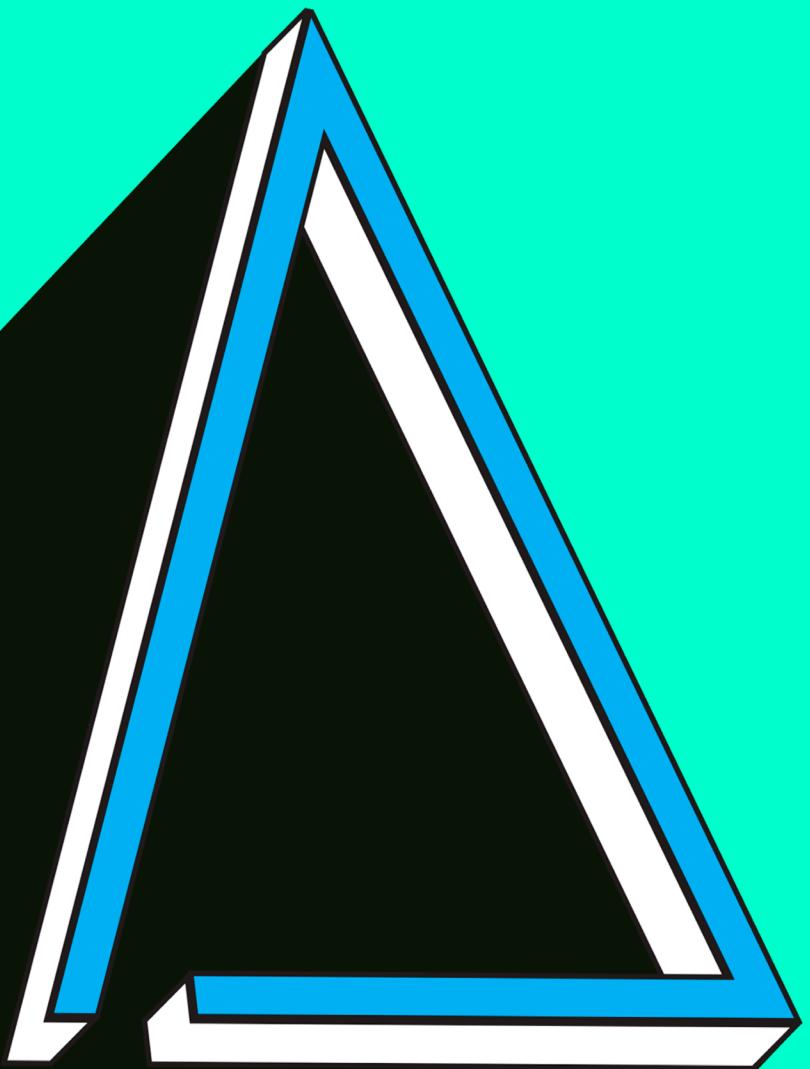


EXHIBIT

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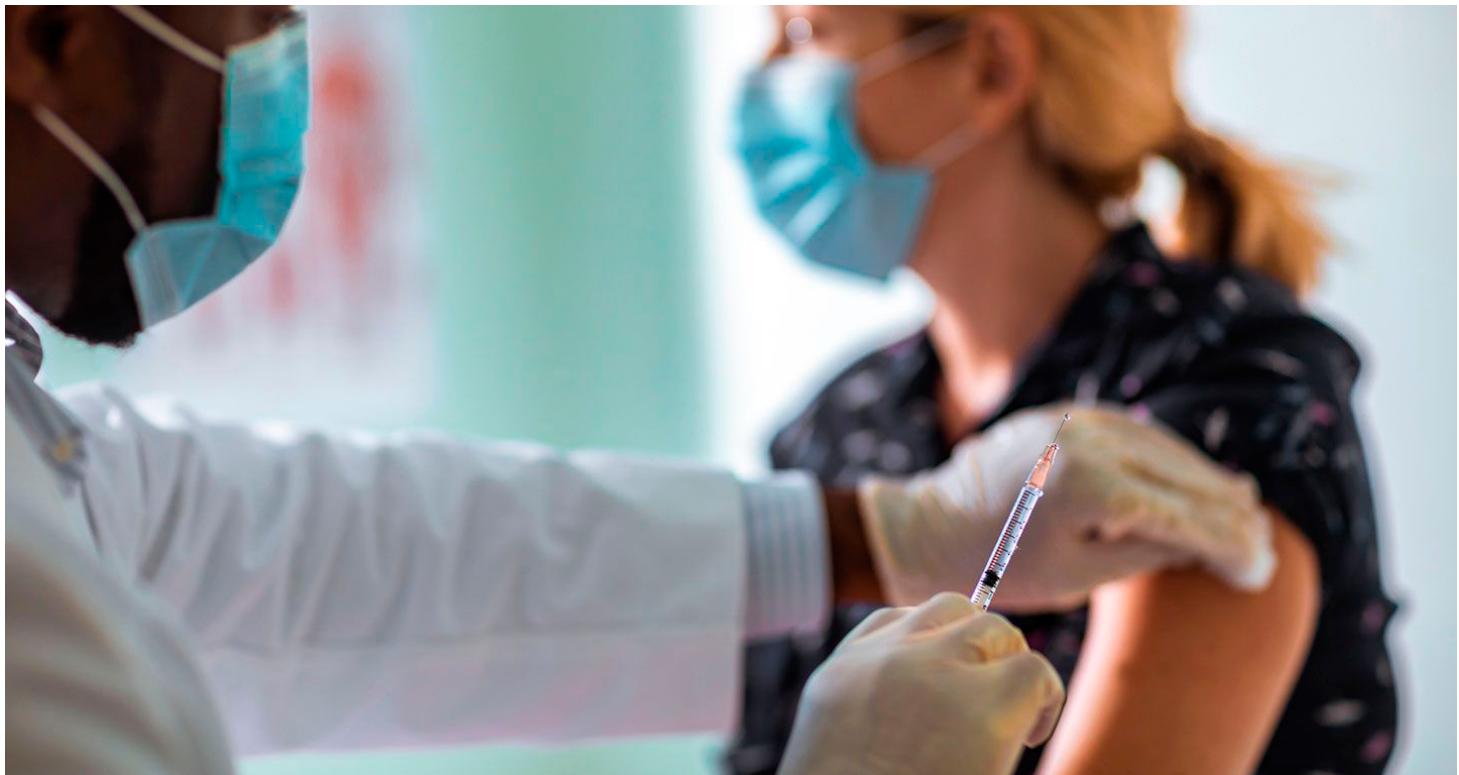


**2020
RECAP
EDITION**

AN INITIATIVE BY:



COVID-19 Vaccine Rollout



The much-awaited COVID-19 vaccines are about to be administered to the masses. A vaccine will have to undergo a few phases of trials before getting approved. Pre-clinical trials involve animal testing and testing on human cells; next is phase-1 safety trials, which occur on a small number of volunteers, further expanded to phase-2 trials, which are done on hundreds of participants from various groups. The phase-3 efficacy trials occur on thousands of participants, and compare the vaccine's efficiency against the placebo effect. Currently, 64 vaccines for COVID-19 are in clinical trials on humans, out of which 20 have reached the final testing stages. Twelve vaccines, mostly in phase-2 and phase-3 trials, are leading the fight against COVID-19 and have been approved for emergency usage in various countries.

Vaccines developed by Pfizer-BioNTech (Phase-2 and Phase-3 trials) and Moderna (Phase-3 trials) have 95 and 94.5 percent efficacy, respectively. They have been approved for emergency use in the US, the EU, and a few other countries. Both of these are genetic vaccines that deliver the mRNA of the pathogen into the cells of our body. The mRNA gives genetic instructions to the cell to build the spike proteins of the virus. The spike proteins are formed in the human cells with this RNA strand, which in-turn helps in developing a primary immune response.

