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CHEMICO- PHYSICALS PROPERTIES OF CORONAVIRUS AFFECTING AIRBORNE TRASMISSIBILITY

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ABSTRACT

Coronavirus was finded to have characteristic pattern of chemical -physical properties at X-ray cristallograpy. This fact influence some diffusion properties related also Brownian moto and shielding effect . Not only carrier size is relevant for airborne transmission of some respiratory virus but also virus size and electrical feature, envelope composition and other . The virus envelope seem involved in avoiding strategies of virus to escape to the hosts immune system. In this work aspect related chemical -physical aspect of coronavirus are investigated. The logarithmic rapid explosion in France, Spain and UK of a second wave of covid-19 seem to reveal other then simply direct contact and by droplet diffusion: airborne can be an real hypotesys of work.

KEYWORDS: coronavirus, covid-19, envelope , shielding effect, Brownian moto, airborne, immune system Diffusion, epidemiology

INTRODUCTION

It is interesting to observe virus external structure and related properties in transmission. Virus in example without envelope and virus with this structure. The molecular composition of this structure produce effect in relationship with hosts cells but also Due determinate chemical-physical properties great influence in phenomena involved in link with carrier Like PM particulate matter , or in droplets , or also in aereosols. In this last environment phenomena like Brownian moto and shielding effect are great movens added also to the virus size. In evolution on virus to avoid the host immune system make

possible to have great advantages Ant this is reflected in some viral structure. Chemical forces, elettrostatic features, Hydrofobic balances and physical phenomena are capable to affect virus behavior in aereosols.

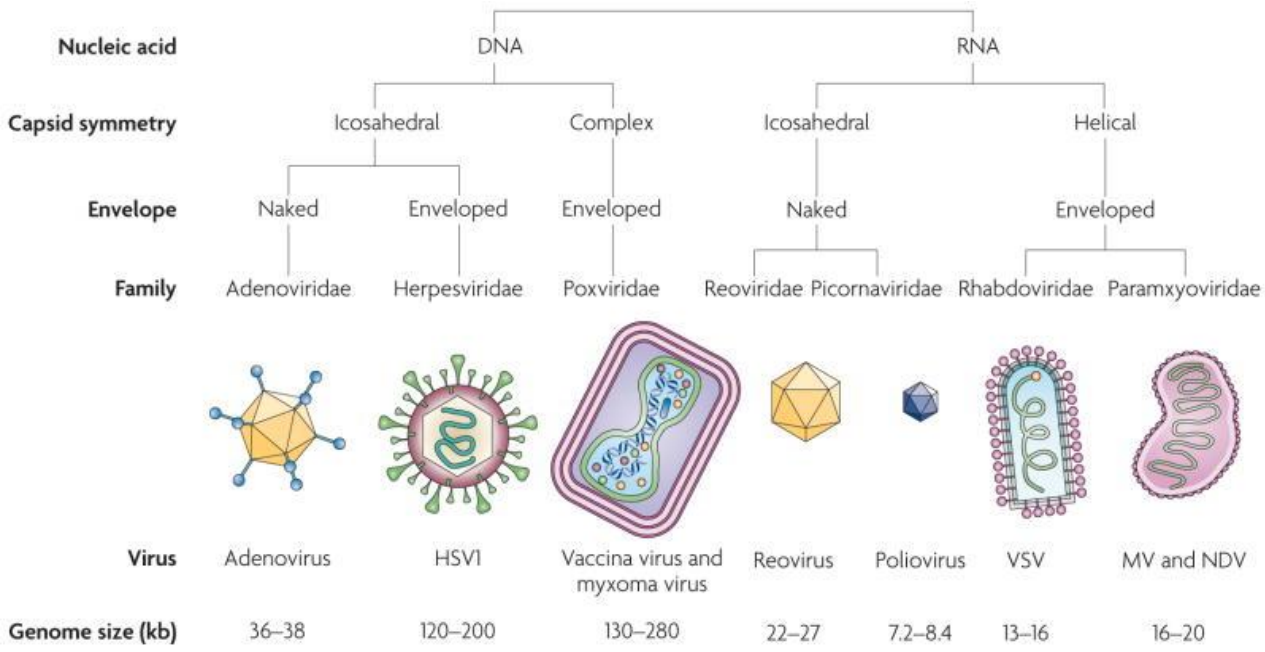

Fig. n 1 some viruses from Nat Rev Microbiol. 2014 R Cattaneo et al

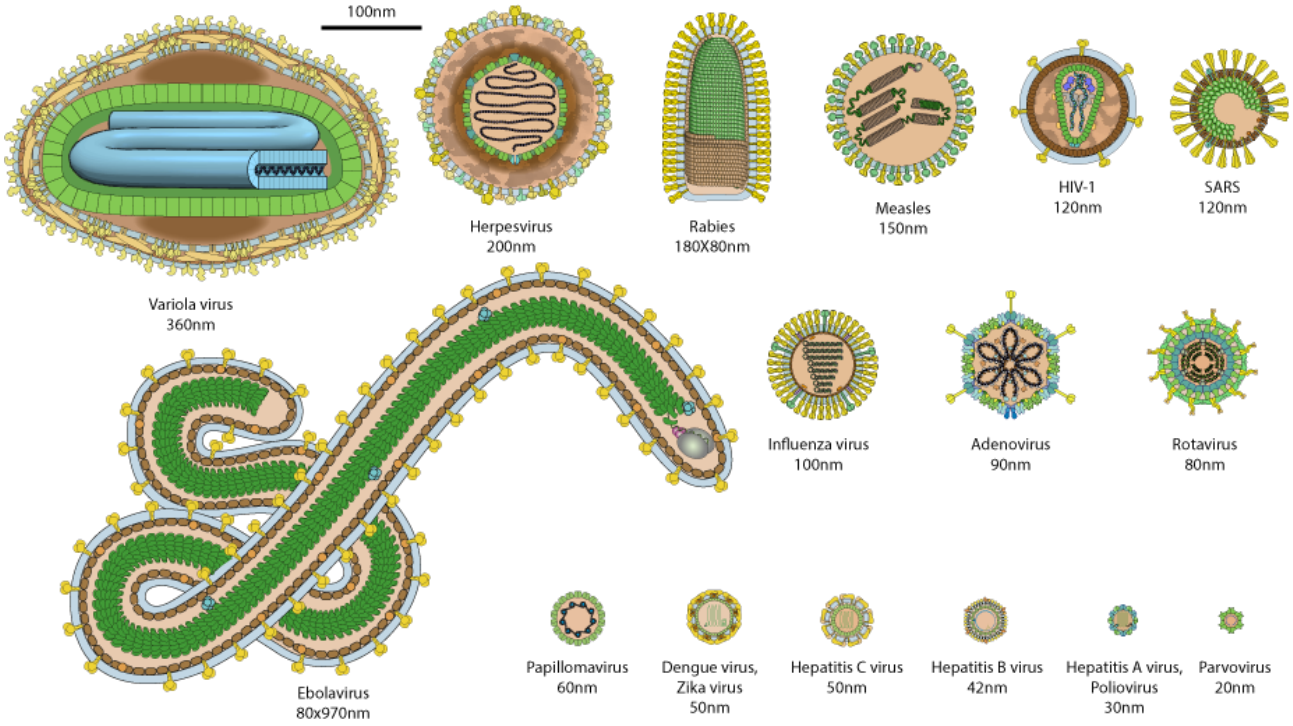

Fig. n 2 virus size

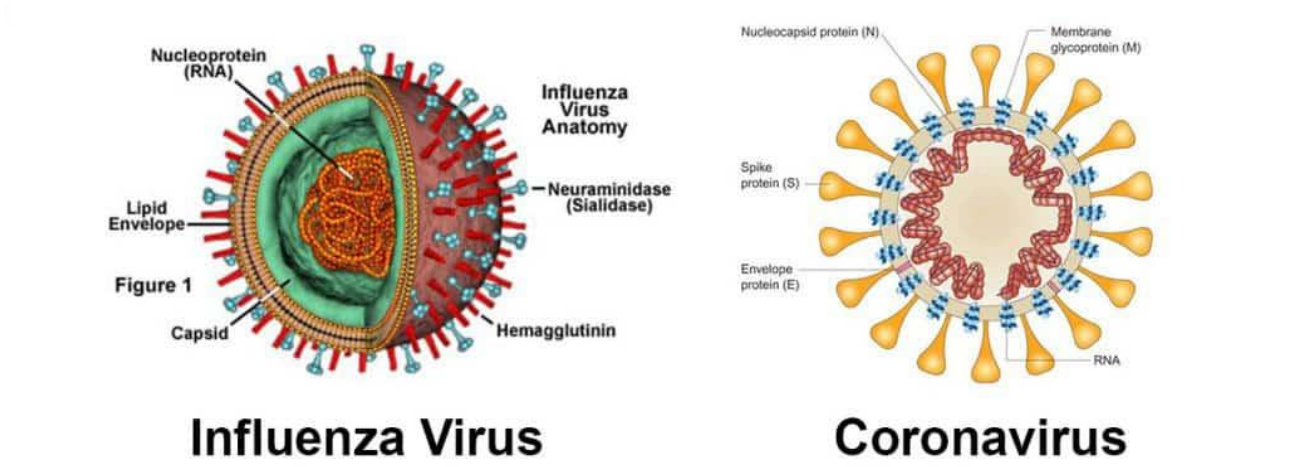

Fig. n 3 influenza and coronavirus structure .

