



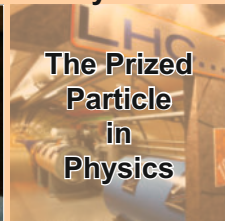
Mathematics of Planet Earth

Nobel Prize 2013

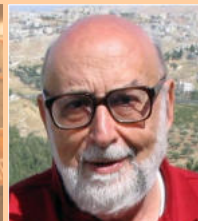
Physics



Peter W. Higgs



The Prized
Particle
in
Physics



François Englert

Chemistry



Martin Karplus



Michael Levitt



Arieh Warshel

Physiology or Medicine



James E. Rothman



Randy W. Schekman



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Comet ISON - One-time visitor to Sun



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Some interesting dilemmas in communicating science & technology: A synthesis



Dr. R. Gopichandran

Communication regarding science and technology is apparently replete with dilemmas. This is particularly so when news media carry messages about developments with significant potential to influence quality of life, markets, and especially, whole landscapes of bio resources. Biotechnology is the typical case in point. The objective of this note is to consolidate some important strands of thinking in this area for the benefit of particularly the young and emerging professionals engaged in science and technology communication.

Weiss (Ref. 1) presents an excellent overview with respect to information on genetically modified organisms in particular and the role of media in convincing the public about benefits or raising an alarm, and the variants of these extremes. Media specialists also recognise the need to explain the process by which science provides answers. This is based on the fundamental premise that it is essential to know the truth and then infer, depending on other determinants of implications. The process of engagement with the public becomes equally important in this context. The perspectives of the stake holder groups could also vary significantly depending on their own circumstances and considerations for development.

Bubela *et al.* (2009) discuss several well-known models that guide communication strategies. Importantly, they state that public perception may consolidate stands contrary to those of scientists. These could also relate to the spread and depth of in sights/information they access and develop. It is equally important to assess these foundations of the superstructure of response to a call for opinion and engagement for decision making. This imperative is aptly articulated by Bubela *et al.* (op.cit.) that it is essential to go beyond personal experiences and anecdotal observations. A larger determinant is reportedly the fundamental difference in the manner in which scientists and communicators view research. An over arching need is to define the process of communication with goals and the diversity of issues that dominate understanding.

An equally robust area is the understanding of climate change phenomenon and its impacts. It is obvious that newer in sights emerge with continually evolving models and the body of empirical evidences. Quite obviously management strategies cannot be isolated from the science of issues. Options for management based on the latter are driven by socio- political considerations and hence the scope for inclusive debates on the implications of processes for internalising externalities. Communication on the continually evolving dynamics and preponderance of determinants has to necessarily include all facets of science, technology and management and cannot be through stand-alone perspectives.

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Charles Lyell

The foremost geologist of his day



Dr. Subodh Mahanti

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“It would be no less desirable that a geologist should be well versed in chemistry, natural philosophy, mineralogy, zoology, comparative anatomy, botany, in short, in every science relating to organic and inorganic nature. With these accomplishments the historian and geologist would rarely fail to draw correct and philosophical conclusions from the various monuments transmitted to them of former occurrences.”

Charles Lyell

“Lyell was responsible for the general acceptance of the principles of uniformitarianism, the idea that rocks and geological formations are the result of the ordinary processes that go on every day, but acting over very long periods of time. This principle was first advocated in a general way by Hutton, but was much more convincingly illustrated and argued by Lyell.”

The Cambridge Dictionary of Scientists, 2000.

“In 1830, Lyell published the first volume of *The Principles of Geology: Being an Attempt to Explain the Former Changes of the Earth's Surface by Reference to Causes Now in Operation*. One copy was destined to become well-thumbed as it began a journey the following year aboard the *HMS Beagle* in the most famous voyage in the history of science. Its owner was Charles Darwin.”

Ray Spangenburg and Diane K. Moser in *“The History of Science in the Nineteenth Century”, 1999.*

Charles Lyell is best known as the author of his classic work *The Principles of Geology: Being an Attempt to Explain the Former Changes of the Earth's Surface, by Reference to Causes Now in Operation*, published in 1830-33. The work is simply known as *Principles of Geology*. Throughout his life Lyell reminded his fellow geologists the importance of field work and extensive travel. The book established Lyell's credentials as an important geological theorist. Through this book he popularised the doctrine of uniformitarianism, originally proposed by James Hutton. The doctrine of uniformitarianism can be simply stated as ‘the present is the key to the past’—the geological remains from the distant past can and should be explained by reference to geological processes now in operation which can be observed directly.

In the first volume Lyell argued with adequate facts that the geological causes seen today were enough to produce past geological effects. The second volume attempted to tackle the vexing question of fossil record. In the third volume, in addition to introducing a new classification of the Tertiary period, he responded to the critics of his propositions.

Lyell's *Principles of Geology* was the most influential geological work in the middle of the 19th century. The book was to be published in 11 editions in Lyell's lifetime



Charles Lyell

and he was working for the 12th edition at the time of his death. It contributed significantly to put geology on a modern footing. One of the important aspects of Lyell's book was his approach to collect facts for the purpose of supporting or rejecting a hypothesis. While there was rigour in its argument, at the same time it was accessible to a wide section of the educated public. Lyell's observational methods and general analytical framework presented in *Principles of Geology* remain

in use today as foundational principles in geology. It may be noted that some of Lyell's mechanisms for geologic processes were later proved wrong.

Principles of Geology exerted a powerful influence on the young Charles Darwin, who was given the first volume by Robert FitzRoy, captain of *HMS Beagle*, just before they set out on the voyage of the *Beagle*. The first stop of *HMS Beagle* ashore was at St. Jago. The rock formations seen ‘through Lyell's eyes’ gave Darwin a revolutionary insight into the geological history of the island and Darwin applied this insight throughout his journey. Commenting on the importance of Lyell's book Darwin wrote: “The very first place which I examined...showed me clearly the wonderful superiority of Lyell's manner of treating geology, compared with that of any other author, whose work I had with me or ever afterwards read.” It may be noted that the theory of gradual change over time, the main focus of Lyell's *Principles of Geology*, also appears in Darwin's theory of evolution. It can be argued that without Lyell it would have been impossible for Darwin to come up with the theory of evolution because evolution by its very definition suggests slow gradual change. On the return of the *HMS Beagle* in October 1836, Lyell invited Darwin to dinner and afterwards they remained close friends till the end.

Lyell's book *Elements of Geology*, published in 1837, was the first modern textbook of geology. It emerged out of his *Principles of Geology* when the factual description of geological formations of different ages contained in it became unwieldy to handle. Lyell thought that *Elements of Geology* would act as a suitable field guide for students of geology. The book went to six editions in Lyell's life time. Eventually it became a two-volume work which was neither portable nor inexpensive handbook for students, as Lyell had originally desired. Towards the end of his career Lyell produced a condensed version *Student's Elements of Geology* for realising his original intention. His book titled *Geological Evidences of the Antiquity of Man* (1863) was a wide-ranging study of the human fossil record. It presented Lyell's views on three key themes from the geology of the Quaternary Period of Earth history: glaciers, evolution, and the age of the human race. He wrote two popular travel-and-geology books namely, *Travels in North America* (1845) and *A Second Visit to the United States* (1849).

Though Lyell contributed considerable knowledge and analysis to geology, his reputation declined after his death, which was to be restored by Archibald Geikie in his *Founders of Geology*, published in 1905. Geikie was the head of the Geological Survey of Great Britain.

Charles Lyell was born on 14 November 1797 at Kinnordy, Forfarshire, Scotland. His father also named Charles Lyell was a lawyer, but also pursued his hobby as a naturalist. In fact he was a botanist of reputation. It was his father who exposed Lyell to the study of nature. In his childhood young Charles developed a habit of collecting butterflies and insects. Lyell's hobby was not well appreciated by fellow villagers. He



Alexander von Humboldt



George Cuvier



Reverend William Buckland

studied in various private schools before entering Exeter College of Oxford University in 1817. In 1819, Lyell obtained his BA degree in classics from Oxford University and then moved to London for studying law. His deteriorating eyesight hampered his law studies and turned his attention to geological studies as a hobby. He presented his first research paper in geology in 1822.

It was entitled "On a recent formation of freshwater limestone in Forfarshire". He undertook geological field excursions. In 1823, he went to Paris where he took part in geological studies of the Paris basin. At Paris he also met Alexander von Humboldt and George Cuvier. In 1823, he was elected Joint Secretary of the Geological Society of London. Lyell was greatly influenced by Reverend William Buckland (1784-1856), an English theologian and a geologist and palaeontologist.

Lyell obtained his law degree in 1825 and was called to the bar. However, he continued to pursue his interest in geological studies. He was asked to survey Forfarshire to complete the map of Scotland. In 1827, he finally abandoned law and embarked on a geological career.

Based on his own field

experiences, Lyell preferred Hutton's ideas on the history of Earth to the common geological teaching of the time. He adopted and expanded the ideas of Hutton and made them popular. He reinforced and expanded Hutton's ideas by his extensive observations and clearly formulated arguments.

In those days most geologists believed that the Earth was shaped by cataclysmic events and that the history of Earth spanned only a few thousand years. Lyell was responsible for the general acceptance of the principle of uniformitarianism.

Lyell helped to develop the business of modern extractive

industries, such as coal and oil industry by endorsing geological surveys and advancing the study of geology. He proposed that geological surveys, by identifying mineral-rich regions, could provide 'economic advantages'.

Based on his studies of Vesuvius and Etna volcanoes, Lyell supported the idea of gradual building (or so-called 'backed up-building') of volcanoes, which was in opposition to the idea that volcanoes must have been formed by a combination of eruptions and upheavals proposed by Leopold von Buch and backed by other geologists.