The vaccines developed by Gamaleya (Phase-3 trials), Oxford-AstraZeneca (Phase-2, Phase-3 trials), CanSino (Phase-3 trials), Johnson & Johnson (Phase-3 trials)

are adenovirus-based, which means the viral mRNA is delivered via the adenovirus. This enables the vaccine to be stored easily as the mRNA is not so fragile anymore. CanSino's vaccine has been approved for limited usage in China. Similarly, Oxford-AstraZeneca's vaccine has been approved for emergency usage in India and Britain, Gamaleya's vaccine in Russia.

The vaccines developed by Novavax (phase-3 trials) and Vector Institute (Phase-3 trials) are protein-based, which means that the pathogen's protein particles are injected for inducing an immune response. Vector Institute's vaccine has been put to early use in Russia. The vaccines developed by Sinopharm, Sinovac, and Bharat Biotech, all of which are in Phase-3 trials, use the virus's inactivated form to generate an immune response in the recipients. Bharat Biotech's vaccine has been put to emergency use in India, but concerns about the lack of results of the third phase trial are bubbling. Similarly, Sinopharm's vaccine has been approved in a few countries, including China.

Taking the current situation into account, countries have planned out the vaccine rollout meticulously. In the US, individual states are responsible for preparing the vaccine rollout by taking the CDC guidelines into account. According to the CDC guidelines, phase one of vaccination will include healthcare workers, vulnerable older adults, essential workers. Phase two will concentrate on people working in crowded areas, and the last phase will focus on administering the vaccine to young-adults and children. The UK

has prioritized healthcare workers and citizens based on their vulnerability. Vaccine rollout will begin on January 16th in India, and the healthcare workers will be prioritized to receive the vaccine, followed by frontline workers. Next up are the adults above the age of 50, followed by the rest of the population. The Co-WIN application will be used for registration, and vaccines will be administered based on the priority.

The wealthiest nations of the world, which includes the US, the UK, EU, and Japan, have already pre-

ordered half of the vaccines planned to be produced, due to which the options are limited for the lower to middle-income countries. Many such countries have joined the COVAX facility, which aims to cover twenty percent of the population of low and middle-income countries by the end of 2021.

—J. Vishwathiga, B'19

Sources: [1], [2], [3]

Image Source: [1]

Notable Scientific Advancements in 2020

Restoring Vision in Ageing Mice Using Epigenetic Reprogramming

Degeneration during ageing is a problem for all organisms. One theory of ageing states that it is a result of the loss of epigenetic changes that are associated with youthful cell states. Ageing isn't necessarily unidirectional, and the goal is to reverse ageing without erasing cell identity. In a paper published in Nature on 3rd December 2020, scientists restored youthful vision in older mice with glaucoma and in mice that suffered injuries to their retinal cells. The expression of three genes, Oct4, Sox2 and Klf4 (jointly called OSK) was induced in the eyes of the mice and restored regeneration of the axons of the optic nerve. This method was both effective and safe and shows promise for being applicable in humans as well.

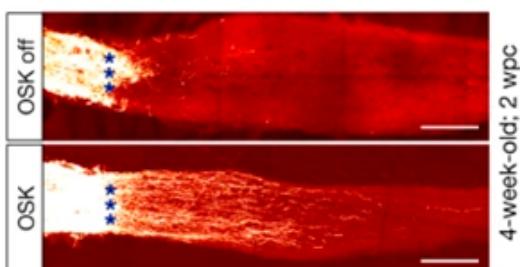


Fig.: Longitudinal sections of the optic nerve using a neuronal tracer to visualise axons. The mice where the OSK genes were turned on show greater axonal regeneration after injury.