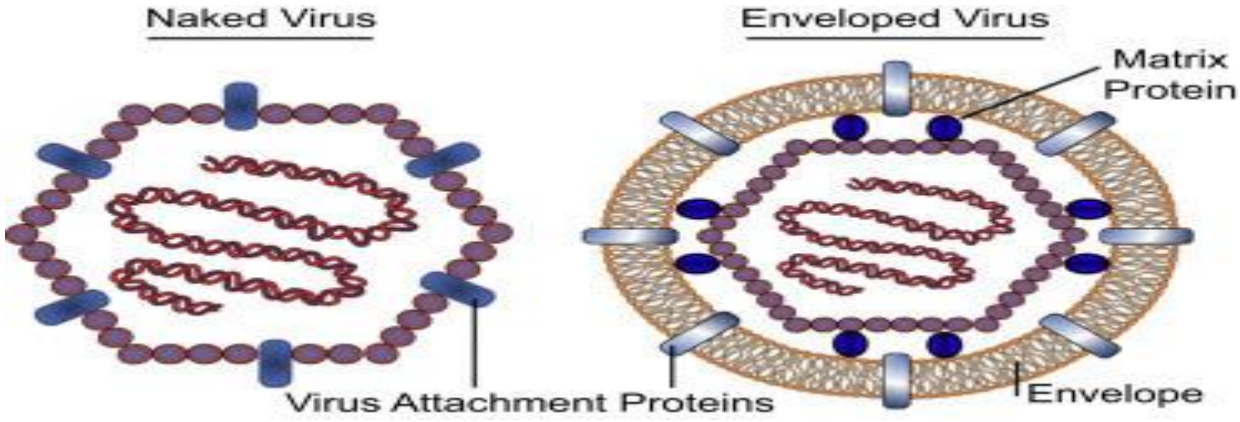

Fig. n 4

Review **European Annals of Otorhinolaryngology, Head and Neck Diseases**

L.de Gabory et al :

"Coronaviruses belong to the *Coronaviridae* family which has 4 genera: α–β–γ–δ. Genera α and β contain 7 coronaviruses transmittable to humans: 4 are responsible for trivial upper and lower respiratory- infections, the 3 others, SARS-CoV-1, MERS-CoV, and SARS-CoV-2 are responsible for severe lower-respiratory infections. They have an S surface glycoprotein (Spike) arranged like a crown which allows them to attach themselves to the epithelial receptor angiotensin-converting enzyme 2 (ACE2) and the protease-transmembrane TRMPSS2 . The A and B influenza- viruses (IV) and the seasonal -flu belong to the *Orthomyxoviridae* family and are responsible for 290,000 to 650,000 deaths/year world-wide through respiratory failure . They have a haemagglutinin surface- glycoprotein that attaches to sialic acid .

The inter-human transmission of viral-infection occurs through close direct contact with an infected person, by touching a surface contaminated with short-distance projections, and impaction of droplets of secretion (fomites) . Transmission can occur over a longer -distance by airborne droplets . The objective of this clarification was to analyse the objective data of patients' contagiousness by transporting the virus through producing- secretions and the possibility of them penetrating the air-ways. Assessing transmissibility is important for the otorhino-laryngologist who is at the forefront of treating the upper aero digestive tracts and because many viruses cause ENT -manifestations. the current SARS-CoV-2 pandemic and the annual flu epidemic require professionals to be up to date with the latest knowledge about these mechanisms in order to adapt their practices."

According article Inhaled particles and respiratory disease

John E. Salvaggio, MD New Orleans, Louisiana 1994

"An aerosol, which is essentially a collection of airborne -particles, might be defined as any system of solid particles or liquid -droplets of sufficiently small diameter to maintain stability as a suspension in the air. Particles comprising an aerosol must contain droplets sufficiently large so as not to diffuse like a gas- molecule but sufficiently small to remain airborne for some length of time. Particles with these properties usually range between 0.1 to 10 µm. Aerosols composed of solid- particles can either be designated as dusts if the particles are produced by dispersion or as smoke if they are produced

by condensation. Mists are aerosols that contain liquid particles."Infection"All principles of aerosol deposition discussed previously apply to transmission of infection with microbial and viral- aerosols. Infection with aerosol -transmission of these agents has been well known for many years. In keeping with the theme of this conference, Legionnaire's disease, which appeared as an outbreak of pneumonia in 1976, was attributed to aerosol -infection from contaminated- water, resulting in one of the initial examples of building-related lung disease."

Richard James Thomas :

"The aerodynamic- diameter of inhaled-particles determine where within the respiratory- tract pathogens incorporated within the particles deposit and interact with host tissues. A number of mechanisms determine deposition of particles within the respiratory- tract including inertial impaction, Brownian diffusion, gravitational sedimentation, and electrostatic effects. Small- particles (<1–3 μm) diffuse deep into the lung tissue, depositing in the alveoli by a number of mechanisms including diffusion, sedimentation, and electrostatic effects. In contrast, larger particles (>8 μm) impact further up the respiratory- airways due to greater inertion, depositing in a size-dependent manner from the nasal passages to the larger bronchioles. This relationship is extant across mammalian species albeit differences in respiratory anatomy and physiology dictate the penetration of a particular particle size into the respiratory tract"

Mahesh Jayaweera et al :

"The practice of social distancing and wearing masks has been popular world-wide in combating the contraction of COVID-19. Undeniably, although such practices help control the COVID-19 pandemic to a greater extent, the complete control of virus-laden droplet and aerosol- transmission by such practices is poorly understood. Infectious agents may spread from their natural reservoir to a susceptible host in different pathways. There are various classifications reported in the literature for modes of transmission of different infectious-agents. has presented a classification for virus transmission, including human-human transmission, airborne- transmission, and other means of transmission such as endogenous infection, common vehicle, and vector spread. many respiratory- viruses are believed to transmit over multiple routes, of which droplet and aerosol transmission paths become paramount, but their significance in transmitting the disease remains unclear . infected people spread viral particles whenever they talk, breathe, cough, or sneeze. Such viral -particles are known to be encapsulated in globs of mucus, saliva, and water, and the fate/behavior of globs in the environment depends on the size of the globs. Bigger -globs fall faster than they evaporate so that they splash down nearby in the form of droplets . Smaller -globs evaporate faster in the form of aerosols, and linger in the air, and drift farther away than the droplets do. Respiratory- particles may often be distinguished to be droplets or aerosols based on the particle size and specifically in terms of the aerodynamic-diameter. One could dispute that, unlike larger droplets, aerosols may pose a greater risk of the spread of the COVID-19 disease among many susceptible- hosts positioned far from the point of origin. it has been proven that viral- disease outbreaks via aerosol transmission are not as severe as one would think, because of dilution and inactivation of viruses that linger for extended -periods in the air . There has been no discernible evidence on the minimum

infectious viral -load for COVID-19 pandemic, but many researchers speculate that a few hundreds of SARS-CoV-2 virus would be enough to cause the disease among susceptible hosts. Small aerosols are more susceptible to be inhaled deep into the lung, which causes infection in the alveolar tissues of the lower respiratory- tract, while large droplets are trapped in the upper airways . For easy apprehension, aerosols can be defined as suspensions of solid or liquid-particles in the air, which can be generated by either natural or anthropogenic phenomena . since the recent past, evidence has been provided to refute the former hypothesis and speculated that aerosols also play a major- role in transmitting the disease No conclusive studies have been conducted on differentiating between the modes of transmission of viruses via droplets and aerosols; unresolved dichotomy. The most important environmental -factors that could impact on the viability of airborne -microorganisms are temperature, humidity, radiation (sunlight), and open-air (ventilation) . Most viruses, including SARS-CoV-2, are less than 100 nm in size . Viruses in aerosols lose or gain the viability and infectivity because of environmental-stresses caused by temperature, relative humidity, and sunlight before they reach a susceptible host. Environmental- tolerance of the virus-laden aerosols depends on the specific phenotype available, the composition of the bio-aerosols containing virus and their payload, and physical characteristics in the surrounding environment . As the environmental factors play a major role in transmitting payloads of SARS-CoV-2 virus in different geographical locations of outdoor and indoor- environments, it is worthy of exploring the effects of environmental factors on the transmission of SARS-CoV-2 virus. there have been associations between air pollution represented by air- pollutants such as $PM_{2.5}$, PM_{10}, NO_2, and O_3 and COVID-19 infection . SARS-CoV-2 could bind with particulate matter and could be airborne. In an indoor environment, such viral- loads primarily become airborne by advective forces propelled by local- ventilation patterns and travel further away through diffusion and dispersion processes. ”