Lyell made significant contribution in the field of stratigraphy, the branch of geology dealing with the study of the nature, distribution, and relations of stratified rocks of the Earth's crust. After his geological excursions to the Auvergne volcanic district of France and certain areas of Italy, Lyell concluded that the recent strata (rock layers) could be categorised according to the number and proportion of marine shells encased

within. He travelled to these areas with Roderick Impey Murchison (1792-1871). Lyell incorporated a Tertiary period into his classification system of geologic time, which was far more detailed.

It may be noted that the term 'Tertiary' was first used by Giovanni Arduino in 1770s. Arduino, based

on his observations of geology in northern Italy, classified geologic time into Primitive (Primary), Secondary, and Tertiary. Later a fourth period, the Quaternary period was added. Lyell subdivided the Tertiary period into four epochs based on the proportion of fossil molluscs resembling modern species found in those strata and named them as Eocene, Miocene, Older Pliocene, and Newer

Pliocene. The divisions worked out by Lyell were found to be adequate for the region (parts of the Alps and plains of Italy) to which the designations were originally applied. However, the system could not be successfully applied to other parts of Europe and America.



Roderick Impey Murchison

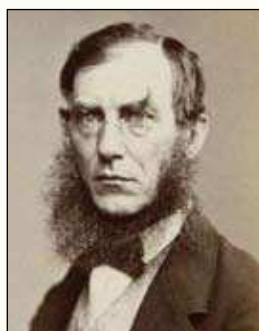


Giovanni Arduino

It may be noted that the classification of the Tertiary rocks proved to be a matter of unusual difficulty because they occurred in disconnected basins, forming a series of detached areas. Today the International Commission on Stratigraphy does not recognise the Tertiary period as a formal unit. The traditional span of the Tertiary period was divided between Palaeogene (Palaeocene, Eocene and Oligocene epochs) and Neogene (Miocene and Pliocene epochs) periods. The term Tertiary is still found in common usage and includes five geologic epochs—Palaeocene, Eocene, Oligocene, Miocene and Pliocene). The Tertiary covers roughly the time-span between the extinction of the dinosaurs and the beginning of the most recent Ice Age.

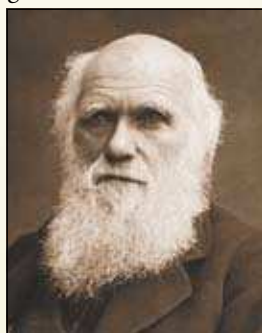
The Modern Geologic Time Scale, which documents intervals of geologic time relative to one another, is the result of continuous development and updation over the last two centuries. In the Geologic Time Scale, time is usually divided on the basis of the Earth's biotic composition. The Phanerozoic Eon, consisting of Palaeozoic (meaning ancient life), Mesozoic (meaning middle life) and Cenozoic (meaning recent life) Eras, represents the period of Earth's history with advanced life forms, and the Pre-Cambrian, consisting of Proterozoic and Hadean Eras, represents the period before advanced life. Eras are further divided into major Periods and Eons.

It should be noted that Lyell and Joseph Dalton Hooker (1817-1911), the British plant taxonomist and explorer, played an instrumental role in arranging the peaceful co-publication of the theory of natural selection by Darwin and Alfred Russel Wallace. Lyell was sceptical about evolution. Darwin discussed evolutionary ideas with Lyell from 1842. Only after the publication of *On the Origin of Species* (1859), Lyell offered a lukewarm endorsement of evolution in the tenth edition of his *Principles of Geology*. In fact his book *Geological Evidences of the Antiquity of Man* (1863)



Joseph Dalton Hooker

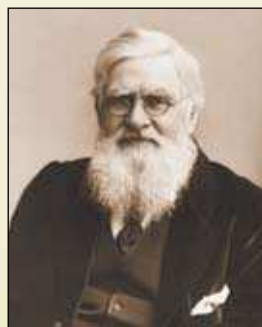
me think of the time when I first saw him, and how full of sympathy and interest he was about what I could tell him of coral reefs and South America. I think that this sympathy with the work of every other naturalist was one of the finest features of his character. How completely he revolutionised Geology: for I can remember something of pre-Lyellian days. I never forget that almost everything I have done in science I owe to the study of his great works. Well, he had a grand and happy career, and no one ever worked with truer zeal in a noble cause."



Charles Darwin

Lyell was knighted in 1848. In 1858, he received the Copley Medal, the highest award of the Royal Society. He was elected foreign member the Royal Swedish Academy of Sciences (1866). He became the President of the British Association for the Advancement of Science in 1864. He was the President of the Geological Society of London (1834-1836).

Lyell died on 22 February 1875. He was buried in Westminster Abbey. At the time of his death he was revising the 12th edition of his *Principles of Geology*. Mount Lyell, the highest peak in Yosemite National Park in USA is named after Lyell. A crater on Moon and a crater on Mars were named after Lyell. Mount Lyell in western Tasmania, Australia and Lyell Range in north-west Western Australia bear his name. Louis Agassiz named the jawless fish *Cephalaspis lyelli* from the Old Red Sandstone of southern Scotland in honour of Lyell.



Alfred Russel Wallace

Some of the books on Lyell's life and work

are: *Charles Lyell, The Years to 1841: The Revolution in Geology* by Leonard Wilson (1972); *Lyell in America: Transatlantic Geology, 1841-1853* by Leonard Wilson (1998); *Lyell: The Past is Key to the Present*, edited by Derek J. Blundell and Andrew C. Scott (1998).

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(The article is a popular presentation of the important points on the life and work of Charles Lyell available in the existing literature. The idea is to inspire the younger generation to know more about Charles Lyell. The sources consulted for writing this article have been listed. However, the sources on the Internet have not been individually listed. The author is grateful to all those authors whose writings have contributed to writing this article. The author is also grateful to the sources from which the illustrations/photographs have been reproduced.) ■

VP website



The Prized Particle in Physics



Rintu Nath

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The Royal Swedish Academy of Sciences has announced the award of the Nobel Prize in Physics for 2013 jointly to Peter W. Higgs of the University of Edinburgh, UK, and François Englert of Université Libre de Bruxelles, Brussels, Belgium, “for the theoretical discovery of a mechanism that contributes to our understanding of the origin of mass of subatomic particles, and which recently was confirmed through the discovery of the predicted fundamental particle, by the ATLAS and CMS experiments at CERN’s Large Hadron Collider.” The awarded theory is a central part of the Standard Model of Particle Physics that describes how the Universe is constructed. According to the Standard Model, everything consists of just a few building blocks.

Responding to news that Peter Higgs and Francois Englert have been awarded the 2013 Nobel Prize for Physics, John Pethica, Physical Secretary and Vice-President of the Royal Society, said,

“Peter Higgs and Francois Englert are deserving winners of the Nobel Prize. Their work has helped shape our fundamental understanding of the world around us. The search for and finding of the Higgs boson at the Large Hadron Collider in CERN has captured the public imagination in a spectacular way that will help inspire the next generation of physicists. Their ideas have helped drive a truly international undertaking in the pursuit of a key part of the standard model.”

The Standard Model also rests on the existence of a special kind of particle: the Higgs particle or Higgs boson. The Higgs boson helps us comprehend the Universe

better. Without the Higgs boson, there would be no mass. For sure, without mass there would be no atoms, no planets, no stars, and no galaxies. And there would be no plants, animals, nor human beings! Massless particles would travel at the speed of light following the diktats of Einstein’s theory of relativity; and they would continue to do so for ever. They would have no past, present or future. Higgs particle gives us mass, and our existence. The theory proposed by Englert and Higgs described a mechanism that explains how subatomic particles gain mass by interacting with a ‘Higgs field’ that permeates all space.



Peter W. Higgs



François Englert

has to understand the fundamental particles and how fundamental forces interact with them.

Molecules are made of atoms. Atoms are made of protons, neutrons, and electrons. Although electrons are considered one of the fundamental particles, protons and neutrons are made of even smaller

The Standard Model

The building blocks of our Universe are the fundamental particles and fundamental forces. To understand our Universe, one

particles called quarks.

Over the years, the physicists have worked out a mathematical model – The Standard Model – that describes the fundamental particles and interaction of the fundamental forces. Fundamental particles are broadly classified as fermions (named after physicist Enrico Fermi) and bosons (named after Indian physicist Satyendra Nath Bose who proposed them). Fermions are the fundamental particles that make up matter we are familiar with and bosons are the particles that carry or transmit the forces.

Apart from the fundamental particles, nature has four fundamental forces: electromagnetic force, strong nuclear force, weak nuclear force, and gravitational force. The Standard Model also explains three out of the four fundamental forces and their interactions. The theory explains the three fundamental interactions called the electromagnetic, strong, and weak nuclear interactions that mediate between the subatomic particles.

The Standard Model was driven forward sometimes by new experimental discoveries and sometimes by theoretical advances and spanned many decades and many continents. During 1961 American theoretical physicist Sheldon Lee Glashow proposed a symmetry structure to combine electromagnetic and electroweak interactions. Glashow predicted a short range neutral weak current. In 1964 Peter Higgs proposed a mechanism to explain how subatomic particles gain mass by interacting with a field that permeates all space. He proposed that the field prevails throughout the cosmos: any particle that interacts with it is given a mass via the Higgs boson. The field was later named ‘Higgs field’ and the process came to be known as ‘Higgs mechanism’. The Higgs mechanism is believed to give rise to the masses of all



Sheldon Lee Glashow



Abdus Salam



Steven Weinberg

The Nobel Prize in Physics 1979 was awarded jointly to Sheldon Lee Glashow, Abdus Salam and Steven Weinberg “for their contributions to the theory of the unified weak and electromagnetic interaction between elementary particles, including, inter alia, the prediction of the weak neutral current”.

the elementary particles in the Standard Model.