Engineering a 'Super-Enzyme' That Breaks Down PET In Order To Combat Plastic Pollution

Plastic pollution is becoming an increasingly serious concern, with microplastics recently being found in the human placenta. This super-enzyme, derived from bacteria (*Ideonella sakaiensis* 201-F6) that naturally produce PET (polyethylene terephthalate) degrading enzymes, was created by linking two separate enzymes, which makes it function six

times faster than previously engineered enzymes at room temperature. Combining this enzyme with others that break down natural materials can allow complete recycling of mixed materials, which are currently either dumped in landfills or burnt. Research continues to find new combinations of enzymes that can act faster and more efficiently.

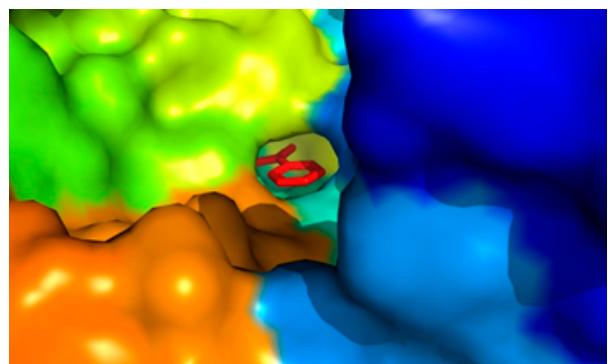
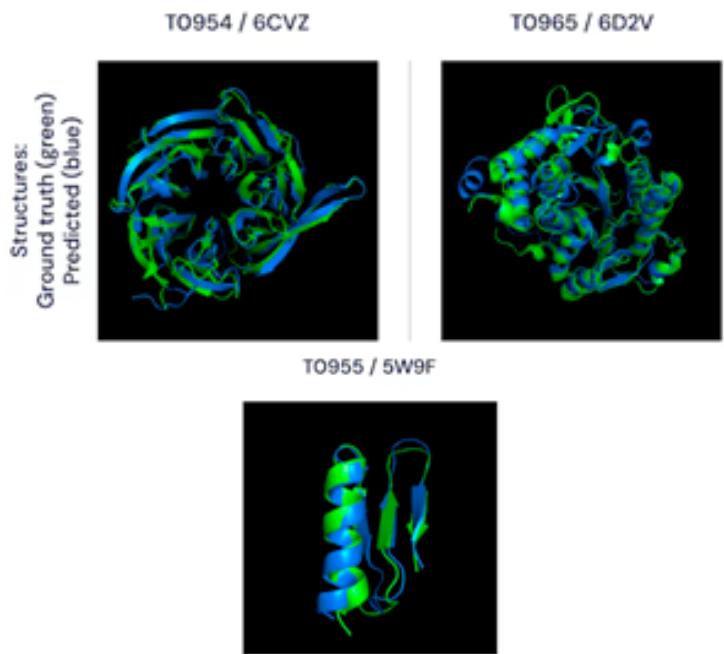


Fig.: Structure of the super-enzyme

DeepMind's AlphaFold The Most Accurate So Far To Predict Protein Folding

The problem of predicting how a protein will fold is nearly 70 years old. Levinthal's paradox states that if a protein were to sample every single possible confirmation before arriving at its native, stable state, it would take longer than the age of the universe. In reality, proteins fold correctly in a matter of milliseconds. Artificial Intelligence has come to the rescue. AlphaFold, created by Google's DeepMind project has been dubbed as making 'unprecedented progress in the ability of computational methods to predict protein structure'. AlphaFold uses a combination of neural networks and deep learning to achieve its objective.



SOFIA Discovers Water On The Sunlit Part Of The Moon

Although the presence of water on the moon was first validated as early as in 2009, it was only in 2020 that NASA's observatory SOFIA found water molecules on its sunlit surface. Previous observations were based on a spectral signature, which reflected data as a function of wavelength and failed at distinguishing between water and its close chemical relative, hydroxyl (-OH). But researchers were able to spot the unique signature of water near the Clavius Crater as well as at a low-latitude position of Mare Serenitatis using SOFIA. They found that this water exists at 100 to 400 parts per million trapped in a cubic meter of soil spread across the lunar surface. These studies have raised the prospect of not only fuel but also future long-term human establishments on the moon.

