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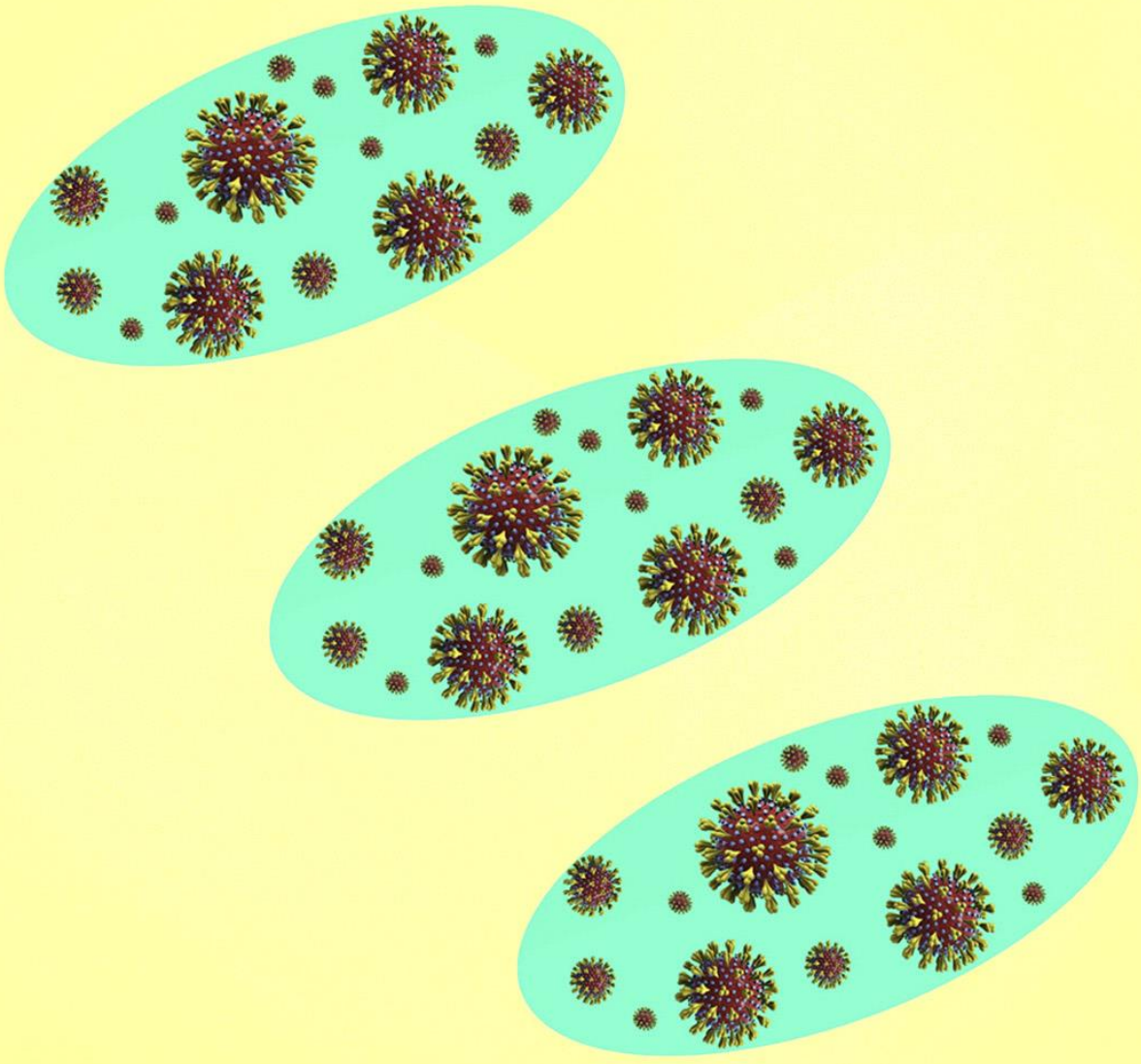

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From the Publisher's Desk

Welcome to Biotechnology Kiosk!

The current issue of BK is now online for our readers with the regular features that include research articles by international experts and biotechnology advances around the world. This issue contains research articles in the field of COVID-19 along with news and views on the current cutting-edge topics that include latest research breakthroughs in redox biology for the treatment of type 2 diabetes.

We are glad to announce a collaborative venture between BK and Intech Open, U.K. for a joint book project 'Biotechnology to Combat COVID-19' (https://www.intechopen.com/welcome/d834c746c5b159a201a9cdadfc473486). Readers are encouraged to consider submitting their works to this book. Intech Open is the world's leading publisher of open access books, and we are glad to participate in this project.

We do hope that you will enjoy reading this issue of Biotechnology Kiosk. Please do write to us with your comments. Your suggestions are always appreciated.

Dr. Megha Agrawal & Dr. Shyamasri Biswas.

Co Editors-in-Chief, Biotechnology Kiosk

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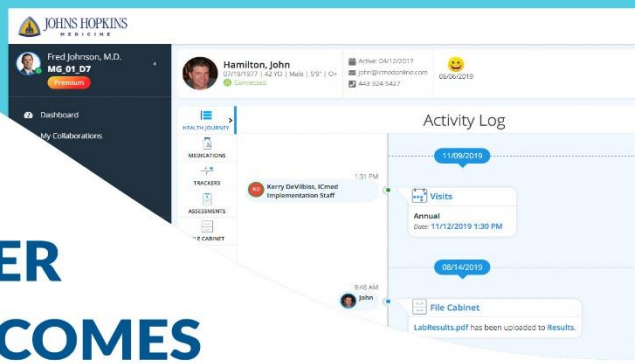

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Mini Review

MATERIALS FOR DIAGNOSIS, PREVENTION AND CONTROL OF COVID-19 PANDEMIC

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Abstract

The coronavirus infection disease 2019 (COVID-19) pandemic is causing an extreme effect on the worldwide society and economy. The episode of COVID-19 poses various challenges that include diagnosis, prevention and proper medication. Hence, most national governments across the globe have advised to accelerate the advancement of biomaterials and techniques for the development of effective diagnosis, therapeutics and control of COVID-19. This study endeavors to give a point of view on how the improvement of novel materials can assist researchers with handling the difficulties with COVID-19 and mitigate the challenges.

Keywords: COVID-19, Diagnostics, Pandemic, Biomaterials, SARS-CoV-2, Biosafety.

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Introduction

The serious respiratory disorder as a result of the 2019 novel coronavirus (2019-nCoV) which is also called coronavirus 2 (SARS-CoV-2) has been increasing exponentially worldwide since the origination of the disease in Wuhan City of Hubei Region of China [1]. Coronaviruses are a cluster of viruses belonging to the clan Coronaviridae, which has an average radius of 60 nm. Some virus uses animals as the initial host for spreading and then gradually move their way to infect humans also. Predecessors to MERS and SARS coronaviruses were seen in mammals, especially in bats. Researchers showed that SARS virus made up their way from bats to nocturnal, small mammals (also called civets) and to human beings. Research evidence has shown that coronavirus originated from bats, which then transmitted through an in-between carrier. Although scientists have not yet recognized the transmittable intermediary creature [2]. Figure 1 represents four structural proteins that includes spike envelop membrane nucleocapsid.

