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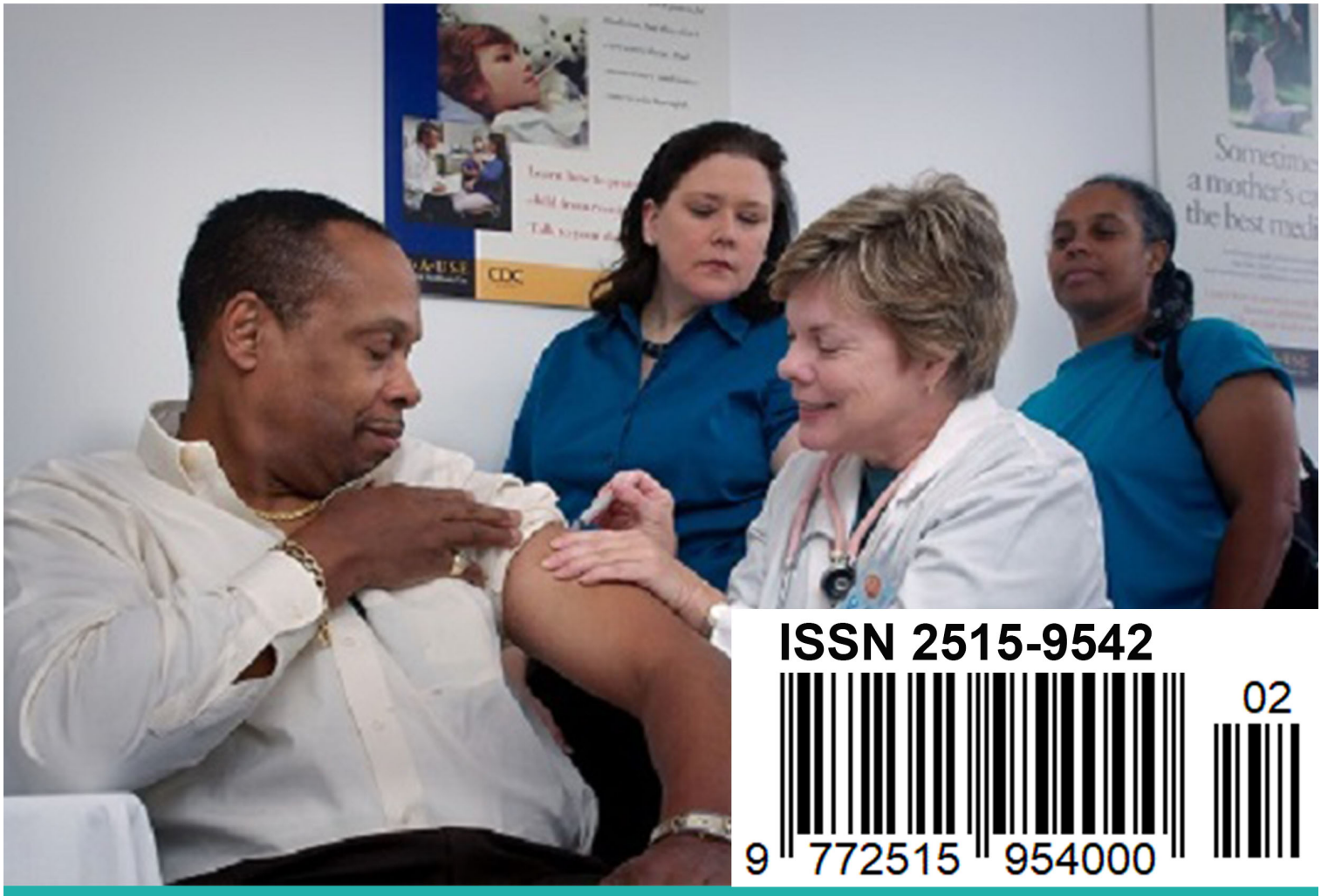
Types of COVID-19 Vaccines in Vogue: Could There be Something Amiss?



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Galápagos Islands: What Sustains its Rich Ecosystem?

Situated about 600 miles west of coast of Ecuador in Pacific Ocean, Galápagos volcanic islands are known for its rich ecosystems and endemic animal species. This inspired Darwin's theory of evolution of species. It is known that rising up of the nutrient-rich deep waters to the surface supports the growth of phytoplankton which helps Galápagos's rich ecosystem flourish and sustain. But what control and determine the upwelling of deep waters to the surface was unknown so far. According to the latest research, strong turbulence generated by the local northward winds at upper-ocean fronts determines upwelling of the deep waters to the surface.

Galápagos archipelago in Ecuador is remarkable for its rich and unique biodiversity. The Galapagos National Park cover 97% of the land area of the islands and the waters around the islands is designated 'Marine Biosphere Reserve' by UNESCO. Colourful sea birds, penguins, marine iguanas, swimming sea turtles, giant tortoises, variety of marine fish and molluscs, and the islands' iconic turtles are some of unique animal species endemic to the island.