Progress On Solving The Black Hole Paradox

Stephen Hawking's black hole information paradox is one of the longest-standing unsolved problems in theoretical physics. Simply put, gravity dictates that anything that goes inside a black hole should be lost forever. However, according to the rules of quantum mechanics, information can never be lost- hence the paradox. In studies carried out by Donald Marolf and others, it has been calculated that as a black hole becomes old, it spills out any information that goes in. The researchers show exactly how to solve the Page curve, which further indicates that information can get out of a black hole. This eliminates the logical contradiction that caused the paradox. Although this theory does not precisely explain how information gets out, it certainly is a giant leap towards solving the paradox, that is, if it holds up to scrutiny.

See Individual Protein Atoms For The First Time

For the first time, the location of individual atoms has been determined by using Cryo-EM technology. Resolution revolution of Cryo-EM since 2013 has continued to advance, and finally, in 2020, Yip et al. and Nakane et al. were able to determine the atomic constitution in a stable iron-storing protein called apoferritin. Both Yip, Nakane and his colleagues used different hardware advances and new techniques to enhance the final image's resolution. This leading-edge technique might be used in future to achieve a high-resolution image of many macromolecular complexes and understand their composition and conformation.

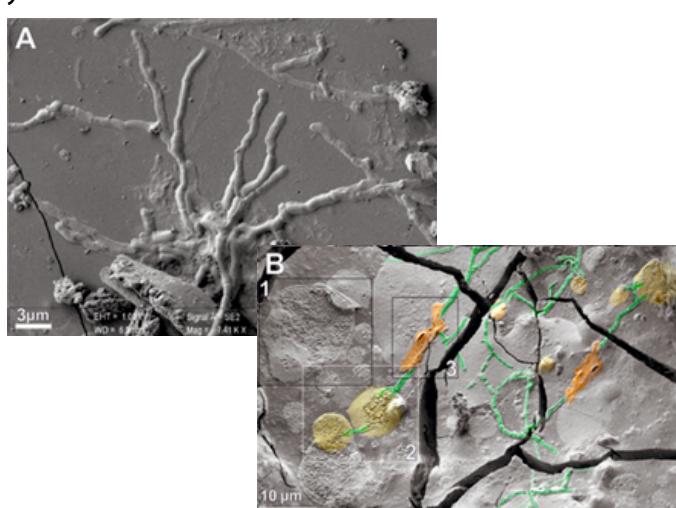


Fig.: A. SEM image of brain axons; B. SEM image of spinal cord axons (green)

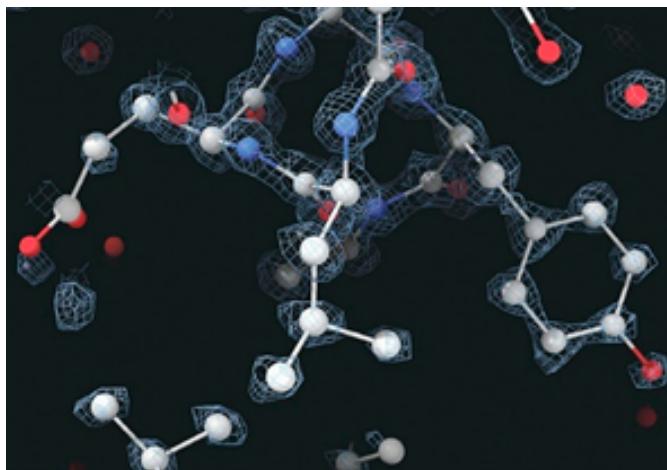
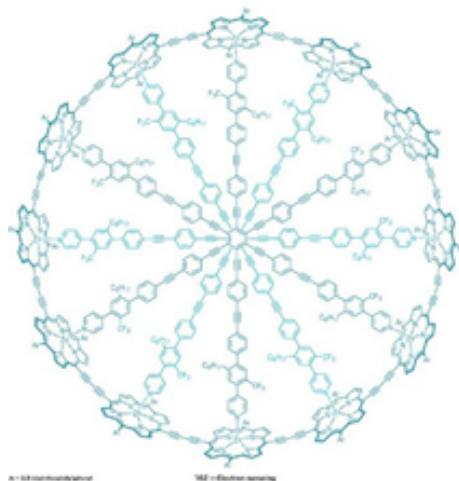