Science News *from research organizations*

Research exposes new vulnerability for SARS-CoV-2

Electrostatic interactions enhance the spike protein's bond to host cells

2020Northwestern University

“The spike -protein contains the virus' binding site, which adheres to host cells and enables the virus to enter and infect the body. Using nanometer-level simulations, the researchers discovered a positively charged- site (known as the polybasic cleavage site) located 10 nanometers from the actual binding site on the spike protein. The positively charged -site allows strong bonding between the virus protein and the negatively charged human-cell -receptors.” (1)

Sandhya Verma et al :

“Corona-viruses are enveloped RNA viruses that cause respiratory and enteric- infections in humans and many domesticated animals. Members of the family Coronaviridae contain single-stranded, positive-sense genomes that range from approximately 27 to 31 kb in length. The viral- genes are expressed through a discontinuous transcription mechanism that yields a nested set of subgenomic RNAs . Coronavirus virions contain at least three envelope proteins, membrane (M), spike (S), and envelope (E). The genomic RNA is encapsidated by the nucleocapsid (N) protein as a helical nucleocapsid . The S protein is the viral receptor attachment protein that facilitates

infection through fusion of viral and cellular membranes and is the major target of neutralizing- antibodies during infection . The M protein is a major envelope component that plays an important -role in virus assembly. The E protein is a minor component of the viral envelope that also plays a critical role in virus budding. Coexpression of the E and M proteins is sufficient for formation of virus-like particles . Deletion of the E gene from the mouse hepatitis- coronavirus (MHV-CoV) genome results in severely crippled virus , whereas elimination of expression of the gene in porcine transmissible gastroenteritis coronavirus blocks virus assembly In this study, we examined the importance of negatively- charged amino acids located within the carboxy-terminal 22 amino acids of the MHV-CoV A59 N protein. We found that two of the residues, DD440-441, are functionally important for virus output. When both of the aspartic acids were replaced by negatively -charged glutamic acid residues, viruses with no new changes and a wild-type phenotype were recovered. Significantly, viruses were not recovered when both residues were replaced with positive- charges. Replacement of both amino- acids with neutrally charged alanine or individual replacement of either residue with positively charged arginine was tolerated, but the vast majority of the recovered viruses also had compensating changes which restored the wild-type phenotype. A few very crippled- viruses were recovered that retained the single charge reversal substitution at position 441 without additional new -changes. Altogether, the results indicate that the negative- charges at positions 440 and 441 are key residues. The data support the idea that the residues are involved in virus -assembly. Maintenance of the overall negative charge within the carboxy end of the N protein appears to be important, since most of the compensating -changes are predicted to impact the overall charge of the domain." (2)

MATERIAL AND METHODS

With observational approach some relevant scientific literature are analyzed and a research hypothesis project is proposed in order to produce a global conclusion.

All literature comes from biomedical databases but also some Preprint are reported

RESULTS

From literature :

Transmission of SARS-CoV-2: implications for infection prevention precautions Scientific brief 9 July 2020 WHO

Airborne- transmission is defined as the spread of an infectious agent caused by the dissemination of droplet- nuclei (aerosols) that remain infectious when suspended in air over long distances and time.(11) Infection prevention and control of epidemic- and pandemic-prone acute respiratory -infections in health care WHO Guidelines 2014

Airborne transmission can be further categorized into obligate or preferential airborne -transmission (9). Obligate airborne -transmission refers to pathogens that are transmitted only by deposition of droplet nuclei under natural conditions (e.g. pulmonary- tuberculosis). Preferential airborne- transmission refers to pathogens that can initiate infection by multiple routes, but are predominantly transmitted by droplet nuclei (e.g. measles and chickenpox)."

Wallace Woon Fong Leung et al :

"The WHO declared the novel coronavirus (COVID-19) outbreak as a pandemic on March 12, 2020. Within four months since outbreak in December 2019, over 2.6 million people have been infected across 210

countries around the globe with 180,000 deaths. COVID-19 has a size of 60–140 nm with mean- size of 100 nm (nano-aerosol). The virus can be airborne by attaching to human- secretion (fine particles, nasal/saliva droplets) of infected person or suspended fine- particulates in air. While NIOSH has standardized N95, N99 and N100 respirators set at 300-nm aerosol, to-date there is no filter standards, nor special filter technologies, tailored for capturing airborne -viruses and 100-nm nano-aerosols. The latter also are present in high number concentration in atmospheric- pollutants. This study addresses developing novel charged PVDF nanofiber filter technology to effectively capture the fast-spreading, deadly airborne coronavirus, especially COVID-19, with our target aerosol size set at 100 nm (nano-aerosol), and not 300 nm.

The virus and its attached aerosol were simulated by sodium chloride aerosols, 50–500 nm, generated from sub-micron aerosol generator. PVDF nanofibers, which were uniform in diameter, straight and bead-free, were produced with average -fiber diameters 84, 191, 349 and 525 nm, respectively, with excellent morphology. The fibers were subsequently electrostatically charged by corona discharge.

The amounts of charged- fibers in a filter were increased to achieve high efficiency of 90% for the virus filter but the electrical interference between neigh-bouring fibers resulted in progressively marginal increase in efficiency yet much higher pressure- drop across the filter. The quality -factor which measured the efficiency-to-pressure-drop kept decreasing. By redistributing the fibers in the filter into several modules with lower-fiber packing density, with each module separated by a permeable, electrical-insulator material, the electrical interference between neighboring charged fibers was reduced, if not fully mitigated. Also, the additional scrim materials introduced macropores into the filter together with lower fiber packing density in each module both further reduced the airflow resistance. With this approach, the quality factor can maintain relatively constant with increasing fiber amounts to achieve high filter efficiency. The optimal amounts of fiber in each module depended on the diameter of fibers in the module. Small- fiber diameter that has already high performance required small amounts of fibers per module. Large diameter fiber required larger amounts of fibers per module to compensate for the poorer performance provided it did not incur significantly additional pressure drop. This approach was applied to develop four new nanofiber filters tailored for capturing 100-nm airborne COVID-19 to achieve over 90% efficiency with pressure drop not to exceed 30 Pa (3.1 mm water). One filter developed meeting the 90% efficiency has ultralow-pressure drop of only 18 Pa (1.9 mm water) while another filter meeting the 30 Pa limit has high efficiency reaching 94%. These optimized filters based on rigorous engineering approach provide the badly needed technology for protecting the general- public from the deadly airborne COVID-19 and other viruses, as well as nano-aerosols from air -pollution which lead to undesirable chronic diseases.

The size of the COVID-19 has been determined under Transmission- Electron Microscope (TEM) to be 60–140 nm, which averages to 100 nm . This is similar in size as the SARS corona-virus, which is also 100 nm. The common influenza virus is 80–120 nm, which averages out to 100 nm. As the virus can be attached to particulates less than 100 nm, the smallest- size for the COVID-19 and its carrier (droplet or particle) can still be about 100 nm" (3)

K. Sholanov:

ELECTROPHYSICAL PROPERTIES OF THE VIRUS RELATED TO ITS STRUCTURE

"For further analysis of virus electrical-properties, an import role belong to the research results of scientists believing that genome of COVID-19 germ is recombinant (hybrid) virus composed of the SARS-CoV-2 virus and the second one that has ho equivalents . In this case, before entering human -body COVID-19 germ can be considered as impurity biopolymer consisting of aliovalent molecules. This creates conditions for the emergence of electrical-conductivity properties in the polymer as a consequence of the emergence of free electrostatic- charges . One method of creating conductive polymers is formation of a molecular complex with charge- transfer between molecules forming impurity. Depending on the structure of the components, different arrangement of hybrid virus- molecules is possible. It can be assumed that donors and acceptors form separate RNA- chains. Donor- groups increase the cations number and acceptor groups increase the anions number. Thus, impurity bio-polymer acquires an electrostatic charge. The presence of virus electrostatic charge is confirmed by some observations. researchers from NIH, CDC, UCLA and Princeton- University found that the virus is stable during different periods in the aerosol and on the surfaces of different- materials. Although, the experiments in question were performed by the researchers for other purposes, results of these experiments can be considered in terms of contact -electrification of the virus by various bodies. It is known that during the contact- electrification, double electric layer is formed with different potential of surface charges. Charge transfer between contacting- bodies ends when the intensity value caused by the field becomes equal to the field value conditioned by the difference between the activities of the output of contacting materials charged particles. If the virus does not have an electric -charge, then it would be stable for a long time in all materials. Duration of charged particles exit from the hybrid -virus is determined by the difference in band structure of the contacting body.The presence of a charge in the COVID-19 virus germ assumes that there exists the next transfer mechanism: due to the emergence of the potential difference between human- body and the virus, the ionized virus is attracted to human -body surface and then enters human body. High contagiousness of COVID-19 can be explained by the presence of the transfer mechanism of the virus that uses air ions. Air ions are generated by air -ionization. At the same time, the negative air ions are mostly created by oxygen, and the positive ones are mostly created by carbonic acid- gases. Air ions interact and link up viral ions with opposite signs, and form agglomerate of COVID-19 viruses in the air, which predominantly via respiratory- system get into the lungs. This explains the reasons of extreme contagiousness of COVID-19 virus. A natural question arises on how air is ionized. Special devices are used to ionize air, although in this case for the ionization on a global scale it is possible to use long-wave ultraviolet- radiation (315-400 nm).For such UV- radiation formed, by an artificial satellite, the ozone -screen of the Earth is not an obstacle. Thus, virus and air ions agglomerate formed by UV radiation from the artificial satellite using, perhaps, laser equipment may cause large-scale coverage of COVID-19 population all over the planet. Experience has shown that the disease is not always transmitted from person to person, the disease often appears in a person spending time- outdoors, which is due to inhalation of virus agglomerate. At the same time, concentration of the agglomerate can be varied by varying the degree of air-ionization." (4)