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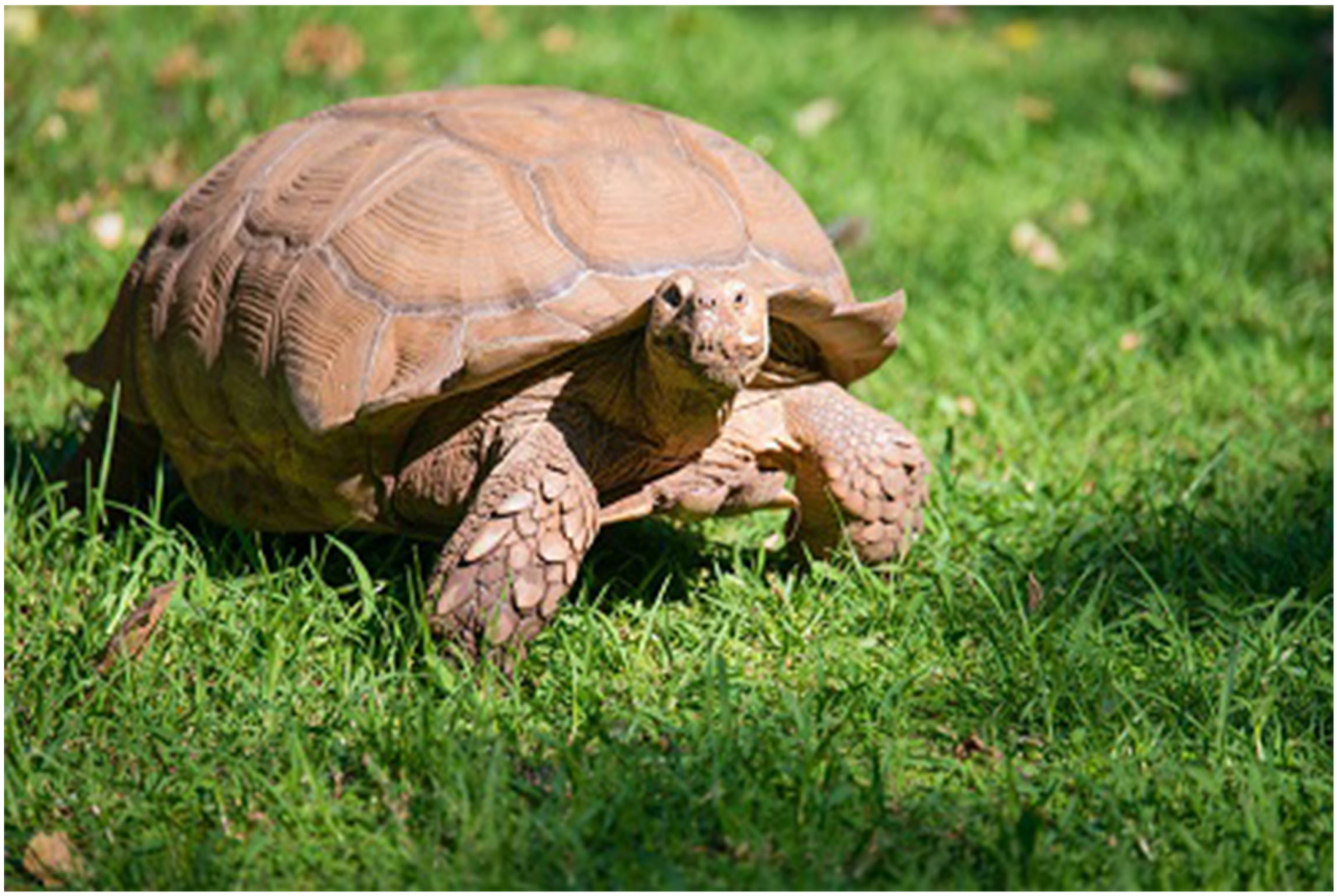
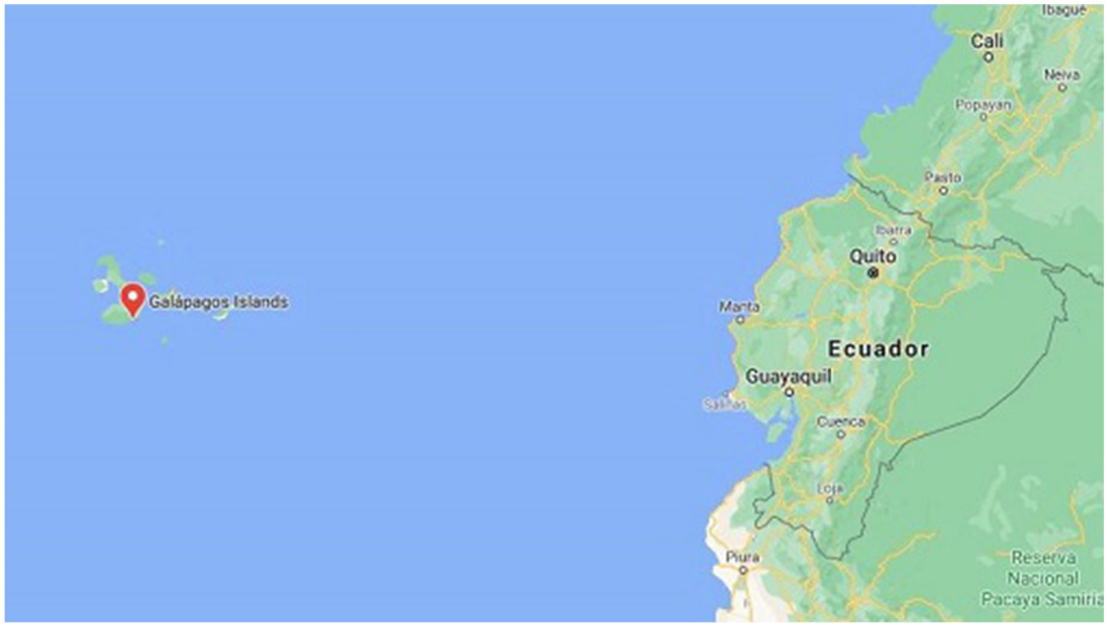