During the same time Francois Englert independently published his own, similar theory, along with his now deceased colleague Robert Brout. In fact the paper jointly written by Englert and Brout was published before Peter Higgs published his paper. A few weeks later, two American theoretical Physicists, Gerald S. Guralnik from Brown University, Carl Richard Hagen from the University of Rochester, and one British theoretical physicist, Thomas W. B. Kibble from Imperial College London, UK, jointly published paper explaining a similar mechanism.

In 1967 another American theoretical physicist Steven Weinberg and Pakistani theoretical physicist Abdus Salam incorporated the Higgs mechanism into Glashow's electroweak theory, giving it its modern form.

The neutral weak currents as predicted by Glashow were discovered at CERN in 1973. After this experimental validation, the electroweak theory became widely accepted and Glashow, Salam, and Weinberg shared the 1979 Nobel Prize in Physics for discovering it.

Discovery of Higgs boson

Till recently, the Higgs boson existed only in theory; no experimental evidence of the existence of the Higgs boson was found. During last 40 years physicists tried to find the Higgs boson and did several experiments to create conditions that could simulate the formation of the early Universe. Fermi Lab in

2013 Nobel Prize in Chemistry



Martin Karplus



Michael Levitt



Arieh Warshel

The Nobel Prize in Chemistry 2013 was awarded jointly to Martin Karplus, Michael Levitt and Arieh Warshel "for the development of multi-scale models for complex chemical systems".

Martin Karplus

Université de Strasbourg, France and Harvard University, Cambridge, MA, USA

Michael Levitt

Stanford University School of Medicine, Stanford, CA, USA

Arieh Warshel

University of Southern California, Los Angeles, CA, USA

Chemical reactions occur at lightning speed. In a fraction of a millisecond, electrons jump from one atomic nucleus to the other. Classical chemistry has a hard time keeping up; it is virtually impossible to experimentally map every little step in a chemical process. Aided by the methods, now awarded with the Nobel Prize in Chemistry, scientists let computers unveil chemical processes, such as a catalyst's purification of exhaust fumes or the photosynthesis in green leaves.

[A detailed account of the awarded work will be published in a future issue of Dream 2047.]

Collider (LHC), a larger and more powerful particle accelerator, which could accelerate protons up to 7 trillion electron volts (TeV). Scientists did a number of experiments during last three years to search for any evidence that confirms the existence of the Higgs boson.

The Standard Model does not predict an exact mass of the Higgs boson. In a particle accelerator like LHC, smashing protons at near-light speed generates a vast shower of particles that are created only at extremely high energies. Systematic analysis of data is carried out to search for a particle over a range of masses. Scientists knew that Higgs boson cannot be observed directly because of its extremely short life of "a millionth of a millionth of a millionth of a second". They were looking for the Higgs boson that only fleetingly exists in a soup of particles but leaves behind a trail of other particles that could prove its existence. It was predicted that Higgs boson should have a mass much more than that of protons.

Finally on 4 July 2012, scientists of CERN announced that the long-sought Higgs boson does exist. Experiments conducted in the Large Hadron Collider yielded results that were consistent with its existence. Scientists found data

corresponding to a particle weighing about 125 billion electron-volts (GeV), which is about 133 times heavier than protons, thus confirming Higgs boson.

The theory on the fundamental particle Higgs boson, as proposed by Peter Higgs and François Englert, was conclusively confirmed by the ATLAS and CMS experiments at CERN's Large Hadron Collider after a gap of 48 years. This year's Nobel Prize in Physics follows this long-sought discovery.

The road ahead

According to scientists a key riddle in cosmology may be answered by the discovery of the Higgs boson. In addition to explaining the masses of elementary particles, the Higgs boson may have far-reaching implications for the generation



The Nobel Prize in Physiology or Medicine 2013



James E. Rothman



Randy W. Schekman



Thomas C. Südhof

The Nobel Prize in Physiology or Medicine 2013 was awarded jointly to James E. Rothman, Randy W. Schekman and Thomas C. Südhof “for their discoveries of machinery regulating vesicle traffic, a major transport system in our cells”.

James E. Rothman

Yale University, New Haven, CT, USA

Randy W. Schekman

University of California, Berkeley, CA, USA, Howard Hughes Medical Institute

Thomas C. Südhof

Stanford University, Stanford, CA, USA, Howard Hughes Medical Institute

The 2013 Nobel Prize in Physiology or Medicine honours three scientists who have solved the mystery of how the cell organises its transport system. Each cell is a factory that produces and exports molecules. For instance, insulin is manufactured and released into the blood and chemical signals called neurotransmitters are sent from one nerve cell to another. These molecules are transported around the cell in small packages called vesicles. The three Nobel Laureates have discovered the molecular principles that govern how this cargo is delivered to the right place at the right time in the cell.

[The full story of the awarded work will be published in a future issue of *Dream 2047*.]

of the matter content in the Universe. In a recent paper in *Physical Review Letters*, two physicists - Sean Tulin of the University of Michigan in Ann Arbor and G  rardine Servant of the Catalan Institute for Research and Advanced Study in Barcelona, Spain - have suggested that the Higgs boson may have had a key role in the early Universe, producing the observed imbalance between matter and antimatter particles and determining the density of the mysterious dark matter that makes up five-sixths of the matter in the Universe. They suggest that there may have been an asymmetry in the early Universe between the Higgs boson and its antimatter counterpart, the anti-Higgs. They propose a new cosmological scenario where the “Higgs chemical potential mediates asymmetries between visible and dark matter sectors, either generating a baryon asymmetry from a dark

matter asymmetry or vice-versa.” The Higgs boson is not known to have an antiparticle currently, but the standard cosmological model allows for there to have been both

Higgs bosons and anti-Higgs bosons in the very early Universe.

Tulin and Servant’s idea is that there was an imbalance between the numbers of these particles. The Higgs interacts with ordinary matter, and that imbalance in the number of Higgs and anti-Higgs particles could have translated into an asymmetry in the amount of matter and antimatter. The team has dubbed the idea ‘Higgsogenesis’, after baryogenesis, the name of an early-Universe process that has been proposed to create more baryons (particles including protons and neutrons) than anti-baryons.

Tulin and Servant show that if the Higgs also interacted with dark matter – for example by generating dark-matter particles when it decays – it could produce a ratio of dark to visible matter that is just what we see in the Universe today. One consequence of the Higgs interacting in this way would be a new potential test for dark matter, which has so far proven difficult to see directly.

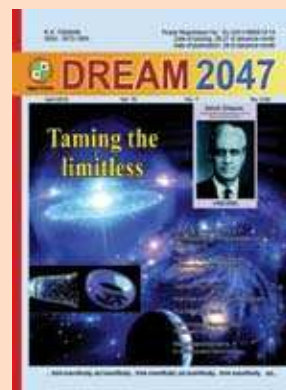
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Our Microbiomes



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The word biome is used by ecologists to describe a complex biotic community characterised by life forms, animals, plants, birds, insects, reptiles, fungi, and lichens that can be found in a place; especially such a community that has developed to climax. According to one definition (Wikipedia): "A microbiome is the collective genomes of the microorganisms that reside in an environmental niche. The term "microbiome" was coined by Joshua Lederberg, who argued that microorganisms inhabiting the human body should be included as part of the human genome, because of their influence on human physiology. The human body contains over 10 times more microbial cells than human cells,"

Scientists have long known that the human body coexists with trillions of individual germs, what they call the microbiome. Until now, they have mostly studied those that cause disease. One may recall health officials saying about a third of the population carries *Staphylococcus aureus* harmlessly in their noses or on their skin but can infect others. Indeed, within the body of a healthy adult, microbial cells are estimated to outnumber human cells by a factor of ten to one; although their total mass is much less because the mass of these cells is much less than that of cells that are conventionally believed to solely constitute a human body.

The National Institutes of Health in USA have taken up a research initiative termed as the Human Microbiome Project (HMP). It takes advantage of recent technological advances and is as big a project as the Human Genome Project that revealed the DNA sequences of the genes of the human body. The mission of HMP is to generate resources enabling comprehensive characterisation of each microbe present in a human body and analysis of its role in human health and disease.

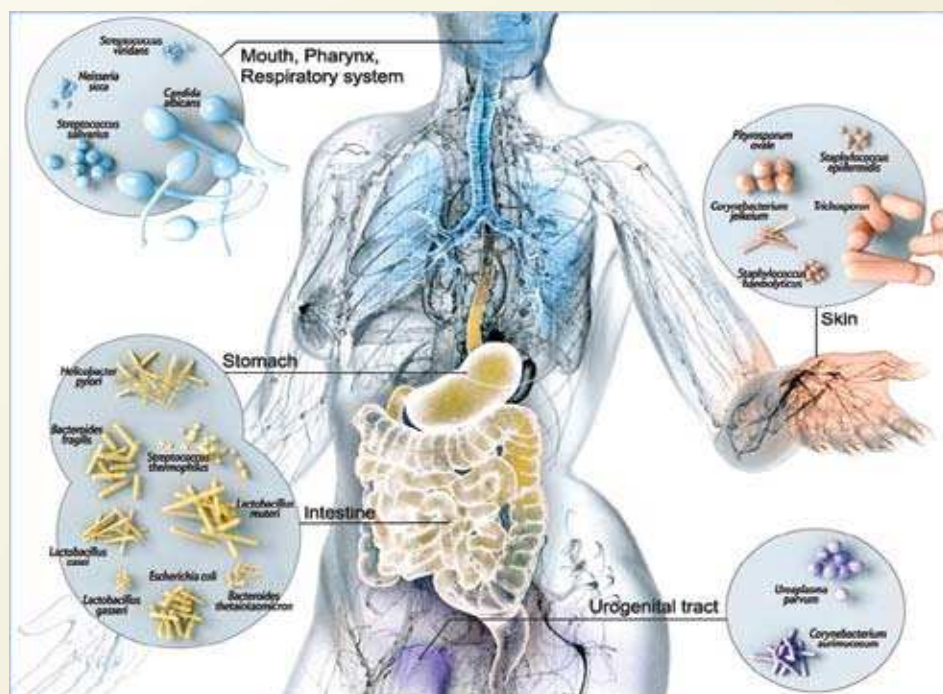
Traditional microbiology has focussed on the study of individual species as isolated units. However, many, if not most, have never been successfully isolated as viable specimens for analysis, presumably because their growth is dependent upon a specific micro-environment that has not been, or cannot be, reproduced experimentally. Even among those species that have been isolated, analyses of genetic makeup, gene expression

patterns, and metabolic physiologies have rarely extended to inter-species interactions or microbe-host interactions.