Kumar Singh Saikatendu et al :

" among all corona-viruses are four structural proteins: the matrix (M), small envelope (E), and spike (S) proteins that are embedded in the viral membrane and the nucleocapsid –phospho protein (N), which exists in a ribonucleo protein complex in the lumen. The N-terminal domain of corona viral N proteins (N-NTD) provides a scaffold for RNA binding, while the C-terminal domain (N-CTD) mainly acts as oligomerization modules during assembly. The C terminus of the N protein anchors it to the viral- membrane by associating with M protein. We characterized the structures of N-NTD from severe acute respiratory syndrome corona-virus (SARS-CoV) in 2 crystal forms, at 1.17 Å (monoclinic) and at 1.85 Å (cubic), respectively, resolved by molecular replacement using the homologous avian infectious bronchitis virus (IBV) structure. Flexible loops in the solution structure of SARS-CoV N-NTD are now shown to be well ordered around the β-sheet core. The functionally important positively -charged β-hairpin protrudes out of the core, is oriented similarly to that in the IBV N-NTD, and is involved in crystal packing in the monoclinic- form. In the cubic form, the monomers form trimeric units that stack in a helical array. Comparison of crystal packing of SARS-CoV and IBV N-NTDs suggests a common mode of RNA recognition, but they probably associate differently in vivo during the formation of the ribonucleoprotein complex. Electrostatic potential distribution on the surface of homology models of related coronaviral N-NTDs suggests that they use different modes of both RNA recognition and oligomeric assembly, perhaps explaining why their nucleocapsids have different morphologies" (5)

Dewald Schoeman et al :

"The envelope protein **Structure**

The CoV E- protein is a short, integral membrane protein of 76–109 amino acids, ranging from 8.4 to 12 kDa in size . The primary and secondary- structure reveals that E has a short, hydrophilic amino terminus consisting of 7–12 amino acids, followed by a large hydrophobic transmembrane domain (TMD) of 25 amino acids, and ends with a long, hydrophilic carboxyl terminus, which comprises the majority of the protein . The hydrophobic region of the TMD contains at least one predicted amphipathic α-helix that oligomerizes to form an ion-conductive pore in membranes .

Comparative and phylogenetic analysis of SARS-CoV E revealed that a substantial portion of the TMD consists of the 2 nonpolar, neutral amino acids, valine and leucine, lending a strong -hydrophobicity to the E protein . The peptide exhibits an overall net charge of zero, the middle region being uncharged and flanked on one side by the negatively charged amino (N)-terminus, and, on the other side, the carboxy (C)-terminus of variable charge. The C-terminus also exhibits some hydrophobicity but less than the TMD due to the presence of a cluster of basic, positively- charged amino acids .

Functions of the envelope protein

Despite its enigmatic nature, research conducted to date has been able to propose three roles for the CoV E protein. The interaction between the cytoplasmic tails of the M and E proteins drives VLP production, suggesting that E participates in viral assembly . The hydrophobic TMD of E is also crucial to the release of virions . Lastly, SARS-CoV E is implicated in the pathogenesis of the virus . The progress made in these three aspects of E will be reviewed accordingly.

Although viroporins are not essential to viral replication, their absence does weaken or attenuate the virus and

diminishes its pathogenic -effects . They tend to be small -proteins (~ 60–120 amino acids) of a predominantly hydrophobic nature that oligomerise in the membranes of infected cells, forming hydrophilic pores. The hydrophobic residues line the outside of the structure, oriented toward the phospholipids, while the inside of the pore is made up of the hydrophilic- resides . Most viroporins share certain structural features such as an amphipathic α-helix in the hydrophobic domain (HD) along with a cluster of positively -charged, basic amino acids (such as lysine or arginine) which anchor the pore to the membrane through electrostatic interactions with the negatively- charged phospholipids . It should be cautioned that the charge on the lipid- head group of membranes used can modulate the ion-selectivity of the viroporin. Neutral lipids appear to negate the selectivity of the viroporin as the channels formed did not seem to differentiate cations from anions. negatively charged lipids were more cation-selective than neutral lipids, being more permeable to cations . This suggests that the lipid- head group of the membranes in use should be taken into consideration when interpreting the results as it might skew the results and inaccurate conclusions may be drawn. At times, the ion- channels were only marginally more selective of cations, bringing into question the ion-selectivity of the CoV E viroporin for one cation over another. In fact, an ion- channel is only considered ion-specific when its permeability is nearly exclusive to one ion while extremely low to others ." (6)

Woo, M. H. et al :

"Although respirators and filters are designed to prevent the spread of pathogenic aerosols, a stockpile shortage is anticipated during the next flu- pandemic. Contact transfer and reaerosolization of collected microbes from used respirators are also a concern. An option to address these potential problems is UV- irradiation, which inactivates microbes by dimerizing thymine/uracil in nucleic acids. The objective of this study was to determine the effects of transmission mode and environmental conditions on decontamination efficiency by UV. In this work, filters were contaminated by different transmission- pathways (droplet and aerosol) using three spraying media (deionized water [DI], beef extract [BE], and artificial saliva [AS]) under different humidity levels (30% [low relative -humidity {LRH}], 60% [MRH], and 90% [HRH]). UV- irradiation at constant intensity was applied for two time intervals at each relative humidity condition. The highest inactivation- efficiency (IE), around 5.8 logs, was seen for DI aerosols containing MS2 on filters at LRH after applying a UV intensity of 1.0 mW/cm^2 for 30 min. The IE of droplets containing MS2 was lower than that of aerosols containing MS2. Absorption of UV by high water content and shielding of viruses near the center of the aggregate are considered responsible for this trend. Across the different media, IEs in AS and in BE were much lower than in DI for both aerosol and droplet -transmission, indicating that solids present in AS and BE exhibited a protective-effect. For particles sprayed in a protective medium, RH is not a significant parameter

Transmission mode.

IE for aerosols was higher than for droplets. Water in the droplets absorbs UV , and shielding of viruses near the center of the aggregate likely also contributes to this trend. The size of droplets generated from the ultrasonic nebulizer was around 9 to 10 μm , whereas aerosols from the Collison- nebulizer measured 1 to 2 μm . The evaporation time for a 1-μm droplet at HRH is 0.0077 s at 20°C. As the residence time of aerosol in the mixing- chamber was 0.21 s, these particles reached equilibrium during transit. the

evaporation time of 9- to 10-µm droplets at HRH and 20°C, 0.63 to 0.7 s, is much longer than the residence time. Therefore, the larger-droplets retain much of their water at contact.” (7)