sea birds, penguins, marine iguanas, swimming sea turtles, giant tortoises, variety of marine fish and molluscs, and the islands' iconic turtles are some of unique animal species endemic to the island.

Galápagos is a very significant biological hotspot. It became famous worldwide because of its association with the landmark theory of evolution by natural selection. The British naturalist, Charles Darwin visited the islands way back in 1835 while on voyage on HMS Beagle. The endemic species of animals on the islands inspired him to conceive the theory of origin species by natural selection. Darwin had noted islands differed on physical and geographical features like soil quality and rainfall. So did plants and animal species on different islands. Remarkably, the shapes of shells of giant tortoise were different on different islands – on one island the shells were saddle shaped while on the other, the shells were dome shaped. This observation made him think how new species could come into being at different locations in the course of time. With the publication of Darwin's Origin of Species in 1859 theory, the biological uniqueness of Galápagos islands became well recognised worldwide.

Given islands are volcanic in origin with an average rainfall and vegetation, one of the issues is to explain the mechanism of interaction of factors that support and sustain such a rich ecosystem comprising of unique wildlife habitats. This understanding is important for assessing and mitigating vulnerability of the islands to current environmen



tal realities like climate change.

It is known for some time that rising up (upwelling) of the nutrient-rich deep waters to the surface of the sea around the islands support the growth of phytoplankton (microscopic single-celled photosynthetic organisms like algae) which form the base of the food webs of the local ecosystems. Good base of phytoplankton means the creatures forward in the food chain thrive and flourish. But what factors determine and control the upwelling of deep waters to the surface? According to the latest research, local northward winds play a key role.

Based on a regional ocean circulation modelling, it has been found that the local northward winds at upper-ocean fronts generates a vigorous turbulence that determines the intensity of upwelling of deep waters to the surface. This localized atmosphere–ocean interactions is at the foundation of sustenance of the Galápagos ecosystem. Any assessment and mitigation of vulnerability of the ecosystem should factor this process in.

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The Milky Way: A More Detailed Look of the Warp

The researchers from the Sloan Digital Sky survey have reported most detailed look at the warp of our home galaxy

Usually, one think of spiral galaxies as a flat disc rotating around its centre but about 60-70% of the spiral galaxies including our home galaxy Milky Way have discs with a slight warp or twist.

Not much was known about the warp or twist in our home galaxy because of position of the solar system within the Milky Way

The researchers of the Sloan Digital Sky Survey (SDSS), a consortium of several research organisations dedicated to creation of most detailed 3-dimensional maps of the Universe, after carefully studying the positions and motions of stars all over the Milky Way have traced out the warp. They have reported findings that the Milky Way's disc is warped and the wrap travels around the galaxy once every 440 million years.

The analysis showed that the twist or the warp is caused by the ripple or the wave travelling through the Milky Way causing individual stars to move up and down. The twist or the warp is continuing gravitational ripple passing through the galaxy caused most likely due to interaction with the satellite galaxy about 3 billion years ago.

Interestingly, our home galaxy Milky Way is expected to collide with the Andromeda galaxy in about 4 billion years from now when both the galaxies will merge with each other.