Fig.: An atomic model of the structure of the protein mapped using cryo em in which individual atoms and their bonds are shown as sphere and sticks blue mesh represents the cryo-EM density data

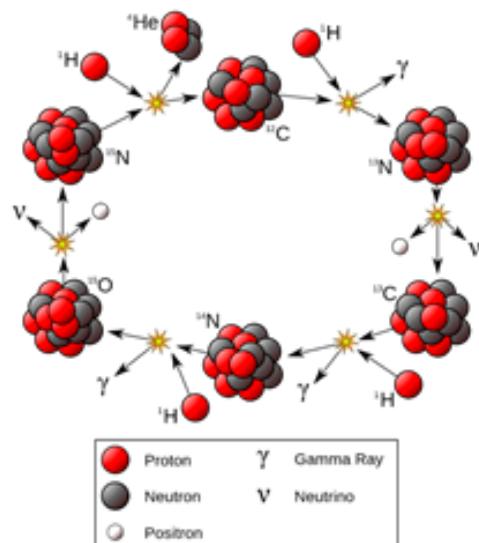
Porphyrin Wheel With 162 Delocalized Electrons - Largest Aromatic Ring



Currently, the butadiyne-linked six-porphyrin nanoring C-P₆ shows global aromaticity when oxidized, reduced or electronically excited. Researchers made a series of molecular rings containing zinc porphyrins linked together by alkynes, used template molecules and removed electrons from the molecule until it had the right number to become aromatic or anti-aromatic. In the largest possible structure's +6 oxidation state, the molecule has 162 π -electrons and shows clear signs of aromaticity becoming the largest aromatic ring ever synthesized. It is remarkable that this simple Hückel's rule, which states that molecular rings with $[4n+2]\pi$ -electrons are aromatic, precisely predicts the magnetic response of such large aromatic nanorings (162 π -electrons).

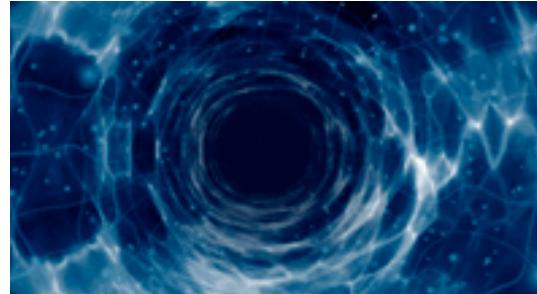
CNO Fusion Cycle In The Sun Has Finally Been Experimentally Proved

The fusion of hydrogen into helium can be theoretically understood by the carbon–nitrogen–oxygen (CNO) cycle. In this cycle, carbon, nitrogen, and oxygen catalyze the fusion of hydrogen. Its rate



of emission of neutrinos gives us information on the metallicity of the Sun. This year, this theory was experimentally proved in Laboratori Nazionali del Gran Sasso in Italy. They have found evidence of the presence of neutrinos produced in the CNO fusion cycle in the Sun using the highly radiopure, large-volume, liquid-scintillator detector of Borexino. Advancements in the thermal stabilization of the detector have made this breakthrough discovery possible.

