

Black & White

Aniket Sule

Homi Bhabha Centre for Science Education
Tata Institute of Fundamental Research
Mumbai

National Scientific Temper Day

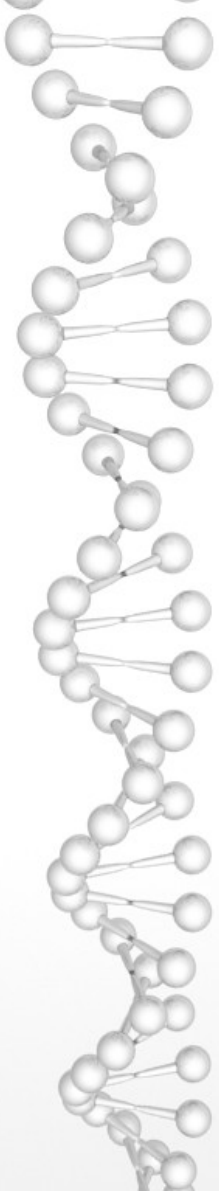


- जेवढा पुरावा, तेवढा विश्वास
- जितना सबूत, उतना यकीन
- More the evidence, more the believability

An Example by Dr. Dabholkar



- I want to go from *Gadchiroli* to *Urmori*, but I don't know the road. I ask four people with directions and I get these answers:
 - I had a dream few days back and in that dream I traveled by this particular road
 - I was on *Gadchiroli* bus stand a few days back and I overheard discussion between two people. One of those told other one that this particular road should be taken
 - My friend traveled from *Gadchiroli* to *Urmori* 3 months back and he took this particular road
 - I had to urgently go from *Gadchiroli* to *Urmori* last week and I took this route.
- Now whose advice you are most likely to follow? Why? ³



The Process of Science

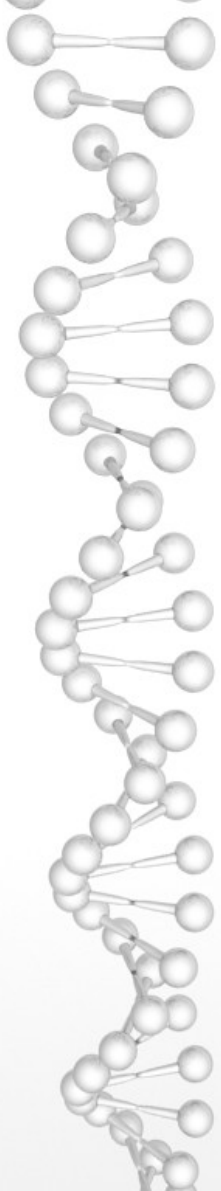


- Science is not just a school textbook with collection of facts
- It has a process and method of scrutinising the evidence
 - If something wants to be called as 'scientific', it must submit to the scrutiny of science
 - I cannot say "I should be called as an elephant, although I look like a human." Can I?

The Scientific Temper



- Scientific Temper is a way of life which entails
 - the search for truth and new knowledge,
 - the refusal to accept anything without testing and trial,
 - the capacity to change previous conclusions in the face of new evidence,
 - the reliance on observed fact and not on pre-conceived theory,
 - the hard discipline of the mind
 - And its use not merely for the application of science but for life itself and the solution of its many problems.
 - *Pt. Jawaharlal Nehru* (in 'Discovery of India')



The Process of Science

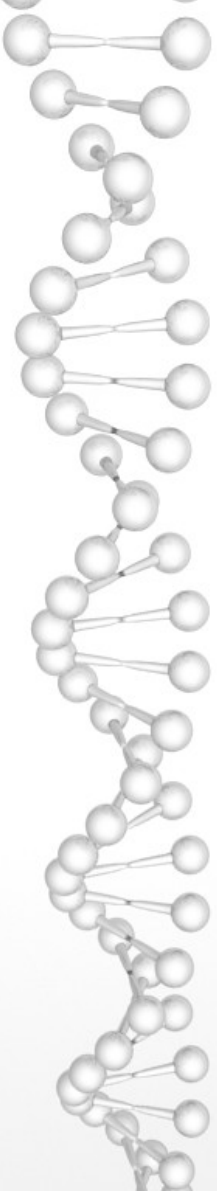


- A mind with scientific temper will not make compartments like 'things which can be explained by science' and 'things which cannot be explained by science'
 - If you claim to have scientific temper, you should not be afraid to apply it in all aspects of your life.
 - Before Newton, science could not explain why fruits fall down and don't float.
 - Till 300 years back, science could not explain why there are epidemics of certain diseases.
- Some things are difficult to explain only because we are not able to carry out experiment for those cases to check which of the proposed theories is correct.

