

Goethals News

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Special Issue on Science and Religion

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Prof. Dr. Aleksandar Zecevic
Santa Clara University, USA

"As secularism and fundamentalism spread globally, our universities are called to find new ways of creatively renewing this commitment to a dialogue between faith and culture that has always been a distinguishing mark of Jesuit learned ministry...Can Jesuit universities today, with energy and creativity, continue the legacy of Jesuit learned ministry and forge intellectual bridges between Gospel and culture, faith and reason, for the sake of the world and its great questions and problems?"

The Course on science and religion between Santa Clara University, California, and St. Xavier's College, Kolkata, is a small attempt to find an answer to the above- mentioned question. A Journey that begins with chanting of *Nihil Ultra* (Nothing Beyond) and reaches fruition when we become men and women for others.

As I present to you the VIth edition of the Goethals Newsletter on "Science and Religion", these very words echo through my sentiments and it is our purpose to resolve this oft forcefully sculptured conflict through curiosity, compassion and knowledge. At St. Xavier's, the holistic vision of the Jesuits as laid down by its founding father St. Ignatius of Loyola and its pioneer St. Francis Xavier, is to create 'Men and Women For Others' who are tolerant of each stratum of the society and who harbour in themselves, the spirit and the empathy to contribute to the good of a larger society.

It was with these ideas in mind, that the course of Science and Religion was conceptualized in the year 2012 in association with Santa Clara University, USA, and the very warm and enthusiastic participation of Professor Dr. Aleksandar Zecevic, who over the last few years, has motivated our students and guided them onto this platform of seamless amalgamation of religious ideologies and scientific

"There is no conflict between science and religion. Conflict only arises from an incomplete knowledge of either science or religion or both" – Russel Nelson, surgeon and religious leader.

Dear Friends,

Fr. Adolfo Nicolás SJ, former Superior General of the Society of Jesus, issued the following challenge to Jesuit universities across the world:

disciplines. The novelty of the idea indeed triggered the curious young minds which manifested in a manifold increase in participation every year as more and more students tried to answer the questions that troubled their conscience as they aimed to consolidate the importance of religion in the field of scientific research.

An overwhelming response, worth mentioning, came from the students of the **Postgraduate Department of Biotechnology**, which was in itself a success story, since it proved that students from scientific disciplines were accepting of the concept of a conjunction between science and religion and their views and opinions strengthened our unique concept.

The students have, over the years, penned down articles which strongly advocate this undeniable unison and have brought to the table, new ideas, starting from evolutionary history, quantum mechanics to modern hypotheses in science, which positively placed arrays of scientific formulae and equations parallelly with the wise and well-watered theories in religion. The interactive sessions with Professor Zecevic, are what the students look forward to, each year, where they good-heartedly question and debate, in order to gain comprehensive understanding of both science and religion, in an unbiased manner.

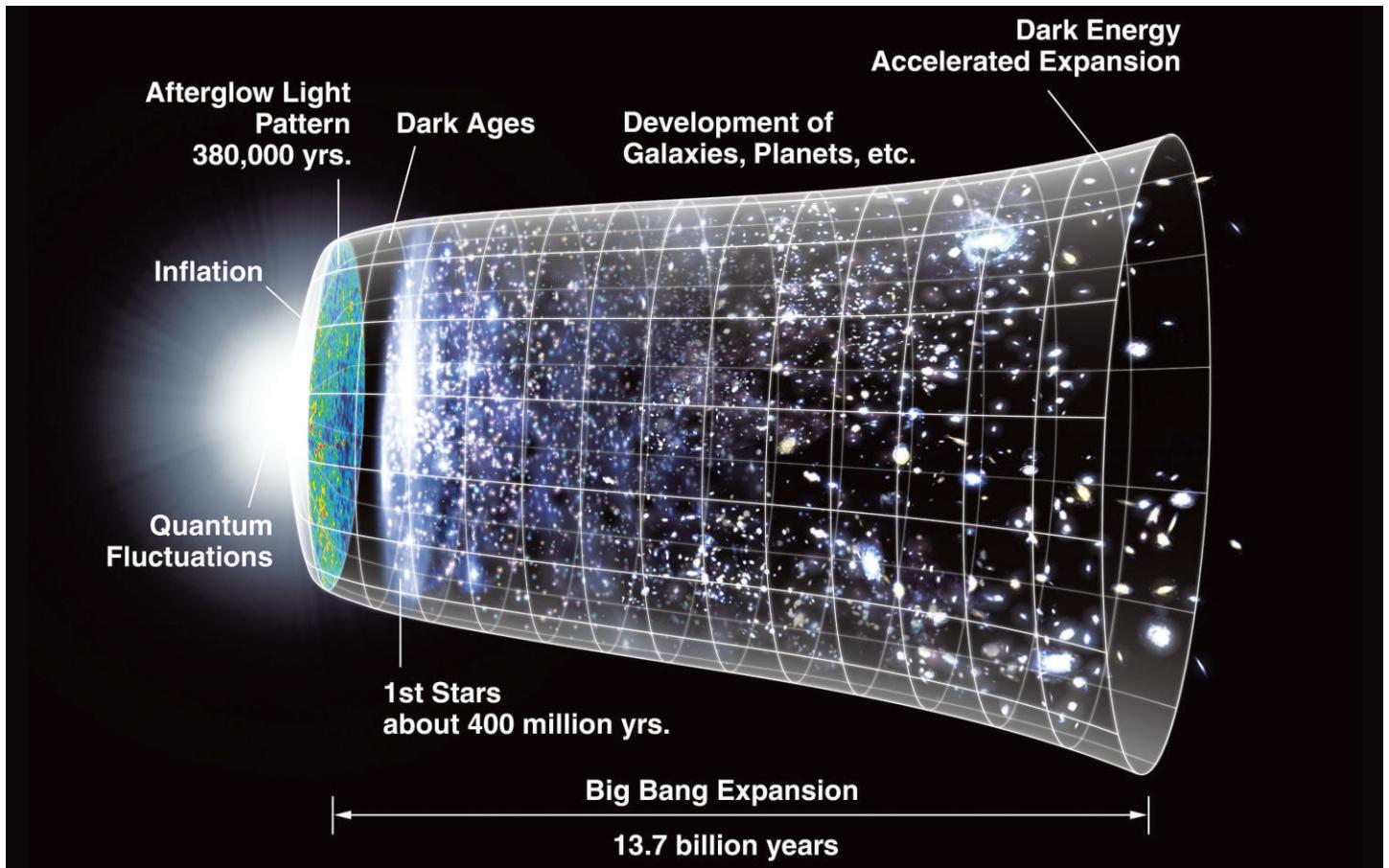
This year's issue of Goethals Newsletter, taken out straight on warm mittens and served to you, will delight you with the humour in religion and science and fire your curiosity with the well-tailored articles. Many evolved souls have poured their thoughts in these pages in the past and it gives me great pleasure to have been a part of this exercise – this journey within – to welcome you to partake of the nectar contained herein.