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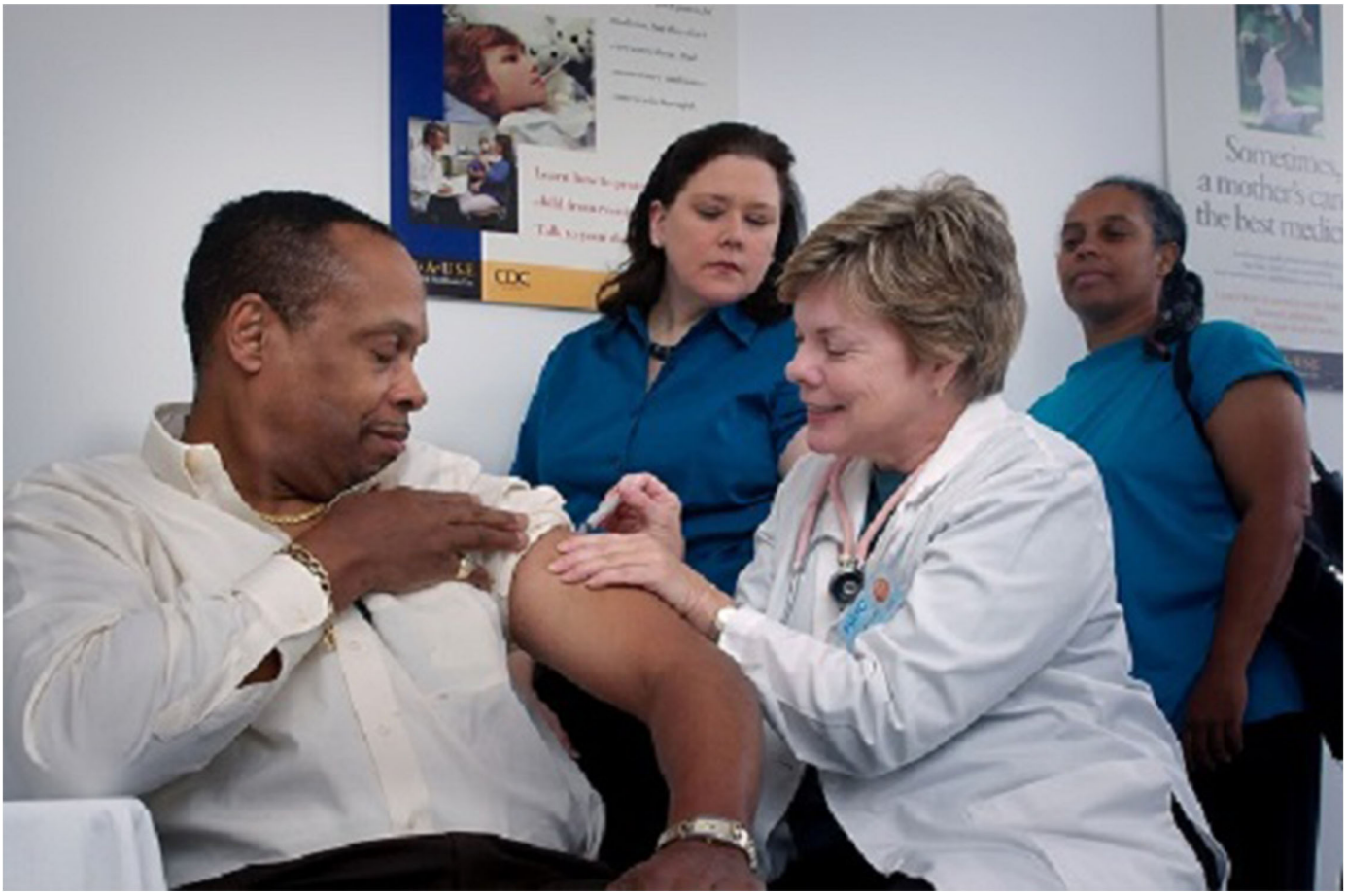
Types of COVID-19 Vaccines in Vogue: Could There be Something Amiss?

In the practice of medicine, one generally prefers time tested proven path while treating and trying to prevent diseases. An innovation is usually expected to pass the test of time. The three approved COVID-19 vaccines, two mRNA vaccines and one genetically engineered adenovirus vector DNA vaccine, are based on concepts and technologies that have never been used on human beings in the past (though few are approved for use in veterinary medicine). Inactivated vaccines stood the test of time for more than half a century and played key role in control and eradication of many infectious diseases. Were the disadvantages of good-old time-tested method of active immunity development through inactivated vaccines comprising of killed or attenuated germs heavy enough to discard altogether to opt for technologies that were never used on humans before? Apparently, the extraordinary situation presented by the pandemic seems to have superfast-tracked testing and use of the emergent, high potential vaccine and therapeutics development technologies which otherwise would have taken several years to see the light of the day.



