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Biophysical Methods for Locating the Resonance Frequency of the Virus. Key Factor in the Fight Against Covid-19

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Abstract

When everyone was over this pandemic a month ago, the world is faced with new outbreaks that are once again causing concern for the evolution of the disease. Scientists are working hard to find new methods to combat Covid-19. The biophysical methods based on the search for the resonance frequency of the virus, are presented as an interesting alternative to more traditional methods such as early detection tests of the disease. This study shows the progress and importance of other alternatives such as biophysical methods to combat this type of virus in the future.

Keywords: resonance frequency, virus, covid-19, resonance, biotic structures, biophysical methods

1. Introduction

The latest data on infected people is again alarming. Just when it was thought that this pandemic had been brought under control, the new numbers of people infected worldwide by Covid-19 call into question the systems and measures taken by health and political authorities in all countries.
The new coronavirus SARS-CoV-2, which causes the disease COVID-19, continues to spread around the planet and has already infected more than 23.8 million people, while the global number of deaths is above 818,000 and those

recovered exceeds 15.2 million people, representing 4.44% and 63.86% respectively (4,13).

The numbers of those infected and killed in the most affected countries are as follows: the most affected country is the United States, with more than 5.7 million infections and more than 178,000 deaths, followed by Brazil, with more than 3.6 million cases and a cumulative total of more than 115,000 deaths, and India, with 3.1 million infections and more than 58,000 deaths. Below them are Russia, which has more than 963,000 infections and more than 16,000 deaths; South Africa, with more than 613,000 cases; Peru, which has more than 600,000; Mexico, which has more than 563,000 cases; Colombia, which has more than 551,000; Spain, which is the ninth country with more than 412,000 infections, and Chile, with more than 400,000 cases (30).

The various environmental sounds are mechanical vibrations, since they are periodic variations of air pressure or of the things around us that produce the sounds. It could be said that in our natural environment objects and living beings are recognized by their characteristic sounds that have been heard all life and from which we have learned. The song of a bird can be recognized instantly, and one has to be a little more observant or expert to distinguish between a blackbird, a dove, a duck or another type of bird. The same would happen with the noise of a large engine, you could easily distinguish if it is a low range or high range car only by the roar of the engine of the vehicle, and it is left to the most experts, to distinguish by the roar of the engine if it is a Porsche 911, a Ferrari F8 Spider, a Lamborghini Aventador or another type of model. The vibrations coming from the car's engine subject the parts of the car and its occupants to continuous mechanical oscillations. Each being, organism or structure generates a vibratory movement proper to the body, which is transmitted in the form of sound waves through the air, such that they define and characterize it as their own. This vibration is given by the oscillation of the body in a number of repetitive events or occurrences called frequencies. Each body has its own or natural frequencies. The pattern of movement of a structure that oscillates in its natural frequency is called normal mode (28, 29).

When we subject an element to a periodically applied force that presents a frequency equal to or multiple of its natural frequency, something curious and well known occurs: the object begins to vibrate at this natural frequency so that, with this sustained force, the element will vibrate with greater and greater amplitude, and may even collapse. This is what is known in Physics as Resonance and in this case it is referred to as Resonance frequencies.

Although this phenomenon was first observed in the field of acoustics, it occurs with all types of waves, which is why we speak of acoustic resonance; mechanical; electromagnetic; etc. An example of resonance occurs when we make a tuning fork (which is a U-shaped metallic bar, which produces a certain tone) tremble, next to a second tuning fork at rest, but with the characteristic that it has the capacity to oscillate at the same frequency as the first one. In this case, we will see that the second tuning fork will begin to vibrate as if by magic. But the resonance phenomenon stopped being anecdotal to become popular after the collapse and collapse, by the action of the wind, of the Tacoma Narrows Bridge in the state of Washington, USA in 1940.