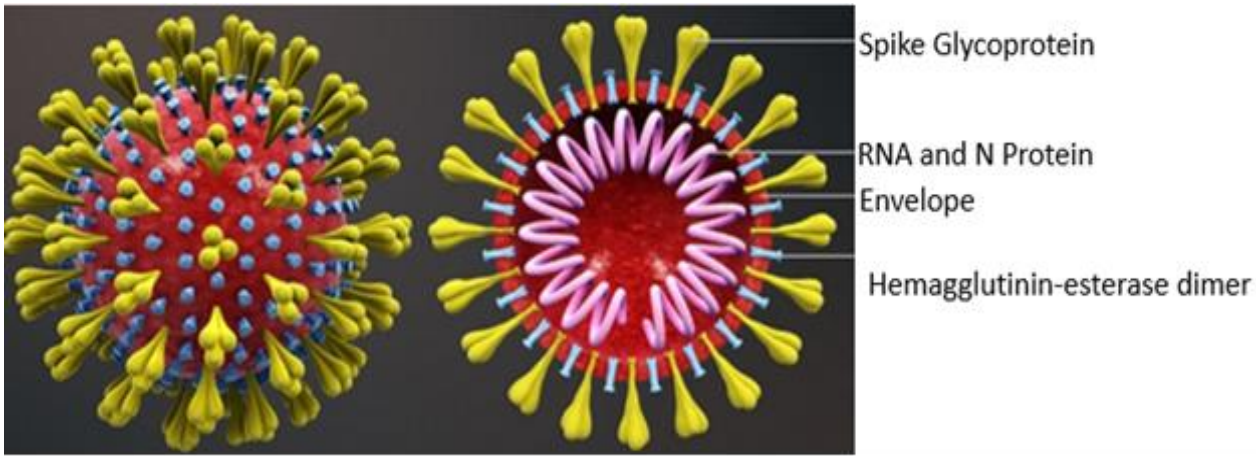

*Figure 1: Schematic of four structural protein's in covid-19 (**Source:** https://commons.wikimedia.org/wiki/File:3D_medical_animation_corona_virus.jpg).*

The first case of corona virus was reported in the winter of 1960. In 2001, a Canadian research team reported nearly 500 patients with Flu-like symptoms that showed that corona virus strain was infested in 17-18 cases by a polymerase chain reaction. At the first stage, the corona was observed as a normal non-lethal virus [3]. Subsequently, in 2003, numerous studies reported evidences showing the spread of coronavirus in countries mostly in the United States America, Vietnam, Taiwan, Hong Kong and Thailand. Figure 2 shows various pandemics that occurred before COID 19, such as Spanish flu in 1918, Hong Kong flu in 1968 and Pandemic flu in 2009 along with their mortality rates. Numerous cases of a serious respiratory disorder triggered by coronavirus were reported in 2003 and a high mortality rate was reported with more than 1000 patients. A continuous daily testing of 1000's continuous testing revealed the complications.

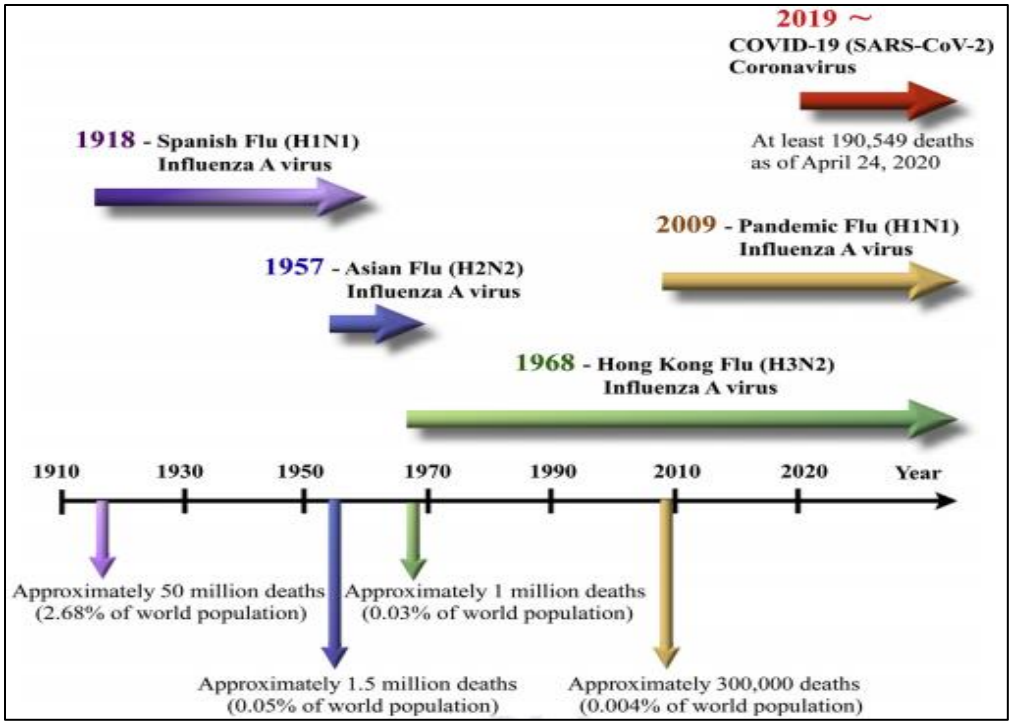

Figure 2: *History of different pandemics during different periods since 1918 and virus spread afterw*ard (***Source:*** *Biomedical (2020)).*

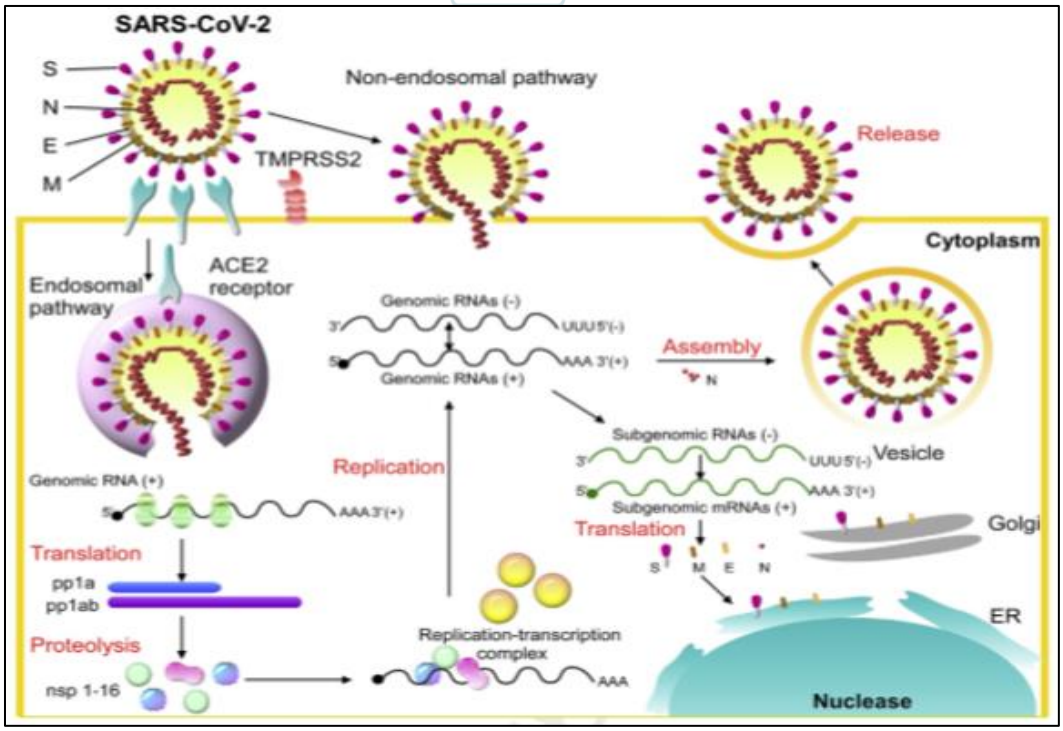

*Figure 3: Schematic representing the lifecycle of SARS-CoV-2 (****Source:*** *Biomedical (2020)).*