In the words of **Martin Luther King Jr.** – "Science investigates, religion interprets; science gives man knowledge which is power, religion gives man wisdom which is control". Hence, choose both instead of either, they are the two faces of your hand.

Happy Reading,

Xavier Savarimuthu, SJ
Assistant Director, GILRS





We Live in a Finely Tuned Universe



Arion Mitra

Department of Computer Science, 2nd Year

“Because there is a law such as gravity, the universe can and will create itself from nothing.” - Stephen Hawking

It is natural for us to ask questions such as, “Why is the speed of light 299,792,458 m/s, and why is the elementary charge of an electron 1.602×10^{-19} Coulomb? And what would happen if the speed of light was something different or the charge of electron had a different value?” In looking for answers to these questions, we will inevitably find that even the slightest variation from the actual values would result in a universe that is not hospitable to life. This remarkable sensitivity is what is sometimes referred to as the “fine tuning” of the universe.

The fine tuning of the universe is seen very clearly if we compare the relative strengths of the four forces of nature: the strong nuclear force, the weak nuclear force, the electromagnetic force and gravity. The electromagnetic and

nuclear forces are responsible for the highly efficient production of carbon, the element upon which all known life is based. These forces interact in such a way that they create an equivalence of energy levels, which enables the production of carbon by fusing three helium atoms. According to John Gribbin and Martin Rees (authors of *Cosmic Coincidences*), “The conditions in our Universe really do seem to be uniquely suitable for life forms like ourselves, and perhaps even for any form of organic complexity. But the question remains - is the Universe tailor-made for man?”.

This is a difficult question for science to answer. When the Big Bang occurred billions of years ago, matter was randomly distributed throughout space. There were no stars, planets or galaxies. But as the universe expanded, gravity began to pull atoms together, gathering them into

clusters that eventually became celestial objects. The important point here is that the gravitational force had to have precisely the right strength that is required for such clusters to form. Had the force been a bit stronger, it would have immediately resulted in a "Big Crunch", and had it been just slightly weaker, the atoms would have been separated so widely that they would never form stars or galaxies.

From a purely scientific standpoint, one might argue that the theory of inflation gives an adequate explanation for such precision and balance. This theory states that in the early stages of cosmological evolution, the universe underwent a period of exponential expansion. If the parameters in the inflationary models have the right values, it is possible to show that the critical density of the universe would naturally become what it is today. In this way, some of the universe's fine-tuning can be explained away.

Most theoretical physicists agree that some form of inflation did take place, and believe that this phenomenon could indeed account for many instances of "fine-tuning" in the Universe. But what is often left out from these speculations is the fact that inflationary models require a great deal of fine-tuning themselves. In order to produce the rate of expansion that is associated with the inflation process (and the corresponding critical density), these models require several parameters to take on very precise values. These values are so precise that the problem of fine-tuning remains, and is only pushed back one step.

As our understanding of physical reality improves, it is possible that we may one day discover a Theory of Everything that explains why the universal constants and physical laws have to have such specific values. For the time being, however, we must choose between the following three hypotheses.

The Multiverse Hypothesis. For many theorists, the multiverse hypothesis has the best chance of explaining the appearance of fine-tuning in our universe. This theory suggests the existence of an external causal force - a mechanism capable of creating an incredibly large number of universes, each with its own set of physical laws. The multiverse model allows for an infinite number of parallel worlds, in which case the existence of a universe like ours (with finely tuned physical constants) becomes much more likely, and even probable.

There are, however, several problems with this hypothesis that prevent scientists from fully embracing it. Perhaps the most important one is that there is no empirical evidence for the existence of multiple universes. There is also the fact that there ought to be infinitely many such universes, which is an idea that many physicists find difficult to accept (most of them believe that everything in the physical world is finite, and

that infinities of any kind are the result of inadequate modeling).

The "Observer Excuse". A somewhat different way to explain the fine-tuning of the universe (without invoking the notion of a Creator) is to posit the so called "observer excuse." Those who promote this line of reasoning maintain that we should not be surprised by the fact that we are living in a Universe which appears to be designed - if it did not have the physical characteristics that it now has, then we wouldn't be there to observe it! In other words, the only Universe that could surprise us would be one where the physical constants were not supportive of life.

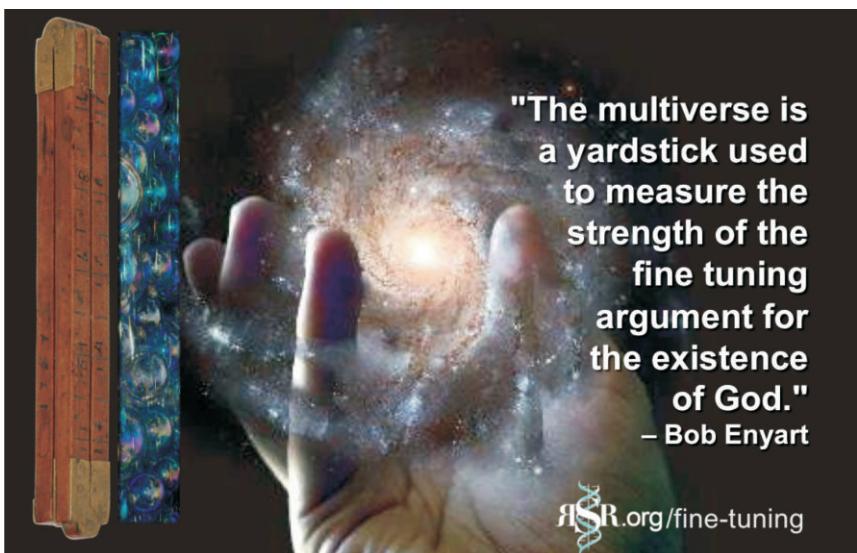
The Coincidence Hypothesis. A third way to explain fine-tuning resorts to arguments that are based on chance coincidences. Those who hold this view argue that humankind has won the "lottery of life", admittedly against tremendous odds. They point out that while the chances of a life-permitting Universe are tremendously small, they are not zero.

What can we conclude from all this? It seems that there are two possible approaches to explaining the fine-tuning of the universe.