The three approved COVID-19 vaccines currently being administered to the people in the UK under massive immunisation programme to combat the pandemic as per priorities set up by the authorities are

1) BNT162b2 (manufactured by Pfizer/BioNTech): a mRNA Vaccine, carries message for expression of viral protein antigen in the human cells

2) mRNA-1273 (manufactured by Moderna): a mRNA Vaccines act in the same way as above

3) ChAdOx1 nCoV-2019 (by Oxford/AstraZeneca): basically, a DNA vaccine, uses genetically engineered adenovirus as a vector to carry spike-protein gene of novel coronavirus which is expressed in the human cells that acts as antigen for active immunity development

All the above mentioned three COVID-19 vaccines are expected to induce active immunity against novel coronavirus. The process of immunity development (both humoral and cellular) begins following exposure to antigens. In the case of mRNA vaccines, this happens after viral spike proteins are expressed in the human cells following injection of the vaccine containing viral messenger RNA. In the case of other, immunity development happens after expression of coronavirus DNA incorporated in the adenovirus. One may argue that these vaccines are not truly vaccines in strict sense because they themselves are not the antigens and cannot trigger the immune response per se until translated into viral proteins in human cells. Vaccine, by definition triggers the process of development of active immunity but in the case of these three vaccines it has to wait till viral genes are translated into proteins that in turn could act as antigens. These

three approved vaccines are based on technologies that were never used on humans before.

In the last five decades or so, vaccines have played key role in dealing with prevention of several infectious diseases (except malaria). The time-tested gold standard was to use killed inactivated germs or germ parts as vaccine. It almost always worked. This is how several infectious diseases were controlled and some eradicated too in the past.

If the current pandemic had struck humanity say a decade ago, we would still have used the good old time-tested vaccines made using killed germs but science has progressed much in the recent past. Advances in molecular biology of genes and its potential applications in therapeutics and vaccine development coupled with encouraging results on animal models meant saying goodbye to the existing method of inducing active immunity by exposing to weakened antigens. The idea of tricking human body to produce the viral proteins in the cells that could act as antigens for initiation of antibody formation against the self-manufactured viral proteins is sleek and smart and may be the beacon of future days to come. Just that neither mRNA nor genetically modified adenovirus has ever been used on human beings to trick the body to induce active immunity. Of course, there is first time for everything new. Yes, may be in the peacetime after studying impact for little longer period including on vulnerable population.

True, these new techniques are answers to some of safety issues like reversion risks, unintentional spread or production errors etc associated with the olden types of vaccines. Plus, new methods are better targeted – specific antibody against specific viral antigen. But someone missed to take note of something that everyone knew that this pandemic is due to coronavirus, a virus that has a recent history of several epidemics in the past two decades, and a virus known to be notorious for rapid mutation because of lack of proofreading nuclease activity, thereby implying viral antigens are not going to remain static structurally for a long period of Time. Apparently, this is what the situation looks like now.

Yes indeed, clinical trials were successfully done for viral gene-based vaccines which proved safety and efficacy well within the permissible range. The same applies to the traditional whole virion inactivated COVID-19 vaccine as well whose initial efficacy of about 70% in trial in Brazil was brought down to 50.7% after some volunteers developed mild symptoms. But then whole virion inactivated vaccines are known to elicit mild reactions due to its very nature, possibly a trade-off for active immunity against wider range of antigens.

The performance data of the three approved vaccines in the UK, especially pertaining to level of protection provided to the vulnerable people would tell the deeper story in future. For now, if the choice of a vaccine comprising of a wide range of antigens derived from killed inactivated virus may have been better for effectiveness over a longer period of time is in oblivion. May be, for vulnerable people viz. for those at higher risk due to advanced age or comorbidities, quick induction of passive immunity through neutralising antibodies may have been better option and active immunity route for otherwise healthy.

Apparently, the extraordinary situation presented by the pandemic seems to have superfast-tracked testing and use of emergent, high potential vaccine and therapeutics development technologies which otherwise would have taken several years to see the light of the day.

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DOI: https://doi.org/10.29198/scieu/210101

COVID-19: Use of Hyperbaric Oxygen Therapy (HBOT) in Treatment of Severe Cases

COVID-19 pandemic has caused a major economic impact all over the globe and has resulted in disruption of "normal" life. Countries across the world are battling to find solutions to this disease that includes strengthening the immune system and developing vaccines to combat the pandemic. In this context, use of Hyperbaric Oxygen Therapy (HBOT) may seem to hold a promise for the treatment of severe cases of COVID-19. HBOT involves delivering oxygen to the body's tissues at higher pressures than atmospheric pressure with the hope of reducing inflammation and revival of cells thereby improving the immune system

The COVID-19 pandemic has thrown life out of gear in almost the entire world. Scientists and researchers across the globe are in race against time to develop a cure for this disease that has affected millions and resulted in hospitalization and deaths of thousands of people, especially those above the age of 70 and having comorbidities such as diabetes, asthma and cardiovascular disease. A number of anti-viral medications to combat COVID-19 have been tried to stop viral replication along with lifestyle changes such as wearing a mask and maintaining social distancing to prevent community spread. Recently, a number of different type of vaccines (1-3) have been approved for emergency use authorization by governments in various countries that will hopefully help in developing and providing immunity against COVID-19 for a long term. The idea behind these is to strengthen the immune system to help the body fight infections. Hyperbaric Oxygen Therapy (HBOT) can also be looked at as a potential treatment for treatment of severe cases of COVID-19, especially those that require hospitalization.