Some relevant questions

Is the microbiome of every human body similar, if not why? The answer is, no. Microbiome of each animal body, whether human or otherwise, is different from that of all other bodies, just as the genome. There are millions of kinds of microbes present and the population density of each kind can be different, even if the same kind are present in two bodies. We don't all have the same composition of different bacteria although they all seem to have been organised to do almost the same things. It may be that our

bacteria living on the human forearm than on any other part of the body. According to a new study, on average, 44 different types of bacteria reside on the forearm, compared with 19 species living behind the ear, says a study by the National Human Genome Research Institute. The team took skin samples from 20 sites on the bodies of 10 healthy volunteers who had been asked to wash with a mild soap for one week and come to the lab after not washing for 24 hours. The skin sites were picked to



Some of the microorganisms that comprise the body's microbiome.
(Credit: Bryan Christie for Scientific American)

lifestyle and environment induces each of us to have arrived at a particular composition of microbiome within us.

About the location of the microbiome in the human body, some scientists had suggested that most of the microbiome is concentrated in the intestines. But that may not be really true. It is much more likely, as some recent studies indicate that the microbiome of a body is spread out throughout the body. For example, it has been found that there is a greater diversity of

represent three micro environments: oily, moist, and dry. Oily sites included the space between the eyebrows, beside the nose, inside the ear, back of the scalp, and upper chest and back. However, the microbiome present in different parts of a body is seldom exactly the same; it has a local flavour, so the composition of microbes present in different parts is different.

As to the question of how the microbiome originates in a body, some workers in this field believe that the human

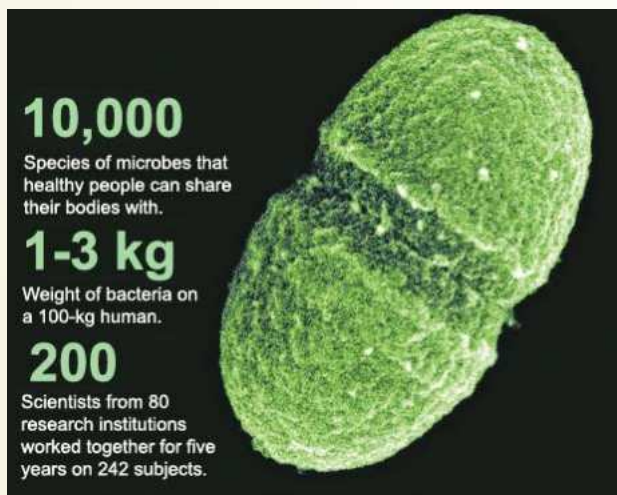
gut (intestine) is sterile at birth. Immediately after birth, it is colonised by numerous types of microorganisms. Some of these microorganisms enter the body through air that is breathed in; some through water and food, and still others through contact with persons around and objects surrounding the person at different stages of life. Indeed scientists have developed an atlas of the bacteria that live in different regions of the human body.

The microbiome present in the body has great impact on our health. The microbes affect the functioning of the cells of our tissues and also affect our immunity towards attack from other harmful microbes. There

is a prevalent idea that the composition of bacteria present in the intestines of a person may affect mood and behaviour. This idea is supported by a series of elegant studies by several published scientific studies.

There is evidence to indicate that a microbiome can affect the mind too and hence the behaviour of a person. The idea that the composition of bacteria present in the body of a person may affect mood and behaviour is indeed supported by a series of elegant studies by several published scientific studies. For example, a recent study showed that a specific dietary manipulation positively affected memory and reduced anxiety-like behavior. These changes were associated with significant increases in diversity of the microbiome as analysed by the most up-to-date molecular methodology (pyrosequencing - a method of DNA sequencing based on the "sequencing by synthesis" principle). Microbes present in a body are not static; they can travel throughout the body via the blood stream so they can indeed affect the nerve cells that control the body and the mind.

Scientists have determined how the microbiome in an individual human differs from that in another. It is quite likely that the genome determines the microbiome. The propensity of a body to host a particular



Non-human microorganisms outnumber our own cells by a factor of 10 to 1.

microbiome is very likely determined by its genome. The history of an individual since birth also affects the microbiome. The food one has eaten, the air one has breathed, or the water one has drank, all contribute to the differences in the microbiomes present in different bodies.

Do the population characteristics of a microbiome remain constant throughout life, or it can change? If yes how can or does it change? It is very unlikely that a microbiome remains constant, unchanged through an individual's life. The environment as well as physical exercises affect as much as the exposure to different chemical or biological substances. However, a substantial change

in a mature adult is very slow. The microbiome in a body develops a balance as the body ages, which is not very easy to disturb and not all kinds of microbes are acceptable to an existing microbiome, some can easily fall prey to those already present in it.

Food

Whatever substances that are ingested in a body affect its microbiome. Food – solid, liquid or gaseous – affects the microbiome and contributes to its development. The food that a person consumes depends not only the geographical location where he or she lives, but also the family which nurtured him/her since s/he was

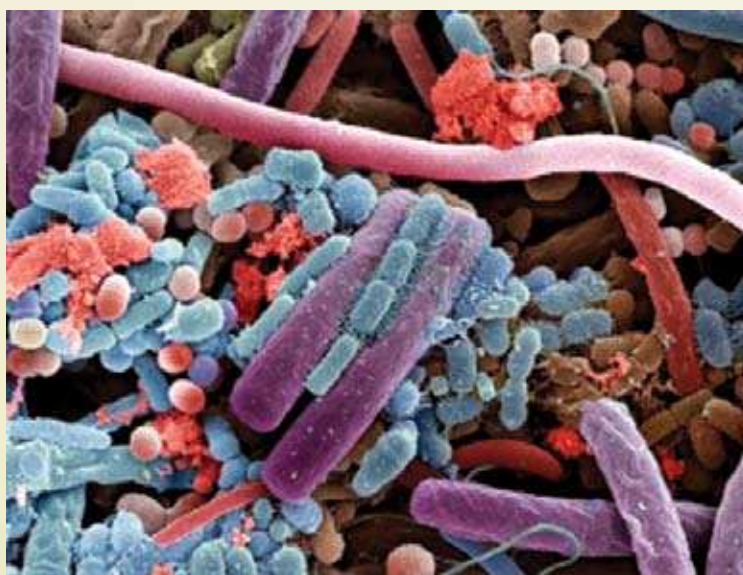
born. It also depends on the feeding habits one develops over time; very often acquired from the family.

No food is totally sterile; that is, free from any kind of microbes. There is always a possibility of some microbes settling on it as soon as it gets exposed to the atmosphere. All biological organisms have a microbiome of their own, which get transferred to our body as soon as we ingest them. Even if one does not get sick on eating drinking or breathing something, the microbiome within is slowly affected and may lead to a disease in the long term. However, body of a really healthy person has lots of immunity and it is very likely that some of the microbes get excreted

whether through urination, defecation or sweat and these processes indeed help in keeping the balance of the microbiome. Only when one is careless for a longer period, even a healthy body cannot defend its healthy microbiome. Indeed stomach upset, diarrhoea, constipation, acidity and indigestion are symptoms of some change in intestinal microbiome.

Toiletries and cosmetics

Manufacturers of cosmetics and toiletries often dupe customers into believing that any microbe is dangerous for the human body; that any natural body odour is foul and must be suppressed with the smell of some perfumes.



The genetic codes of microbes in the human body, such as these tongue bacteria (seen in a coloured scanning electron micrograph) could be the key to more accurate diagnosis. (Credit: STEVE GSCHMEISSNER/SPL)

Most of these products are targeted for the skin or teeth. The claims and the purported actions of such products often have no basis and are not supported by scientific data. In fact some of them may have long-term adverse effect on human body. Each of them does affect the balance present in the microbiome of the skin or in the mouth which may help in the healthy growth of the body. Just like the food items these products also carry some microbes that can alter the microbial composition of the microbiome they get in contact with.

Diseases

Innumerable diseases can affect the human body. Despite the efforts of innumerable persons who have contributed to the development of a very large body of knowledge about the causes and cures of very many diseases, it still remains a mystery why a particular disease attacks a particular person at a particular time. For many diseases the knowledge is still incomplete and efforts are on to find more about them. It is very likely that the microbiome of the body of a particular person may help in finding the clues.

One such disease is amyotrophic lateral sclerosis, commonly known as ALS. In spite of efforts of many scientists no cure for this disease has been found. The disease usually strikes between ages 40 and 60. There is no confirmation of a theory that it is totally a genetic disease. More men than women get it. No one knows what causes ALS. It can run in families, but usually it strikes at random. It is a nervous system disorder that attacks nerve cells called neurons the brain and spinal cord. These neurons transmit messages from your brain and spinal cord to your voluntary muscles - the ones you can control, like in your arms and legs. At first, the disorder causes mild muscle problems. Some people notice trouble walking or running, trouble writing, speech problems.