Naturalistic Non-design: Our universe is just one of an unlimited number of universes, each of which has different parameters and laws. In such a setting, fine-tuning will be rare but not impossible, so we should not be surprised that at least one universe has parameters that are suitable for the emergence of life.

Supernatural Design: On this view, there is an all-powerful Creator who is beyond any physical reality, and who created and fine-tuned our universe.

There is no doubt, of course, that atheists would like to rule out Supernatural Design as a viable possibility. However, the fact remains that science can neither prove nor disprove the existence of a Creator. As a result, this explanation must remain in play, even if we have a preference for the explanation proposed by the Naturalistic Non-design hypothesis.





A Knock on the Door of Truth



Avipsa Dey

Department of Biotechnology, 2nd Year

Being born in an austere Hindu family, the acceptance of God had come at a very early age. Every morning I would wake up to the sound of my father reciting the mantras in front of various idols in the small temple at our house and later see my mother pouring water over the sacred 'Tulsi' in the backyard after her daily bath. I was taught to pray to the Lord every time I left the house, and no meal was had until we had offered our prayers to the Divine.

It was a Sunday evening and I was having my usual conversation with my father about the happenings of the week when the subject of black holes came up. I happened to hear of them in school, but I wasn't really clear about the concept. It was then that my father made a very interesting analogy. In "Sanatan" Dharma lies existence of a Devi called Shakti, the wife of Shiva, the God of Destruction. Shakti exists in many forms and one such form is Kali, the black goddess which consumes everything which comes in front of her, no matter how strong the being is, which is similar to black holes. Nothing that enters the black hole can escape it, not even light. To me it was very strange to see how a new concept of modern physics came so close to the beliefs of ancient Hinduism. Before this I had never questioned God or his attributes, but this was the first time I was inclined to use reason to learn more about the Divine.

In monotheistic thought, God is conceived of as a Supreme Being and the principal object of faith. Over the centuries, theologians have given various attributes to God, such as omnipresent (being present everywhere and in every being), omniscient (all knowing) and omnipotent (possessing

unlimited power). But is it really justified to assign attributes to a Deity about whom practically nothing is known? In this particular case, the word unknown may actually be an understatement, since it allows for the possibility that we may get some answers in the future. It is therefore better to use the term 'unknowable', which implies that some truths will never be accessible to us.

While theologians have no difficulty accepting the idea that certain aspects of reality are unknowable to us, it would be interesting to see if scientists share this outlook. Surprisingly, both science and mathematics allow for the existence of unknowable truths, although these two disciplines have greatly enhanced our understanding of the physical world. As an illustration, consider a cell, which represents the basic unit of life. It is fascinating to observe how cells interact, and how complex multicellular systems operate without losing their integrity. Biology can provide partial explanations for how such interactions are coordinated and synchronized, but it cannot answer why living matter is organized in such a manner. This, to me, is an example of an unknowable truth.

Mathematics and physics face similar problems, because the explanations that they provide rely on axioms and laws of nature. Axioms are propositions that are implicitly assumed to be true and the laws of nature are inferred from observations of physical phenomena, but they themselves cannot be explained. They are simply accepted, and can therefore be viewed as unknowable truths.

Another example of unknowable truths arises in chaos theory, which studies dynamic systems that are highly sensitive to initial conditions. The behaviour of such systems is often associated with the so-called Butterfly Effect, which is a term that was introduced by Edward Lorenz to illustrate the properties of atmospheric phenomena. The models that describe these phenomena are so sensitive to perturbations that the movements of a butterfly's wings in the Amazon rainforest could hypothetically affect the weather pattern in China. Because of that, we cannot make meaningful long-term predictions, regardless of how powerful our computers may be.

Quantum mechanics introduces a somewhat different type of unknowable truths, because it claims that the laws governing the behaviour of microscopic particles are nondeterministic. To illustrate what this means, suppose we were to perform 1,000 identical experiments involving a single electron. If we are interested in measuring the spin of these particles, one would expect that we would obtain the same results in all cases. Quantum mechanics tells us, however, that this will not be the case, and that we cannot predict what we will see when we observe one of these particles. All we can know is the probability distribution that describes what will happen when we perform measurements on all 1,000 electrons. This distribution would tell us, for example, that 70% of them will be in the "spin up" state and that the remaining 30% will be in the "spin down" state, but nothing more than that.

What is even more interesting is that before we make an observation, each of the electrons will be in a state where its spin is yet to be determined. Such a state is known as the state of superposition, in which mutually exclusive outcomes (such as spin up and spin down) can potentially coexist. A simple analogy that explains this strange phenomenon involves a coin toss. We know that any such experiment has 2 possible outcomes – heads or tails. But what is the state of the coin while it is still up in the air? Is it heads or tails, or is it both (or perhaps none)? This situation is similar to the state of superposition, because both outcomes coexist as potentialities until the observation is made. As with

quantum particles, here, too, we cannot make accurate predictions for a single toss – we only know that the number of heads and tails will be approximately equal if we perform a large number of them. Because this type of in determinism is inherent in quantum mechanics, we can say that the outcome of an individual experiment is unknowable.

How does all this relate to religion? If we agree that unknowable truths exist in science, it is reasonable to conclude that the same can be said about God. Theologian Paul Tillich adopted this position, and argued that we cannot use a human category like "existence" to describe something that transcends our experience. He wrote that: "The being of God is being itself. The being of God cannot be understood as an existence of a being alongside others or above others. ...