Further research concluded and recognized the pathogenesis of the disease and exposed it as coronavirus. Consequently, in 2004, WHO and centers for disease control and prevention acknowledged as “state of emergency” with 50 patients of serious respiratory disorders was reported during a study conducted in Hong Kong. It was found from the study that 30 out of 50 were infected with the deadly corona virus. In 2012, several infected patients and deaths were presented in reports published in Saudi Arabia. The COVID-19 first case was reported and quarantined from a pneumonia infected patient who was a resident in Wuhan, china [4].

Figure 3 represents the putative life pattern of SARS CoV- 2 in swarm cells that starts from spike protein and hACE2 receptor binding. The conformational change in the S protein after receptor binding encourages viral envelope combination with the cell layer through the endosomal pathway. The viral RNA genome is then discharged into the cytoplasm and deciphered into viral replicas polyproteins pp1a and 1ab, which can be divided into little items by infection-encoded proteinases. The polymerase translates a progression of sub genomic mRNAs by intermittent record. The sub genomic mRNAs are finally converted into viral auxiliary proteins. The S, E and M proteins enter the endoplasmic reticulum (ER), Golgi device, and the N protein is joined with the positive-abandoned genomic RNA to shape a nucleoprotein complex. The auxiliary proteins and nucleoprotein complex are collected with the viral envelope at the ER-Golgi middle of the road compartment. The recently collected viral particles are then discharged from the contaminated cell.

COVID-19 -Source and Transmission

In December 2019, unidentified cases of severe pneumonia were reported in adults to local hospitals from Wuhan, the major transportation hub of China and the capital city of Hubei region. The observation system, which was activated after the SARS outburst in addition to respiratory samples that were obtained from the carriers or infected and were subsequently directed to laboratories for etiologic inquiries. The outburst was reported to the World Health Organization by China on December 31st, 2019. The virus was later recognized as coronavirus on 7th January, which had homology with the bat coronavirus and similarity with the SARS CoV. Samples which were collected from the wuhan seafood marketplace also confirmed positive, indicating that coronavirus was initiated from china [5]. The number of cases exponentially surged up even without cases that were not found to have any exposure with the live animal market. This supported the theory that human-human interaction was the main reason for this spreading[6]. It was suspected that the Chinese New Year celebration fueled the widespread cases due to the massive gathering of people. Countries such as Japan, South Korea and Thailand (outlying areas of China) had subsequently numerous cases that were found in people who were coming back to their country from Wuhan. On 20th Jan 2020 transmission to healthcare workers who were the caretakers for the patients was pronounced. Population of Wuhan (11

million) were put under containment zone and were under complete lockdown with restrictions in and out of Wuhan. The lockdown was forced in other cities of Hubei region due to the critical risk of spreading the disease. Some countries outside China also reported cases of COVID-19 which confirmed that a native human-human outburst was happening in those countries [7]. Other countries including India initiated screening processes at airports to find symptomatic people with symptoms (symptomatic) who were coming back from China mainly. Further, countries including India took drastic measures such as evacuation of citizens from Wuhan and they were placed in isolation for 14 days followed by rapid testing that was done for the virus.

Figure 4 represents the key sources through which corona virus will spread from animals to humans and then from human-human transfer.

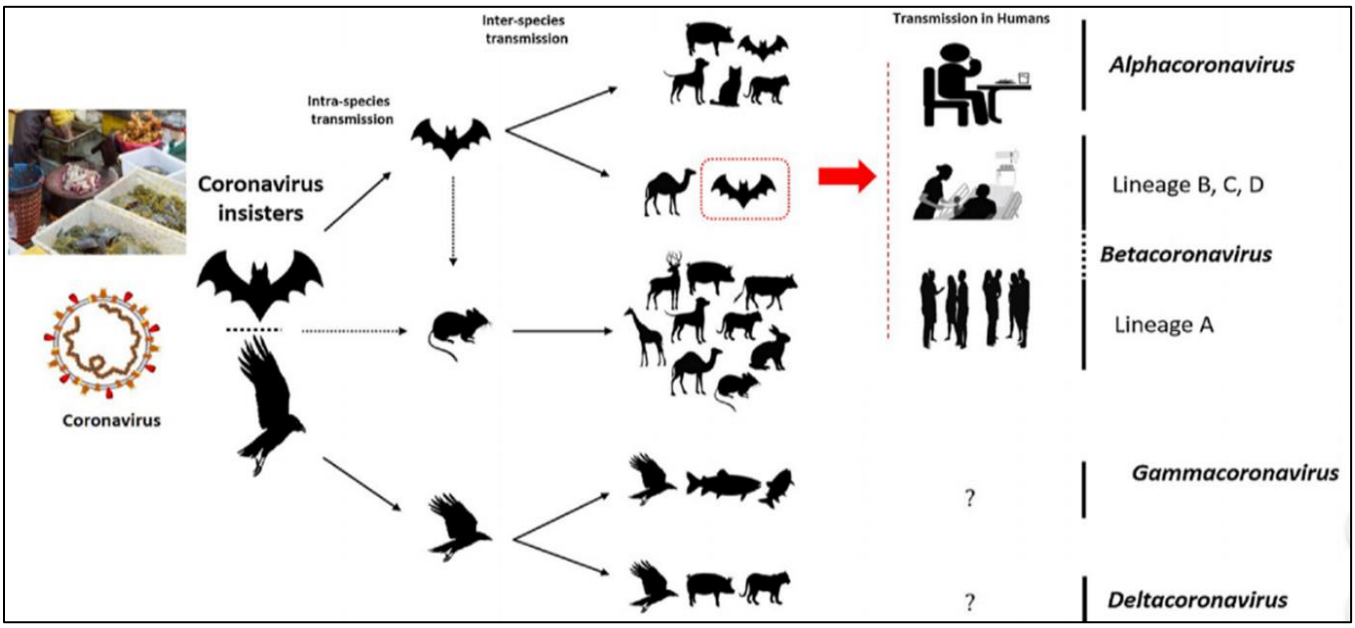

*Figure 4: Transmission cycle of -COVID 19 from origin to allover the globe (**Source:** Journal of Advanced Research (2020)).*