Besides physiological diseases there are many mental diseases for which no clue is available. For example autism, or the urge to indulge in unnatural sexual activities, like raping a minor - that is becoming not very rare in India. Why do some people get into a fit to indulge in such cruel violence, no one really knows. It can be safely conjectured that future research finding about human microbiome may reveal some facts.

Research

Advances in DNA sequencing technologies have created a new field of research, metagenomics that allows comprehensive examination of microbial communities, even those comprised of cultivatable organisms. Instead of examining the genome of an individual bacterial strain that has been grown in a laboratory, the meta-genomic approach allows analysis of genetic material derived from complete microbial communities harvested from natural environments. It can therefore be safely concluded that there has not been sufficient scientific effort devoted towards research about human microbiome, mainly due to lack of tools available.

Conventional techniques used in scientific research with microbes depend on the isolation of DNA of the target microbe to characterise it and hence differentiate it from others. The main difficulty is in identifying the microbes that may be much fewer in number, but are present amongst a large population of other kinds of cells.

Conclusion

In India there is hardly if any research underway on human microbiomes. It is an emerging challenge for all scientists. Indians need to recognise this challenge and

give serious thought towards contributing actively in this field.

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Comet ISON - One-time visitor to Sun

Once in a while, the night sky is lit up by the appearance of bright objects sporting luminous 'tails'. These are comets, which often appear without any advance notice. That is why, except a few the appearance of most comets cannot often be predicted in advance as eclipses can be. The sudden appearance of comets has often triggered superstitious beliefs, including their links with an oncoming catastrophe or disaster. One of the earliest recorded depictions of Halley's Comet is found in the Bayeux Tapestry (embroidered cloth) that records the Norman conquest of England in AD 1066. The comet is depicted as a star with a streaming tail and is believed to have been included as a symbol of bad omen. The present article will try to answer many questions about comets and will also introduce the readers to Comet ISON which is expected in our skies later this year.

Comets and their origin

A comet is an irregular shaped object of our solar system made up of ice and dust. It can also be described as a 'dirty snowball' or a frozen mud ball. The most prominent ice is water ice, followed by frozen carbon dioxide, ammonia, methane, etc. The dust and the ice are loosely held together and hence evaporate quite easily as a comet approaches the Sun.

People in ancient times considered comets as stars with hair trailing behind. For centuries, scientists believed comets travelled within the Earth's atmosphere. In 1577, the Danish astronomer Tycho Brahe showed that comets actually travelled far beyond the Moon. Most astronomers of 15th and 16th century thought a comet was seen only once and never again. They believed that a comet approached the Sun in a straight

line, spun around it, and then disappeared into space in a straight path. Subsequently Isaac Newton, in his *Principia Mathematica* of 1687, proved that an object moving under the influence of his inverse square law



Edmond Halley

of universal gravitation must trace out an orbit shaped like one of the conic sections and demonstrated the path of a comet seen in 1680 to be shaped like a parabola. Around the same period, scientists began developing mathematical formulas to predict the orbit of comets around the Sun. These calculations were carried out manually without calculators and computers. In 1705, the

English astronomer Edmond Halley applied Newton's method to twenty-three comets seen between 1337 and 1698. He noted that three of these, the comets of 1531, 1607, and 1682, had very similar orbits and suggested that they were the same comet seen at regular intervals. He was the first to successfully predict the comet's next appearance in 1758, but unfortunately he died 16 years before the comet was visible in the sky once again.

Comets originate from two places. Short-period comets (those with orbits of up to 200 years) generally come from the



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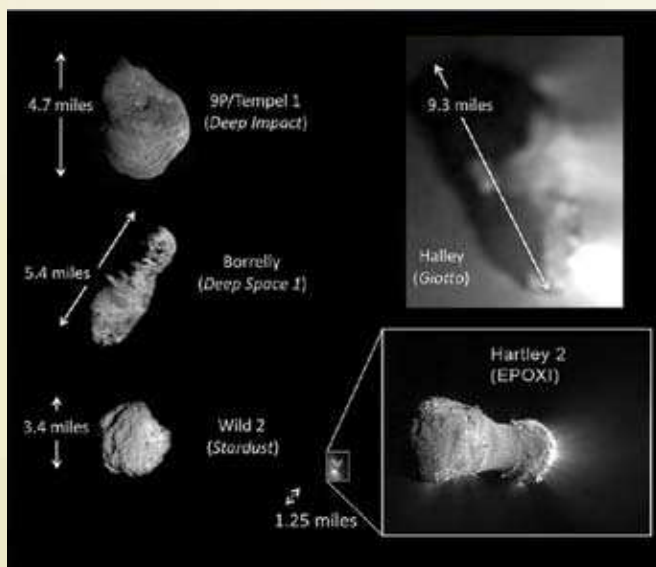
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Mohan Gore

Kuiper belt while long-period comets, such as comet Hale-Bopp, whose orbits last for thousands of years, are thought to originate in the Oort cloud. Kuiper Belt is the region of the solar system extending from planet Uranus to about the distance of 50 AU; it was discovered by Dutch-American astronomer Gerard Kuiper. 1 AU is the distance between Earth and Sun (nearly 15 crore kilometres). The Oort cloud is named after the Dutch astronomer Opik Oort. It is a region almost at the very edge of the Solar System at about 50,000 AU, or nearly a light year – a place where millions of comets can be seen moving around in every direction.

Comets are believed to be dislodged occasionally from the Oort cloud by the effect of the gravitational fields of nearby stars, sending them hurtling towards the Sun. Once in a while, two comets may come very close to each other and collide. When this happens the comets change their directions. Sometimes their new path brings them into the inner solar system. This is when a comet begins to shine and develops its characteristic tail. As they approach the Sun, the ice begins to vaporise, producing their magnificent tails. Unfortunately, comets don't live very long once they come near the Sun. It is something analogous to a snowman melting in summer heat. This journey of a comet towards the Sun is the most glorious part of their lives. Most comets lose a lot of mass while travelling through the inner solar system and are eventually destroyed.

The structure of comet

A comet consists of four different parts named nucleus, coma, dust tail, and ion tail. The nucleus is made up of ice, dust and small rocky particles and may range from a few kilometres to a few tens of kilometres in size. Surrounding



The nucleus of a few famous comets, imaged by spacecrafts

the nucleus is the coma, a visible fuzzy atmosphere of the comet which extends up to 10,000 kilometres or more across. The dust tail of a comet becomes visible by reflected sunlight. Some comets show two distinct tails, the second one being an ion tail. It is often thought that a comet's tail always follows behind it. But the truth is that the tail is always pointed away from the Sun and so can be either behind the comet (when it is approaching the Sun) or in front of it (when it is moving away from the Sun). This is because the Sun releases streams of charged particles known as the solar wind which pushes the comet's tail away from the Sun. So if a comet is moving towards the Sun the tail will follow behind. On the other hand if the comet is moving away from the Sun the tail will be in front of the comet.

Why study Comets?

It is believed that comets may have been the first solid objects to condense out of the solar nebula 4.5 billion years ago at the birth of the solar system. Everything including the Earth and other objects elsewhere in the solar system has continuously evolved since that time. Therefore, it is expected that the original composition of the solar nebula may be preserved in the pristine form in a comet nucleus. Therefore, they may contain clues of developments 4.5 billion years ago. Comets could have also played a role in forming the early atmosphere of the Earth by introducing water and complex molecules necessary for the beginning of life on Earth. In addition, one of the main reasons to study comets is the real possibility of the collision of a comet with the Earth. Studies of comets that crash into the Sun, especially when they enter the Sun's atmosphere, can also help provide detailed information about the magnetic activities of Sun and its atmosphere.

Famous comets in observational history

Comet Hale-Bopp was observed by Alan Hale of New Mexico and Thomas Bopp of Arizona on 23 July 1995 when the comet was around the Jupiter's orbit. With satellite observations, it was predicted that the nucleus of the comet was about 40 km across. It was visible even through bright city skies and may have been the most viewed comet in recorded history. Comet Hale-Bopp holds the record for the longest period of naked-eye visibility – an astonishing 19

Eyes on Comet ISON

After the discovery of comet ISON in September 2012 and later predictions of its brightness and visibility with naked eye in November and December 2013, likeminded organisations, selected scientists, science communicators and amateur astronomers from India thought to take this opportunity to develop a nationwide campaign to develop the spirit of enquiry and observations of this comet.

Vigyan Prasar (VP, New Delhi), National Council for Science and Technology Communication (NCSTC, New Delhi), Homi Bhabha Centre for Science Education (HBCSE, Mumbai), Indian Institute of Astrophysics (IIA, Bengaluru), Inter University Centre for Astronomy and Astrophysics (IUCAA, Pune), National Centre for Radio Astrophysics (NCRA, Pune), All India Peoples Science Network (AIPSN), Navnirmiti, Mumbai, Amateur Astronomers Association of Delhi (AAAD), and Bangalore Amateur Astronomers Association are a few listed organisations that joined together to organise the campaign at national level.

From March to June 2013, resource material in the form of posters on various topics of astronomy (19 in number), handbook on universal astronomy (consisting of daytime astronomy activities), handbook on comet (compilation of select articles on comets), and a set of slide shows on astronomy were developed in Hindi and English. Special efforts were also made to make them available in other Indian languages. Each available material is provided for public viewing and downloads at the specially designed website for the campaign i.e. www.eyesoncometison.in. This website is also providing the day-to-day updates on the visibility map of the comet in the early morning sky for major locations in the country.