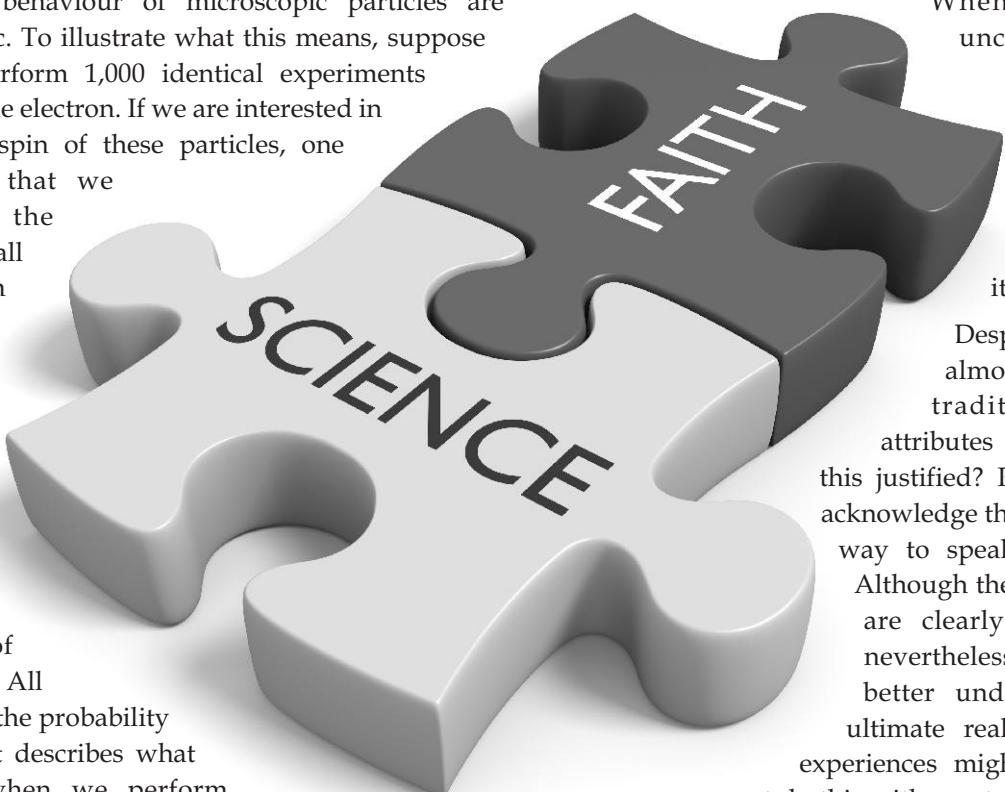
Whenever infinite or unconditional power and meaning are attributed to the highest being, it has ceased to be a being and has become being itself."

Despite that, however, almost every religious tradition uses human attributes to describe God. Is this justified? Perhaps it is, if we acknowledge that we have no other way to speak of such matters.

Although the words that we use are clearly inadequate, they nevertheless help us gain a better understanding of the ultimate reality, and how our experiences might relate to it. We

must do this with great care, however, since interpreting religious texts literally is bound to cause confusion, and can easily lead to conflicts.

If we manage to avoid the trappings of language and focus instead on the fundamental teachings of different religions, we will find that they are surprisingly compatible. Christianity tells us, for example, that God is loving, and that love is patient and kind; it rejoices in truth, and not in wrongdoing. Islam asks its followers to serve the poor, orphans and the slaves out of love for Allah. Hinduism teaches one to perform his duties, and Buddhism preaches 'As you sow, so shall you reap'. If we understand religious scriptures in this way, the discrepancies that come from literal interpretations can be largely avoided. In the end, I believe that all faiths are inherently good. Belief has never been the problem – it is the deliberate misuse of religion that causes harm and spreads intolerance.



Humours in Science and Religion

Dr. Xavier Savarimuthu, SJ.

I am sure after going through the pages on the issues of science and religion, you are feeling quite heavy. I thought of refreshing your mind before you move on to the next set of articles; therefore I have named this article as "Humours in Science and Religion". They correspond to various dimensions of our lives and so I am presenting them here for your humorous reading.

Why go to church?

If you're spiritually alive, you're going to love this! If you're spiritually dead, you won't want to read it. If you're spiritually curious, there is still hope!

A Church goer wrote a letter to the editor of a newspaper and complained that it made no sense to go to church every Sunday or Saturday.

He wrote: "I've gone for 30 years now, and in that time I have heard something like 3,000 sermons, but for the life of me, I can't remember a single one of them. So, I think I'm wasting my time, the preachers and priests are wasting theirs by giving sermons at all."

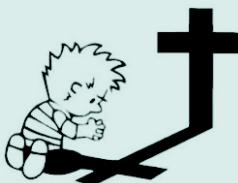
This started a real controversy in the "Letters to the Editor" column.

Much to the delight of the editor, it went on for weeks until someone wrote this clincher: "I've been married for 30 years now. In that time my wife has cooked some 32,000 meals. But, for the life of me, I cannot recall the entire menu for a single one of those meals. But I do know this: They all nourished me and gave me the strength I needed to do my work. If my wife had not given me these meals, I would be physically dead today. Likewise, if I had not gone to church for nourishment, I would be spiritually dead today!"

When you are DOWN to nothing, God is UP to something! Faith sees the invisible, believes the incredible & receives the impossible!

Thank God for our physical and our spiritual nourishment! If you cannot see God in all, you cannot see God at all!

B. I. B. L. E. simply means: Basic Instructions Before Leaving Earth!



Lessons in Life

A lovely little girl was holding two apples with both hands.

Her mum came in and softly asked her little daughter with a smile; my sweetie, could you give your mum one of your two apples?

The girl looked up at her mum for some seconds, then she suddenly took a quick bite on one apple, and then quickly on the other.

The mum felt the smile on her face freeze. She tried hard not to reveal her disappointment.

Then the little girl handed one of her bitten apples to her mum, and said: mummy, here you are. This is the sweeter one.

No matter who you are, how experienced you are, and how knowledgeable you think you are, always delay judgement.

Give others the privilege to explain themselves.

What you see may not be the reality. Never conclude for others.



Hospital Bill

You don't have to be Catholic to appreciate this one!!

A man suffered a serious heart attack while shopping in a store. The store clerk called 911 when they saw him collapse to the floor.

The paramedics rushed the man to the nearest hospital where he had emergency open heart bypass surgery.

He awakened from the surgery to find himself in the care of nuns at the Catholic Hospital. A nun was seated next to his bed holding a clipboard loaded with several forms & a pen. She asked him how he was going to pay for his treatment.

"Do you have health insurance?" she asked.

He replied in a raspy voice, "No health insurance."

The nun asked, "Do you have money in the bank?"

He replied, "No money in the bank."

"Do you have a relative who could help you with the payments?" asked the irritated nun. He said, "I only have a spinster sister & she's a nun."

The nun became agitated & announced loudly, "Nuns are not spinsters! Nuns are married to God." The patient replied, "Perfect. Send the bill to my brother-in-law."



Irony of life

The Lawyer hopes You
get into trouble,

The Doctor hopes You
get sick,

The Police hopes You
become a Criminal,

The Teacher hopes You
are born Stupid,

The Landlord hopes You
don't buy a House,

The Dentist hope Your
Tooth Decays,

The Mechanic hope Your
Cars Breakdown,

The Coffin Maker wants
You dead.....

Only a Thief wishes You
"Prosperity in life"
And Also Wishes
"You have a Sound Sleep"

Secret of Grandpa

Grandpa was celebrating his 100th birthday. Everybody complimented him on how healthy, athletic and well-preserved he appeared.