Beliefs



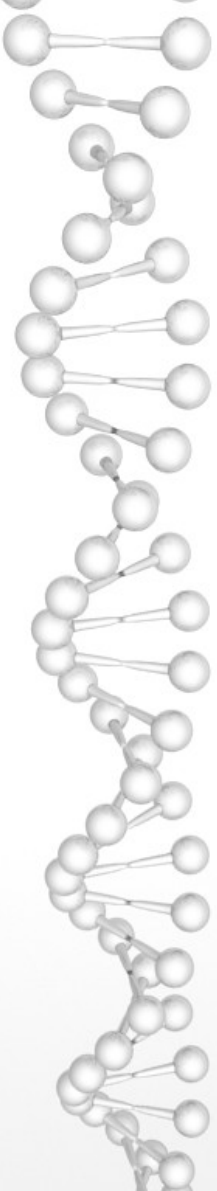
- Most people have beliefs ingrained in them during their upbringing.
- No one has a right to question other person's beliefs
 - Constitutional right to freedom includes right to hold a belief
 - However, these rights are for your personal life.
- The conflict arises only when
 - A claim is made that some particular belief is 'scientific'.
 - If this is claimed, then it must be scrutinised in a scientific way.
 - When personal beliefs of some scientist / official / minister, start affecting his / her decision making in their official duties.



Common Mistakes



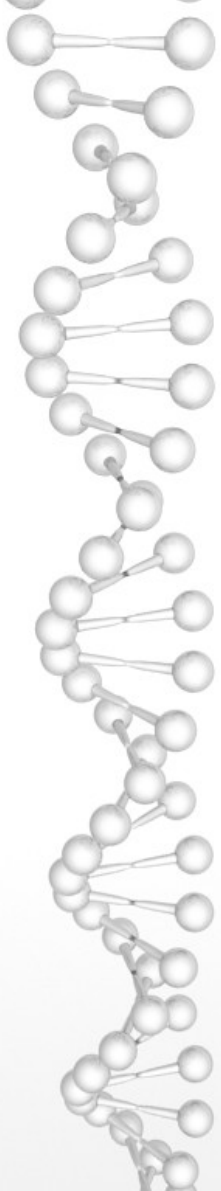
- Science doesn't know everything. So how can you be sure that my claim is wrong?
 - If I ask you “what is my height?”. What answer would you give?
 - Is it possible that my height is:
 - 1.70 mt
 - 5 ft. 6 in.
 - 5 ft. 9 in
 - 10 ft.
 - 100 mt.
 - You may not know exact answer to many things, but in most cases you can still tell “what is reasonable”.



Common Mistakes



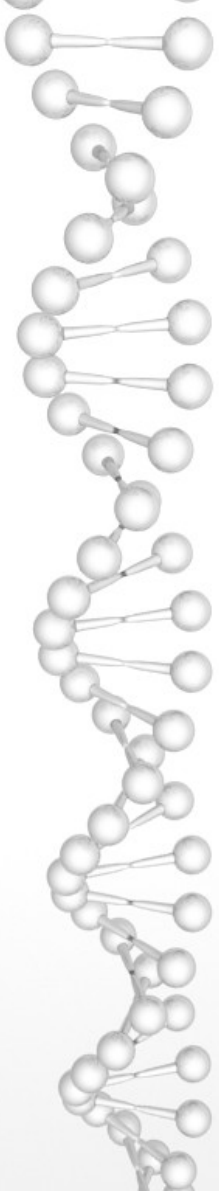
- Science is always evolving. So in future it may turn out that my claim was correct.
 - “In 19th century, people thought airplanes were not possible”
 - “Einstein proved Newton’s theory was insufficient”
- Scientific theories are based on evidence at hand. If there is a new evidence, then scientific theories must account for that or modify themselves.
 - But a lack of (scientific) evidence cannot make my presumptive claim to be valid.
 - Should ‘flat earth’ be mentioned as possible alternate theory in our school textbooks?



Common Mistakes



- I know a person with degrees in science who also believes in this claim.
 - Our higher education has become highly specialised and application oriented. The quality of instruction there also varies widely. So all people with science degrees are not equally expert.
 - Holding degrees in science / technology is not same as having scientific temper. Otherwise we would not have people in scientific institutions
 - Offering satellite models in temple before satellite launches.
 - doing *pujas* in the institute at the launch of new projects.
 - On the other hand, to have a scientific temper, you don't need any degrees in science.



Common Mistakes

- The guy making the claim seems to be following tools and methods of science.
 - On a remote island in the Pacific that operated as an airbase during WW2, airplanes brought food and supplies.
 - After the war, local tribes could not understand why the flying objects bringing food won't land any more.
 - So they mimicked soldiers' actions by lighting fires along the runway, shaping a hut like a control tower, and placing a controller inside wearing pieces of wood like headphones.
 - And then, they waited for the planes to land.
 - By studious observation of soldiers' actions on the ground, they had inferred that when you do these actions, the planes land. They followed all precepts and forms of scientific investigation
 - A story told by Richard Feynmann in his 1974 address to Caltech students on "science, pseudoscience and learning how not to fool yourself"

