vitamin for one organism may not be so for another, like Vitamin C is important for humans but not for many animals, which can synthesise it.

By this understanding, Vitamin D may be a vitamin but, in fact, considering the way it acts, it is more correctly called a hormone, or even a precursor to a hormone. Hormones are substances produced by cells of an organism to signal to other cells to act in different ways. All cells in the body are found to have the capacity to identify the Vitamin D signal and react in many ways. The other difference between Vitamin D and a true vitamin is that the body can, in fact, produce Vitamin D with the help of sunlight and is hence not entirely dependant on external sources.

When Vitamin D is present in the intestines, it makes it possible for calcium to be absorbed by the body from food. Too little Vitamin D leads to a drop in calcium levels in the blood and different ailments, mainly affecting the bones, like osteoporosis, osteomalacia and rickets – a disease where the bones become soft and get deformed, accompanied by muscle spasms and seizures.


Ibhar Al Mheid


Kenneth Brigham

Beyond bones

It is also known that all cells in the body have a receptor, or a surface feature that helps connect with Vitamin D, which then spurs the cells to action, depending on the nature of the cell. Adequate levels of the vitamin are then known, generally, to prevent a brace of daily ailments, from high blood pressure to back pain, alleviate symptoms of chronic diseases like diabetes and arthritis and actually prevent infectious diseases, including H1N1 and even cancer. The study reported by Dr Ibhar Al Mheid was a formal monitoring of Vitamin D levels and the corresponding ability of blood vessels to relax after being constricted, and also the resistance offered by blood vessels to blood flow.

Five hundred and 54 employees of Georgia Tech participated, average age 47 and generally healthy. It was found that 14 per cent of the group had Vitamin D levels that were *deficient*, and in 33 per cent the levels were *insufficient*. When the vascular elasticity and other markers were measured, it was found that, after making allowances for age, weight and cholesterol levels, Vitamin D deficiency was directly associated with bad health of the arteries. "We found that people with Vitamin D deficiency had vascular dysfunction comparable to those with diabetes or hypertension," Dr Al Mheid says.

More interesting were the results of continued observation over the next six months. Participants, whose vitamin D levels increased over this period, either from dietary supplements or ample sun exposure, tended to improve their measures of vascular health and had lower blood pressure. Forty-two study participants with Vitamin D insufficiency whose levels later went back to normal had an average drop in blood pressure of 4.6 millimetres of mercury (the standard "normal" BP is 120/80 mm of mercury).

"This was an observational study rather than an interventional one, and it was difficult to tease out how the people who restored their Vitamin D levels improved their parameters," Dr Al Mheid says. "We are hoping to conduct a study where we have participants take a defined regimen of Vitamin D."

Says Kenneth Brigham, medical director of the Emory/Georgia Tech Center for Health Discovery and Wellbeing, "With his findings showing the relationship between Vitamin D deficiency and vascular dysfunction, Dr Mheid has helped advance our understanding of the importance of the vitamin in preventing a common health problem in ageing adults."

Getting more Vitamin D

The best way to get Vitamin D is by exposure to the sun. UV light in bright sunlight acts on the skin to synthesise a pre-Vitamin D which the liver and kidneys are able to activate into the biological important form, which builds up in the intestines. Supplements in milk and cereals or cooking fats, though common, are not important sources, but a diet rich in oily fish can correct deficiency. The best solution for most persons who live and work in enclosed spaces is to seek even short periods of exposure to the sun, including some cultural adaptation to allow skin to be left uncovered. It is considered that improvement of Vitamin D levels among people in all parts of the world can significantly bring down the cost of hopitalisation and lost working hours.

The Emory/Georgia Tech Predictive Health Institute is a health care initiative that focuses on maintaining health rather than treating disease. The institute aims to change the future of healthcare by creating a model of health using new tools of bioscience to identify and measure risks and deviations to develop common processes that promote health maintenance.

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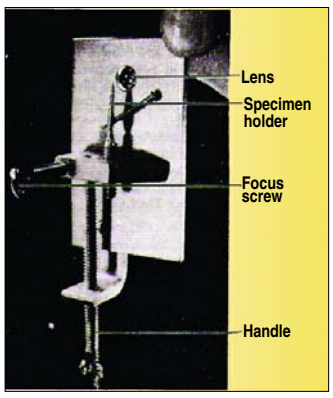
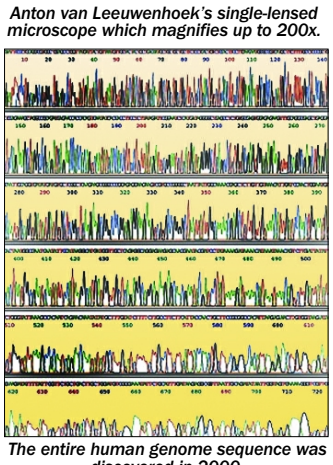
Building blocks

For a generation of students born at a time when incredible technological advances are commonplace, it is valuable to see how far we have come in understanding the mechanisms of genetic processes, writes tapan kumar maitra



Anton van Leeuwenhoek's single-lensed microscope which magnifies up to 200x.