"I will tell you the secret of my success," Grandpa said, "My wife and I were married 75 years ago. On our wedding day, we made a solemn pledge. Whenever we had an argument, or fight, the one who was proved wrong would go outside and take a walk for 5 kms. Gentlemen, I have been walking in the open air day after day for some 75 years now."

One friend further asked, 'But your wife is also slim and energetic?'

Grandpa said, 'That is another secret, my wife used to follow me behind checking whether I go for 5 kms or sit in a park!!!'



Scientific Language

Wife called her scientist husband...

"Honey... It's Saturday... you're late..."

Husband: I'm busy with my team in an experiment.

Wife: What's that?

Husband: We've just added a derivative of C_2H_5OH (alcohol) with ambient temperature H_2O (water) and aqueous CO_2 (soda).

To cool this mixture added some super low temperature, solidified H_2O (ice cubes), now while waiting for some protein (snacks), we are fumigating the lab with vapours of nicotine (smoking)...

It's 4 or 5 round experiment.. So I will be late.

Wife: Oh dear... I won't disturb you. Take your time...



The cost of paan-spitting

Australia has an efficient medical ...and billing system. Last month during Christmas a family from Hyderabad, was on holidays in Australia. Apart from his wife and two children, this man from

Hyderabad was also accompanied by his old father. They were driving down one of the free ways. The Indian Family was in their car and was followed by a Local Aussie Lady, driving at a safe distance. Suddenly the Aussie Lady saw a head of an old man coming out of the window and vomiting blood. She took a quick action and informed the 000 for help.

In no time, there appeared an Air Ambulance Helicopter. The well trained staff quickly shifted that old man on to the stretcher. Oxygen supply started. Doctors examined him thoroughly. Sometime later, the old man was declared safe and fit to travel again.

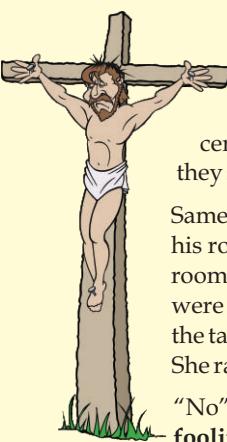


Kudos to Quick Help and Well Done, Aussie Lady.

But for these services, our Hyderabadi man had to pay AUD 3500.

With these unplanned heavy financial charges, the Hyderabadi man was in shock and he blasted his aged Father :

"paan kha ke khidki ke bahar pichkari maarni ki kya zarurat thi?" What was the need for you to make this messy red spraying paan-spit (spitting betel leaf juice) in public through the car window?

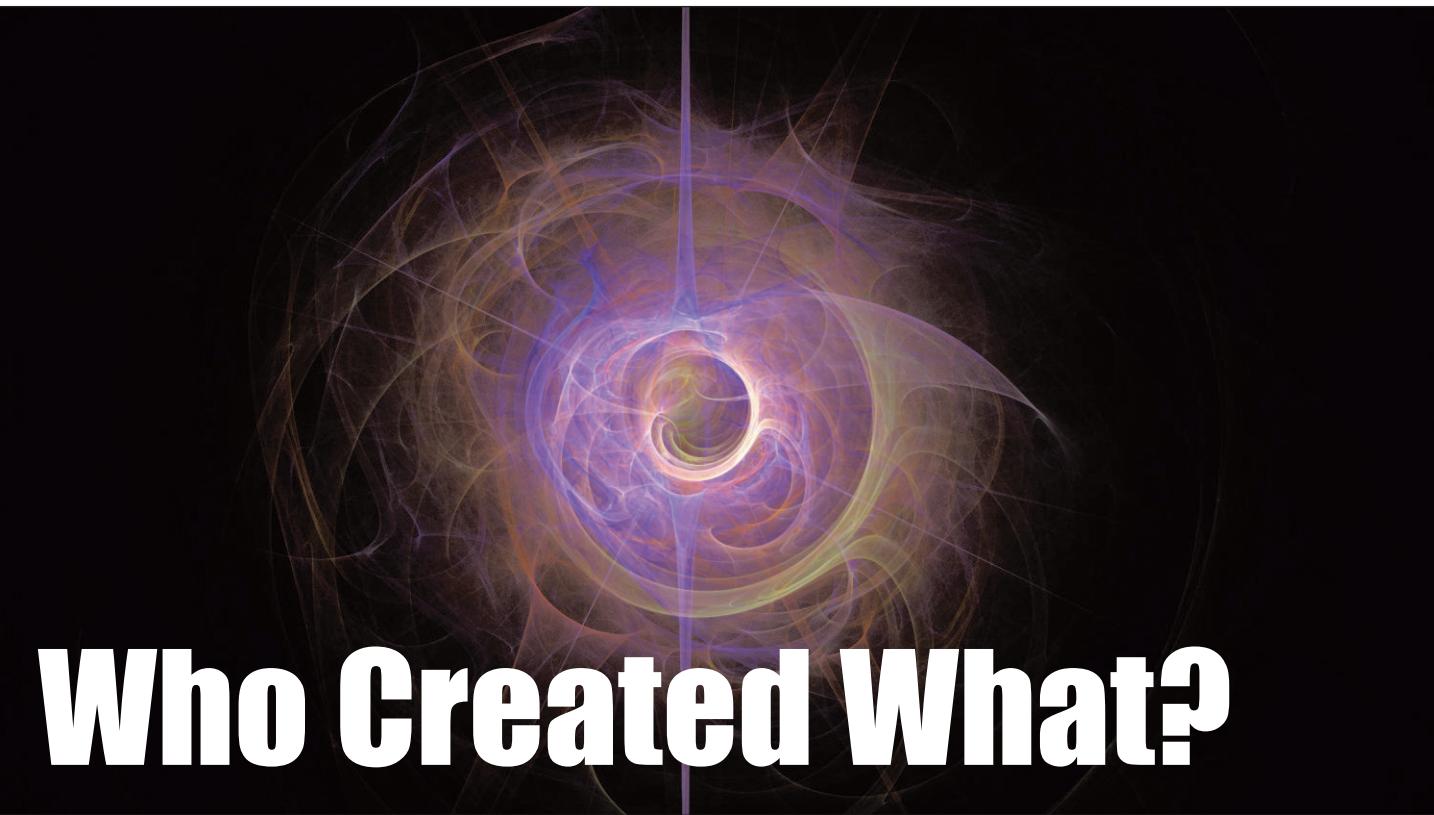


Learning Mathematics

Little Sameer was failing in maths. His parents tried everything. Tutors, mentors, flash cards, special learning centres, but nothing helped. As a last resort, someone told them to try a Catholic School. "Those nuns are tough" they said.