Between July and September 2013, three national level workshops were conducted to train 170 science communicators, amateur astronomers, and teachers. At present all the trained resource persons are helping to conduct the state-level workshops. It is expected that by the end of November 2013 the campaign will train 1,500 resource persons and this campaign is expected to reach about a lakh of students through programmes organised in schools by the trained resource persons.



Image of comet C/1995 O1 (Hale-Bopp) (Image Credit: Johannes-Kepler-Observatory, Linz, Austria)

months. It will not appear again for another 2,400 years.

Comet Swift-Tuttle was seen in July 1862 by American astronomers Lewis Swift and Horace Tuttle. As Comet Swift-Tuttle moves closer to the Sun every 120 years, it leaves behind a trail of dust debris that

provides the ingredients for a spectacular fireworks display known as the Perseid meteor shower seen in the month of July and August every year as the Earth passes through the this debris.

Comet Hyakutake was discovered by an amateur astronomer named Yuji Hyakutake from Japan on 30 January 1996 with the help of binoculars. The Hubble Space Telescope studied the nucleus of this comet in great detail. It was discovered that the visit of Comet Hyakutake is not the first to the inner solar system. Astronomers have calculated its orbit and believe that it was here about 8,000 years ago. Its orbit will not bring it near the Sun again for about 14,000 years.

Comet Halley is the most widely known comet in the history of astronomy. It was named after the British astronomer Edmund Halley, who calculated the orbit and determined that the comet was also seen in 1531 and 1607. On the basis of the calculations he predicted that the comet follows 76-year orbit. The debris left behind

by this comet's tail is still lying in the orbit of Earth and is visible in the form of the Orionid meteor shower in late October. Comet Halley will return to the inner solar system in 2061.

Comet Shoemaker-Levy 9 was discovered by astronomers Carolyn and Eugene Shoemaker and David Levy in 1993. Subsequently it was predicted that the same will fall on the planet Jupiter. As predicted, more than 20 fragments of comet Shoemaker-Levy 9 collided with Jupiter between 16 and 22 July 1994. The Hubble Space Telescope took many spectacular images of this event as the comet's pieces crashed into Jupiter's southern hemisphere. The impacts created atmospheric plumes many thousands of kilometres high, visible in the form of hot foam of gas with large dark mark covering the planet surface.

Comet ISON

The official name of the comet is C/2012 S1. Two Russian astronomers named Vitali Nevski and Artyom Novichonok discovered the comet on CCD images obtained on 21 September 2012 with a 0.4m f/3 reflector telescope of the International Scientific Optical Network (ISON) near Kislovodsk, Russia. At the time of discovery, the visible

models to find various parameters of Comet ISON, it is confirmed that the comet had started its journey from the Oort cloud nearly 10,000 years ago. It is a first-time visitor to the Sun with a hyperbolic orbit, confirming that it will not visit our Sun again. It will pass very close to Sun – within 1 AU – making it a Sun-grazing comet. NASA's *Swift* mission observed ISON for about two months when it was around 740 million kilometres away from the Sun. Observations showed that ISON was shedding about 50 tons of dust and 60 kg of ice every minute.

On its journey towards the Sun, comet ISON will continue to brighten throughout November 2013 and is expected to be at its perihelion (the closest point to our Sun) in late November. Comet expert John Bortle wrote on 13 June 2013 that he expects the comet to be seen by unaided eye about three weeks before the 28 November the perihelion date.

In November, ISON will pass very close to the bright star Spica and the planet Saturn in the sky, both in the constellation Virgo. These bright stars might help us find the comet easily. At perihelion, the comet will come within 1.2 million kilometres, or about one Sun-diameter of our Sun's surface. If all goes well, and the comet doesn't fragment,



*Comet ISON on the morning of Oct. 8, 2013
(Image Credit: University of Arizona Sky
Center Adam Block /
CaelumObservatory.com)*

survives its close pass near the Sun. The comet will be visible in the evening sky after sunset as well in the morning sky before sunrise in December. As ISON's distance from the Sun increases, it will fade gradually.

Do make it a point to witness one of the most fascinating sights of the cosmos by keeping an eye on the early morning sky (around 0430 hrs. till sunrise) of late November and early December 2013.



*Comet ISON – 30th November 2013 at sunrise
(Graphic made by Ajay Talwar)*



*Comet ISON – 10th December 2013, 1 hour before sunrise
(Graphic made by Ajay Talwar)*

magnitude of the comet was 18.8, which is extremely faint (the limiting magnitude of human eye is 6; on this scale one can say the comet was thousand times fainter than what we see as a faint star). Later, astronomers at Remanzacco Observatory in Italy also confirmed the comet's presence. When it was discovered, the comet was at a distance of about 6 AU – about the distance of Jupiter from Earth.

With observations and mathematical

its closest approach to the Sun will turn it into a very bright object. It may also form a long comet tail around this time. There has been some mention, or speculations, that comet ISON could even become a daylight object. During its perihelion period, comet ISON will appear close to the Sun and will be visible just before sunrise (only 4.4° north of the Sun on 28 November).

December 2013 is likely to be the best month to see Comet ISON, assuming it

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Varicose veins: Diagnosis and Treatment



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Most common in the legs and ankles, varicose veins can be easily recognised as dark blue, swollen, twisted, enlarged veins near the surface of the skin. They crop up when the valves situated within the veins in the legs go weak. In normal times, the blood flows upwards from the legs toward the heart. The veins are blessed with one-way leaflet valves, which act to hold the blood column against the gravity and do not let the blood flow back. When these valves weaken, the blood tends to collect in the legs, and the pressure within the veins begins to build up. The veins, because of this growing pressure, appear swollen, twisted, and enlarged.



Varicose veins can present in many ways. For some people, they are simply a cosmetic nuisance. In others, they produce aching pain and discomfort. This especially happens when a person needs to stand for a long spell of time. Sometimes they may, however, trigger more serious problems. Long-standing varicose veins may produce swelling in the leg, venous eczema, skin thickening (lipodermatosclerosis) and ulceration.

Life-threatening complications are uncommon, but in some cases, varicose veins can be a sign of a blockage in the deeper veins called deep vein thrombosis. In this situation, the patient requires specialised treatment and possibly, hospitalization.

What are the symptoms?

Varicose veins can be identified simply by virtue of their appearance. They can be seen as dark blue, swollen, twisted enlarged veins coursing under the skin. While some people may not have any complaints, and may not report to a doctor; others may present with mild symptoms, which include:

- Heaviness, burning, aching, tiredness, or pain in legs
 - Worse pain after sitting or standing for a long time
 - Swelling in the feet and ankles
 - Itching around one or more of the enlarged veins
- Some people may develop more serious symptoms, which include:
- Changes in colour of the skin
 - Dry, thinned skin
 - Changes indicative of inflammation
 - Scaling
 - Open sores
 - Tendency to bleed after a minor injury or
 - Skin ulcers near the ankle

Extremely painful ulcers may form on the skin near varicose veins, particularly near the ankles.

Ulcers are caused by long-term fluid buildup in these tissues, caused by increased pressure of blood within affected veins. A discoloured spot on the skin usually begins before an ulcer forms. See your doctor immediately if you suspect you've developed an ulcer.

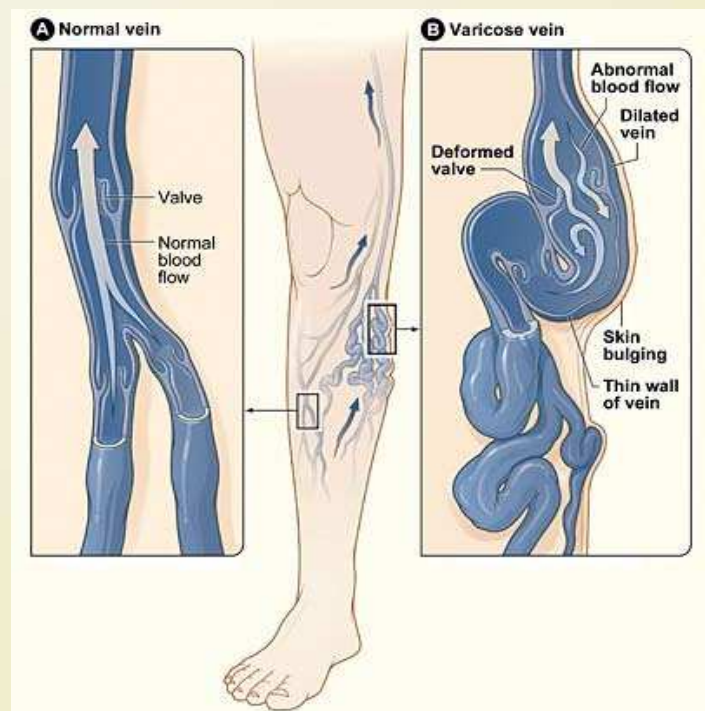
What causes varicose veins?

While the arteries carry oxygenated blood from the heart to different parts of the body, veins perform the function of returning the used blood from different parts to the heart, so that the blood can be circulated again. To return blood to the heart, the veins in the legs must work against gravity. Muscle contractions in the lower legs act as pumps, and elastic vein walls help blood return to the heart. Tiny leaflet valves in the veins open as blood flows toward the heart then close to stop blood from flowing backward.

When this mechanism goes awry, veins become varicose. The following factors may increase a person's risk of developing varicose veins:

Age

The risk of varicose veins increases with age. As a person gets older, his veins tend to lose their elasticity causing them to stretch. The valves in the veins may become weak, allowing blood that should be moving toward the heart to flow backward. Blood pools in the leg veins, and they enlarge and become varicose.



Sex

Women are more likely to develop the condition. The hormonal changes that occur during pregnancy, pre-menstrual phase (in each monthly cycle), and when a woman goes through menopause can contribute to their development. Female hormones tend to relax vein walls. Taking hormone replacement therapy or birth control pills may also increase the risk of varicose veins.