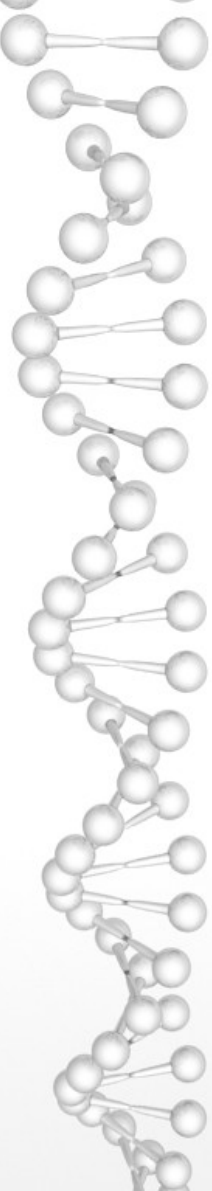
Common Mistakes



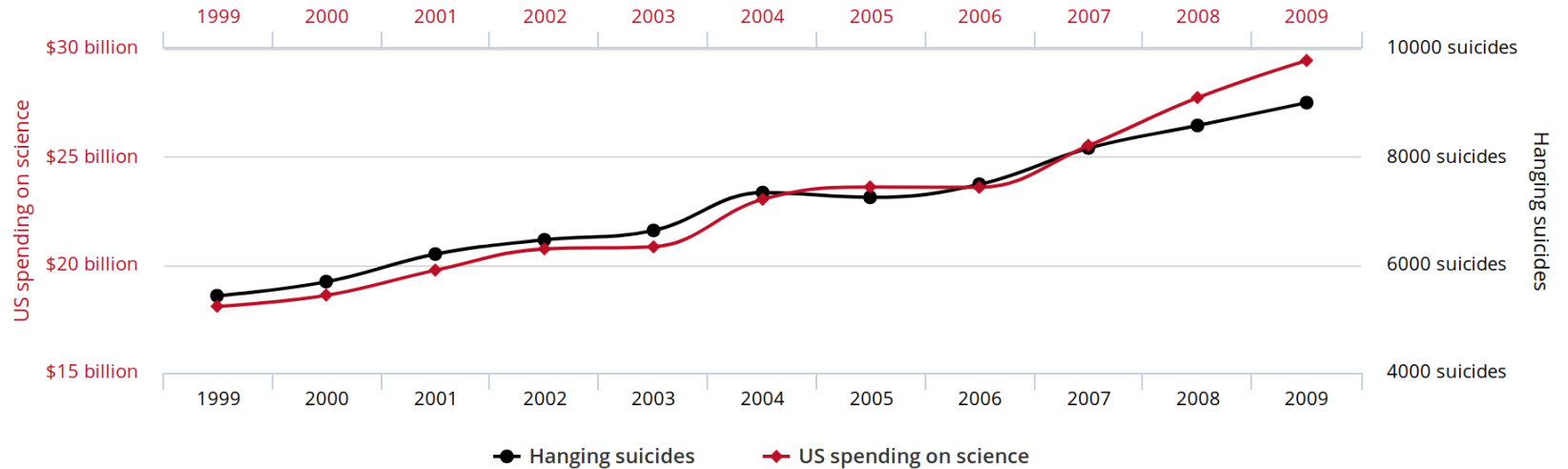
- I have done my bit of internet research. I found videos and blogs supporting the claim.
- Real scientific research goes through a quality control process before it is published.
 - Other scientists carefully check new research to see if there is enough evidence to support the claim.
 - When real scientists make videos / write blogs to popularise their work, they will also give reference to the original research paper.
- On the other hand, fraud claims take refuge in videos and internet blogs, where one can post anything without any scrutiny.
 - This would not be published in any real scientific journal instead of some obscure magazines which publish all kinds of bad research.
- In short, google search is not same as 'research'.

Common Mistakes

- I know several people for whom this alternate medicine worked or got good confirmations of astrological predictions. This means it works.
 - In any studies involving human subjects there are always many factors which decide final outcome. It is impossible to say that because something worked for person A, it will work for person B
 - That is the reason, we do large scale statistical studies to see any effects. Success in one or two cases is not proof of effectiveness.
 - Human mind has tendency to only remember things favorable to its belief and forget any evidence disproving that belief. This is called 'confirmation bias'
 - Thus, past stories as evidence is not a reliable method of data collection.
 - Correlation is not same as causation
 - <http://www.tylervigen.com/spurious-correlations>



Common Mistakes



tylervigen.com

Does this correlation prove that “the more USA spends on science research, the more people commit suicide by hanging themselves? So to reduce suicides, USA should reduce spending on science research”.

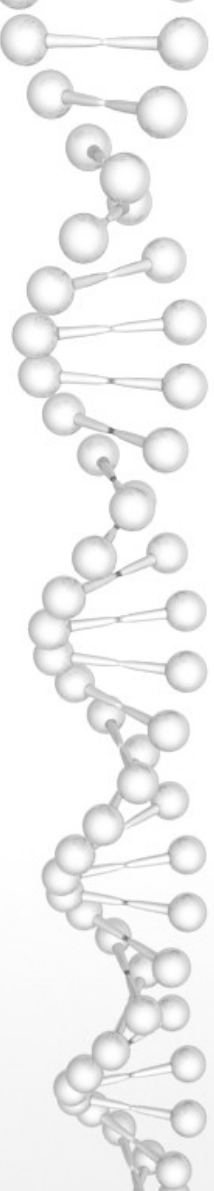
Questions you should always ask



- Feasibility:
 - Does it defy common sense?
 - “Moon is nothing but a giant *rawa laddoo*”
 - Is it inconsistent with some basic, well established scientific principle?
 - “Earth is actually flat”.
- Part of the big picture:
 - Is it inconsistent with other scientific facts?
 - If **Indian cows inhale as well as exhale Oxygen**, then physiology and anatomy of Indian cows has to be different than other cows.
 - Are all prerequisites in place?
 - e.g. You cannot have a **Vedic nuclear bomb** without uranium mining