Identification/Diagnosis of COVID-19

Prior to the cases of SARS-CoV, human CoVs were believed to lead a self-limiting lower respiratory infection and cold-like upper respiratory infection [9]. Corona virus-infected first death in china was reported by a patient who was in isolation for SARS-CoV with acute pneumonia [10]. It was found that, there were some resemblances in the medical features of infection induced by COVID-19 as in previous beta-CoVs and other respiratory infection viruses [11]. Similar to MERS-CoV and SARS-CoV, which triggered epidemics in the earlier years [9], shortness of breath, cough and common fever were reported as the initial symptoms of COVID-19[6]. Diarrhea was also reported in

about 20–25% of patients with MERS-CoV and SARS-CoV infection [9]. However, intestinal symptoms have rarely been reported in patients with COVID-19[6]. In addition to previous findings another medical study conducted with a total of 99 patients have testified chest pain, nausea vomiting and confusion were found. Bilateral or Unilateral association companionable with viral pneumonia was established on thorax CT imaging or x-rays of the examined patients, bilateral multiple lobular and sub-segmental consolidation areas were detected in patients admitted in the ICU. Fatigue, Dry-cough, fever and myalgia indications were stated most in a research report that studied 41 patients that were hospitalized; with fewer, indications of expectoration, hemoptysis, hemoptysis, diarrhea, and headache were correspondingly detected. Further, nearly half of these patients were found with comorbidities including hypertension, cardiovascular disease and underlying diabetes mellitus.

The patients with underlying comorbidity exhibited a more critical situation that was derived from the knowledge expanded after the past epidemics. For instance, in MERS and SARS, the identification of n-CoV 2019 infection was established on rapid spread through human interaction, travelling and detailed laboratory testing. The analytic tools that are used include viral cultures, serology and molecular methods. The diagnostic methods, which were used commonly, are molecular methods such as real-time PCR or reverse transcription-polymerase chain reaction (RT-PCR). The samples were prepared with RNA that was acquired from respiratory samples such as sputum, nasopharyngeal aspirates, oropharyngeal swabs, broncho-alveolar lavage or deep tracheal aspirates [Figure 5].

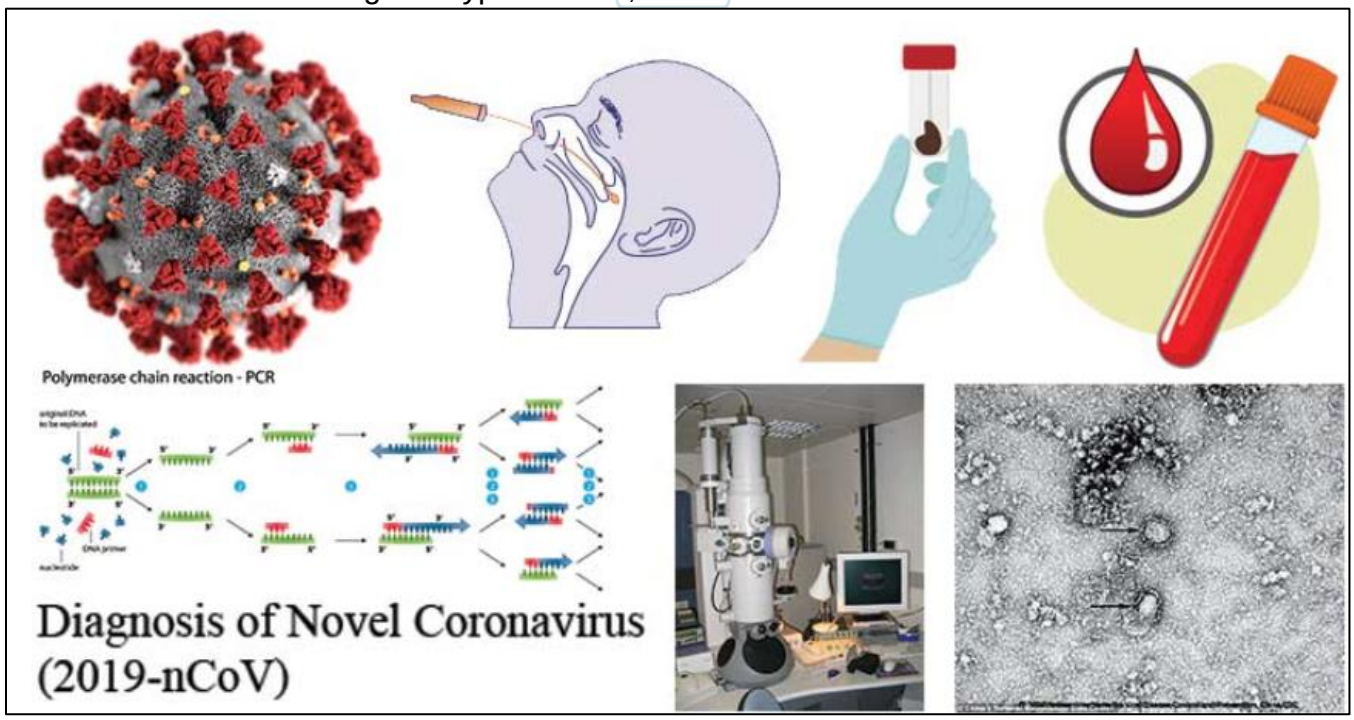

*Figure 5: Diagnosis of covid-19 with the Polymerase Chain Reaction (PCR) (**Source:** https://www.civilsdaily.com/news/pcr-test-for-diagnosis-of-the-covid-19/).*

To be specific, lower respiratory tract samples offers a considerably greater genome fraction and viral load than upper respiratory tract samples. The mentioned procedures are constructive under the condition of calculating results rapidly, presenting the structure of genome and viral load. The dependency of antibody finding is normally lesser because of sensitivity compared to the molecular methods and it is regularly applied in reflective diagnosis. Viral culture is considered as a time-consuming technique if matched with other techniques. So this is considered more beneficial at the initial phase of epidemic before other indicative techniques became medically available [12]. For vaccine evaluation trials and in-vivo and in-vitro antiviral treatment, vaccine cultures can be used.

Bhardwaj et al [13] simulated the effect of surface wettability, relative humidity and ambient temperature on the aeration time of the droplet at two altered temperatures, 25o C and 40oC outdoors in summer and inside a room with air-conditioning at humidity as 50o and 30%, respectively. The evaporation time is directly proportional to the droplet's radius or two-third the power of volume and inversely proportional to the temperature, for a 15○C rise in temperature about 50% and probably the probability of contamination through interaction with an infected droplet reduced with the rise in ambient temperature.

