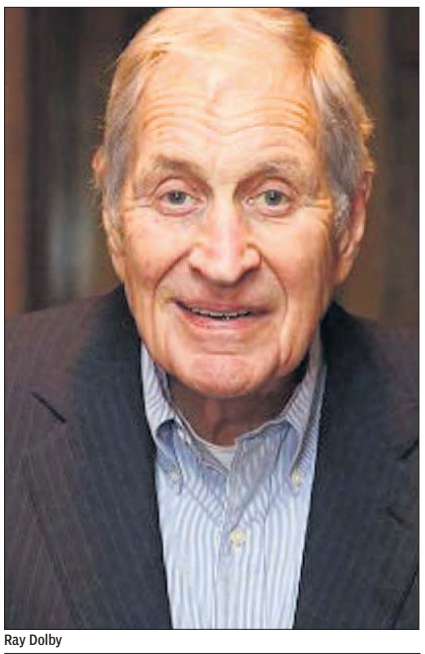
But the melody lingers

RAY DOLBY, WHO DIED LAST FRIDAY, REVOLUTIONISED THE QUALITY OF THE AUDIO EXPERIENCE, SAYS
S ANANTHANARAYAN

Ray Dolby (1933-2013) gave his name to the *noise reduction* system that brought music hall quality to sound recorded on magnetic tape and played back in every home. The quantum jump in quality made it meaningful to build better and costlier recording and playback equipment and the great burgeoning of recorded music in the decades till the '90s is surely thanks to Dolby NR.

Recording and playback of sounds became a practical possibility with Edison's invention of the phonograph in 1877. And as the technology was perfected, the decades that followed ushered in the new industry, of the sale of recordings, mainly music, which fast grew to be the major component of the world of entertainment. By 1877, great music had been written by master composers and was performed by soloists and orchestras. But while the music was immortal by being written down, it took performers for the music to be heard. Hence, the growth of sumptuous music halls in the Western world. But the experience was still limited and expensive.


Ray Dolby

Recorded music changed that forever. Now the genius of the composer and its interpretation by the orchestra could be carried in a phonograph record and played at will. Quality rapidly improved and prices fell and the greatest music, as also popular music, became truly available to common people.

The principle of the phonograph is simplicity itself. For creating the recording, vibrations of the original sound are transferred to a stylus, which marks an undulating groove on a soft, moving surface. The groove is then transferred to a more durable medium and the medium, which could be in the form of a cylinder or a disk, with the groove in a spiral, is set moving at the same speed as the original soft surface. A stylus placed in the groove then picks up the original sound vibrations and converts them to an electric current, which can drive a loudspeaker. But while there were great strides in improving the material of the records, the accuracy of the recording, with hi-fi and stereophonic sound, and the quality of the turntable, the pick-up and the amplifiers, a problem that could not be avoided was the appearance of scratches in the record groves. The scratches created unwanted crackle and disturbance and stole away the advantages of quality recording and faithful amplification.

The next revolution was the magnetic tape, which recorded the vibrations not as physical markings on a hard medium but as undulating magnetism embedded in plastic tape, to be picked up by a sensitive bit of coiled wire, the pick-up head. With the magnetic tape, there could be an accurate control of speed of the medium and the quality could be kept uniform, with no hint of scratches or crackle.

But although the tape recorder allowed home recording as well, it did not replace the disk record player, because bakelite, and later plastic (vinyl) discs could be mass-produced and were very simple to use. It was with the invention of the compact cassette, or musicassette, by Philips in 1963, that there was a real alternative to the phonograph disc. The introduction of portable audio cassette players made cassettes so popular that in the 1980s their sale overtook that of the Long Play records that had dominated.

But for all its convenience and versatility, the magnetic tape, during playback, introduces a *hiss*, or a high-pitched disturbance, which mars the quality of sound. Early measures, like filtering out the higher frequencies, affected the quality of the music, as tonality depends greatly on higher frequencies. One method tried was to boost the higher frequencies during recording so that they would be louder than the unwanted tape hiss. This also distorted the music and made the bass very dim during playback if the volume of the tape hiss were to be kept low. The same problems also beset the reproduction of speech and music in films, which also had high background noise.

Dolby's solution

Dolby's solution was apparently simple — amplify the high frequencies during recording and diminish the same frequencies during playback. The original sound then stays unchanged, but the noise, which enters during playback, gets suppressed. Though simply expressed, doing this in practice is complex. What takes place is that dim sounds at high frequencies are enhanced, so that a figure called the *dynamic range*, or the ratio of the loudest to the faintest sounds, is *compressed*. During playback, this process is undone, or the range is *expanded*.

