Santa Claus and misconception

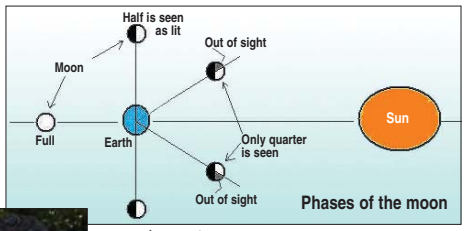
It would appear that the time has come for people to sit up and take notice, says s ananthanarayanan

PICTURES of St Nick riding through the night sky have been found to generally show the moon with the wrong orientation. This finding follows a remarkable film by the Harvard-Smithsonian Centre for Astrophysics on popular misconceptions in science. The film starts with two simple questions on astronomy posed to graduating students of Harvard University — all of them having had a science education in school — and the responses show they still know little more about science than what they'd learned in primary school. The film continues with interviews of ninth grade students (a year older than Class IX in India), which reveal that a lesson dealing with the same questions seem to have done little to create understanding. Would science remain a closed book to many even in a world that is rapidly getting technical and science driven?

Peter Barthel.

Peter Barthel of the Kapteyn Astronomical Institute, University of Groningen in Holland, continued with a study of misconceptions about the phases of the moon that persist in illustrations of Christmas scenes in children's books, wrapping paper and Christmas cards in the USA and The Netherlands. The USA is the leader in creating the image of Santa Claus and The Netherlands is the origin of St Nicholas, or Sinterclass, and hence Santa Claus. Christmas time illustrations generally show Santa and his sleigh riding the sky in the early evening and a common motif is of the sky with stars and a crescent or quarter moon. Barthel finds that the illustrators seem oblivious of the correct orientation of the waxing quarter moon, which would be seen with its right side lit in the early evening in the northern hemisphere. In conjunction with the findings of the Harvard-Smithsonian Centre, Barthel thinks Christmas would be a good time to spread some understanding of the physical origin of the phases of the moon. His paper is to appear in the December issue of the journal, *Communicating Astronomy with the Public*.

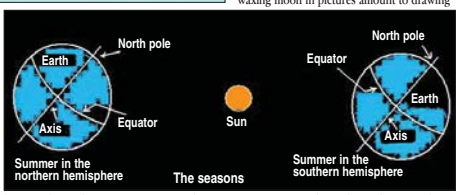
The first question posed to the Harvard graduates was: "Why does it get warmer in the summer?" Most of the answers were that it was because the earth was closer to the sun in the summer. The answer is wrong, of course, as the reason is that different parts of the earth face the sun at different times of the year. The second question was: "Why is the moon not always a full moon, but has phases?" The answers, quite incorrect again, were more varied, the bulk being that it was because of the earth's shadow and that it was because of clouds. The responses were no different from those of ninth graders who were asked the same questions before they had done a lesson on the earth's orbit and the phases of the moon. And the interesting thing was that the ninth graders did no better even after the lesson!



The phases of the moon occur, of course, because the earth-moon-sun positions change in the course of the lunar month. When the sun and moon are on opposite sides of the earth, we see the whole illuminated side of the moon as a full one. When they are at a right angle, we see the moon sideways and only half the moon is lit; and when the moon is near the sun, we see only a sliver, the crescent moon. In between, we see the quarter moon, as it is growing from the crescent to the half moon, the *waxing phase*, or as it is reducing from the quarter to the crescent, the *waning phase*.

An important difference between the waning and the waxing moon is which side of the moon is lit. A crescent moon, on the way to becoming a quarter moon, in its waxing phase, would be seen around sunset in the west, with its lighted side on the right (this is in the northern hemisphere). But a quarter moon reducing to a crescent, the waning phase, would be seen very early in the morning, in the east, with its lit side to the left.

This is really all there is to understand in the phases of the moon, a phenomenon that all of us see throughout the year, is reported every day in the newspaper, is spoken of in the context of the tides and taught to us in school. And yet the Harvard study showed that the bulk of successful Harvard graduates who would go forth to occupy important positions, who regularly drive automated cars, use cell phones and lap-tops, seemed not to be overly concerned with what science is about. The Peter Barthel study shows that this refinement of understanding is also missing in popular culture and commercial usage — the incorrect representations of the waxing moon in pictures amount to drawing street scenes with cars being driven on the wrong side of the road!



Talking science

Barthel has developed his study for publication in *Communicating Astronomy with the Public*, a free, peer-reviewed journal for astronomy communicators, online and in print, published from Germany. The objective is to disseminate astronomy discoveries to non-scientific audiences, a task seen as growing in importance. This week, the world has seen reports of conclusions about global warming being rubbished and a report that more than half of Americans question the *theory of evolution* and four congressional candidates saying science is a hoax. In a world that has been shaped, during the last few centuries, so dramatically by science, and which is now facing a crisis whose resolution may lie only in the reduction of carbon emissions and population control, apathy towards science education would leave people as consumers only and declare open season for commercial and political carpetbaggers.