Nifty Noise Makes Quantum States Live 10000 Times Longer



A simple strategy, that allows quantum systems to fend off decoherence for 10,000 times longer, was devised by the scientists at the University of Chicago. The “trick” is to mod the system into thinking that the noise isn’t there. They achieved this by applying an alternating magnetic field to the 4H-SiC divacancy in addition to the electromagnetic pulses meant to control the spin states in quantum systems. These pulses cause the spin of the divacancy to oscillate between its two qubit states (via electron spin resonance), and this oscillation comes handy when “writing” quantum information to the sample. The technique had been tested on solid-state qubits (quantum bits) made from silicon carbide defects and could help advance many areas of quantum science—quantum computing, communications, and sensing.

Have Signs Of Life Been Found In The Clouds Of Venus?

Phosphine (PH_3), a gas produced mainly by microbes on Earth and considered to be a strong signature of life on other worlds, was detected in the clouds of Venus. The discovery is perhaps the strongest evidence yet of life beyond Earth. But the scientists, upon conducting research, concluded that the presence of PH_3 merely suggests an atmospheric surface of phosphorus, or delivery from interplanetary space. The only measured values of atmospheric phosphorus on Venus come from Soviet Union's Vega 2 lander in 1985, but the lander was only sensitive to phosphorus as an element, so its chemical speciation can't be known. No phosphorus species have been reported at the planetary surface. Moreover, Venus' harsh conditions would throw the idea of the habitable zone wide open.



Sources can be accessed by clicking on the abstract titles

How The Pandemic Infected Scientific Publishing

"I see the disinfectant that knocks it out in a minute, one minute and is there a way we can do something like that by injection inside, or almost a cleaning? Because you see it gets inside the lungs and it does a tremendous number on the lungs, so it would be interesting to check that." This statement was made by Donald Trump on 24th April 2020 in a press briefing and prompted the producers of Dettol, Clorox and Lysol to issue warnings telling users not to ingest any such cleaning products. Trump went on to clarify that his comments were 'made sarcastically', but he was still widely condemned for his irresponsible actions.

This, of course, was not an isolated instance of a popular media figure or politician making baseless and even dangerous claims regarding COVID-19. In times of global crises, the spread of misinformation, either intentionally or unintentionally, can exacerbate the situation. While scientific publishing is less susceptible to misinformation, it is not immune. Till date, [Retraction Watch](#) has listed 61 papers related to COVID-19 that have been retracted. Here are some notable mentions:

Topping the list of retractions is an article titled "[5G Technology and induction of coronavirus in skin cells](#)", and appeared in the *Journal of Biological Regulators and Homeostatic Agents*. The paper makes bizarre claims about 5G possessing the ability to cause COVID-19 in human cells. The explanation is just as absurd, stating that the DNA inside human cells can act as a receiver for 5G waves, emit waves of different shapes that create holes in the cytoplasm, which

leads to the assembly of the genome of the SARS-CoV-2 virus. Other ludicrous statements from the paper include "5G causes $720!$ (factorial) diseases in humans" (which is larger than the number of stars in the universe).

[This paper](#) was published in *The Lancet* and studied the usage of hydroxychloroquine to treat COVID-19. *The Lancet* is one of the oldest and most respectable medical journals. There were doubts raised about the study. The Surgisphere Corporation, who were responsible for data collection and analysis for the study, [did not share](#) the complete dataset with independent third-party reviewers, and their results could not be verified. The paper was subsequently retracted.

A similar incident occurred at the New England Journal of Medicine with an article titled "[Cardiovascular Disease, Drug Therapy, and Mortality in Covid-19](#)". Many scientists raised concerns about the quality of the data that was used to arrive at the study's conclusions. The retraction was requested by the authors themselves when the third-party they obtained data from did not share it with reviewers. This rush to publish has been exploited by some academics. A particularly grim case of the failure of the screening process occurred in March 2020, when the [same paper](#) was published in three different journals. "Mental health burden for the public affected by the COVID-19 outbreak in China: Who will be the high-risk group?" was published in *Psychology, Health and Medicine*, *Asian Journal of Psychiatry and Psychiatry*