The entire human genome sequence was discovered in 2000.

GENETICS is the study of inheritance in all of its manifestations, from the distribution of human traits in a family pedigree to the bio-chemistry of the genetic material in our chromosomes — deoxyribonucleic acid or DNA. Scientists introduce and describe the processes and patterns of inheritance.

For a generation of students born at a time when incredible technological advances are commonplace, it is valuable to see how far we have come in understanding the mechanisms of genetic processes by taking a very brief, encapsulated look at the modern history of genetics. Although we could discuss prehistoric concepts of animal and plant breeding and ideas going back to the ancient Greeks, we will restrict our brief overview to events beginning with the discovery of cells and microscopes. For our purposes, we would divide the history of genetics into four periods: before 1860, 1860-1900, 1900-1944, and 1944 to the present.

Before 1860

Before 1860 the most notable discoveries paving the way for our current understanding of genetics were the development of light microscopy, the elucidation of the cell theory, and the publication in 1859 of Charles Darwin's *The Origin of Species*. In 1665, Robert Hooke coined the term "cell" in his studies of cork. Hooke saw, in fact, empty cells observed at a magnification of about 30 power. Between 1674 and 1683, Anton van Leeuwenhoek discovered living organisms (protozoa and bacteria) in rainwater. Leeuwenhoek was a master lens-maker and produced magnifications of several hundred power from single lenses. More than 100 years passed before compound microscopes could equal Leeuwenhoek's magnifications. In 1833 Robert Brown — the discoverer of Brownian motion — discovered the nuclei of cells, and between 1835 and 1839, Hugo von Mohl described mitosis in nuclei. The era ended in 1858 with Rudolf Virchow summing up the concept of the cell with his Latin aphorism *omnis cellula e cellula* — all cells come from preexisting cells. Thus, by 1858, biologists had come to an understanding of the continuity of cells and a cell's nucleus.

1860 to 1900

This period encompasses the publication of Gregor Mendel's work with pea plants in 1866 to the rediscovery of his work in 1900. It includes the discoveries of chromosomes and their behaviour — insights that shed new light on Mendel's research.

From 1879 to 1885, with the aid of new staining techniques, W Flemming described the chromosomes — first noticed by C von Nageli in 1842 — including the way they split during division, and the separation of sister chromatids and their movement to opposite poles of the dividing cell during mitosis. In 1888 W Waldeyer first used the term chromosome. In 1875 0 Hertwig described the fusion of sperm and egg to form the zygote. In the 1880s Theodor Boveri, as well as K Rabl and E van Breden, hypothesised that chromosomes were individual structures with continuity from one generation to the next despite their "disappearance" between cell divisions. In 1885 August Weismann stated that inheritance is based exclusively in the nucleus. Further, in 1887 he predicted the occurrence of a reductional division we now call meiosis. By 1890 Hertwig and T Boveri had described the process of meiosis in detail.

1900 to 1944

From 1900 to 1944 modern genetics flourished with the development of the chromosomal theory which showed that chromosomes were linear arrays of genes. In addition, the foundations of modern evolutionary and molecular genetics were derived.

In 1900 three biologists working independently — Hugo de Vries, Carl Correns and Erich von Tschermak rediscovered Mendel's landmark work on the rules of inheritance, published in 1866, thus beginning the era of modern genetics. In 1903 Walter Sutton hypothesised the behaviour of chromosomes during meiosis and explained Mendel's rules of inheritance, thus leading to the discovery that genes were located on chromosomes. In 1913 Alfred Sturtevant created the first genetic map using the fruit fly. He showed that genes existed in a linear order on chromosomes. In 1927 L Stadler and HJ Muller showed that genes could be mutated artificially by X rays.

Between 1930 and 1932 RA Fisher, S Wright and JBS Haldane developed the algebraic foundations for our understanding of the process of evolution. In 1943 S Luria and M Delbriick demonstrated that bacteria have normal genetic systems and thus could serve as models for studying genetic processes.