Obesity

If a person is overweight, the pressure on the veins stands increased. This increases the risk of developing varicose veins.

Vocation

Some vocations such as of a traffic cop or a surgeon require standing for long periods of time. Others call for long hours of continuous sitting. In these settings, the blood flow tends to slow down unless active steps are taken to safeguard against this continuous pooling of blood.

Family history

If other family members had varicose veins, there is a greater chance of you developing varicose veins.

Prevention

There is no way to completely prevent varicose veins. However, if a person works to improve his circulation and muscle tone, it can reduce his risk of developing varicose veins. Exercising, watching your weight, eating a high-fibre, low-salt diet, avoiding high heels and tight hosiery, elevating your legs, and changing your sitting or standing position regularly are some of the simplest measures you can take to prevent varicose veins:

Simple measures to take

Some self-care measures work well to decrease the discomfort caused by varicose veins. These measures include:

Exercise

Get moving. Walking is a great way to encourage blood circulation in the legs. Your doctor can recommend an appropriate activity level for you.

Don't tip the scales

Watch your weight, and your diet. Shedding excess weight takes unnecessary pressure off your veins. What you eat can help, too. Follow a low-salt diet to prevent swelling caused from water retention.

Watch what you wear

Don't wear tight clothes around your waist, legs or groin. Tight panty-leg girdles, for instance, can cut off blood flow.

Select footwear well

Avoid high heels. Low-heeled shoes work calf muscles more, which is better for your leg veins.

Elevate your legs

To improve the circulation in your legs, take several short breaks

daily to elevate your legs above the level of your heart. For example, lie down with your legs resting on three or four pillows.

Move

Avoid long periods of sitting or standing. Make a point of changing your position frequently to encourage blood flow. Try to move around at least every 30 minutes or so.

Ease the pressure

Don't sit with your legs crossed. This position can worsen circulation problems.

Wear compression stockings

Wearing compression stockings is often the first approach to try before moving on to other treatments. Compression stockings are worn all day. They steadily squeeze your legs, helping veins and leg muscles move blood more efficiently.

When purchasing compression stockings, make sure that they fit properly. Using a tape measure, you can measure your legs to ensure you get the right size and fit according to the size chart found on the stocking package. Compression stockings should be strong, but not necessarily too tight. If you have weak hands or arthritis, getting these stockings on may be difficult.

When to visit a doctor

Self-care measures, such as exercise, elevating your legs or wearing compression stockings can help you ease the pain of varicose veins and may prevent them from getting worse. But if you're concerned about how your veins look and feel and self-care measures haven't stopped your condition from getting worse, see your doctor.

Which specialist doctor to see

You may initially consider going to a family doctor. S/he may recommend that you see a general surgeon, or a doctor who specialises in vascular surgery or possibly, a doctor who treats skin conditions (dermatologist or dermatology surgeon).

Tests and diagnosis

Physical exam

To diagnose varicose veins, your doctor will carry out a physical exam, including looking at your bare legs and feet while you're standing to check for swelling. Your doctor may also ask you to describe any pain and aching in your legs.

Ultrasound test: Colour Doppler test

You may also need an ultrasound test to see if the valves in your veins are functioning normally or if there's any evidence of a blood clot.



In this non-invasive test, you lie on an examination table. A small amount of gel is applied to your skin. The gel helps eliminate the formation of air pockets between the transducer and your body. During the test, the examining doctor presses a small hand-held device (transducer) against your skin over the area of your body being examined, moving from one area to another as necessary. The transducer transmits images of the veins in your legs to a monitor, where the doctor can see them.

With this test, called the colour Doppler test, the doctor can evaluate the extent of blockage or openness of the veins and the functioning of the venous valves

Wide choice of treatments

Thanks to less invasive modern day procedures, varicose veins can generally be treated on an outpatient basis. If you don't respond to self-care, compression stockings, or if your condition is more severe, your doctor may suggest one of these varicose vein treatments:

Sclerotherapy

In this procedure, your doctor injects small- and medium-sized varicose veins with a solution that scars and closes those veins. In a few weeks, treated varicose veins should fade. Although the same vein may need to be injected more than once, sclerotherapy is effective if done correctly. Sclerotherapy doesn't require anaesthesia and can be done on an outpatient basis.

Laser surgeries

Doctors are using new technology in the form of laser treatments to close off smaller varicose veins and spider veins. Laser surgery works by sending strong bursts of light onto the vein, which makes the vein slowly fade and disappear.

No incisions or needles are used. The principle is simple: your doctor uses a highly focussed beam of light, which excites the formation of scar tissue in the vein. The vein closes and loses its source of blood and dies. After a year or two, the vein is likely to disappear.

Simple laser treatment

Simple laser vein treatment can treat spider veins and tiny varicose veins just under the skin's surface. Usually, more than one laser session is needed. These sessions are usually scheduled every 6 to 12 weeks.

However, if you have poor blood circulation feeding these tiny veins, the larger "feeder" vein must first be treated with surgery, endovenous laser or radiofrequency treatment, or sclerotherapy.

Endovenous laser treatment

This technology is now increasingly being used for larger varicose veins in the legs. Your doctor inserts a thin tube (catheter) into an enlarged vein and uses a laser beam through this tube (endovenous) to heat the tip of the catheter. As the catheter is pulled out, the heat destroys the vein by causing it to collapse and seal shut. This procedure is usually done for larger varicose veins. While doing this, the doctor watches the vein on a duplex ultrasound screen. Using duplex ultrasound a surgeon can visualise the structure of the vein as well as the flow or movement of blood within a vein.

Laser is less painful than vein ligation and stripping surgery, and it has a shorter recovery time. This is because the treatment is done through a small incision. A larger groin incision is not needed. Plus, these treatments do not require general or spinal anaesthesia. Only local anaesthesia or a light sedative is needed.

After endovenous laser treatment, you will wear compression stockings for 1 week or more. To follow up, your doctor will use duplex ultrasound to make sure that the vein is closed.

Results of endovenous laser treatment

In carefully chosen cases, endovenous laser treatment closes veins in about 94 out of 100 cases. When it does not close a vein, you might need a second treatment. The doctor may offer you a choice between another laser treatment, radiofrequency treatment, or sclerotherapy. In some cases, vein surgery is recommended.

For the best chance of success, be sure to have a doctor with a lot of endovenous laser experience.

Risks of endovenous laser treatment

Side effects of laser treatment include skin burns, skin colour changes, feeling of burning, pain, or prickling after recovery, from nerve damage (less likely than after vein stripping surgery), and small or large blood clotting in the vein or a deep vein (less likely than after vein stripping surgery).

The more experience your doctor has had with laser, the less risk you are likely to have.

Vein stripping

This procedure involves removing a long vein through small incisions. This procedure does not affect the circulation in your leg adversely because veins deeper in the leg take care of the larger volumes of blood.

Endoscopic vein surgery

You might need this operation only in an advanced case involving leg ulcers. Your surgeon uses a thin video camera inserted in your leg to visualise and close varicose veins, and then removes the veins through small incisions.

Varicose veins and pregnancy

Some women develop varicose veins during pregnancy. Pregnancy increases the volume of blood in the body, but decreases the flow of blood from the legs to the pelvis. This circulatory change can produce enlarged veins in the legs. Varicose veins may surface for the first time or may worsen during late pregnancy, when the uterus exerts greater pressure on the veins in the legs. Changes in the hormones during pregnancy also may play a role. Varicose veins that develop during pregnancy generally improve without medical treatment within three months after childbirth.

Varicose veins that develop during pregnancy generally improve without medical treatment within three to 12 months after delivery.

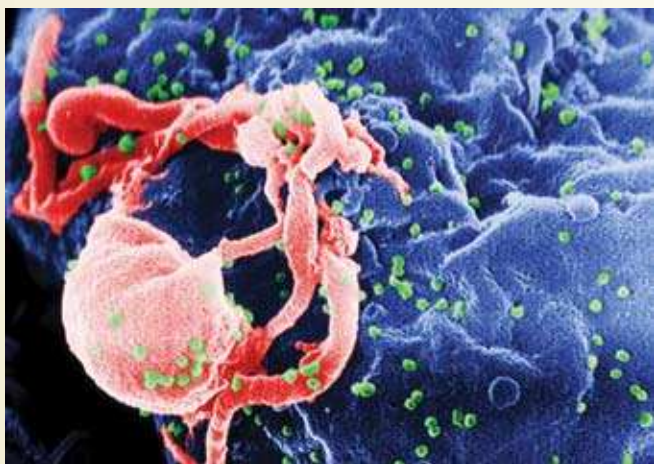
Recurrence

Current treatments for varicose veins and spider veins are effective. However, it's possible that varicose veins might recur, and require a repeat treatment. ■

Recent developments in science and technology

A human gene to treat HIV infection

Human immunodeficiency virus (HIV) is a slowly replicating retrovirus (a RNA virus which inserts a DNA copy of its genome into the host cell in order to replicate) that causes acquired immunodeficiency syndrome (AIDS). In a person with AIDS, progressive



HIV particles (green dots)

failure of the immune system allows life-threatening opportunistic infections such as bacterial, viral, fungal or protozoan infections that usually do not cause disease in a healthy person, and cancers to thrive and in most cases results in death. Some 34 million people worldwide are infected with the human immunodeficiency virus (HIV) that causes AIDS – the vast majority of them in poor and developing countries.