Research. The first is a journal by Taylor and Francis, and the second and third belong to Elsevier. Even more humorously, the article was published on the same day, 14th April 2020, in the first two journals. It might be tempting to write off such instances on the grounds that they are anomalies and do not impact the public at large. In May 2020, several Latin-American countries began to include the drug ivermectin in their treatment regimes. There was mass drug administration of ivermectin to [350,000 people](#) for treatment or prevention of COVID-19 in Bolivia, and Paraguay began restricting the ivermectin market. These measures were based on the results of a pre-print "[Ivermectin in COVID-19 Related Critical Illness](#)" published to SSRN, an online repository. The data that was used in the study also came from the Surgisphere Corporation (just as in *The Lancet* study). There were also other discrepancies in the paper, and methodological flaws were pointed out by other scientists. Ivermectin is also used in veterinary

medicine, and there were reports of distribution of the veterinary formulation, and fears of human consumption of the same. Clearly, bad science does leak through the editorial and peer review process, and has been demonstrably dangerous. The mean time between submission and acceptance for journal articles fell from [89 days to just 6 days](#) during the first few months of 2020. Our need to accelerate research should not come at the expense of quality, accuracy, transparency, and reliability. Many academics have made suggestions to ameliorate these issues. These include better training for peer reviewers, conducting systematic reviews and upgrading and maintaining databases. The problem of disseminating large volumes of research to the public and policy-makers during the pandemic is one that is going to require innovation and creativity.

—Ira Zibbu, B'19

ESI Species of the Year: Rock and Roll Like a Pangolin



Pangolins are some of the coolest mammals ever. They protect, they roll and they are cute. Pangolins are also known as the scaly anteaters.

Their scales make them unique because they are the only mammals known to have keratin scales as protection from predators. A pangolin can curl up

into a ball when threatened, with its overlapping scales acting as armour, while it protects its face by tucking it under its tail. The babies are born with soft scales that harden once they grow. They are named after the Malay word *penggulung*, which means "one who rolls up", explaining the animal's tendency to roll up when in danger and sleep curled up. Pangolins aren't popular for these quirks, but rather for the fact that they are the most trafficked mammals globally. Roughly 10,000 pangolins are reported to be trafficked each year. Assuming only 10% to 20% of the actual trade is reported, the true number trafficked over a two-year period was 116,990 to 233,980, according to Annamiticus, an advocacy group. There are eight extant species of pangolins — 4 live in Africa and 4 in Asia. All are at risk of extinction according to the International Union for Conservation of Nature (IUCN). They have become an easy target for illegal activities, mainly in Asia and Africa, for their meat and scales. Despite having no major wild predators, their numbers have plummeted because of these illegal activities. The scales are exported to China and Vietnam because they are in high demand for Chinese traditional medicine. The scales are used to treat blood clots and other diseases, but none of these have any scientific proof. Deforestation and habitat loss has accelerated

the process of extinction; some species, such as *Manis pentadactyla* have become commercially extinct in certain ranges due to overhunting. At the beginning of the pandemic, the SARS-CoV-2 virus was thought to have jumped to humans from animals, and one of the main suspects was the pangolin. But recently, it was found that while the pangolin virus was "genetically related" to the one infecting humans, it was "unlikely to be directly linked to the outbreak because of the substantial sequence differences". The 99% similarity was only in one region of the genome. Across the entire genome, the similarity was only 90.3%. It is high time we realise our mistake and fix it. Since pangolins are nocturnal creatures who are very shy, studying them and their habitats is difficult. Still, researchers and conservationists are working on mapping the current distribution and range and estimating population sizes. They are also researching their behaviour and ecology so that they can identify ways to ensure their survival. Community help can also ensure the protection of these remarkable species. So this year let us celebrate the pangolins, who still strive despite all these hardships.

-Vidyareshmi Hanehalli, B'19

Sources: [1], [2], [3], [4]

Art By Dheeraj C., B'17

2020: ★★☆☆☆



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