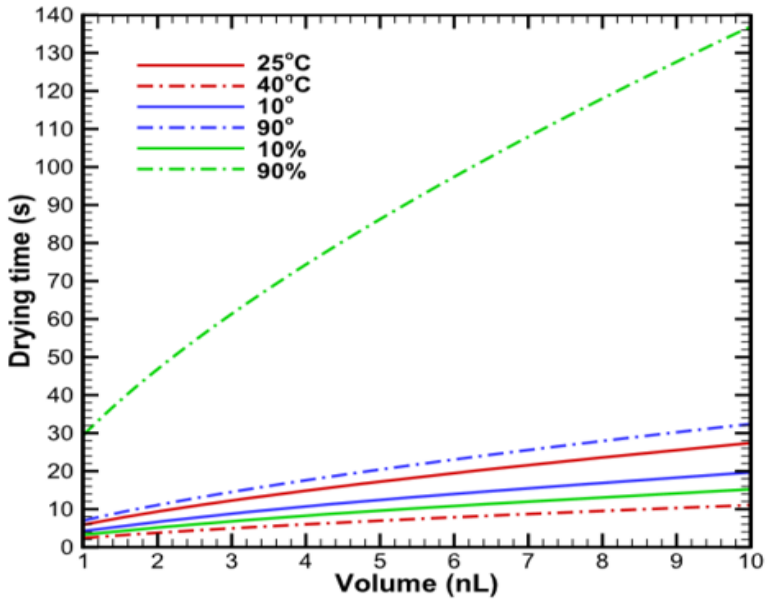

*Figure 6: Influence of droplet volume on evaporation time as a function of relative humidity, ambient temperature and surface wettability (**Source:** Physics of Fluids (2020)).*

Wettability of the droplet on solid surface evaluated by the contact angle measurement. The drop dispersion on the hydrophilic surface is higher and the loss of mass rate of liquid from the drop to the ambient is enhanced [Figure 6] i.e. the evaporation time will be reduced. The variance in temperature in several parts of the surface can reveal with the effect of the surface. A minor change in the surface

temperature can advance intensify the surface effect by manipulating the evaporation time.

Prevention of COVID-19

Controlling the spread is the most important method for prevention. The varieties in properties of the virus make it challenging namely, transmission from people with no symptoms (asymptomatic). To control the virus, some studies suggested the exposure to air (ventilation) at homes to be exposed with sunlight. Other preventable measures such as wearing a mask, even a surgical mask may be able to contain the spread together with following good hygiene during coughing in public. It is recommended that medical personnel and caretakers must wear a surgical mask during contact with the patients. It is also suggested that medical care professionals should be given, fit verified N95 respirators and shielding suits and goggles [Figure 7].

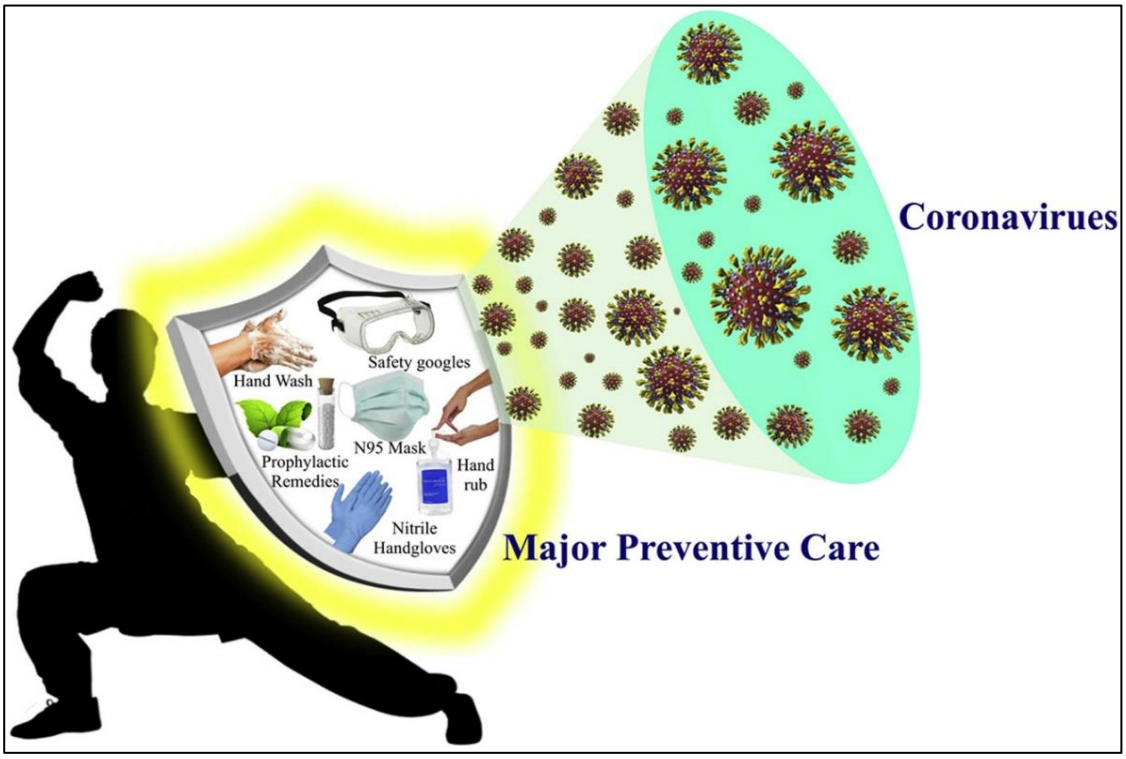

*Figure 7: Safety materials for prevention of COVID-19 (**Source:** Archives of Medical Research (2020)).*

To reduce the risk of community spread, it is recommended that people suspend unnecessary travel to areas with continuing transmission and avoid crowded areas. Good cough hygiene should be practiced by coughing in tissues/sleeves which can reduce the spread compared to coughing on the hands and practice sanitization of hands every 15–20 min periodically. Patients with respiratory symptoms are also at high risk, so they should be wearing an N95 mask or surgical masks [15].

Material Science for COVID-19: Biosafety Materials

"Biosafety material science" is a concept that has not formally been suggested up till now. Numerous studies associated to biosafety of materials (coating etc.) have already been done, including prevention, pathogen detection, control of infectious diseases and virus detection, PPE, biological invasion monitoring, salvation of human and biological resources, and defense from bioterrorism, biological weaponries [16]. Detailed studies of biosafety materials have been conducted that have advanced a broad understanding for researchers [17]. Studies have shown that the material science and engineering have wide usage in biosafety and biosafety of materials [Figure 8].

Currently, the research focus is to develop efficient materials for potential solution to the current covid-19 threats. To this end, studies have indicated that by selecting the nanoparticles with their suitable size and concentration as a filler material along with the selection of host material as well as fabrication methods can lead to the solution. Personal protection equipment or called PPE's such as shielded clothing masks, ambulance and goggles, etc. are known to provide protection against corona virus. However, because of lack of biosafety materials, these materials result in a catastrophe for the safety of numerous of health professionals as well as patients. Thus, there is an urgent need of the biosafety materials to use in current pandemic situation as well as in other applications [18].