The time has come, it would appear, for each one to nudge his/her neighbour and point out every instance where it is science that is making the world function, so that people wake up and take notice. It may be the time for science evangelism!

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Revealed

Stonehenge may have been a place of worship 500 years before the first stone was erected, writes david keys

EXTRAORDINARY new discoveries are shedding new light on why Stonehenge, Britain's most famous ancient site, was built — and when. Current research now suggests it may already have been an important sacred site at least 500 years before the first stone circle was erected — and that the sanctity of its location may have determined the layout of key aspects of the surrounding sacred landscape.

What's more, the new investigation — being carried out by archaeologists from the universities of Birmingham, Bradford and Vienna — massively increases the evidence linking Stonehenge to prehistoric solar religious beliefs. It increases the likelihood that the site was originally and primarily associated with sun worship.

The investigations have also enabled archaeologists to putatively reconstruct the detailed route of a possible religious procession or other ritual event they suspect may have taken place annually to the north of Stonehenge. That putative prehistoric religious "procession" (or, more specifically, the evidence suggesting its route) has implications for understanding Stonehenge's prehistoric religious function — and suggests that the significance of the site Stonehenge now occupies emerged earlier than has previously been appreciated.

The crucial new archaeological evidence was discovered during ongoing survey work in which archaeologists have been "X-raying" the ground, using radar and other geophysical investigative techniques. As the archaeological team from Birmingham and Vienna was using these high-tech systems to map the interior of a major prehistoric enclosure (the so-called "Cursus") near Stonehenge, they discovered two great pits — one towards the enclosure's eastern end, the other nearer its western end.

When they modelled the relationship between these newly-discovered Cursus pits and Stonehenge on their computer system, they realised that, viewed from the so-called "Heel Stone" at Stonehenge, the pits were aligned with sunrise and sunset on the longest day of the year — the summer solstice (midsummer's day). The chances of those two alignments being purely coincidental are extremely low.

They then began to speculate on what sort of ritual or ceremonial activity might have been carried out at and between the two pits. In many areas of the world, ancient religious and other ceremonies sometimes involved ceremonially processing round the perimeters of monuments. So the archaeologists thought it possible that the prehistoric celebrants might have perambulated between the two pits by processing around the perimeter of the Cursus. Initially this was pure speculation, but then it was realised that there was, potentially, a way of trying to test the idea. On midsummer's day there are in fact three key alignments — not just sunrise and sunset, but also midday (the highest point the sun reaches in its annual cycle). For at noon the key alignment should be due south.

The "eureka moment" came when the computer calculations revealed that the midway point (the noon point) on the route aligned directly with the centre of Stonehenge, which was precisely due south. For decades, modern archaeology held that Stonehenge was a relative latecomer to the area and that the other large monument in that landscape — the Cursus — pre-dated it by up to 500 years. But the implication of the new evidence is that, in a sense, the story may have been the other way round — that the site of Stonehenge was sacred before the Cursus was built, says Birmingham archaeologist Dr Henry Chapman, who has been modelling the alignments on the computerised reconstructions.

The Independent, London

The impact of molecular biology

tapan kumar maitra **discusses techniques that will almost certainly continue to revolutionise the study of membranes and their proteins**

MEMBRANE proteins mediate a remarkable variety of cellular functions and are, therefore, of great interest to cell biologists. However, the study of these proteins has been of recent vintage but it has begun to yield definitive insights and answers. Some of these answers have come from the application of biochemical techniques to membrane proteins. Several of these applications are described in this chapter, including SDS-polyacrylamide gel electrophoresis, hydropathy analysis and procedures for labelling membrane proteins with radioactivity or fluorescent antibodies. Two other biochemical approaches that can be used to study membrane proteins are affinity labelling and membrane reconstitution.

Affinity labelling utilises radioactive molecules that bind to specific membrane proteins because of known protein functions. For example, a compound called *cytochalasin B* is known to be a potent inhibitor of glucose transport. Membranes that have been exposed to radioactive cytochalasin B are therefore, likely to contain radioactivity bound specifically to the protein(s) involved in glucose transport.

Membrane reconstitution involves the formation of artificial membranes from specific purified components. In this approach, proteins are extracted from membranes with detergent solutions and separated into their individual protein components. The purified proteins are then mixed with phospholipids under conditions known to promote the formation of membrane vesicles called *liposomes*. These reconstituted vesicles can then be tested for their ability to carry out specific functions that are known, or thought, to be mediated by membrane proteins.