HBOT involves delivering 100% oxygen to the body tissues at high pressures (higher than the atmospheric pressure). This hyperoxic condition results in delivering higher amounts of oxygen to body's cells thereby improving their revival and survival. HBOT has been reported almost four centuries ago, however, has not been implemented as a definitive treatment due to lack of scientific evidence. However, recent preliminary data from clinical trials suggest significant improvements with respect to morbidity and mortality in severe cases of COVID-19 patients when treated with 100% oxygen at high atmospheric pressures. A small single centre trial carried out in USA on 20 COVID-19 patients and 60 matched controls using HBOT gave encouraging results with respect to in patient mortality and ventilator requirement (4). Another randomised controlled trial has been planned to investigate effects of normobaric oxygen therapy (NBOT) versus hyperbaric oxygen therapy (HBOT) for severe cases of hypoxic COVID-19 patients (5). The advantage of HBOT is that it is a non-invasive technique that is cost effectve compared to other treatment regimens. However, care should be taken that it needs to be adminis tered by trained personnel and should noy be carried out at home under normobaric conditions using pure oxygen cylinders available in the market.

While HBOT promises to be a low-risk intervention for the treatment of severe cases of COVID-19, it will require a large number of randomised controlled clinical trials with a significant number of patients resulting in a strong positive outcome, before the therapy can be approved beyond a reasonable doubt.

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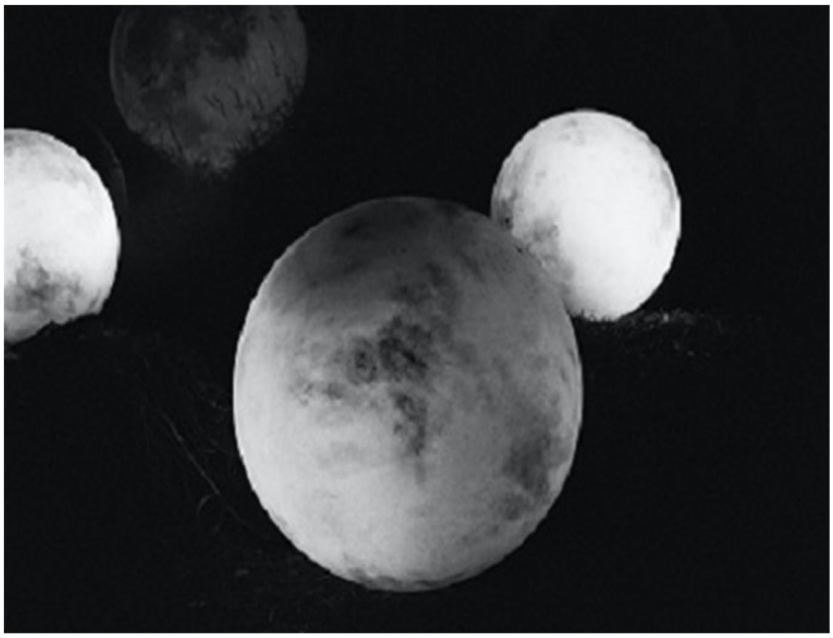
Exoplanet Study: Planets of TRAPPIST-1 are Similar in Densities

The seven planets in the stellar system of TRAPPIST-1 are similar in densities.

Stars in the galaxies have stellar systems comprising mainly of their planets and satellites. For example, our home stellar system viz. solar system has nine planets (of varying densities, sizes and compositions) and their satellites. Mercury, Venus, Earth and Mars, the four planets closet to Sun have rocky surfaces hence are referred to as terrestrial planets. On the other hand, Jupiter, Saturn, Uranus, Neptune are made of gases. The planet Earth in the stellar system of Sun is unique in supporting life.

The quest for Search of habitable worlds beyond Eartth means search for habitable planets in the stellar systems of other stars. There could be trillions of planets outside of the solar system. Such planets are called exoplanets. Does any of the innumerable exoplanets support life? Any such exoplanet can only be terrestrial one with hard rocky surface like Earth. Study of terrestrial exoplanets therefore, is a very interesting area of study. The exoplanet community is an active research community in pursuit of identifying potential life-bearing worlds in the stars outside of the solar system.



The dwarf star TRAPPIST-1 was discovered in 1999. This ultra-cool star is situated at a distance of 40 light years. In 2016, three exoplanets were reported in the stellar system of this star which was revised to seven subsequently in 2017. Three of the exoplanets are thought to be in habitable zone (1).

The knowledge about these exoplanets in the stellar system of TRAPPIST-1 is growing continuously. The earlier studies had revealed that these planets are roughly the size and mass of the Earth. This meant these planets have rocky surfaces hence Earth-like terrestrial planets. And, these are closely located in orbits in close proximity to the star. The latest finding reported is that all the planets are of similar densities and made of similar materials.