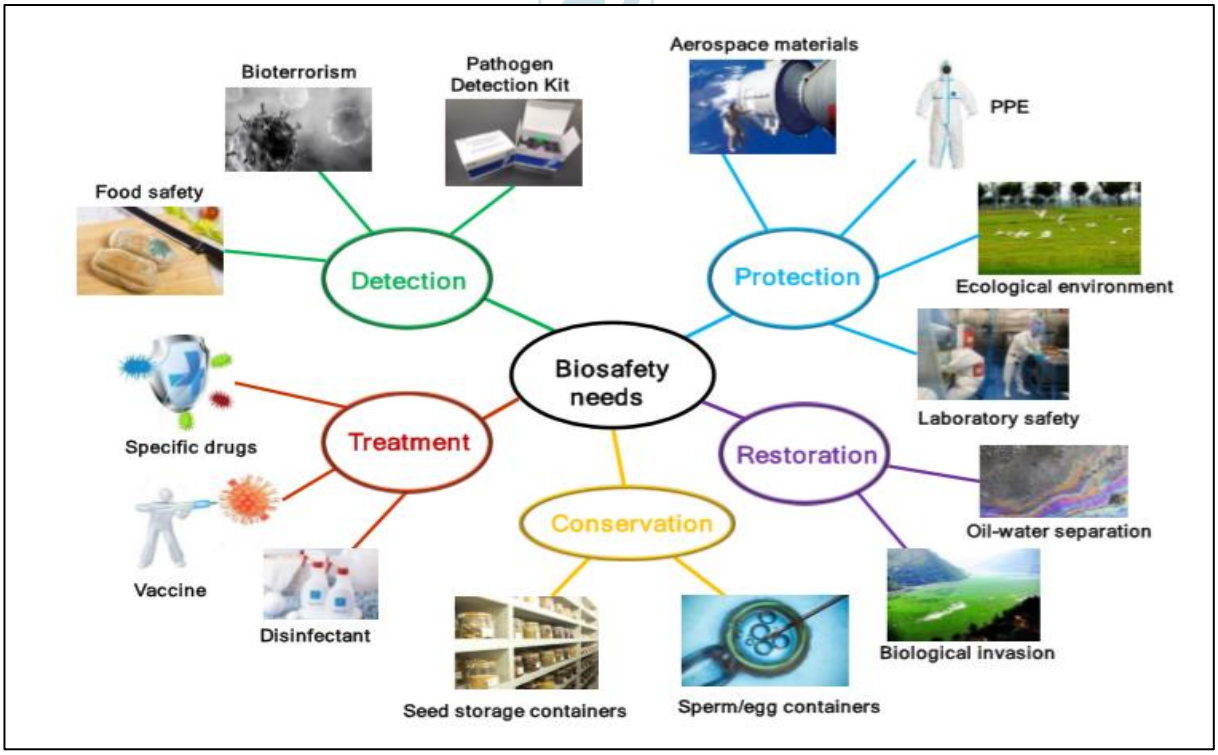

*Figure 8: Biosafety requirements and their conforming biosafety constituents (**Source:** Materials Chemistry (2020))*

Figure 8 illustrates that the material science and engineering is the best possible solution to resolve the existing challenges in the biosafety, which includes the detection, disinfection of pathogens, viral vaccines, personal protective equipment and prevention of biological species.

Viral vaccines from biosafety materials

It has been proven from the evolution virus that immunization (vaccination) is considered the only primary successful solution to totally comprehend the outbreak of virus. Vaccines efficiently contains the infection by enhancing the immunity system against a deadly pathogen. Even though many safety concerns are there in the efficiency in viral delivery system and numerous biosafety resources have been broadly studied and considered for in vivo delivery and releasing of viral vaccines comprising cationic proteins, liposomes, biological membranes and polymers. Recent researches have shown that in the form of DNA, protein or mRNA, viral vaccines can be provided. Further, all these forms can be effortlessly enzymatically tarnished when entering the blood circulation [19]. For example, in SARS-CoV-2, it contains 1273 amino acids, with a molecular weight of about 140 kDa. The DNA encoding SARS-CoV-2 would be higher than 3800 bp. To ensure the antibody available for use and assist them with being endocytosed into the cells, delivery vehicles are required. Ionizable liposomes were used to carry negatively charged mRNA for the SARSCoV- 2 spike protein by Moderna. Moreover, research shows that polymers such as low molecular-weight polyethylene mine (PEI) modified with fatty chains and poly (β-amino) esters (PABEs) can be designed to deliver DNA and mRNA. Adding to it, a cationic protein, which is natural, called as protamine with nucleic acids, can create complexes, which are negatively charged, thus being applied to provide mRNA-based therapeutics and stimulate /excite immune response [19].

Additionally, biological membranes such as RBC membranes and extracellular vesicles including macrovesicles, apoptotic bodies and exosomes can be isolated and applied for delivery of biomolecule-based vaccines. Lately, micro needle patch, an efficient drug delivery system, has appealed widespread methodical benefits due to its admirable property such as exceptional therapeutic efficiency and painless penetration. It is known to deliver a highly effective transdermal delivery method to make refined improved tools with advanced conditions for biomedical applications [20]. Altogether, it can be summarized that, biosafety materials are significant in the advancement of biomolecule-based therapeutics and it is at present applied to fight viral infection.

Conclusion

In this review, the disease outline of COVID-19 has been described as dynamic that continues. The profile of COVID 19 is evolving rapidly in the world. The zoonotic source of SARS-CoV-2 is not confirmed yet, however, sequence-based analysis has suggested bats as the key reservoir. DNA recombination was found to be involved at spike glycoprotein, which assorted SARS-CoV. Until now, no promising clinical treatments or prevention strategies have been developed against human coronaviruses. SARS had a mortality rate of 9.5%, whilst the current novel coronavirus

appears to have a mortality rate around 2%, based on the number of confirmed cases and deaths. We conclude by stressing the importance of biosafety materials in constraining COVID 19. As for the ongoing and future research, a lot of efforts are anticipated to be based on nanotechnology-based materials that are believed to provide the solution for diagnosis, prevention and the treatment of COVID-19 patients. We hope that in the near future there would be some positive information about the major role of material science in providing biosafety solution.

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Column

Combating the pandemic with a potential cure: A thermostable mRNA vaccine emerges as a promising candidate against COVID-19

Dr. Shripriya Singh

Senior Contributing Editor, Biotechnology Kiosk

Abstract

The ongoing global pandemic caused by the deadly SARS-CoV-2 (COVID-19) has initiated worldwide efforts to develop effective vaccines against the virus. Many promising strategies have been considered in developing vaccines. Among the various vaccine candidates, mRNA vaccine has emerged as a leading contender to contain COVID-19. We describe here some of the recent advances in thermostable mRNA vaccine and discuss its potential to neutralize the virus.

Keywords: COVID-19, SARS-CoV-2, Vaccines, mRNA, Thermostable

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Introduction

As the COVID-19 pandemic continues to wreak havoc, the world is asking how close we are to a potential cure. All eyes are set upon the arrival of a vaccine. According to the World Health Organization a vaccine is a biological preparation that provides active acquired immunity to a particular infectious disease. A vaccine typically contains an agent that resembles a disease-causing microorganism and is often made from weakened or killed forms of the microbe, its toxins, or one of its surface proteins. The rat race to develop the vaccine had begun the moment the novel virus strain was identified. However, it is not as easy as it seems. When we inject a foreign substance in a human body it is bound to elicit an immune response and this response needs to be tamed and well directed to avoid any deleterious side effects.

Development of a vaccine is a multiphase process which requires stringent testing and control at every step. The product has to pass through clinical trial phase before it can be made available to human beings. Classically speaking it takes almost ten to fifteen years to produce a potent vaccine against diseases. But keeping in mind the current state of pandemic with the death toll increasing every moment we cannot afford to wait so long. More than thirty-five companies and academic institutions had joined the race for the vaccine and more than four of them have successfully entered the clinical trial phases. In a couple of cases the animal testing stage was skipped to quickly enter the human trial phase. However, despite the expedited testing we cannot ignore the fact that a vaccine might prove useful against a particular disease but might cause some other serious side effects.