Sameer was soon enrolled at St. Mary's. After school on the very first day Sameer ran through the door and straight to his room, without even kissing his mother hello. He started studying furiously, books and papers spread all over his room. Right after dinner, he ran upstairs without mentioning TV and hit the books harder than before. His parents were amazed. This behaviour continued for weeks, until report card day arrived. Sameer quietly laid the envelope on the table and went to his room. With great trepidation, his mother opened the report. Sameer has gotten an 'A' in maths! She ran up to his room, threw her arms around him and asked, "Sameer, how did this happen? Was it the nuns?".

"No" said Sameer. "On the first day of school when I saw that man nailed to the plus sign, I knew they weren't fooling around".



Who Created What?



Arpita Mandal

Department of Biotechnology, 2nd Year

The origin of life still remains an unsolved mystery, despite the numerous theories that were developed to explain it. The two schools of thought that are the most radically opposed when it comes to this question are Creationists and Darwinists. Creationists believe that God created all forms of life on earth (including humans), endowing non-living matter with life through a deliberate, supernatural act. In contrast, Darwinists typically believe that life evolved from a single self-replicating protocell which in turn came into existence through spontaneous chemical reactions.

This theory (which is commonly known as abiogenesis) assumes that simple molecules can naturally coalesce into macromolecules when their concentration and the atmospheric conditions are favorable. Such a possibility was first recognized in 1924, when Alexander Oparin determined that chemicals such as methane, hydrogen and ammonia must be present in the earth's atmosphere for amino acids to form, and that oxygen impedes this process (to the point that it becomes impossible).

Some 30 years later, Stanley Miller performed an experiment attempting to reproduce the conditions that Oparin identified. Methane, ammonia, hydrogen and water were placed in a flask that was subjected to an electrical discharge, and after several days the experiment yielded a number of organic compounds (including amino acids). Similar

experiments were subsequently performed by other scientists, using different energy sources and different chemical configurations that might have existed in the earth's atmosphere in the distant past. The results that they obtained were consistent with Miller's findings, and confirmed Oparin's hypothesis.

In order to put these results in the proper perspective, it is important to keep in mind, that none of these experiments included oxygen. This was a rather odd omission, given that the earth possesses an oxygen rich atmosphere. Oxides have been found in rocks that were formed some 300 million years before the appearance of the first living cells, which indicates that oxygen was present in the atmosphere at that time. Those who favor a biogenesis as an explanation for the origin of life must therefore show how this could have happened under such circumstances. More importantly, they also have to show how the extraordinary complexity that we see in nature can emerge from purely random processes.

Creationists hold a very different view, and have tried to justify their beliefs by developing a theory called Intelligent Design. From their perspective, every word in the Bible represents the literal truth, and the world was really created in 7 days. We should note in this context that there is also a "softer" variant of this outlook, which asserts that both evolutionary science and a belief in creation are true.

However, the term Creationist is typically associated with individuals who reject those aspects of science that conflict with their beliefs.

There is no doubt that creationism in its extreme form has many weaknesses, and cannot be reconciled with science. However, this is by no means the only position that is open to people of faith. Many contemporary Christian leaders and scholars hold that there is no conflict between the spiritual meaning of creation and the science of evolution. The former Archbishop of Canterbury, Rowan Williams, claims, for example, that: "for most of the history of Christianity, there's been an awareness that a belief that everything depends on the creative act of God is quite compatible with a degree of uncertainty or latitude about how precisely that unfolds in creative time." Leaders of the Roman Catholic church have made similar statements, as have scholars such as physicist John Polkinghorne, who argues that evolution is the mechanism through which God created living beings.

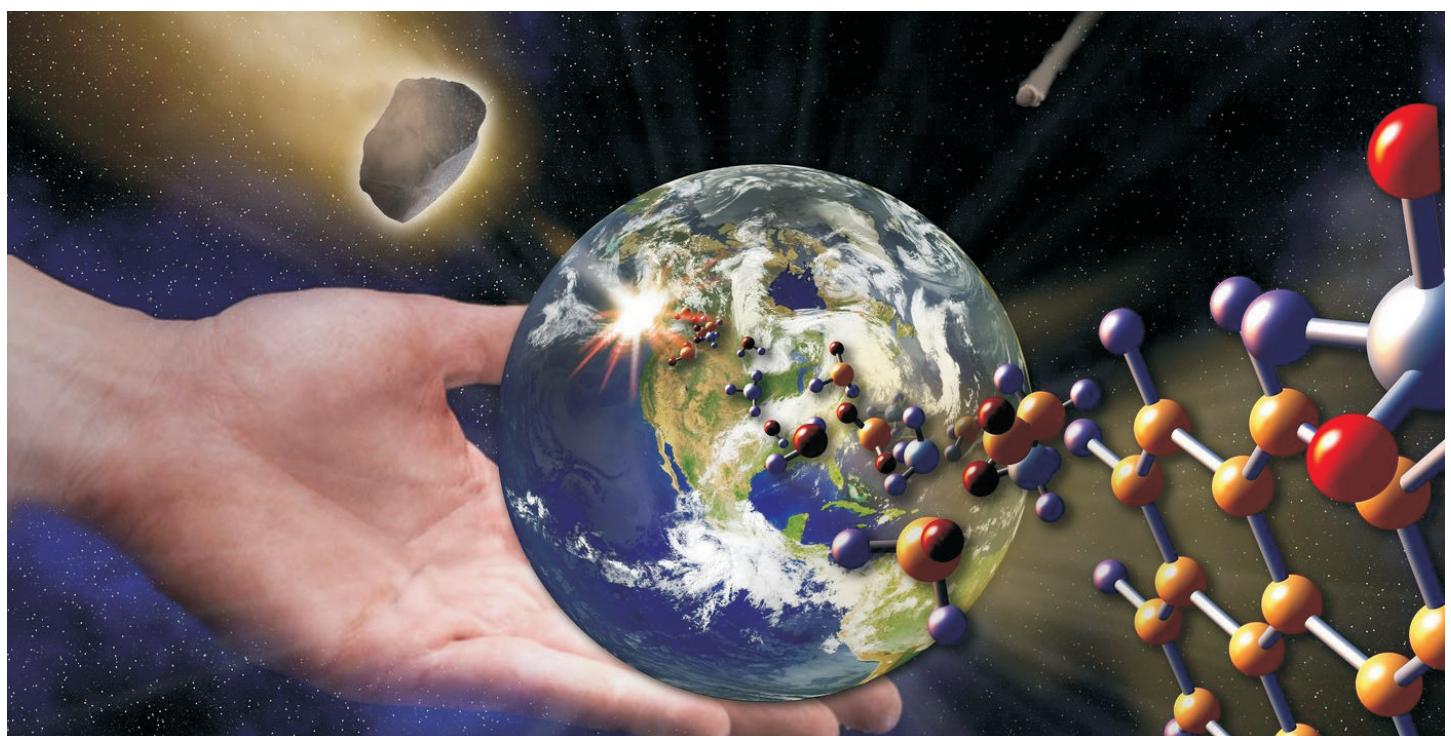
Such moderate views actually have a long history, dating back to ancient times. Many Christian and Jewish thinkers viewed the Biblical account of creation as an allegory, long before Darwin proposed his theory of evolution. As early as the first century, for example, Philo of Alexandria speculated that it would be a mistake to think that creation happened in six days, or in any set amount of time. St. Augustine (who lived some 300 years later) adopted a similar position, and argued that everything in the universe was created by God in a single moment.