Let us take a few statements and Examine



Fake Claim 1

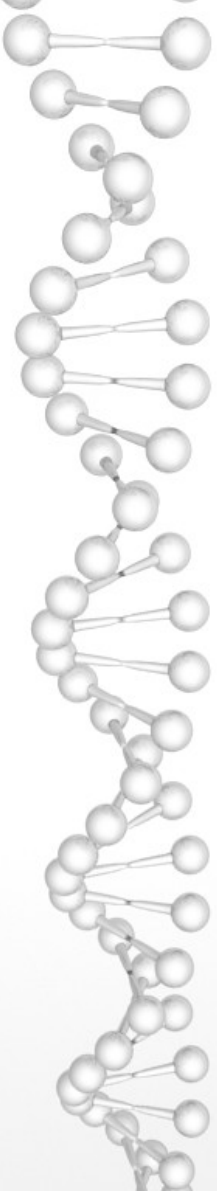


- **Two moons in the sky** on July 27! The next time this cosmic event will happen again, will be 36,996 years later. **Mars** will be the most brilliant star in the sky. This is because it **will have an apparent diameter as big as the Full Moon!**
 - A typical social media forward which becomes active every year in July / August.

Analysis



- Scientific explanation
 - Mars is going around the Sun just like Earth. In the course of this orbit when they are on the same side of the Sun, almost in the same line, they will obviously be closest to each other. However, this distance is not drastically different than other points in the orbit.
 - Even when Mars is at its closest, the Moon will appear about 70 times bigger than Mars
- Common Sense Explanation
 - Have we seen any such dramatic thing happening in all our life?
 - Has there been any news that Mars has left its orbit and heading towards the Earth?
 - Are all astronomers and government officials running for underground shelters?

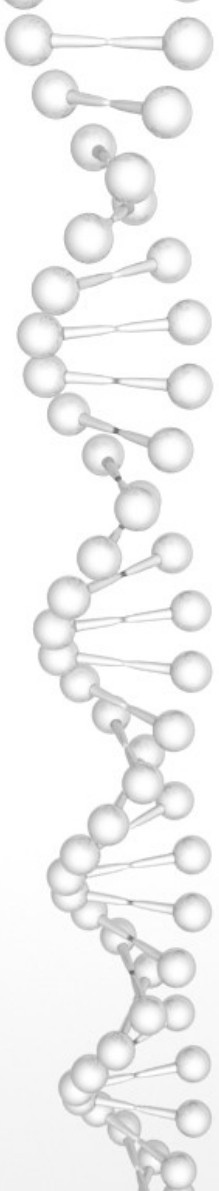


Fake Claim 2

- VERY URGENT! Tonight at 00:30 to 03:30am make sure to turn off your phone, cellular, tablet etc & put far away from your body! Singapore TV announced on the news! Please tell your family & friends! **Tonight 12:30pm to 3:30am for our Planet will be getting very high radiation! Cosmic rays will pass close to Earth, So please turn off your cell phone! Do not leave your device close to your body, it can cause you terrible damage! Check Google & NASA / BBC News!**
 - Popular social media forward

Analysis

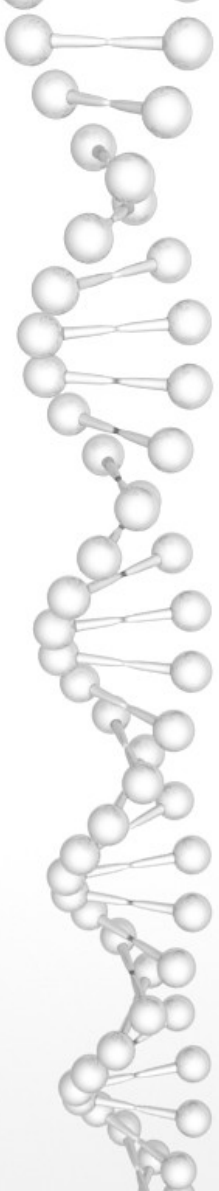
- Cosmic rays are charged particles traveling through the universe. For the Earth, the biggest source of charged particle shower is the Sun.
 - Most of these particles are stopped / deflected by the magnetic field of the Earth.
 - Most of what remains get absorbed by the atmosphere.
- Cosmic ray storms (which occur once every few years)
 - Won't affect tropical countries like India, unless the Earth's magnetic field disappears
 - Has your magnetic compass stopped working?
 - Will affect satellites more than anything else on the Earth.
 - Are you seeing announcements everywhere that satellite TV channels won't work from tomorrow?



Common Sense Rule



- How to spot fake science forwards
 - Look for any of these words
 - VERY URGENT!
 - XYZ TV just announced on the news!
 - Please tell your family & friends! Forward to everyone!
 - If you don't follow the instructions, it can cause you terrible damage!
 - Check Google & NASA BBC News!
 - If you see any of these, the forward can be safely assumed to be a fake one.