Various strategies have been employed to create the vaccine and among all approaches a messenger RNA (mRNA)-based vaccine has emerged as a versatile and rapid platform to quickly respond to this challenge. In our current article we shall discuss the salient findings of a research recently published in Cell by a team of researchers who have developed a thermostable mRNA Vaccine against COVID-19 (1).

The highlights of the research

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), a novel human corona virus closely related to SARS-CoV is responsible for the COVID 19 pandemic. The clinical manifestations caused by SARS-CoV-2 range from non-symptomatic infection to mild flu-like symptoms, severe acute respiratory distress syndrome, pneumonia and even death (2). The number of cases has crossed the 3.5 million mark with over 250,000 deaths (the numbers are increasing every moment).

Corona viruses belong to a class of enveloped positive-sense, single-stranded RNA viruses, and the virion is composed of a helical capsid formed by nucleocapsid (N) proteins bound to the RNA genome and an envelope made up of membrane (M) and envelope (E) proteins, coated with a ‘‘crown’’-like trimeric spike (S) protein.

Similar to other human coronaviruses, the full-length S protein of SARS-CoV-2 consists of S1 and S2 subunits. First, the S protein mediates viral entry into host cells by binding to its receptor, angiotensin-converting

enzyme 2 (ACE2), through the receptor-binding domain (RBD) at the C terminus of the S1 subunit, which subsequently causes fusion between the viral envelope and the host cell membrane through the S2 subunit. The full-length S protein, S1, and RBD are capable of inducing highly potent neutralizing antibodies and T cell-mediated immunity and, therefore, have been widely selected as promising targets for corona virus vaccine development. Figure 1is the summary of the research.

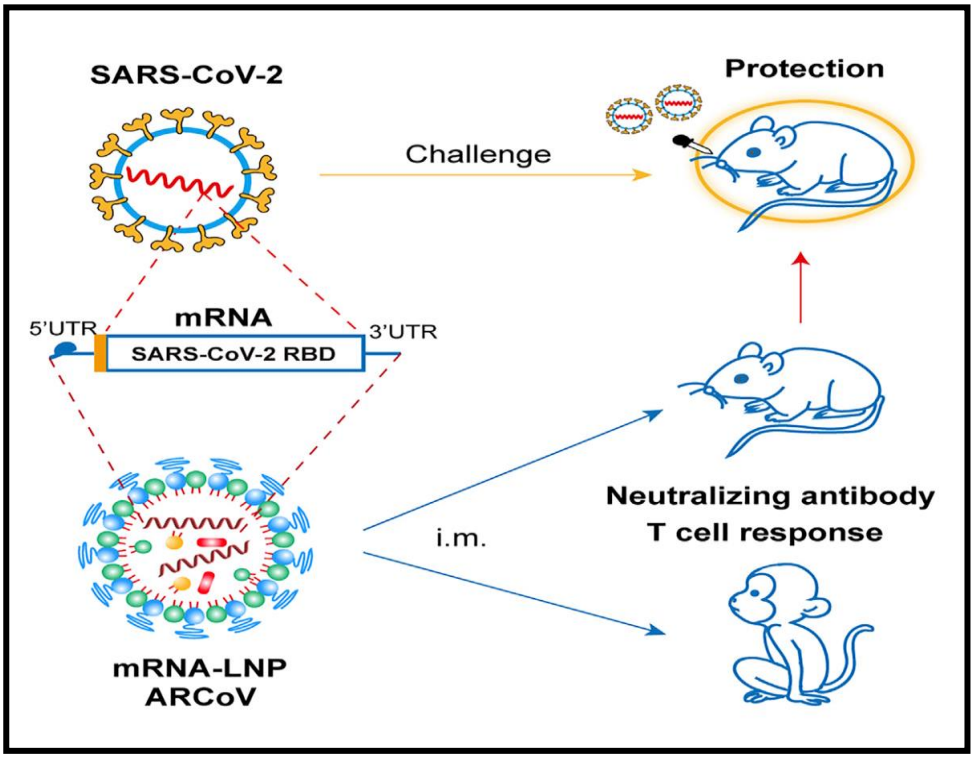

Figure 1: The diagrammatic summarization of the research highlighting the potential of the thermostable mRNA based ARCoV vaccine. (***Source:*** *Cell 2020 (1)*).

Messenger RNA (mRNA)-based therapy is one of the latest approaches for treating cancer and other infectious diseases (3). The mRNA vaccine field has developed rapidly in basic and clinical research owing to the technological advances in mRNA modification and delivery tools. It has been observed in preclinical studies that mRNA-based vaccines induce potent and protective Immune responses against various pathogens in small and large animals, with an acceptable safety profile. Clinical trials for mRNA vaccines against viral diseases such as influenza, Zika, Ebola, cytomegalovirus and rabies infection have been carried out in many countries successfully. The biggest advantage of the mRNA vaccine platform is its potential of scalable production within a very short period of time which makes it the preferred choice during times of this pandemic. Messenger RNA manufacturing avoids the lengthy process of cell culture and purification and the stringent biosafety measures for traditional virus vaccine

production. A clinical-scale mRNA vaccine can be designed and manufactured rapidly, within weeks, when the viral antigen sequence becomes available. It took only 42 days for Moderna's mRNA-1273 to enter the phase I clinical trials as the very first mRNA vaccine against COVID-19 in the United States in March 2020.