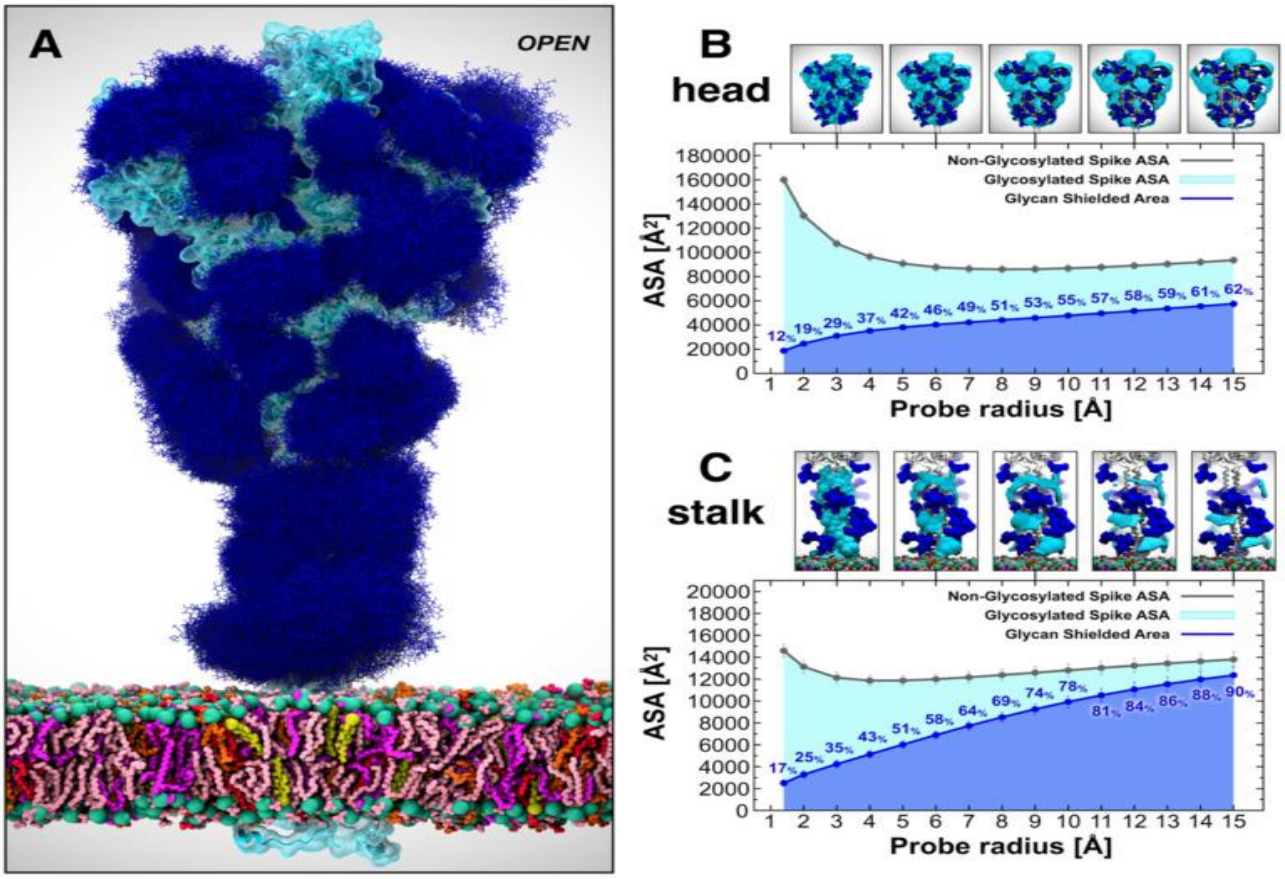

Fig . N5

Casalino L et al :

“Corona-viruses, including SARS-CoV-2, are lipid-enveloped positive-sense RNA viruses. Together with the host-derived membrane, a set of structural proteins provide an organizational scaffold that wraps and contains the positive-sense viral RNA. Among them, the most critical is the spike, or S, protein, which is conserved to varying degrees across the *Coronaviridae* family and plays a key role in the virus’ initial attachment and fusion with the host.” cell.

Glycan shield of the SARS-CoV-2 S protein.Glycan shield of the SARS-CoV-2 S protein.

a highly- dense coating of non-immunogenic or weakly immunogenic complex carbohydrates on otherwise dangerously exposed viral- proteins constitutes a perfect camouflage (or shield) to evade the immune system.To this end, the HIV-1 Env glycan shield, which is largely structured by oligomannose (Man5–9) N-glycans, has been shown to be quite effective in allowing the virus to thwart the immune- system. (8)

BROWNIAN MOTO

Brownian motion, is the random motion of particles suspended in a liquid or in a gas.

It is random fluctuations in a particle's position inside a fluid sub-domain, followed by a relocation to another sub-domain position. Each relocation is followed by more fluctuations inside the new closed volume. (fluidin a thermal equilibrium, at determinate temperature). there exists no preferential direction of flow . the fluid's

overall linear and angular momenta remain null over the time. The kinetic energies of this molecular Brownian motions, together with molecular rotations and vibrations energy , sum up to the caloric component of a fluid's internal energy .

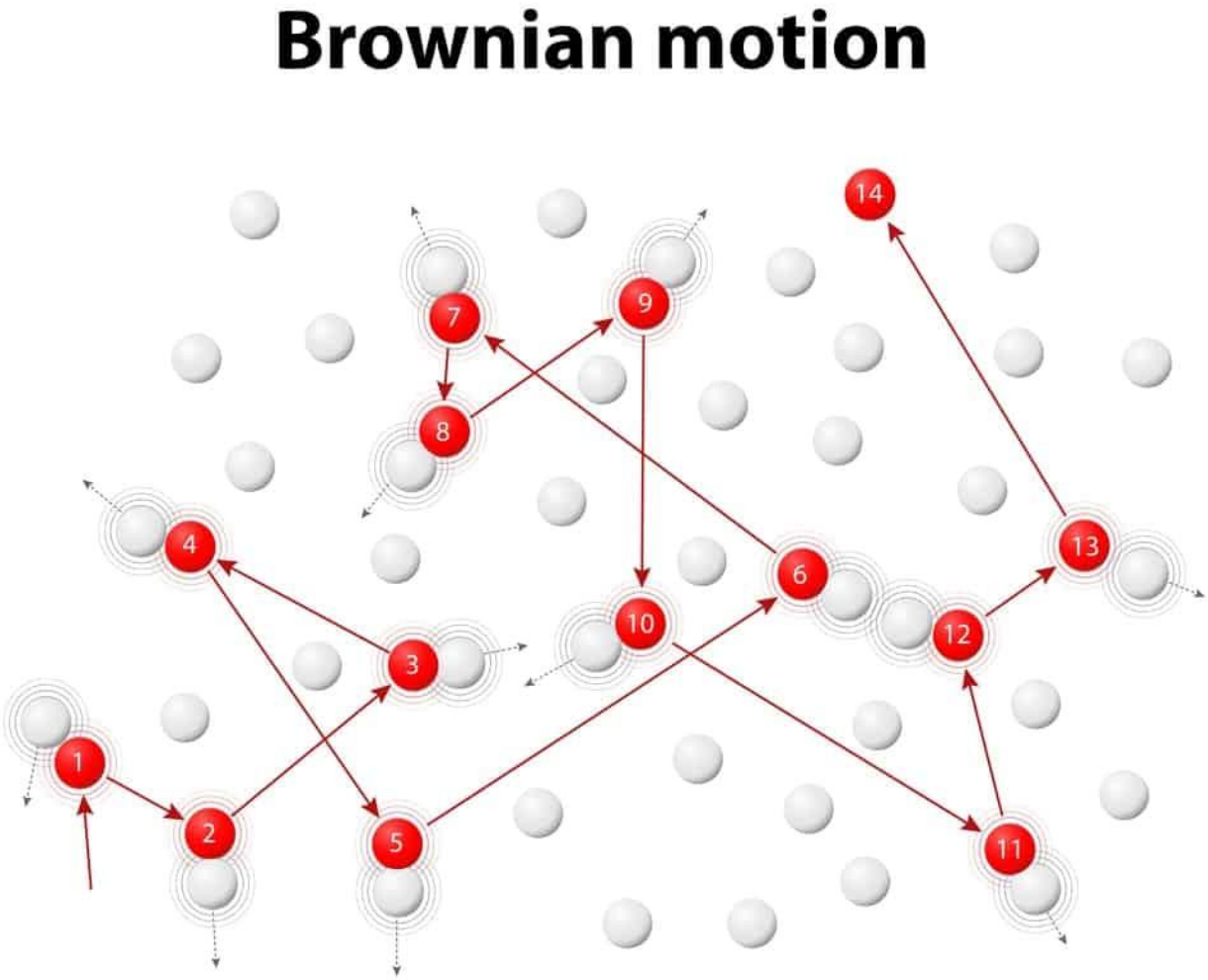

Fig. n 6 Brownian moto

In different way it is interesting verify if virus as other nanoparticle repulse themselves due their electrical feature in surface.

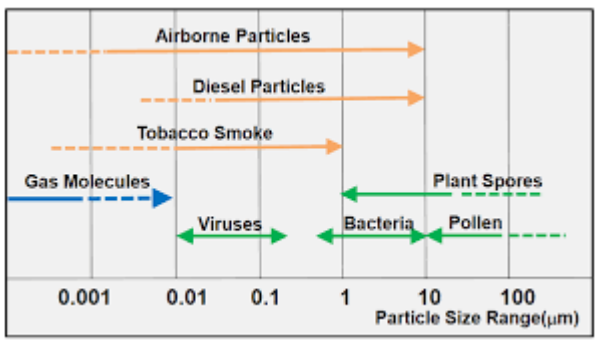

Fig n 7From M. Gameiro da Silva

And from website : https://indico.cern.ch/event/925746/contributions/3890322/attachments/2050532/3436917/Effects_of_COVID-19_on_Indoor_Air_Quality_Andre_Henriques.pdf

""The larger the aerosol, the larger is its weight, the sooner it will fall (large -droplets from sneezes) The larger the aerosol, the larger is the drag force and consequently the lower the velocity of the aerosol will be The slower it gets, the smaller is the lift force, the sooner it starts to perform a downward -motion. In case of a forced -ventilation, velocity may remain constant after initial projection The higher the velocity, the longer a particle maintains airborne higher velocity, higher possibility of a larger droplet to became airborne (due to lift force)." (9)