Fake Claim 3

- During an eclipse, the wavelength and intensity of light radiations available on the earth's surface is altered.
- Especially, the blue and ultraviolet radiations, which are known for their natural disinfecting property, are not available in sufficient quantities during eclipse. This leads to uncontrolled growth of micro-organisms in food products during eclipse and the food products are not suitable for consumption.
 - Mitali Madhusmita of *Sri Sri Tattva Panchakarma*
 - As quoted by NDTV on 26 July 2018

Analysis

- Eclipse is a play of shadows. Nothing more.
 - If you stand in shadow of a building, does it mean suddenly Sun will start sending some dangerous rays towards you?
- Ultraviolet radiation is absorbed by the Ozone layer in our atmosphere.
 - Does our atmosphere disappear during eclipse?
- Strong UV radiation can indeed kill bacteria
 - But if you have radiation that strong, it can also burn your skin and give you skin cancer. Do you see that happening?
- Does light from Sun / Moon always fall on our food?
 - What about new moon, what about waning fortnight?
 - What about food kept inside our houses?

Fake Claim 4



- The structure seen here, is the legendary 'Ram Setu', built by Ram's army during his invasion of Lanka
 - Popular social media forward

Image Credit: https://en.wikipedia.org/wiki/Adam%27s_Bridge

Analysis

- Although historical identification of Lanka is also questionable, here let us focus on scientific aspect of the claim.
- See size of Sri Lanka in this image
 - How wide this 'bridge' should be to be seen in this image?
 - How much material and how much labour would be needed to build this structure?
- Is there another explanation to this?
 - According to experts, these are naturally occurring shoals and corals forming series of islands. They are not continuous.

Examples of Shoals

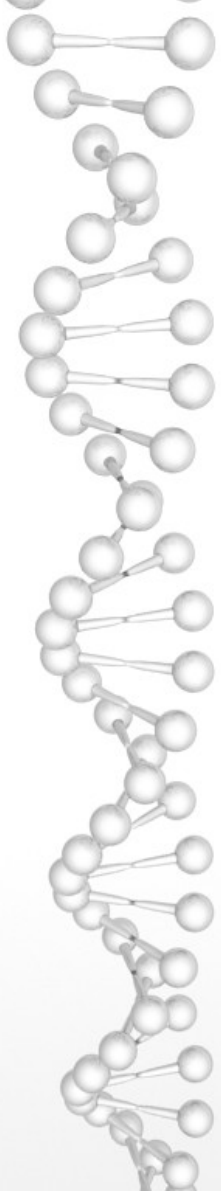


Yasawa Islands, Fiji
Image Credit: Wikimedia Commons



Nosy Iranja, Madagascar

By tato grasso - Own work, CC BY 3.0,
<https://commons.wikimedia.org/w/index.php?curid=44385909>



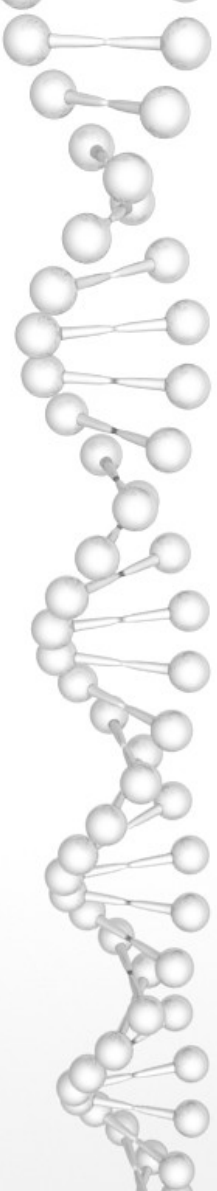
Fake Claim 5



- Stephen Hawking emphatically said on record that our Vedas might have a theory which is superior to Einstein's theory of $E=mc^2$.
 - Dr. Harsh Vardhan,
 - Minister for Science & Technology, Govt of India
 - Indian Science Congress, 2018

Analysis

- Obviously no known Hawking book / article / speech says anything like this. On the other hand, Hawking was a staunch rationalist. Then where did this idea come from?
- In 2011, a facebook page titled 'Stephen Hawking' made a post saying exact same thing.
 - So it seems minister's speechwriter got the idea from there.
 - The problem is, the page was not a page of real Hawking.
 - It was created and maintained by someone called 'hari.scientist'.
 - It seems this Hari got this crazy idea from a book written by Dr. Sivarambabu (Organizing secretary, I-SERVE, i.e. Institute of Scientific Research on the Vedas).



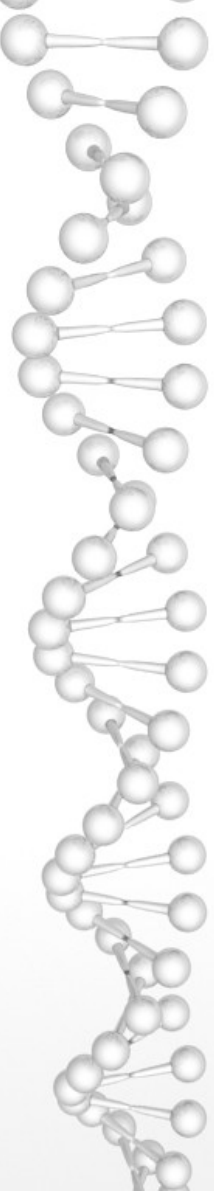
Fake Claim 6

- We all read about *Karna* in the *Mahabharata*. If we think a little more, we realise that the *Mahabharata* says *Karna* was not born from his mother's womb. This means that genetic science was present at that time. That is why *Karna* could be born outside his mother's womb.
 - Prime Minister Narendra Modi
 - At an event in Mumbai in 2015

Analysis



- First of all, modern medical procedure of IVF (i.e. test tube babies) does not need modern genetics. So this story does not relate to genetics as such.
- Secondly, even for IVF, you need to understand female hormones, ova (eggs) from mother, sperms, sperm count and sperm motility of father and ultrasound imaging.
 - Do we see evidence of any of that?