The process, of compressing an expanding, is called *companding*. The device needs to first sense the loudness of the high frequency part, which is the part above 1 kHz, or the pitch above the second octave above Middle C on the piano keyboard, to decide the level of compression to be applied. At the time of playback, the decompression of the dynamic range is reversed, with the highest frequencies being diminished the most. That the two processes, which would usually take place on different equipment, should be standardised so that the music is not changed is evident. There is also need to keep it possible for music that has been compressed to be played back on equipment that does not have decompressing capability. This places a limit on the level of enhancement that can be employed.

Ray Dolby's Dolby Labs Inc first manufactured a system for use in professional recording studios. When this system was widely accepted, a simplified and cheaper system for consumer markets was developed. This system, known as Dobby B, became standard in prerecorded musicassetttes that flooded the markets from the 1970s. This is the version of Dolby Noise Reduction that allowed the music to be played back on cheaper players that did not have the Dolby decoding capability.

Dolby NR is relevant where the medium affects the output, which is the case in analog recording and playback. The medium does not get involved in digital recording and playback, where what is recorded is description of the sound, for creating the sound again during playback, not the sound itself. It is, hence, only *data* that is recorded in the medium. Dolby's role in digital sound is in the coding of the data of frequencies and the levels of loudness, for providing more channels, to create richer sound effects. As listeners have a pair of ears and no more, there is really nothing better in sound reproduction than stereophonic sound. But in surround sound, as many as six channels (Dolby 5.1) are used to create enhanced effects, or to introduce or compensate for acoustics of the listening hall.

But Dolby NR gave enormous impetus to the effort the world over, which led to greater quality of recorded music. The best music became affordable, it created commercial opportunities, benefited the musicians and ushered in and guided the developments in digital music. The name of Ray Dolby will sound in people's ears long after he is gone.

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HALLMARKS OF CANCER

TAPAN KUMAR MAITRA LISTS A SERIES OF PROPOSED ACQUIRED TRAITS THAT ARE COMMON TO, AND ESSENTIAL FOR THE DEVELOPMENT OF THE DISEASE

Because so many combinations of mutations involving tumor suppressor genes and oncogenes can lead to cancer, the question arises as to whether there are any common principles that would help simplify the picture. As a unifying concept, in 2000 Douglas Hanahan and Robert Weinberg proposed that a series of six acquired traits were common to, and essential for, the development of cancer, but each could be acquired through a variety of different genetic and epigenetic mechanisms. These six "hallmarks of cancer" are as follows:

■ Self-sufficiency in growth signals: Cells do not normally proliferate unless they are stimulated by an appropriate growth factor. Cancer cells escape this requirement through the action of oncogenes that produce excessive quantities or mutant versions of proteins involved in growth stimulating pathways. One such pathway commonly activated in cancer cells is the Ras pathway. About 25-30 per cent of all human cancers have mutant Ras proteins that provide an ongoing stimulus for the cell to proliferate, independent of growth factors. Mutations affecting other components of the Ras pathway are common as well.

■ Insensitivity to antigrowth signals: Normal tissues are protected from excessive cell proliferation by a variety of growth-inhibiting mechanisms. Cancer cells must evade such antigrowth signals if they are to continue proliferating. Most antigrowth signals act during late Gl and exert their effects through the Rb protein, whose phosphorylation regulates passage through the restriction point and into the S phase. For example, TGFb normally inhibits proliferation by triggering the TGFb-Smad pathway, which produces Cdk inhibitors that block Rb phosphorylation and thereby prevent passage from Gl into the S phase. In cancer cells, the TGFb-Smad pathway is disrupted by a variety of different mechanisms, including mutations, epigenetic changes and interactions with viral proteins.

Mutations in the RB gene also make cells insensitive to the antigrowth effects of TGFb or any other growth inhibitor that exerts its effects through the Rb protein.

■ Evasion of apoptosis: Evading apoptosis, which would otherwise destroy genetically damaged cells, is crucial to the survival of cancer cells. This is frequently accomplished by loss-of-function mutations in the p53 tumor suppressor gene, which disrupt the. main pathway by which DNA damage would otherwise trigger apoptosis. Several oncogenes, such as BCL2, also promote cancer cell survival by producing proteins that interfere with apoptosis.