Using space and ground-based telescopes, the scientists have done a precise measurement of the transit times (the time taken by the planets to transit the star measured indirectly by dips in the brightness of the star when the planets cross in front of it) which enabled them refine the mass ratios of the planets to the star. Following this, they carried out photodynamical analysis and derived the densities of the star and the planets. This revealed that all the seven exoplanets have similar densities and Eartl-like composition possibly due to little less iron content than the Earth (2,3). This latest development in the understanding of density and composition of planets in the stellar system of TRAPPIST-1 is significant because it builds the knowledge-base for a model of understanding of Earth-like exoplanets outside of solar system.

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The Nebra Sky Disk and 'Cosmic Kiss' Space Mission

The Nebra Sky Disk has inspired the logo of the space mission 'Cosmic Kiss'. This space mission of the European Space Agency is the declaration of love for space.

Ideas from observation of night sky played important role in religious beliefs of ancient civilisations. Generally, ancient societies had some notion of the interplay of stars and planetary bodies on human lives. However, there are few direct physical evidences of this. Nebra Sky Disk, the 3600 years old bronze disk found in 1999 in Mittelberg near Nebra (Saxony-Anhalt, Germany) is unique because it is the oldest concrete physical depiction of cosmic phenomena. Considered to be the most important archaeological discovery of the last century, Nebra Sky Disk was included in the list of UNESCO's The Memory of the World Register in 2013 (1).

The Disk's discovery in 1999 was not in the normal archaeological excavation under supervision of experts. Instead, it was found by private persons in an illegal excavation along with few other artifacts and was in illegal possession of antique dealers until 2002 when it was seized by the Swiss Police in a raid and returned to the State subsequently following court proceedings. The extraordinary situation associated with its discovery had posed several issues including its dating. Some experts doubted its early Bronze Age origin and suggested its origin could be thousand year later in the Iron Age instead (2). However, a more detailed later study used an interdisciplinary approach to determine the origin and confirmed the Nebra Disk to be of early bronze age (3,4).

Interestingly, one of the papers submitted to the preprint server suggests Nebra Disk to have evidences of the earliest supernova observation (5). If this disk is an illustration of the night sky then the large sun-like object in the disk could probably be some extremely bright sun-like star.

The Nebra Sky Disk has inspired the logo of space mission 'Cosmic Kiss'. This mission is a declaration of love for space. Under this mission, European Space Agency's astronaut Matthias Maurer will travel into space this spring making him the first German to do so (6,7).

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Could Polymersomes be better Delivery vehicle for COVID Vaccines?

A number of ingredients have been used as carriers to successfully deliver vaccines and to enhance their immune response. These include peptides, liposomes, lipid nanoparticles and polymers to name a few. Recently, Lam et al describe the use of artificial cell membrane (ACM) polymersome technology as delivery vehicle for COVID-19 spike protein vaccine that leads to efficient entry into the antigen presenting cells, thereby eliciting a stronger and lasting immune response.

Humans have been dealing with infection since times immemorial. A number of preventions and treatments and are available to deal with infections, of which vaccination has been one of important ones as it provides long lasting immunity against the disease. However, vaccine delivery and elicitation of a robust immune response has remained a challenge since the first vaccine was done in 1796 by Edward Jenner. A number of methods have been developed such as use of peptides, liposomes, lipid nanoparticles, polymers etc. to overcome these challenges and hunt is for novel methods for safe and effective delivery of vaccines that leads to a robust immune response.

Polymersomes is one such technology that consists of self-assembling nano-particles made of rationally designed polymers that have been successfully used in drug delivery of cancer immuno- therapeutics (1). The study involved delivery of cGAMP (an agonist of stimulator of interferon genes (STING)) as polymersomes that led to an increase in the efficacy of cGAMP resulting in an effective immune response that inhibited tumour growth and build enough memory to counter a tumour rechallenge. Use of polymerosmes have been reviewed and described as "the sixth revolution in vaccinology" by David Dowling's group (2).

The review describes the use of self-assembled PEG-b-PPS polymersomes with OVA as an antigen and CpG as an adjuvant (CpG) to induce and enhance CD4+ T cell response in the spleen and lymph nodes (3). Flash nanoprecipitation has been used as a scalable technique for the self-assembly of polymers resulting in polymersomes that can then be used as a delivery vehicle (4) .

Lam et al have exploited the use of self-assembled polymersomes to efficiently deliver the SARS-CoV-2 spike protein in antigen presenting cells of mice. These ACM polymersomes consisted of amphiphilic block copolymer that elicited strong neutralising antibody titers that lasted for 40 days (5).

Polymersome technology thus represents a promising tool for efficient delivery of vaccines in future.

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Climate Change: Rapid Melting of Ice Across the Earth

The rate of ice loss for Earth has increased by 57% from 0.8 to 1.2 trillion tonnes per year since 1990s. As a result, the sea level has risen by about 35 mm. The majority of the ice loss is attributed to warming of the Earth.