Fake Claim 7



- We worship Lord *Ganesha*. There must have been some plastic surgeon at that time who got an elephant's head on the body of a human being and began the practice of plastic surgery.
 - Prime Minister Narendra Modi
 - At an event in Mumbai in 2015

Analysis

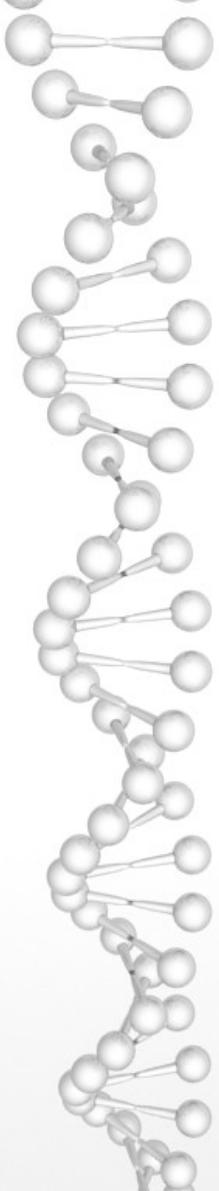


- It is true that indian medical professionals had made big advances in surgery and *Sushruta* (800 BCE) had performed rhinoplasty (repairing the broken nose), which is a type of plastic surgery.
- BUT, a head replacement is not a 'plastic surgery'.
 - If one actually tries to replace head of one human with another head, imagine what all needs to be joined again.
 - Spine, spinal chord with all neurons, all blood vessals, digestive tract ...
- Lastly, if *Ganesha*'s story is proof of plastic surgery, should we say these Egyptian gods are also proofs of plastic surgery?

Analysis



Image Credit: <https://www.realmofhistory.com/2018/01/16/15-ancient-egyptian-gods-goddesses-facts/>

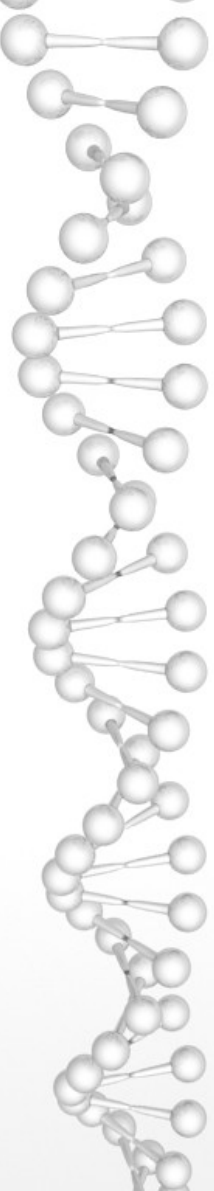


Fake Claim 8

- **India has been using internet since ages.** In *Mahabharata*, *Sanjay* was blind but he narrated what was happening in the battlefield to *Dhritarashtra* anyway. This was due to internet and technology. **Satellite also existed during that period.**
 - Mr. Biplab Deb,
 - Chief Minister, Tripura
 - April 18, 2018

Analysis

- What all technologies do you need to run internet and satellites?
 - Radio waves, electricity, solar power, solar panels, light metals like aluminium, copper wires / fibre optics, transmitters and receivers, relays & switches & routers & servers, internet protocols, programming, super efficient chemical fuels
 - Did we have all these?
- Do other cultures have such stories?
 - Did Tiresias, the blind poet of Thebes also used Internet for prophecies?
- And Mr. CM, *Sanjay* was not blind. *Dhritarashtra* was.



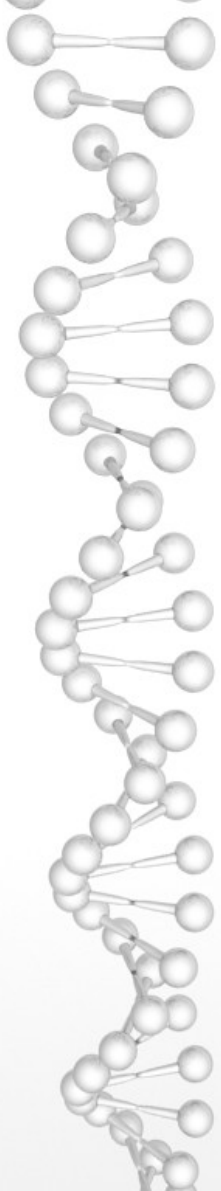
Fake Claim 9



- The knowledge of making aeroplanes existed between 6 and 7000 BC.
 - Capt. A. Bodas
 - Speaking in Indian Science Congress, Mumbai, 2015

Analysis

- This book called '*Vaimanika Shastra*' supposedly written by rishi Bharadwaj 3000 years ago, was examined in detail by scientists from IISc in 1974.
- They concluded that
 - This book is NOT ancient (it cannot be dated before 1904)
 - The planes described are not expressions of something real. They are figments of imagination or poor efforts to put together something which can pass off as a plane.
 - None of the planes have properties or capabilities of being flown.
 - The geometries are unimaginably horrendous from the point of view of flying
 - The principles of propulsion make them resist rather than assist flying.