There is no cure for HIV/AIDS, but a variety of drugs can be used in combination to control the virus. Each of the classes of anti-HIV drugs blocks the virus in different ways. Usually a combination of at least three drugs from two different classes is used to avoid creating strains of HIV that are immune to single drugs. These drugs allow HIV patients to live long, healthy lives, but the drugs are expensive and they often have side-effects and drug resistance can become a problem with long-term use. With HIV/AIDS, as the saying goes, prevention is better than cure and the most universally recommended method for prevention is to avoid blood-to-blood contact between

people and the practice of safe sex.

A recent discovery brings new hope for HIV/AIDS patients. Researchers at King's College, London have identified a human gene that may have the ability to prevent the virus that causes AIDS from spreading after it enters the body. According to the researchers, the gene, called MX2, could be a new target for effective, less toxic treatments where the body's own natural defence system is mobilised against the virus (*Nature*, 18 September 2013; DOI: 10.1038/nature12542). The work was led by Dr Caroline Goujon and Professor Mike Malim at the Department of Infectious Diseases in the college.

In human body, the MX2 gene codes for a protein known as Mx2. Till recently, very little was known about the MX2 gene, but now both its potent anti-viral function and a key point of vulnerability in the life cycle of HIV have come to light. In the recent study, the researchers conducted experiments on human cells in the laboratory, introducing the HIV virus to two different cell lines – one in which the MX2 gene was “switched on”, and in the other it which is was “silenced” – and then observing the effects. They found that in the cells where MX2 was silenced, the AIDS virus replicated and spread, while in the cells where it was switched on, the HIV was unable to replicate and produce new viruses to spread.

The new finding thus advances our understanding of how the HIV virus interacts with the immune system and also opens up opportunities to develop new therapies to treat the disease. The findings suggest that the MX2 gene is a key player in establishing viral control in people with HIV, and that armed with this new knowledge, there are two possible routes for potential drug development using the gene. The first is to develop either a molecule that



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mimics the role of MX2 and the second is to develop a drug which activates the gene's natural capabilities. Prof. Malim notes that it is important to continue finding new ways of mobilising the body's natural defence system, and the MX2 gene appears to play an important role in initiating viral control in HIV sufferers.

Tiger genome sequenced

An international team of genome scientists has for the first time mapped the whole genome sequence of the Amur tiger, also known as the Siberian tiger (*Panthera tigris altaica*) and compared it with the genomes of other big cats including the white Bengal tiger, lion, and snow leopard, with the objective of investigating the genetic diversity and conservation of big cats. The research team led by scientists of South Korea, in collaboration with colleagues from China, the United States, India, Mongolia, South Africa and other countries, have published the latest findings in the journal *Nature Communications* (September 2013 DOI: 10.1038/ncomms3433). The researchers used the DNA of a nine-year-old Siberian tiger from Everland Zoo, South Korea for sequencing.

The Siberian tiger is the largest tiger subspecies, weighing as much as 300 kg and growing to some three metres in length, although some Bengal tigers can grow to the same length. Only about 450 Siberian tigers exist in the wild and around 4,500 tigers of



Siberian tiger

all species are estimated to remain in their natural habitats. The animal is confined completely to the Amur region in far eastern Siberia, where it is now protected.

It's an irony that despite being ferocious animals, these majestic species face more danger than they pose. All are endangered, mainly due to habitat loss, poaching, and dwindling food supplies. As the largest cat species on Earth, the tiger has become one of the world's most endangered species. Understanding of the tiger's genetic diversity and demography has been very limited without the whole-genome sequence of tiger, or any of the *Panthera* species.

Along with Siberian tiger genome, the researchers also sequenced the genomes of other *Panthera* species – a white Bengal tiger, an African lion, a white African lion, and a snow leopard – using the latest sequencing technology. By comparing the genomes, the researchers identified 1,376 big-cat specific genes to reveal how big cats evolved into top predators with extraordinary muscle strength and a carnivorous diet.

According to the researchers, overall, the cat family seems to rely on a narrow set of 1,376 genes linked to strong muscle fibres and digestion of protein. The genes most probably originated in large part with the earliest common ancestor of big cats some 11 million years ago. The researchers are now trying to acquire all the big cat genomes, especially American big cats such as the cougar, jaguar, and black panther, to sequence and make a whole set of cat genome with known clear phenotypes. They want to make this information available and open freely to all researchers interested in and focussed on conservation research, which could be of great help in the global conservation efforts for this beautiful species.

10 types of smell

In the digital age almost everything is quantifiable. For example, taste can be classified into five flavours that we sense – sweet, sour, bitter, salty, and umami, or savoury. Similarly, any colour can be expressed as a combination of three primary colours – cyan, magenta, and yellow which are defined by their wavelengths. Music is also defined by pitch or scale, which in turn is defined by sound frequency. But till now there was no system of classifying odours and it was not known how many odours

we can smell. Of our five senses, smell is the least understood. But recent research shows that, just as there are three primary colours and five basic tastes, there are likely about 10 basic categories of odour which are each associated with distinct chemical features. Researchers Jason Castro from Bates College, Chakra Chennubhotla from the University of Pittsburgh, and Arvind Ramanathan from Oak Ridge National Laboratory used advanced statistical techniques to develop an approach for systematically describing smells (*PLoS ONE*, 18 September 2013 | doi:10.1371/journal.

And we have many ways of describing smells (e.g., sweet, pungent, foetid, etc.). But till now there was no definitive list that organises odours into their basic, or essential, categories, like we have in taste or colour.

The researchers defined basic qualities of smell as “odour space” and tried to identify discrete categories of smell. In order to overcome the limitation of describing smell in terms of a definitive list that organises odours into their basic, or essential, categories, the researchers analysed 144 different odours to see if they could identify consistent odour profiles. These 144



Fragrant substances. (Clockwise from top left) Gardenia flower, lemon, mint, spices

pone.0073289). According to Ramanathan, the work could ultimately result in more complete explanations of how the brain's odour processing mechanism represents and categorises odours, and help in the effort to predict mental impressions of odours from chemicals.

The sense of smell comes about through the stimulation of specialised cells in our nose. We can sense a smell when odour-producing molecules bind to specific sites on the smell receptors in our nose. As is well-known, odours can be rich and complex.

odours were derived from an olfactory “atlas” created in 1985 at the Institute of Olfactory Sciences in Park Forest, Illinois, USA. To assist them with their task, the researchers used advanced statistical techniques – a mathematical technique called non-negative matrix factorisation (NMF) to develop a systematic description of smells.

Their work showed odour could be classified into 10 categories, viz., (i) Fragrant (e.g., floral and perfumes); (ii) Fruity (all non-citrus fruits); (iii) Citrus (e.g., lemon, lime, orange); (iv) Woody and resinous

(e.g. pine or fresh cut grass); (v) Chemical (e.g., ammonia, bleach); (vi) Sweet (e.g., chocolate, vanilla, caramel); (vii) Minty and peppermint (e.g., eucalyptus and camphor); (viii) Toasted and nutty (e.g., popcorn, peanut butter, almonds); (ix) Pungent (e.g., blue cheese, cigar smoke); and (x) Decayed (e.g., rotting meat, sour milk). More complex aromas like baked bread or fresh-brewed coffee might be best described as a combination of two or more of these 10 elements, just “as a combination of pitches make up a chord” in music. Each of these smells, the researchers argue, reveals a component of the human condition that alerts you to your environment. For example, chemical smells signal danger; nutty, popcorn smells tell you there is food nearby. Each plays a role in ensuring your survival.

How birds got their wings

It is generally agreed that birds evolved from a group of small, meat-eating theropod dinosaurs called maniraptorans sometime around 150 million years ago. Theropods are any of numerous meat-eating dinosaurs with short forelimbs that lived in the Triassic to Cretaceous Period and walked or ran on strong hind legs. Recent findings from around the world show that many maniraptorans were very bird-like, with feathers, hollow bones, small body sizes and high metabolic rates like modern birds. But the question remains, at what point did forelimbs evolve into wings – making it possible for dinosaurs to fly?

According to a recent study, maniraptorans experienced a dramatic change in the way their limbs grew in relation to the rest of their body. The study suggests that a lengthening of the dinosaurs’ forelimbs around 150 million years ago allowed the limbs to serve as aerofoils (structures with curved surfaces designed to provide lift and help in flight), which in turn may have eventually enabled the first birds to take off and start to fly. Longer forelimbs were most likely coupled with a shortening of the hind legs, reducing drag and making it easier for the birds to perch on tree branches (*Evolution*, September 2013 | DOI:10.1111/evo.12150). The researchers, McGill University professor Hans Larsson and a former graduate student, Alexander Dececchi, arrived at the above conclusion by examining fossil data, greatly expanded



Archaeopteryx, the oldest known fossil bird

in recent years, from the period marking the origin of birds.

Over the past half-decade, there have been a huge number of near-bird and early bird fossil discoveries from around the world, but mostly in China, and these new fossils now allowed the researchers to ask

these more quantitative questions leading to the surprising discovery. The surprising find was that throughout most of the history of carnivorous dinosaurs, limb lengths showed a relatively stable scaling relationship to body size; that is, their limbs grew in proportion to the increase in body size. This is despite a 5,000-fold difference in mass between the giant *Tyrannosaurus rex* and the smallest feathered theropods from China, the 30-cm-long *Eosinopteryx*. This limb scaling changed, however, at the time first birds appeared, when both the forelimbs and hind limbs underwent a dramatic decoupling from body size. This change may have been critical in allowing early birds to evolve flight, and then to exploit the forest canopy, the authors conclude.

According to an earlier theory, birds began to fly “from the trees down”, essentially by gliding. But the new finding suggests that birds began on the ground and eventually flapped, hopped, and ran their way into the trees. The latter theory is known as “the ground-up theory.” The researchers say they found conclusive evidence that bird ancestors were not arboreal (living in trees).

Rashtriya Vigyan Chalchitra Mela and Competition - 2014

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