In spite of some success with these and similar approaches, membrane biologists have often been stymied in their attempts to isolate, purify and study membrane proteins. Biochemical techniques that work well with soluble proteins are not often useful with proteins that are hydrophobic. Within the past three decades, however, the study of membrane proteins has been revolutionised by the techniques of molecular biology, especially DNA sequencing and recombinant DNA technology.

Vital to these approaches is the isolation of a gene, or at least a fragment of a gene, that encodes a specific membrane protein. With a DNA molecule in hand, the first priority of the molecular biologist is almost always to determine its nucleotide sequence (1). DNA sequencing is in fact one of the triumphs of molecular biology; it is now far easier to determine the nucleotide sequence of a DNA molecule than to fathom the amino acid sequence of the protein for which it codes. Moreover, most of the sequencing procedure is carried out quickly and automatically by DNA sequencing machines.

Once the DNA for a particular protein has been sequenced, the putative, or predicted, amino acid sequence can be deduced using the genetic code that equates every possible sequence of three nucleotides with a particular amino acid (2). The amino acid sequence can then be subjected to hydropathy analysis to identify likely transmembrane segments of the protein (3). Knowing the amino acid sequence also allows the investigator to prepare synthetic peptides that correspond to specific segments of the protein (4). Antibodies made against these peptides can then be radioactively labelled and used to determine which segments are exposed on one side of the membrane or the other.

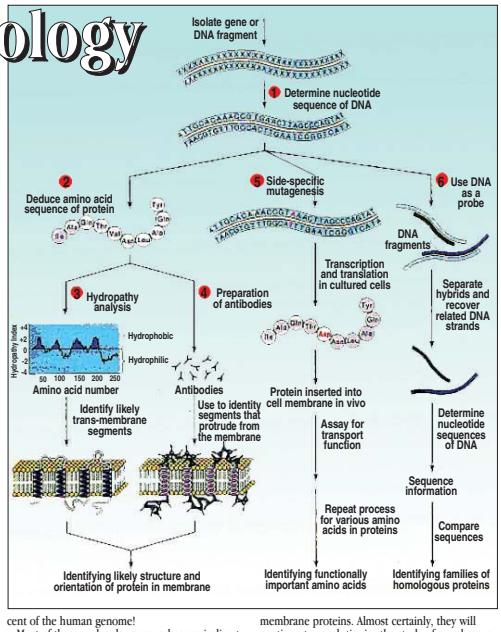
The information gained in this way, combined with the hydropathy data, often provides compelling evidence for the likely structure of the protein and its orientation within the membrane and possibly for its mode of action as well. The structure of the Cystic Fibrosis Trans-membrane conductance Regulator protein that is defective in people with cystic fibrosis was determined in this way.

Another powerful molecular technique, called *site-specific mutagenesis*, is used to examine the effect of specific changes in the amino acid sequence (5). The DNA sequence encoding a specific segment of the protein can be altered by changing particular nucleotides. The mRNA transcribed from the mutant DNA is then injected into living cells (either cultured mammalian ones or amphibian oocytes). The cells use the mRNA to direct the synthesis of a mutant protein, the functional properties of which can then be readily determined. In this way, functionally important amino acids can be identified.

Yet another way to use an isolated gene or gene segment is as a DNA probe to isolate other DNA sequences that are similar to the probe (6). DNA identified in this way is likely to encode proteins that are structurally similar to the protein for which the probe DNA codes. Such proteins are likely to be related to each other, both in evolutionary origin and also possibly in their mechanisms of action.

With techniques for sequencing whole genomes, investigators can now search for nucleotide sequences similar to those already known to encode specific proteins. In this way, various families, or groups, of related proteins can be identified. The use of computerised databases has been extremely valuable in suggesting roles for proteins based entirely on their gene sequences.

From studies based on these and other techniques, we now know that human cells need more than 30 families of membrane proteins to facilitate the transportation of the great variety of solutes that must be moved across membranes. Moreover, the families often contain many different, though related, proteins. Even a single member family may be present in a variety of forms that differ in such properties as time of expression during development, tissue distribution, or location within the cell. Perhaps it is not so surprising then to learn that the genes known to encode transport proteins represent about 10 per cent of the human genome!



Most of these molecular approaches are indirect, in the sense that they allow scientists to deduce properties and protein functions rather than to prove as much directly. Nevertheless, these techniques are powerful tools that have already had a great impact on our understanding of membrane proteins. Almost certainly, they will continue to revolutionise the study of membranes and their proteins.

The writer is associate professor and head, Department of Botany, Ananda Mohan College, Kolkata