Given that such views are diametrically opposed to strict Darwinism, can the two be reconciled in any way? Some scientists (such as Stephen Jay Gould, for example), believe



that they can. Gould saw science and religion as two compatible and complementary fields, whose authority extends to distinct areas of human experience. This view (according to which science and religion represent "non-overlapping magisteria") is shared by many theologians, who believe that ultimate origins and meaning are addressed by religion, but favor verifiable scientific explanations of natural phenomena over those proposed by Creationists.

There are, however, quite a few thinkers who reject such "compromises", and argue that the scientific method undermines religious texts as a legitimate source of truth (Richard Dawkins exemplifies this outlook). His attitude toward religion is perhaps too dismissive, but he is correct in claiming that Creationist beliefs are not supported by empirical evidence, and that any attempt to teach Creationism as science should be rejected.





Science and Religion



Ankita Bhattacharyya

Department of Biotechnology, 2nd Year

"Science investigates, religion interprets. Science gives man knowledge, while religion gives man wisdom - which is power." Martin Luther King

When a child is born, he is raised in an environment which holds beliefs and values that are based on what the people in that community have experienced. This is natural, of course, but I believe that it is necessary to be sceptical when evaluating such beliefs. Scepticism provides just that little push which is essential to pique our curiosity and expand the boundaries of our knowledge.

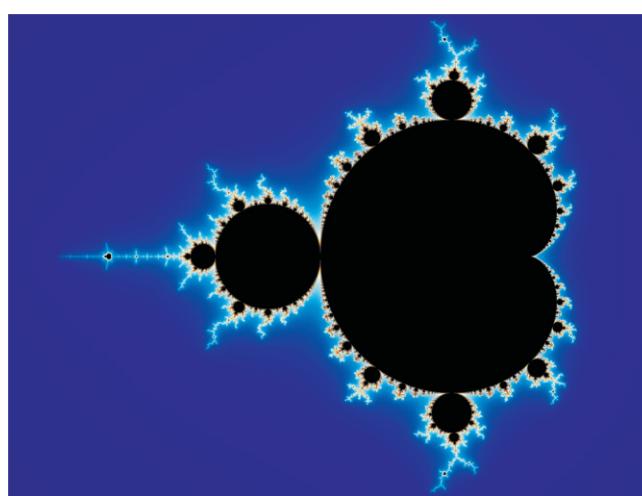
Science plays a critical role in this process, since its objective is to reveal the truth behind observed phenomena, and to bring to light the reasons behind it. In general, a scientific theory becomes accepted when many experiments, measurements and calculations give rise to the same outcome. This is where the scientific method is superior to speculative thought - it is based on evidence that provides support for the ideas that it is trying to validate. At the same time, we must acknowledge that the scientific method has its limitations. Perhaps the most

important one is that our models of physical reality are based on statistical analysis. Because of that, we cannot claim that scientific knowledge is equivalent to logical certainty.

Given that science cannot answer all our questions, what role does religion have to play? And is it completely opposed to everything that science stands for? The answer to the second question is definitely "no". The main idea behind any religion is to search for truth, and provide an explanation to those who seek answers about the meaning and origins of the universe. This is not incompatible with the questions that science poses. The difference, however, is that religion implies the existence of a transcendental Creator who is

omnipotent and whose power and true character are beyond human comprehension.

Having said that, we should add that science is the enemy of superstitious beliefs, not of faith. Despite their contrasting views, I believe that science and religion can coexist. For that to happen, however, it is imperative that we accept that there are certain truths which are unknown, and some which are unknowable.





Truths Unknowable to Man – The Most Complex Organism on Earth



Vaidehi Roy Chowdhury

Department of Biotechnology, 2nd Year

Man is probably the most complex organism living on this Earth. It took almost 2.8 million years for homo sapiens to evolve to his present anatomical form. From a purely biological perspective, however, our species is not particularly unique – we are quite similar to other mammals, both in terms of appearance and basic nature. We also share about 99 per cent of our DNA with two species of apes, bonobos (*Pan paniscus*) and the common chimpanzee (*Pan troglodytes*). So why, then, do we think of ourselves as “special”? Does that 1 percent really make such a difference?

Those who believe that this is the case often point out that in complex non-linear systems small changes in a single parameter can lead to enormous differences. They also argue that we should take into account how genes interact with and regulate each other, and how this process gives rise to the various cell types (and inhibits the formation of other possible types).

A major contribution to our understanding of these interactions was a model proposed by American mathematical biologist Stuart Kauffman, who described the functioning of gene regulatory networks (GRNs) using the concept of random Boolean networks (RBNs). In a GRN (which is a complex dynamic system), each gene is assumed to have two different states, which can be represented by a 1 (ON) and 0 (OFF).

Since the human genome has about 100,000 genes, the total number of possible combinations (and therefore the possible number of cell types) is 2100,000, which is a fantastically large number. We know, however, that the number of different cell

types in the human body is around 250, which is only a tiny fraction of that number. This discrepancy inspired Kauffman to search for a theory that explains why nature favours such a small set of outcomes, and prohibits the rest.

Kauffman assumed that in the RBN model of a self-organising GRN, each gene and its input and output can be represented by nodes in a directed graph (in which the edges represent interactions between the nodes). In these networks, time is considered to proceed in discrete steps, and each node can be in one of two states – 0 or 1. The new state of each node is assumed to be a Boolean function of the previous states of the nodes that influence it.