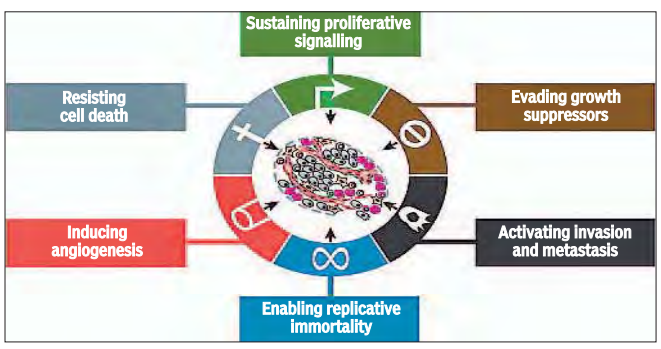
■ Limitless replicative potential: The overall effect of the preceding three traits is to uncouple cancer cells from the mechanisms that normally balance cell proliferation with an organism's need for new cells. However, this would not ensure unlimited proliferation in the absence of a mechanism for replenishing the telomere sequences that are lost from the ends of each chromosome during DNA replication. Telomere maintenance is usually accomplished by activating the gene coding for telomerase, but a few cancer cells activate an alternative mechanism for maintaining telomeres that involves the exchange of sequence information between chromosomes. In either case, cancer cells maintain telomere length above a critical threshold and thereby retain the ability to divide indefinitely.

■ Sustained angiogenesis: In the absence of a blood supply, tumors will not grow beyond a few millimetres in size. Thus, at some point during early tumor development, cancer cells must trigger angiogenesis. A common strategy involves the activation of genes coding for angiogenesis stimulators combined with the inhibition of genes coding for angiogenesis inhibitors. The mechanisms that underlie such changes in gene expression are not well understood, but in some cases they have been linked to the activities of known tumor suppressor genes or oncogenes. For example, the p53 protein activates the gene coding for the angiogenesis inhibitor thrombospondin; hence the loss of p53 function, which occurs in many human cancers, can cause thrombospondin levels to fall. Conversely, RAS oncogenes trigger increased expression of the gene coding for the angiogenesis activator VEGF.

■ Tissue invasion and metastasis: The ability to invade surrounding tissues and metastasize to distant sites is the defining trait that distinguishes a cancer from a benign tumor. Three properties exhibited by cancer cells play a crucial role in these events: decreased cell-cell adhesion, increased motility, and the production of proteases that degrade the extracellular matrix and basal lamina. Decreased adhesiveness is often caused by changes in E-cadherin, which is lost in the majority of epithelial cancers by either mutation, decreased gene expression, or destruction of E-cadherin itself. Changes in other molecules involved in cancer cell adhesion, motility and protease production also play a role in invasion and metastasis. However, the mechanisms underlying these molecular changes are not completely understood and they appear to differ among tumor types and tissue environments.

An enabling trait involves genetic instability. To acquire the preceding six traits, cancer cells need to accumulate more mutations than would be generated by normal mutation rates. Cells must therefore become genetically unstable before enough mutations can accumulate to cause cancer. Genetic instability arises most commonly from mutations that disrupt the ability of the p53 pathway to trigger the destruction of genetically damaged cells. However, defects in genes coding for proteins involved in DNA repair and chromosome sorting also play a role.

Genetic instability is placed in a category separate from the six "hallmark" traits, which are directly involved in cancer cell proliferation and spread, because genetic instability simply enables evolving populations of cancer cells to acquire the six hallmark traits.



The six hallmark capabilities originally proposed in Douglas Hanahan and Robert Weinberg's 2000 perspective. The past decade has witnessed remarkable progress toward understanding the mechanistic underpinnings of each hallmark.

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Why it's hard to swat a fly

IT SEES YOU COMING IN SLOW MOTION, WRITES
IAN JOHNSTON

Trying to swat a fly is like trying to shoot Keanu Reeves in *The Matrix* because time appears to move more slowly in the minds of smaller animals, a new study has claimed. The ultra-nimble fly is capable of processing nearly seven times as much information in a second as a human. This means a rolled-up piece of newspaper that is moving so fast that it appears as a blur to our eyes is, to the fly, more like the slow-motion bullets that are easily dodged by Neo, Reeves' character in *The Matrix*.

A paper published in *Animal Behaviour* journal found the perception of time was linked to the size of an animal's body and metabolic rate. But it can also change depending on the circumstances: time appears to slow down during stressful situations like a car crash because in an attempt to avoid disaster, the brain increases the amount of information it is taking in.

Dogs are able to process information at twice the rate of humans and so tend not to be interested in television. All they see is a flickering image, as if a projector had broken and the film slowed.