Charles P Gerba et al :

"Aggregates of viruses can have a significant impact on quantification and behavior of viruses in the environment. Viral -aggregates may be formed in numerous ways. Viruses may form crystal like structures and aggregates in the host cell during replication or may form due to changes in environmental conditions after virus- particles are released from the host cells. Aggregates tend to form near the isoelectric point of the virus, under the influence of certain salts and salt concentrations in solution, cationic-polymers, and suspended organic matter. The given conditions under which aggregates form in the environment are highly dependent on the type of virus, type of salts in solution (cation, anion. monovalent, divalent) and pH. virus type greatly influences the conditions when aggregation/disaggregation will occur, making predictions difficult under any given set of water- quality conditions. Most studies have shown that viral -aggregates increase the survival of viruses in the environment and resistance to disinfectants, especially with more reactive- disinfectants. The presence of viral- aggregates may also result in overestimation of removal by filtration processes. Virus aggregation-disaggregation is a complex process and predicting the behavior of any individual virus is difficult under a given set of environmental circumstances without actual experimental- data." (10)

Wei Li

"Since the Coronavirus disease (COVID-19) outbreak at the end of 2019, the past two month has seen an acceleration both in and outside China in the R&D of the diagnostics, vaccines and therapeutics for this novel coronavirus. As one of the molecular forces that determine protein structure, electrostatic effects dominate many aspects of protein behaviour and biological function. Thus, incorporating currently available experimental structures related to COVID-19, this article reports a simple python-based analysis tool and a LATEX-based editing tool to extract and summarize the electrostatic features from experimentally determined structures, to strengthen our understanding of COVID-19's structure and function and to facilitate machine-learning and structure-based computational design of its neutralizing antibodies and/or small molecule(s) as potential therapeutic candidates. this article puts forward a brief

update of the structurally observed electrostatic features of the COVID-19 coronavirus.

Work this article reports a comprehensive set of electrostatic features sucked out of the currently (as of March 4, 2020) available COVID-19 coronavirus-related structures inside PDB in both PDF format) and also LATEX formate.

the structurally observed electrostatic-features of the four COVID-19 coronavirus-related experimental structures constitute a preliminary starting point pointing towards a clear, coherent and comprehensive map of COVID-19's structure and function and also machine-learning and structure-based computational- design of neutralizing antibodies and/or small molecule(s) as potential- therapeutic candidates against future outbreaks of the COVID-19 coronavirus diseases

" (11)

Jan-Michael Prill et al :

"Capsid surface shielding of adenovirus vectors with synthetic polymers is an emerging technology to reduce unwanted interactions of the vector- particles with cellular and non-cellular host components. While it has been shown that attachment of shielding polymers allows prevention of undesired interactions, it has become evident that a shield which is covalently attached to the vector- surface can negatively affect gene transfer efficiency. Reasons are not only a limited receptor-binding ability of the shielded -vectors but also a disturbance of intracellular trafficking processes, the latter depending on the interaction of the vector surface with the cellular transport -machinery. A solution might be the development of bio-responsive shields that are stably maintained outside the host -cell but released upon cell entry to allow for efficient gene delivery to the nucleus. Here we provide a systematic comparison of irreversible versus bio-responsive shields based on synthetic *N*-(2-hydroxypropyl) methacrylamide (HPMA) copolymers. the chemical strategy used for generation of the shield allowed for a traceless bio-responsive shielding, , polymers could be released from the vector- particles without leaving residual linker residues. Our data demonstrated that only a bio-responsive shield maintained the high gene transfer efficiency of adenovirus vectors both in vitro and in vivo. As an example for bio-responsive HPMA- copolymer release, we analyzed the in vivo gene transfer in the liver. We demonstrated that both the copolymer's charge and the mode of shielding (irreversible versus traceless bio-responsive) profoundly affected liver gene transfer and that traceless bio-responsive shielding with positively-charged HPMA copolymers mediated FX independent transduction of hepatocytes. In addition, we demonstrated that shielding with HPMA- copolymers can mediate a prolonged blood circulation of vector particles in mice. Our results have significant implications for the future design of polymer-shielded Ad and provide a deeper insight into the interaction of shielded adenovirus vector-particles with the host after systemic delivery." (12)

In website : https://weinproducts.com/news/entry/covidex-air-purifier-virus-removal-efficiency

"to achieve high- particle capture efficiency while maintaining relatively low -breathing resistance, the N95 respirator filters are typically manufactured with charged (pre-treated) fibers. These are further referred to in this paper as electret filters. The

certification tests for N-series filters are carried out until minimum efficiency is achieved or until an aerosol mass of >200 mg has contacted the filter, since, in contrast to mechanical- filters, the particle capture efficiency of electret filters decreases initially with the filter loading . This effect depends on the properties of aerosol particles, and, according to Baumgartner and Lo¨ffler (1987), can be attributed to the neutralization of fiber-charges by the charges of opposite polarity that are carried by aerosol- particles collected on the fiber. Walsh and Stenhouse (1996) suggested an alternative explanation related to the reduction of electrostatic effect as the layer of particles covering the fiber increases, which, in turn, causes shielding of the electric- field. Barrett and Rousseau (1998) attributed the decrease of the electret filter efficiency with loading to the chemical- interaction between fibers and aerosol. Once the loading has achieved a certain level, an electret filter begins acting as a mechanical filter and its efficiency increases. The pressure drop across the filter increases during loading. " (13)

D.C. Walsh et al :

Electrically active fibrous filters, that is fibrous filters whose fibers carry a permanent electric charge, are a popular alternative to conventional- fibrous filters in applications where low- pressure drop and high collection efficiencies are critical. The advantage of these materials is the additional collection efficiency, due to electrostatic mechanisms, that can be achieved without pressure drop increase. Although the efficiency of these materials is always superior to that of a conventional material of similar -structure, the efficiency of these materials can fall as they are loaded with particles, so it is necessary that a proper account be taken of this process during use. Significant advances have been made in understanding the mechanisms responsible for this reduction in efficiency in a recent experimental -study of the loading behavior of a mixed fiber type electrically active material. This study has identified a number of parameters that cause the filtration -efficiency to be reduced, and in so doing also has allowed an empirical equation to estimate the maximum penetration through the material over the course of its life to be elucidated. a series of experiments designed to investigate the effects of particle- size and particle charge on filter -degradation has been performed that prove conclusively that the reduction in filtration efficiency of this material during loading is not a charge neutralization process. (14)

Casalino L et al :

"The ongoing COVID-19 pandemic caused by severe acute- respiratory syndrome coronavirus 2 (SARS-CoV-2) has resulted in more than 7,000,000 infections and 400,000 deaths world-wide to date. Antibody development efforts mainly revolve around the extensively glycosylated- SARSCoV-2 spike (S) protein, which mediates the host cell entry by binding to the angiotensin-converting enzyme 2 (ACE2). In the context of vaccine design, similar to many other viruses, the SARS-CoV-2 spike utilizes a glycan -shield to thwart the host immune response. we built a full-length model of glycosylated SARS-CoV-2 S protein, both in the open and closed states, augmenting the available structural and biological data. Multiple microsecond-long, all-atom molecular dynamics simulations were used to provide an atomistic perspective on the glycan shield and the protein structure, stability, and dynamics. End-to-end accessibility analyses outline a complete

overview of the vulnerabilities of the glycan-shield of SARS-CoV-2 S protein, which can be harnessed for vaccine development. In addition, a dynamic analysis of the main antibody epitopes is provided. beyond shielding, a possible structural role of N-glycans at N165 and N234 is hypothesized to modulate and stabilize the conformational-dynamics of the spike's receptor binding domain, which is responsible for ACE2 recognition. This research work presents hitherto unseen functional and structural insights into the SARS-CoV-2 S protein and its glycan coat, which may be exploited by therapeutic efforts targeting this essential molecular machine." (15)

Zhili Zuo et al :

"Survivability of the three animal viruses at large particle -size (300–450 nm) was significantly higher than at particle- size close to the size of the virion (100–200 nm), which could be due to the shielding effect. The data suggest that particle size plays an important role in infectivity and survivability of airborne- viruses and may, therefore, have an impact on the airborne -transmission of viral illness and disease. The data in this study do not support the use of MS2 bacteriophage as a general surrogate for animal and human viruses.