1944 to the present

The period from 1944 to the present is the era of molecular genetics, beginning with the demonstration that DNA is the genetic material and culminating with our current explosion of knowledge due to recombinant DNA technology.

In 1944 0 Avery and his colleagues showed conclusively that deoxyribonucleic acid — DNA — *was* the genetic material. James Watson and Francis Crick worked out the structure of DNA in 1953. Between 1968 and 1973 W Arber, H Smith and D Nathans, along with their colleagues, discovered and described restriction endonucleases, the enzymes that opened up our ability to manipulate DNA through recombinant DNA technology. In 1972 Paul Berg was the first to create a recombinant DNA molecule.

Since 1972 geneticists have cloned numerous genes. Scientists now can create transgenic organisms with functioning foreign genes. For example, we now have farm animals that produce pharmaceuticals in their milk that are harvested easily and inexpensively for human use. In 1997 the first mammal was cloned, a sheep named Dolly. The sequence of the entire human genome was determined in 2000. Although no inherited disease has yet been cured by genetic intervention, we are on the verge of success in numerous diseases, including cancer. However, the material offered here is much too brief to convey any of the detail or excitement surrounding the discoveries of modern genetics.

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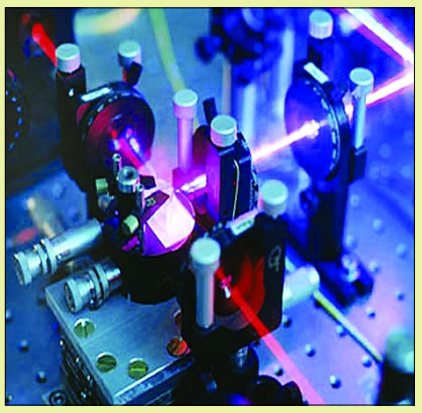
Human ingenuity

Quantum mechanics offers the best way to protect our most valuable data, writes christopher white

CRIMINALS no longer need to swagger into banks with their faces masked. Modern-day robbers are more likely to be armed with a degree in computer science than a gun. Your money or your life could still be at risk using even the smartest of encryption technologies. Conventional encryption, such as what might be used to protect your online banking transactions or the country's national security secrets, uses pure maths. A message containing secure government data or your bank details is transformed into "ciphertext", the encoded, garbled version of the message, for transmission, and then converted back upon receipt. Interception will produce only gibberish – unless it's deciphered.

The only way to decipher the message is by using a "key" – another random string of letters or numbers. Like cracking the world's most complicated safe in a heist movie, to uncrack the code you'd have to try every variation of the 128 letters and numbers – which would take a while. Those 128 bit-long keys are usually considered secure even against attacks that can check all the possible keys. But last year, an encryption used by some 3G networks was cracked by Israeli researchers within hours, allowing them to listen to your phone calls, in theory.

Orr Dunkelman, one of the researchers from the Weizmann Institute of Science, says the networks are still considered safe because their technique "assumes that the adversary can obtain a lot of data, and that he can control the encryption key to some extent". So our private


Quantum Cryptography basically uses the quantum theory with the security schemes based on Heisenberg's Uncertainty Principle.

conversations are safe for now. But it has encouraged businesses and governments to look for an alternative. Since an encrypted message has to be intercepted before it can be decoded, there is a solution found by abandoning maths for physics – specifically for quantum mechanics and the world of the very, very small. At the smallest scales, strange things happen. Waves behave like particles, and vice-versa. One consequence of this is Heisenberg's uncertainty principle and the notion that it is impossible to measure a system without disturbing it.


Andrew Shields

With communications that take full advantage of this, any disturbance created by cyber-criminals' eavesdropping is detectable and transmission can be cut off. "Security comes from knowing you have been compromised, rather than the absolute integrity of the 'safe'," says Norman Apsley, vice-president for business and innovation at the Institute of Physics. "Quantum cryptography has been a goal for some time, but many were sceptical that it would ever become a reality." A forthcoming report by the institute will show how far the science has come.

Andrew Shields of Toshiba Research Europe says, "The technique is based on sending secret digital keys across optical fibres using encoded single photons – particles of light – and so is technically very challenging." Toshiba and the National Physical Laboratory are working towards commercialisation, with products expected to fetch the cost of a high-end firewall. "Ultimately, quantum cryptography could find widespread use in telecom networks," says Shields. "In the near-term, it is most likely to find application in settings where information security is a high priority."

This is good news for us, and bad news for brash bank robbers, old and new. The laws of the universe and a little human ingenuity can foil the hardest and smartest of criminals.

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