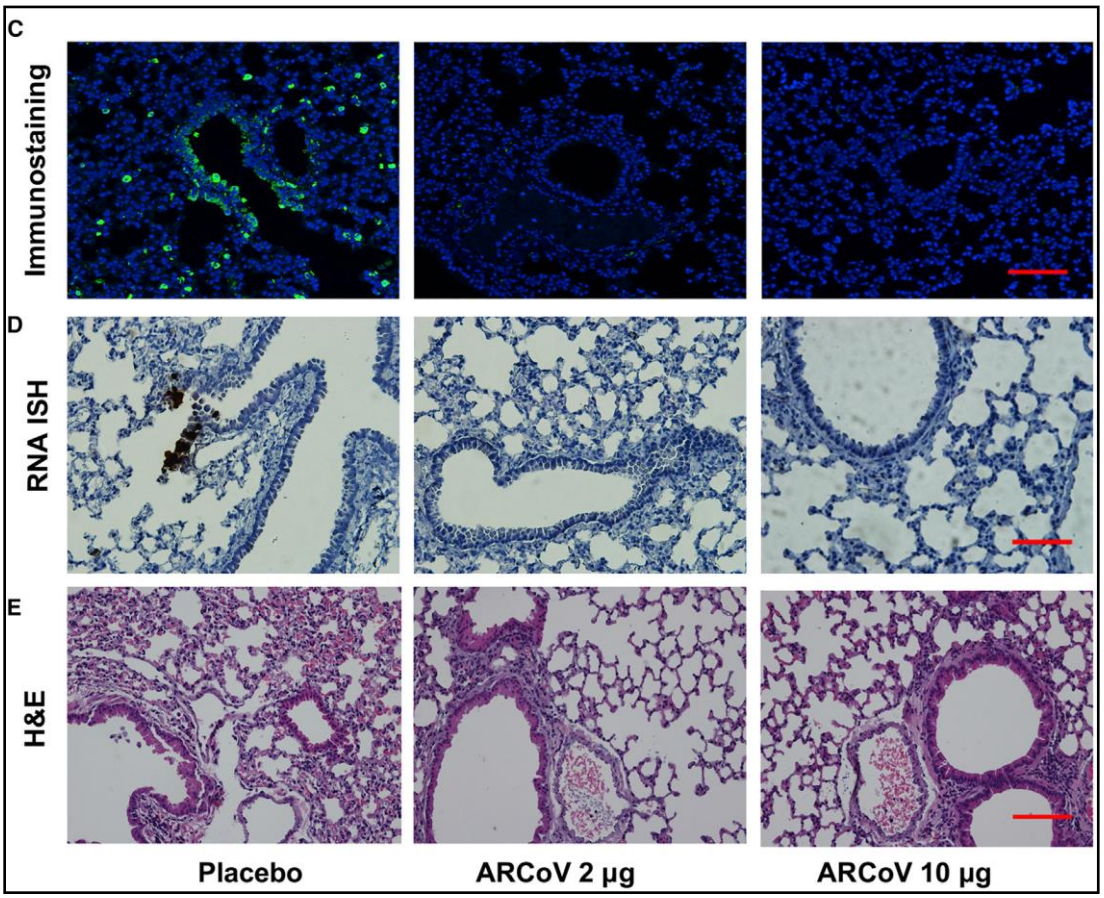

Figure 2: The immunostaining results showing protection of ARCoV against SARS-CoV-2 Challenge in Mice. (***Source:*** *Cell 2020 (1)*).

In the current study the researchers developed a lipid nanoparticle-encapsulated mRNA (mRNA-LNP) encoding the receptor binding domain (RBD) of SARS-CoV-2 as a vaccine candidate (called ARCoV). Lipid nanoparticles (LNPs) are one of the most attractive and commonly used mRNA delivery tools (4). The RBD of SARS-CoV-2 (amino acids [aa] 319–541) was chosen as the target antigen for the mRNA coding sequence. When the the RBD-encoding mRNA was transfected in multiple cell lines such as HEK293T, HeLa, Huh7 and Vero it resulted in high expression of recombinant RBD in culture supernatants. RBD protein expressed from mRNA retained high affinity for recombinant human ACE2 and functionally inhibited entry of a vesicular stomatitis virus (VSV)-based pseudovirus expressing the SARS-CoV-2 S protein. Immunostaining further demonstrated that this RBD protein can be recognized by a

panel of monoclonal antibodies (mAbs) against SARS-CoV-2 RBD as well as convalescent sera from three COVID-19 patients. It was further observed that the Intramuscular immunization of ARCoV mRNA-LNP elicited robust neutralizing antibodies against SARS-CoV-2 as well as a Th1-biased cellular response in mice and non-human primates. Two doses of ARCoV immunization in mice conferred complete protection against the challenge of a SARS-CoV-2 mouse-adapted strain (1). Figure 2 shows the immunostaining results showing protection of ARCoV against SARS-CoV-2 Challenge in Mice.

The scalability and accessibility of COVID-19 vaccines are major challenges to expediting delivery and massive immunization worldwide; therefore, a thermostable and ready-to-use vaccine is the need of the hour. The current ARCoV mRNA-LNP vaccine is manufactured in a liquid formulation without the need of thawing or reconstitution before injection, and a single-dose vaccine is prepared in a prefilled syringe for quick self-administration. The vaccine was tested for its stability and it was observed that the formulation maintained in vivo delivery efficiency at 40C and 250C for at least 1 week (1). However, the long-term stability of the ARCoV vaccine is still under evaluation. ARCoV is currently being evaluated in phase 1 clinical trials.

Concluding remarks

As the medical and scientific fraternity is battling against time to produce a potential cure in the form of a vaccine this thermostable mRNA vaccine candidate has shown promising results. The major advantages of the product are its simple route of administration i.e. the intra muscular route, its liquid formulation which requires no reconstitution, its thermostabilty and efficacy to name a few. The vaccine ARCoV has provided first-line evidence of immunogenicity and efficacy in multiple animal models can thus prove to be a potential vaccine candidate in near future with global accessibility and universal availability. This recent development has made us hopeful once again that after much anticipation we might finally have a potential cure and we are optimistic that soon we shall win this battle against COVID19 pandemic.

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Biotechnology Advances around the World

Editor's Picks

Every issue of Biotechnology Kiosk presents select latest research news picked by the editors-in-chief on significant research breakthroughs in different areas of biotechnology around the world. The aim is to promote further R&D in all of these cutting-edge areas of biotechnology. The editors have compiled and included the following innovations and breakthroughs to highlight the latest biotechnology advances.

Dr. Megha Agrawal
Co Editor-in-Chief

Dr. Shyamasri Biswas
Co Editor-in-Chief

Redox Biology

The potential role of electromagnetic fields in treating type 2 diabetes

In redox biology, the applications of electromagnetic fields 'EMFs' cover a wide range of areas in medical science, in addition to telecommunications, navigation, and mobile devices. EMFs are considered promising in medicine such as in MRIs and EEGs to name a few. However, not much research has been done to understand how EMFs affect biology. Especially, it is of huge interest to study the mechanisms underlying the biological effects of EMFs on blood sugar and insulin sensitivity.

Previous studies on a quantum biological phenomenon indicated that EMFs may interact with specific molecules. It is known that there are molecules in human bodies that can act like tiny magnetic antenna, which can enable a biological response to EMFs. Using the concepts of EMFs, researchers in the US recently discovered a safe new way to manage blood sugar non-invasively. They exposed diabetic mice to a combination of static electric and magnetic fields for a few hours per day that resulted in normalized blood sugar and insulin resistance. This discovery paves the way for using electromagnetic fields (EMFs) as a remote control to manage type 2 diabetes. They showed normalization of two major hallmarks of type 2 diabetes in their new findings published Oct. 6 in Cell Metabolism, (Exposure to Static Magnetic and Electric Fields Treats Type 2 Diabetes, Cell Metabolism, 2020; 32 (4): 561 DOI: 10.1016/j.cmet.2020.09.012).

This study reveals that exposure to EMFs for relatively short periods can reduce blood sugar, which eventually normalizes the body's response to insulin. Further, the effects are shown to be long-lasting, which opens the possibility of an EMF therapy that can be applied during sleep to manage diabetes all day.

Researchers showed that EMFs can potentially alter the balance of oxidants and antioxidants in the liver, improving the body's response to insulin. Their study reveals that the effect is mediated by small reactive molecules which is believed to function as magnetic antennae. It is shown that EMFs can alter the signaling of superoxide molecules, specifically in the liver. This can lead to the prolonged activation of an antioxidant response to rebalance the body's redox set point and the response to insulin.

Researchers demonstrated that by removing superoxide molecules from the liver, they could completely block the effect of the EMFs on blood sugar and on the insulin response. The evidence suggested the important role of superoxide in this process.

This discovery could pave the way to major therapeutic implications in diabetes care, particularly for patients who find current treatment regimens complex.

Compiled and Edited by Dr. Megha Agrawal & Dr. Shyamasri Biswas

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