Survivability of Airborne Virus Similar to RRIV, survivability of TGEV and AIV was much lower at 200 nm than at larger size . One could argue that the discretization phenomenon is responsible for this finding, , as the carrier particle- size gets smaller and approaches the size of virion, it becomes more difficult for the particle to carry virus. the particle size-independent RRTV shown in Figure reported suggests the presence of virus in particles even at 100 nm. the discretization phenomenon was probably not the reason. The main reason for the particle- size associated survivability could be the shielding effect. " 16)

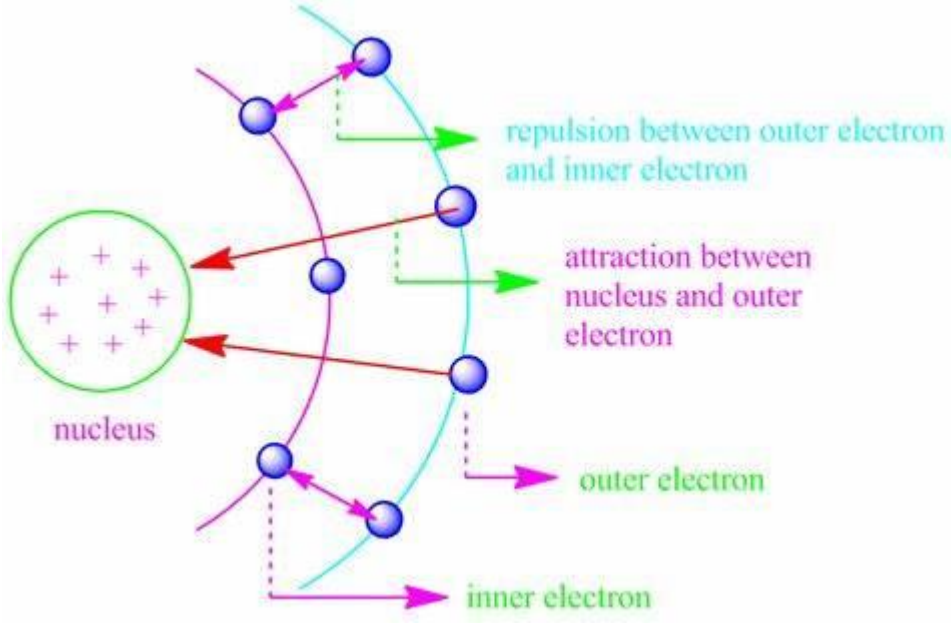

Fig. n8 shielding effect

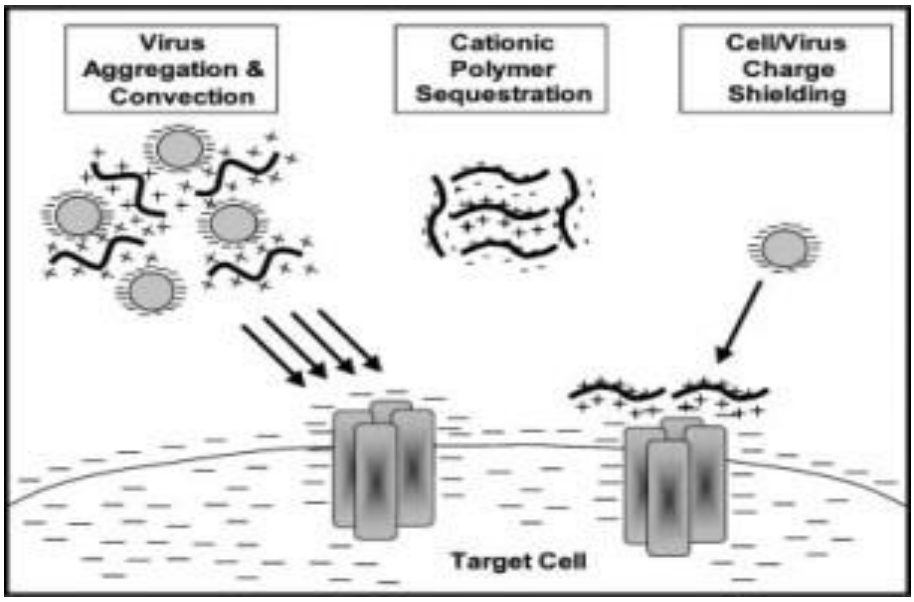

Fig.9 shielding

Howard E. Davis et al :

"In light of the findings described here, we propose a revised physical -model of virus transport. In this model, electrostatic interactions between the virus, target cell, and charged polymers determine the nature and magnitude of the driving force for virus adsorption. For low molecular weight cationic polymers, charge shielding is their mechanism of enhancement, and once sufficient virus and cell charge neutralization has been achieved, adsorption can occur readily. Large molecular weight- polymers can effect the electrostatics of the virus-cell interaction similarly; they have the added ability to aggregate virus sufficiently to enhance adsorption via sedimentation. Anionic- polymers, on the other hand, inhibit the processes of adsorption and transduction via sequestration of cationic polymers, preventing charge shielding and virus aggregation." (17)

L.de Gabory et al :

The influenza virus and SARS-CoV-2 cause trivial upper and severe lower respiratory infections (Influenza virus 290,000 to 640,000 deaths/year). These viruses come into contact with the airways either by direct- projection, by secondary inhalation of airborne droplets, or by handling (fomites). The objective of this article is to clarify the mechanisms of production and penetration of droplets of secretions emitted during all expiratory phenomena likely to transport these viruses and come into contact with the respiratory- mucosa. The droplets > 5 µm follow the laws of ballistics, those < 5 µm follow Brownian motion and remain suspended in the air. The aerosols of droplets are very heterogeneous whether the subject is healthy or sick. During an infectious period, not all droplets contain viral RNA. If these RNAs are detectable around patients, on surfaces, and in the ambient air at variable distances according to the studies (from 0.5 m to beyond the patient's room), this is without prejudice to the infectious nature (viability) of the virus and the minimum infectious dose. There is a time lag between the patient's infectious period and that of RNA detection for both viruses. Subsequently, the inhaled particles must meet the laws of fluid dynamics (filtration) to settle in the respiratory tree. All of this partly

explains the contagiousness and the clinical expression of these 2 viruses from the olfactory cleft to the alveoli. (19)

Wan Yang et al :

The relative importance of the aerosol -transmission route for influenza remains contentious. To determine the potential for influenza to spread via the aerosol route, we measured the size distribution of airborne influenza A viruses. We collected size-segregated aerosol samples during the 2009–2010 flu season in a health centre, a day-care facility and onboard aeroplanes. Filter extracts were analysed using quantitative reverse transcriptase- polymerase chain reaction. Half of the 16 samples were positive, and their total virus concentrations ranged from 5800 to 37 000 genome copies m^{-3}. On average, 64 % of the viral- genome copies were associated with fine particles smaller than 2.5 µm, which can remain suspended for hours. Modelling of virus concentrations indoors suggested a source strength of 1.6 ± 1.2 × 10^5 genome copies m^{-3} air h^{-1} and a deposition flux onto surfaces of 13 ± 7 genome copies m^{-2} h^{-1} by Brownian motion. Over 1 hour, the inhalation dose was estimated to be 30 ± 18 median tissue culture infectious dose ($TCID_{50}$), adequate to induce infection. These results provide quantitative support for the idea that the aerosol route could be an important mode of influenza transmission. (21)

Clive B Beggs

"Objectives While COVID-19 is known to be spread by respiratory -droplets (which travel <2m horizontally), much less is known about its transmission via aerosols, which can become airborne and widely distributed throughout room spaces. In order to quantify the risk posed by COVID-19 infectors exhaling respiratory aerosols in enclosed spaces, we undertook a computer modelling study to simulate transmission in an office building. Methods Respiratory droplet data from four published datasets were analysed to quantify the number and volume of droplets <100µm diameter produced by a typical cough and speaking -event (counting from 1 to 100). This was used in a stochastic -model to simulate (10000 simulations) the number of respiratory particles, originating from a COVID-19 infector, that would be inhaled in one hour by a susceptible individual practicing socially -distancing in a 4 x 4 x 2.5m office -space. Several scenarios were simulated that mimicked the presence of both symptomatic and asymptomatic COVID-19 infectors. Results On average, each cough and speaking event produced similar numbers of droplets <100µm diameter (median range = 971.9-1013.4). Computer simulations (ventilation rate=2AC/h) revealed that sharing the office- space with a symptomatic COVID-19 infector (4 coughs and 10 speaking events per hour) for one hour resulted in the inhalation of 16.9 (25-75th range = 8.1-33.9) aerosolised respiratory -droplets, equating to about 280-1190 particles inhaled over a 35-hour working week. Sharing with an asymptomatic-infector (10 speaking events per hour) resulted in the about 196-875 particles inhaled over 35 hours. Conclusions Given that live SARS-CoV-2 virions are known to be shed in high- concentrations from the nasal cavity of both symptomatic and asymptomatic COVID-19 patients, the results suggest that those sharing enclosed- spaces with infectors for long periods may be at risk of contracting COVID-19 by the aerosol route, even when practicing social -distancing." (22)

Charles D Murin et al :

Enveloped viruses are found across diverse viral families and cause some of the deadliest diseases known to man. Despite a spectrum of differences in their biology and

pathogenesis, all enveloped -viruses share two commonalities: a lipid bilayer envelope co-opted from host cells upon viral egress and the presence of surface-exposed viral glycoproteins for host cell recognition and entry. These viral- glycoproteins or 'spike' proteins are exposed to the adaptive immune response and are the main targets of host antibodies, often being the only exposed antigen. Naturally, viruses have developed mechanisms to avoid such responses through rapid evolution of antibody-targeting epitopes, steric shielding of epitopes by glycan post-translational modifications, immune- decoys such as soluble antigens that share viral spike epitopes, and immuno suppression to evade host- recognition upon cellular entry. In response to the viral arms race, antibodies have in turn developed many creative solutions to overcome viral -evasion, including unique structural adaptations that allow antibodies to more readily penetrate the viral armor and exploit sites of vulnerability.