Climate change, one of the key environmental issues facing mankind is the culmination of the chain of interlinked manmade processes. Deforestation, industrialisation and other related activities lead to an increase in greenhouse gases in the atmosphere which in turn traps more infrared radiation leading to an increase in temperature of the Earth (global warming). A warmer Earth leads to global ice loss caused by melting particularly in glaciers, in mountains and polar regions. As a result, sea level rise hence the increased risk of flooding in coastal areas and adverse impact on society and economy at large. The main reason for the Earth's ice loss is global warming. The extent of ice loss in quantitative terms in relation to Earth's warming was not known hitherto. A new research sheds light on this for the first time.

In order to find out the rate at which the Earth lost ice in the last three decades; the research team primarily used the satellite observation data collected from 1994 to 2017. For Antarctic and Greenland ice sheets, the satellite measurements alone were used while for Antarctic ice shelves, a combination of satellite observations and in situ measurements were used to quantify changes in mountain glaciers and for sea ice, a combination of numerical models and satellite observations were used.

The team found that Earth has lost 28 trillion tonnes of ice between 1994 and 2017. The largest loss was in the Arctic Sea ice (7.6 trillion tonnes), Antarctic ice shelves (6.5 trillion tonnes), mountain glaciers (6.1 trillion tonnes) followed by the Greenland ice sheet (3.8 trillion tonnes), the Antarctic ice sheet

(2.5 trillion tonnes), and Southern Ocean sea ice (0.9 trillion tonnes). In all, the loss was more in the Northern Hemisphere. The rate of ice loss for Earth was increased by 57% from 0.8 to 1.2 trillion tonnes per year since 1990s. As a result, the sea level has risen by about 35 mm and the loss of floating ice has reduced albedo. The majority of the ice loss is attributed to warming of the Earth.

The rise in sea level will adversely affect the coastal communities in times to come.

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Dentistry: Povidone Iodine (PVP-I) Prevents and Treats Early Phases of COVID-19

Povidone Iodine (PVP-I) can be used in the form of mouthwash and nasal spray (especially in Dental and ENT settings) to prevent the spread of the SARS-CoV-2 virus, to reduce cross-infection and to manage patients at the early stage of disease.

Povidone iodine, known commonly as Betadine is used widely in medicine and dentistry as an effective topical antiseptic for over a century. It is the broadest spectrum antiseptic and is effective against a range of microbes such bacteria (gram-positive and gram negative), spores of bacteria, protozoa, fungi and several viruses, including H1N1 influenza virus 1.

Duo to the extraordinary situation presented by COVID-19, range of pharmaceutical strategies including repurposing of existing drugs are being tried to prevent and treat this disease 7. Could povidone iodine, which is known to be effective against some viruses including SARS-CoV be used as an effective antiseptic against SARS-CoV-2 infection as well?

Based on earlier report of effectiveness of povidone iodine against SARS-CoV virus 2, Challacombe et al proposed using nasal spray and mouthwash/gargle of povidone iodine to control the spread of novel coronavirus from dental patients to healthcare workers 3. Soon, other researchers confirmed effectiveness of PVP-1 against SARS-CoV-2 virus in an in vitro study 4,5 and suggested use of PVP-I gargle and mouthwash in dental practice 4 and ENT practice 6 to minimise risk of spread of infection.

Currently, several clinical trials are in progress at various stages to assess efficacy of povidone iodine in the form of mouthwash and nasal spray in prevention and control of COVID-19 7. Few have been completed, and they show very encouraging results. One preliminary study reports 100% viral clearance for 1% povidone iodine in a small group of confirmed stage 1 COVID-19 patients. Further larger studies are required to confirm the benefits of PVP-1 gargle for patients at different stages of COVID-19 8. In another completed study, use of 1% povidone iodine considerably reduced mortality and morbidity among COVID-19 patients 9.

Povidone iodine (PVP-1) mouthwash and nasal spray is simple and very cost-effective intervention for limiting spread of and managing early stage COVID-19 patients.

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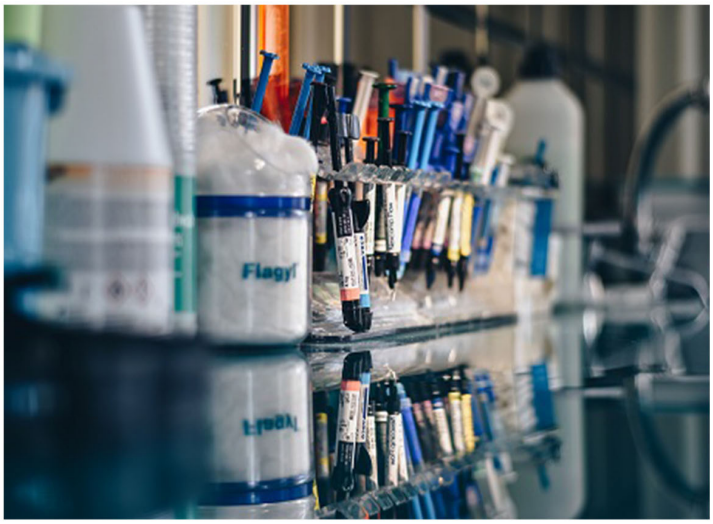

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