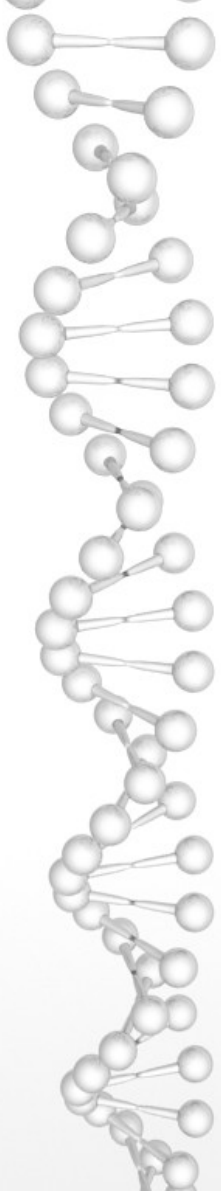
Fake Claim 10

- Why are students not taught that before the Wright brothers, **an Indian called Shivakar Babuji Talpade was the first to invent the airplane.** This person invented the plane eight years before the Wright brothers. Are our students taught these things in IITs or not? They should be.
 - Dr. Satyapal Singh, MoS, HRD, GoI
 - September 2017
 - There was also a bollywood movie called '*Hawaizadaa*' on this topic recently.

Analysis

- There is hardly any documentary proof available for the supposed flight of this aircraft
 - One newspaper at the time had the news “a demonstration of the aircraft had been arranged by Talpade at *Girgaum Chowpatty*”
 - It does not give any details of the aircraft
 - It does not even say if the demonstration was a success
- There are no writings of Talpade available and all parts of his supposed aircraft have disappeared
- At best, we can give him credit for trying
 - But then, many others tried too:

https://en.wikipedia.org/wiki/Early_flying_machines



Fake Claim 11



- **Darwin's theory** (of evolution of humans) **is scientifically wrong**. It needs to change in school and college curriculum. Since man is seen on Earth he has always been man. **Nobody, including our ancestors, in written or oral, have said they saw a monkey turning into a man.**
 - Dr. Satyapal Singh, MoS, HRD, GoI
 - All India Vedic Conference Jan. 20, 2018

Analysis

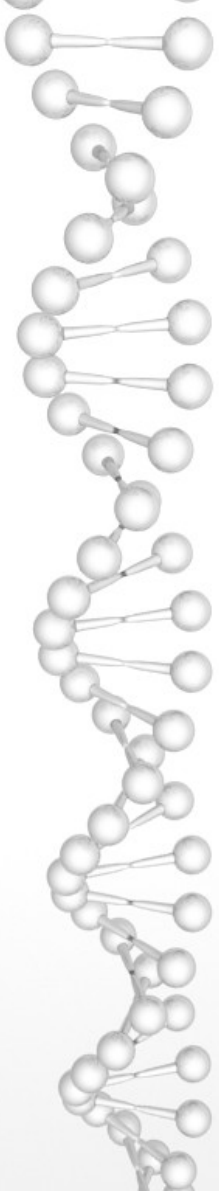


- Darwin was one of the first persons to successfully put forth theory of evolution and knitting it with natural selection.
 - His research was published in 1859.
- Since then we have seen thousands of scientists applying the basic framework given by Darwin to many different situations and verifying the idea
 - In these 160 years the theory of evolution has been improved and modified but the basic idea still holds true.
- Even though we know that general relativity gives much better description of motion of a body, we still teach Newton's laws in school.

Analysis



- Evolution never claims that you will have drastic transformation in one generation.
- Man did not descend from Chimpanzees or any other apes present today.
 - If we start tracing back generations, we will find that humans and all these apes had a common ancestor millions of year back.
 - Go further back, and you can find common ancestor of apes and other monkeys
 - So no question of any of our civilised ancestors seeing an ape or any other monkey turn into a man
- Evolution explains why tigers have stripes, why Giraffes have long necks or why certain bacteria become drug resistant.
 - If we say evolution is wrong, we need a new theory for all of these as well



Fake Claim 12

- Cow is the only animal that ‘inhales and exhales oxygen’ and that people need to understand its ‘scientific significance’. Diseases such as cold and cough are healed if one goes near a cow. Cow dung has ample quantity of vitamin B that results in soaking radioactivity.
 - Mr. Vasudev Devnani
 - Rajasthan education and *panchayati raj* minister
 - at a programme organised at the Hingonia Cow Rehabilitation Centre by *Akshay Patra* foundation in 2017
- Subsequently, several leaders of the same political party tried clarifying that they only refer to Indian cows and not all cows in general.