The nature of the enveloped viral surface has major consequences for viral entry and, consequently, how the adaptive immune system responds. For enveloped viruses, entry hinges on the mechanics of the viral-glycoprotein. (23)

Silvia Comunian et al :

Numerous epidemiological studies have shown the effects of air pollution on respiratory and cardiovascular systems. Short-term exposure to air pollution at higher levels reduces life expectancy by aggravating pre-existing respiratory and cardiovascular diseases . Cardiovascular- effects induced by PM are linked to particles' deposition in the lungs, to their translocation through the air-blood barrier to extra-pulmonary sites, and to the resulting systemic inflammation . Particles' deposition- rates are strictly linked to the particle size smaller particles have the highest deposition efficiency. Numerous studies also highlight correlations between the effect of PM and male- infertility as well as neurodegenerative diseases .

In Lombardy (North of Italy), diesel combustion and solid -biomass burning are responsible for 15% and 50% of the primary fine particles production, respectively . Diesel exhaust is a complex mixture of solid, condensed (or liquid), and gaseous corpuscular- fractions . The solid fraction is represented by diesel exhaust particles (DEPs), with a bio-persistent core of about 10–30 nm in diameter . These primary particles, composed of elemental- carbon, can then agglomerate into larger soot aggregates with mean diameters of 60–100 nm . The DEP- surface can adsorb more than 300 chemical compounds, which include PAHs, aliphatic hydrocarbons, quinones, transition metals, and others. biomass -burning (BB)-derived particles are obtained as a result of inefficient combustion that generates a multitude of partially oxidized organic chemicals, many of which have been associated with adverse- health impacts . DEP has been shown to be even more toxic than BB

These particles are included in PM2.5 fraction, are less than 0.1 micrometers in size, and thus can be classified as ultrafine-particles (UFPs). UFPs can show worse and different toxicity profiles in comparison with those of larger particles with the same composition, as their specific interaction with lung- cells and their capability to translocate across the alveolar epithelial barrier . Nonetheless, it cannot be excluded that systemic toxicity may be mediated also by PM or UFPs associated water-soluble components and/or biochemical mediators released in the lung and then translocated in blood circulation. (24)

EXPERIMENTAL PROJECT HYPOTESYS :

In order to verify the contribution of virus size in aereolised medium can be used two different viral source: one whit lower size comparable to coronavirus and the other a respiratory virus with double size.

This two source must to be introduced in two closed tanks (in channel) whit inside different Condition of air flux (brownian moto) to verify the contribution of viral size in the spread Of this particelles (using also 2 different carrier like PM 2,5 and PM 10).

The sample mut be collected using air flux exit form this tanks (exit channel). In order to determinate viral charge PCR assay must to be used . If it is revealed a difference in viral charge in the sample of smaller virus vs larger This proof the size relationship.

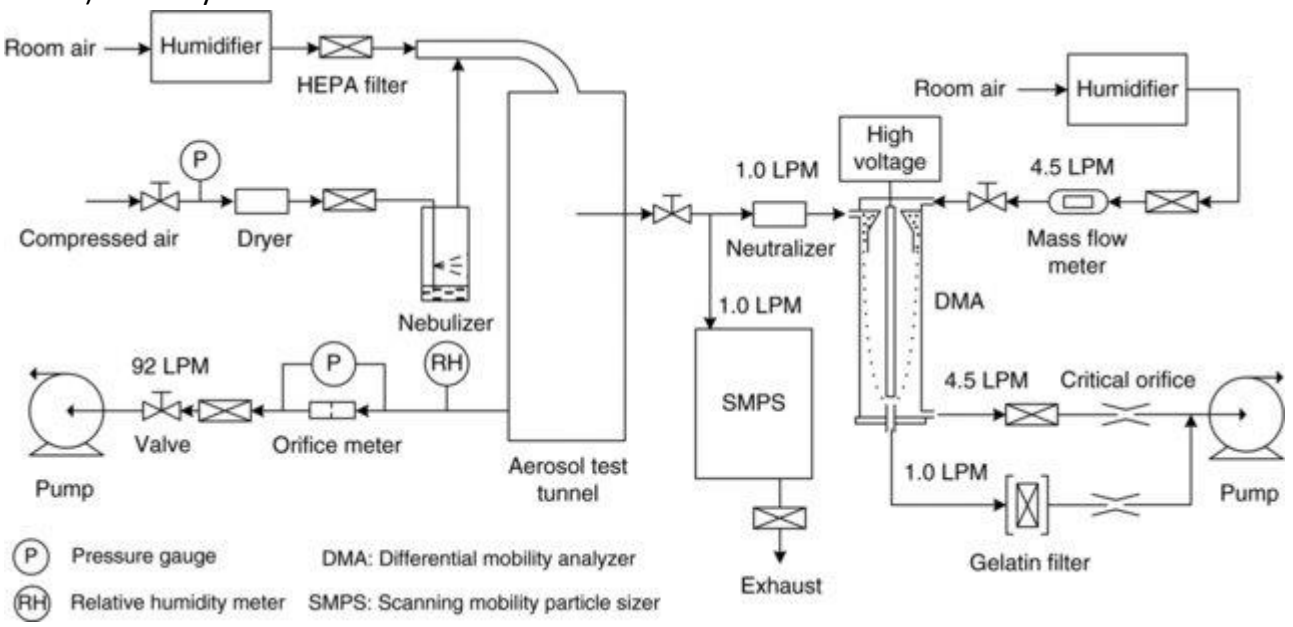

Fig. 10 Schematic diagram of the experimental setup for the characterization of virus aerosols. From Zhili Zuo et al 2012 **Association of Airborne Virus Infectivity and Survivability with its Carrier Particle Size**

DISCUSSION

X – RAY diffractions have showed that coronaviruses present a determinate

pattern :

If a virus have electrical feature it is more affected by Brownian moto , and this properties is also greater if viral size is lower the other. The evolution of enveloped virus due by necessity to avoid immune host system produced molecular composition with specific chemical-physic behavior. This evolution was linked also to the modality of diffusion : especially for airborne transmission. In aereosols virus properties make possible a prolonged presence. Relevant for this process are properties of the carrier like PM , water particles, droplets, droplets nuclei But also virus specific properties like molecular envelope composition, lipophilic hydrophilic balances , electrical feature linked to external conditions like air flux, humidity , temperature , light condition , hydratation condition , air pressure, browninam moto and shielding effect.

CONCLUSION

Because coronavirus follow determinate pattern of transmission it is crucial to observe the chemical-physical properties of the virus as the electrical feature, molecular composition of the envelope , viral size And physical effect that can increase airborne characteristic in aereosols. The same the kind of chemical phisical link of viruses with carrier is relevant for its diffusion. All this properties must be taken in consideration in the same evaluation process.

Even if virus transmission depend on determinate viral charge and other relevant factors a better understanding of this related phenomena is crucial. (It must be remembered also that the smaller particles like aereosols penetrate better lower pulmonary tract then the more larger one). Common properties among some respiratory virus can help in clarifying airborne transmission: If already clearly for some common virus for other it must be finally determinate. This conclusion present great health implication in public policy.

CLARIFICATIONS

This work is produced without any diagnostic or therapeutic intent only to produce research hypothesis to be submitted to the researcher

CONFLICT OF INTERESTS : NO One

ETHICAL CONSIDERATION this work is produced under international ethical principle.

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Electrostatic charged nanofiber filter for filtering airborne novel coronavirus (COVID-19) and nano-aerosols

Wallace Woon Fong Leung□ and Qiangqiang Sun

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ELECTROPHYSICAL PROCESSES EFFECTING THE COVID-19 VIRUS BEFORE IT ENTERS ORGANISM

K. SholanovDepartment of Automation Technology, Karaganda State Technical University, Republic of Kazakhstan

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19)Transmission of COVID-19 virus by droplets and aerosols: A critical review on the unresolved dichotomy

Mahesh Jayaweera,[a,*] Hasini Perera,[b] Buddhika Gunawardana,[a] and Jagath Manatunge[a]

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The influenza virus, SARS-CoV-2, and the airways: Clarification for the otorhinolaryngologist

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Concentrations and size distributions of airborne influenza A viruses measured indoors at a health centre, a day-care centre and on aeroplanes

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Antibody responses to viral infections: a structural perspective across three different enveloped viruses

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Air Pollution and COVID-19: The Role of Particulate Matter in the Spread and Increase of COVID-19's Morbidity and Mortality

Silvia Comunian,[1] Dario Dongo,[2] Chiara Milani,[3,4,*] and Paola Palestini[3,4,5]

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Particle size and pathogenicity in the respiratory tract

Richard James Thomas*