Since a Boolean network with N nodes allows for 2^N possible combinations of zeros and ones, its state will sooner or later reach a previously visited configuration, at which point the network dynamics become periodic (this periodic pattern is known as a limit cycle). Limit cycles can be of varying lengths, depending on the number of participating nodes and the type of interactions between them. Cycles that cannot be reached from states that are outside of them constitute what are known as “Isles of Eden”. Cycles that can be referred to as attractors, and a number of initial states will eventually lead back to them. The set of states that lead to a particular attractor represent its basin of attraction. Kauffman suggested (and recent evidence confirms) that cell types correspond to the attractors in these GRNs, and transitions between attractors can be associated with cell differentiation.

Another important property of a Boolean network is the number of "neighbours" that influence a particular node (this number is usually denoted by K). When K=2, the behaviour of the network is at the "edge of chaos" i.e., at the border between order and disorder. In that particular case, the attractor length L and the number of attractors M have values proportional to N^{1/2}. It is not difficult to see that for N = 100,000, the number of attractors M is close to 250, which is roughly the number of cell types in the human body.

Kauffman established that the "square root law" is not limited to the human genome, and applies to other organisms as well (including even the simplest ones). Given that this is the case, what grounds do we have to consider ourselves "special"? An obvious possibility is human consciousness, which sets us apart from any other living form in the biosphere. Consciousness should not be viewed as just a by-product of "the behaviour of nerve cells, glial cells, and the atoms, ions, and molecules that make them up and influence them", as the famous scientist Francis Crick suggested. The fact of the matter is that every atom in our body is replaced within a period of a year at the most. This means that we are not determined exclusively by our physical makeup – we are also defined by information.

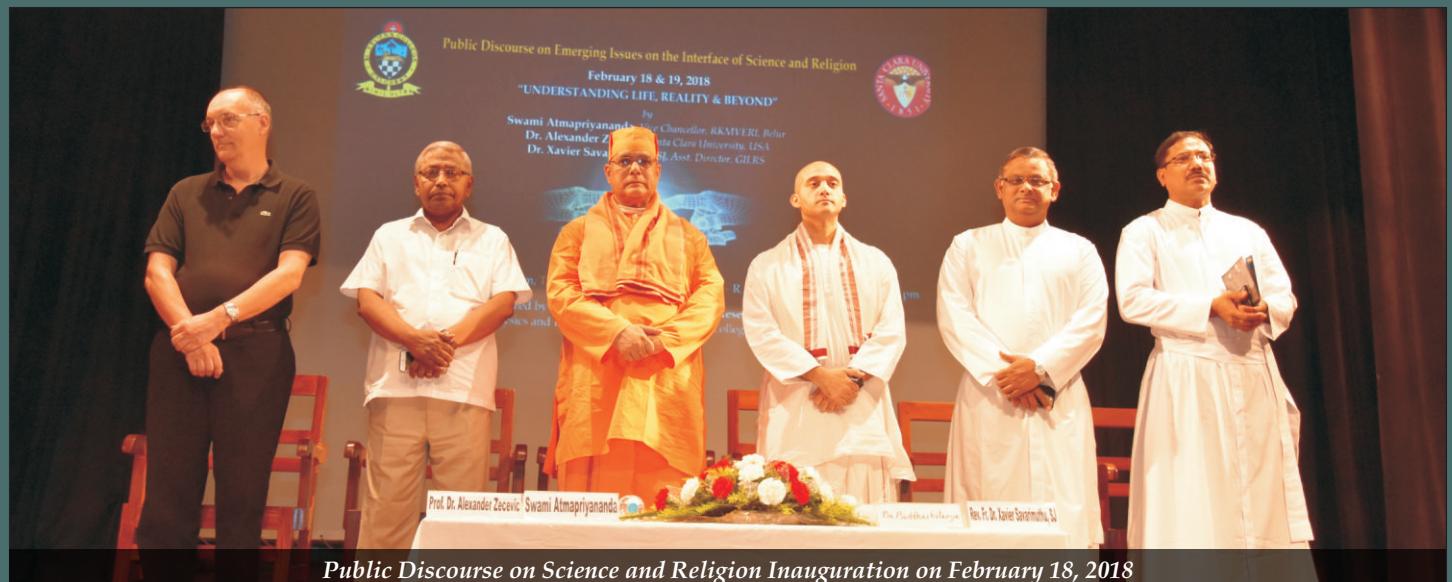
Information preserves our identity even though our physical self is quite "plastic" and prone to changes. It is also an integral part of all our conscious (and unconscious) activities. The eminent Austrian neurologist Sigmund Freud compared the three levels of human psyche with an iceberg submerged in an ocean. In this metaphor, the tip of the iceberg represents the conscious mind – the level which consists of all the mental processes that we are aware of. Just below the tip, submerged near the surface of the ocean, is the layer of the iceberg which represents the preconscious. According to Freud, thoughts and feelings that we are not directly aware of remain in the preconscious mind until they "succeed in attracting the eye of the conscious".

According to Freud, the most important part of our mind is the part which we cannot access. It is the unconscious mind, which corresponds to the portion of the iceberg that is immersed in the ocean. The unconscious mind is a repository of all those mental processes that are "hidden" from us, but influence our behaviour, judgement and feelings. Freud maintained that the unconscious also contains our primitive urges, which often fail to reach the conscious mind because our rational thought processes suppress them.

Freud's analogy has an interesting extension, in which the ocean that the iceberg is submerged in symbolises the collective unconscious. According to Swiss psychiatrist and psychoanalyst Carl Jung, the collective unconscious: "comprises in itself the psychic life of our ancestors right back to the earliest beginnings". It is a psychic system which is present in all of us, and is of a universal and impersonal nature. It is inherited, and is identical in every individual.

In dreams and other exceptional states of our mind, "the most far-fetched mythological motifs and symbols can appear autochthonously at any time" (Jung, 1929). These "primordial images" or "archetypes" typically emerge without any prior sign, and they belong to the basic stock of the unconscious psyche, which is permeable to the information stored in the collective unconscious.

These intricacies of human consciousness and our complex and adaptive intelligence are perhaps the principal reason why our species can claim superiority over other living creatures. Our ability to process information in unique and creative ways has not only made us "special", but has also provided us with the impetus to search for the truth about our origins and the evolution of the entire universe.



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St. Xavier's College, 30 Mother Teresa Sarani, Kolkata 700016, India.
Tel: 0091-33-22801919, Email: goethalscal@gmail.com, Website: www.goethals.in

Director: Fr. Dr. J. Felix Raj, SJ, Asst. Director: Fr. Xavier Savarimuthu, SJ, Staff: Avijan Mondal (For Private Circulation Only)