The scientists used the point at which a flickering light appears as a solid beam as a way to examine how different animals perceive time. Houseflies can see a light flickering at a rate nearly seven times faster than we can. "That's because they are getting much more information per second through their visual system... so that second feels longer," one of the researchers, Dr Luke McNally of Edinburgh University, said. "These animals are perceiving the world in a very, very different way."

This explains why flies seem so hard to hit. "(For the fly) it feels like you are moving so slowly towards them. It's the same as the famous bullet-time scene where the bullets are moving at this incredibly slow rate as far as Keanu is concerned," Dr McNally said.

At the other end of the scale, time rushes by for the slow-moving leatherback turtle because it gets only about a third of the amount of information that humans do in a second. "This perception of time coevolved with how fast you can move, how fast your metabolism is and how small you are," Dr McNally said. "There's very little point in gaining all this information if you cannot react to it."

However, there is at least one animal whose perception of time is at odds with its physical characteristics. "Tiger beetles can run faster than their eyes can keep up," Dr McNally said. "They run towards their prey, then they have to stop, and then sprint again and hope they'll hit into it."

Dr Andrew Jackson, from Trinity College Dublin, who led the study, said the effect may also account for the way time seems to speed up as we get older. "It's tempting to think that for children time moves more slowly than it does for grown-ups, and there is some evidence that it might."

THE INDEPENDENT

PLUS POINTS

Building blocks of life

With the origins of life on earth having mystified and fascinated scientists for centuries, researchers now believe they have added a vital piece to the jigsaw with the discovery that, under certain circumstances, collisions between icy comets and planets produce amino acids, the basic building blocks of life.

The team from Imperial College London, the University of Kent and Lawrence Livermore National Laboratory simulated a 15,000-mph collision and found that the amino acids were created in the searing heat and pressure of the impact, from a mixture of more basic substances found on comets, including ammonia, carbon dioxide and methanol — a form of alcohol. The discovery also has implications for the hunt for extraterrestrial life. Ice on the surfaces of Enceladus and Europa, the moons orbiting Saturn and Jupiter, respectively, could provide the perfect conditions for producing amino acids from meteor impacts.


Zita Martins

In a paper published online by Nature Geoscience, the researchers said their findings "suggest a pathway for the synthetic production of the components of proteins within our solar system, and thus a potential pathway towards life through icy impacts".

Dr Zita Martins of Imperial College London said they had tried a range of different mixtures during the near four-year project before getting positive results. "I'm not going to say it was a eureka moment, but I was extremely happy," she said.

Earth was bombarded by comets and meteorites between 4.5 billion and 3.8 billion years ago and life is thought to have originated about 3.5 billion years ago. Dr Martins said the next steps in the origin of life remained "one of the big questions" in science.

THE INDEPENDENT

Shrimp farming

Ikea-like portable units using microbes and solar power to cheaply grow shrimp indoors could transform the booming aquaculture sector and prevent further environmental degradation, according to its inventors. If made available to farmers in developing countries, the technology could help tackle malnourishment while reducing degradation, and all at a lower cost than current shrimp production, they say.

Founded by biochemical engineering students from University College London, the start-up, Marizca, is producing whiteleg shrimp in central London in its first trial operations. Global production of farmed shrimp has been growing at about 10 per cent a year, according to the World Wildlife Fund and farmed shrimp now accounts for about 55 per cent of global production. But the industry has been criticised over the past decade for environmentally damaging practices that lead to the destruction of mangrove forests and pollution caused by effluents from shrimp ponds.

Marizca co-founder Leonardo Rios says the firm's indoor units will avoid the problems caused by creating outdoor shrimp farms in fragile environments. While such indoor facilities are normally expensive to run, Rios says the use of water-purifying bacteria in their units means less water and energy is needed. Also, the micro-organisms meet up to 30 per cent of the shrimp's food needs.

"The bacteria eat the shrimp waste and, at the same time, the shrimp eat the bacteria when they have reached a certain size," he says. "It makes producing shrimp a lot cheaper."

Using micro-organisms in aquaculture — a technology called biofloc — is not new. Several such operations exist worldwide, but so far they have had limited reach, according to Michael Phillips, a researcher at WorldFish, a non-profit aquaculture research centre. "Biofloc is not yet widely applied because the technology is not yet perfected or even widely available," he says.

What is new about Marizca's biofloc technology is the use of a "unique" starch source, according to Rios. He says the starch helps create prolific micro-organism growth.

Current interest in biofloc stems from a research drive to find an alternative food source for farmed shrimp. According to Phillips, most shrimp farms rely on industrial feed made partly from fishmeal, a practice that many see as unsustainable.

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