Analysis

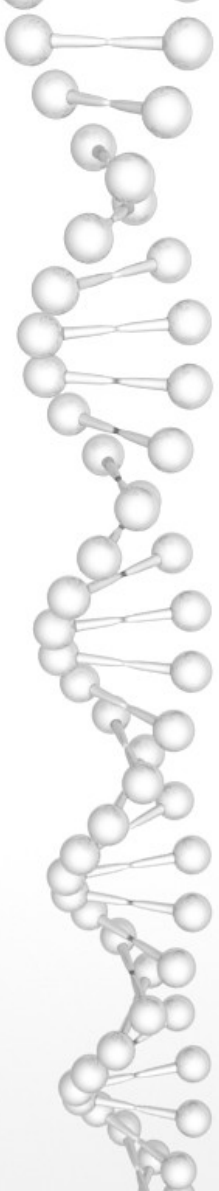


- The key to debunk many false claims is 'quantifying them'.
 - If an ant pushes a truck, is the ant applying 'some force' on the truck?
 - But is it big enough to be taken seriously?
- No animal (including humans) have respiratory system efficient enough to convert ALL inhaled O_2 to CO_2 .
 - So all animals will exhale 'some' oxygen.
- Similarly, any kind of solid will stop 'some' radioactive particles. A thick layer will significantly reduce count of all kinds of radioactive particles.
- So although the statements can be deemed to be true 'in-principle' the implied sentiment in the post is what makes it problematic.

Analysis



- So is physiology of Indian cow different than other cows or buffalos?
 - Can it be verified by autopsy / surgery / scans?
- If you are inhaling Oxygen and exhaling Oxygen, what is the exact purpose of breathing?
- If common colds and cough are cured going near to cow, how does the cow 'transmit' cure to our body and how our body receives it?
- If cow dung absorbs radioactivity, how (Indian) cows developed this adaptation?
 - Why this property may be found only in cow dung and not in excreta of say a goat eating exactly same diet?



Fake Claim 13

- We analyzed 400 samples of Gir cow urine and found traces of gold. The analysis showed traces of gold ranging from 3 mg to 10 mg from 1 litre urine. The precious metal was found in ionic form, which is gold salts soluble in water. The gold from urine can be extracted and solidified using chemical processes. The researchers also screened urine sample of camel, buffaloes, sheep and goat but they did not find any anti-biotic elements. Of the 5,100 compounds found in Gir cow urine, 388 have immense medicinal value that can cure several ailments.
 - Dr. B. A. Golakiya,
 - Head of Dept. Of Biotechnology, Junagadh Agricultural University
 - June, 2016

Analysis



- Seems like the experiment was conducted in a proper research lab, using the right equipment.
 - Prima facie, there is no basis to question the reported data.
- On the other hand,
 - How the gold ends up in cow urine?
 - Can cow transform another element to gold inside its body? If not, then what can be the source of this gold?
 - If the gold in cow urine is originating from the food the cows eat (which in turn may take gold from the soil), then do other animals eating exactly same plants have gold in their bodies too?
 - Are the results statistically significant?
 - All urines are alkaline in nature. All alkalis kill bacteria. So killing bacteria is not same as being of medicinal value.

Fake Claim 14



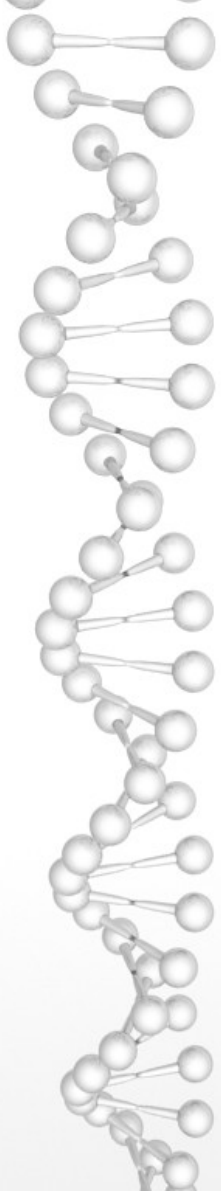
- Astrology is the biggest science. It is in fact above science. We should promote it.
 - Mr. Ramesh Pokhriyal Nishank
 - Uttarakhand chief minister in 2017

Analysis

- All around the world, people have conducted a number of tests on Astrological predictions. All of them prove that the Astrology does NOT work
 - In India, a similar study was performed by a group led by Dr. Jayant Narlikar and Dr. Narendra Dabholkar
 - They also got the same results.
- There is no logical basis for astrology
 - Can Jupiter say
 - There in the distant, I see Earth like a dot. On that dot there is a place called India; in that there is a place called Mumbai; in that there is this building where two people are sitting side by side and I am going to have different influence on them by checking what birth dates they have.
 - It is totally absurd.

The list is endless

- There are many more things which are equally unscientific but we could not cover them due to lack of time
 - Future predication and future well being
 - Palmistry (or any kind of future prediction), Fengshui, numerology, healing crystals, lucky gems, blessed objects from *baba / bua / bapu / peer*
 - Alternative (claimed) healing systems
 - Reiki, magnetotherapy, *pranic* healing, music therapy, magentised water, homeopathy
 - Diets / herbal medicines claiming to 'totally cure' diabetes / cancers
- Now it is your duty to use same questions we discussed earlier to find truth about all these things



**ask
why** AUG 20

NATIONAL
SCIENTIFIC
TEMPER DAY