Since then, engineers have taken into account the resonance in civil constructions, rocket launches, etc. To determine the resonance frequency, one must start by finding the natural frequency of the system (w0) which is the one adopted as soon as the system is allowed to oscillate freely, and this depends on two magnitudes: the stiffness constant (k) of the body and the mass (m) of the same, such that:

$$W_0 = \sqrt{\frac{K}{m}} \qquad (1)$$

In a structure or system, each of its parts may present a natural frequency separately, but as a whole they move sinusoidally at the same frequency and in phase. It is a movement called "normal mode" that obviously has a specific characteristic frequency. The calculation of its possible configurations is necessary to reproduce the "resonance phenomenon" (2).

2. Methods and Materials

Viruses are very simple organisms, without their own metabolism, that is, without the capacity to carry out the processes that allow them to grow, reproduce and maintain their structure. Therefore, by definition, they are parasites and depend on a host, that is, an organism with metabolic capacity in which the virus can "sabotage" its internal machinery to develop itself at the expense of the host. Viruses are at the limit of the biotic. They are made up of genetic material, which carries the hereditary information and can be DNA or RNA; a protein cover that protects these genes, which is defined as a capsid by itself, and in some cases, also present a lipid bilayer (ie fat) that surrounds them. The SARS-Cov-2 virus has a lipid bilayer and therefore soaps affect it structurally (12, 15, 16, 18).

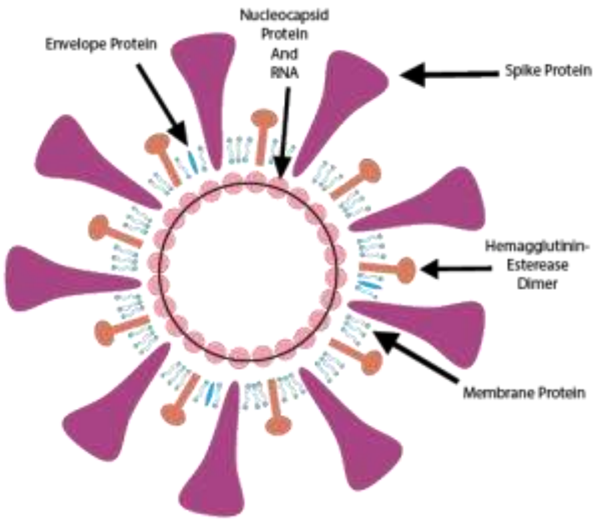

Figure 1.Structure of the SAR-CoV-2 virus
http://covid-19-justsavelives.org/2020/03/25/quieres-saber-mas-sobre-el-covid19/

Viruses tend to vary in shape, some are crystalline and are almost perfect polyhedrons (HIV, for example, is an icosahedron), others have more complex structures. And this fact is very relevant in the effective application of resonance frequencies. Viruses infect host cells by means of specific proteins on their surfaces, which allow them to interact with proteins on the cell surface as a "keychain" model allowing access to the inside of the cell. In the case of SARS-Cov-2 it can infect a wide spectrum of cell types within a human body by interacting with the ACE2 surface proteins present in a large number of cells in different tissues (1, 3, 5, 21, 22).

In the next figure, we can to see the life cycle of SARS-CoV-2 in the host cells. The S glycoproteins of the virion bind to the cellular receptor angiotensin-converting enzyme 2 (ACE2) and enters target cells through an endosomal pathway. Following the entry of the virus into the host cell, the viral RNA is unveiled in the cytoplasm (40,44). ORF1a and ORF1ab are translated to produce pp1a and pp1ab polyproteins, which are cleaved by the proteases of the RTC. During replication, RTC drives the production full length (−) RNA copies of the genome and used as templates for full-length (+) RNA genomes. During transcription, a nested set of sub-genomic RNAs (sgRNAs), is produced in a manner of discontinuous transcription (fragmented transcription). Even though these sgRNAs may have several open reading frames (ORFs), only the closest ORF (to the 5′ end) will be translated. Following the production of SARS-CoV-2 structural proteins, nucleocapsids are assembled in the cytoplasm and followed by budding into the lumen of the endoplasmic reticulum (ER)-Golgi intermediate compartment. Virions are then released from the infected cell through exocytosis (24, 27, 33, 35).

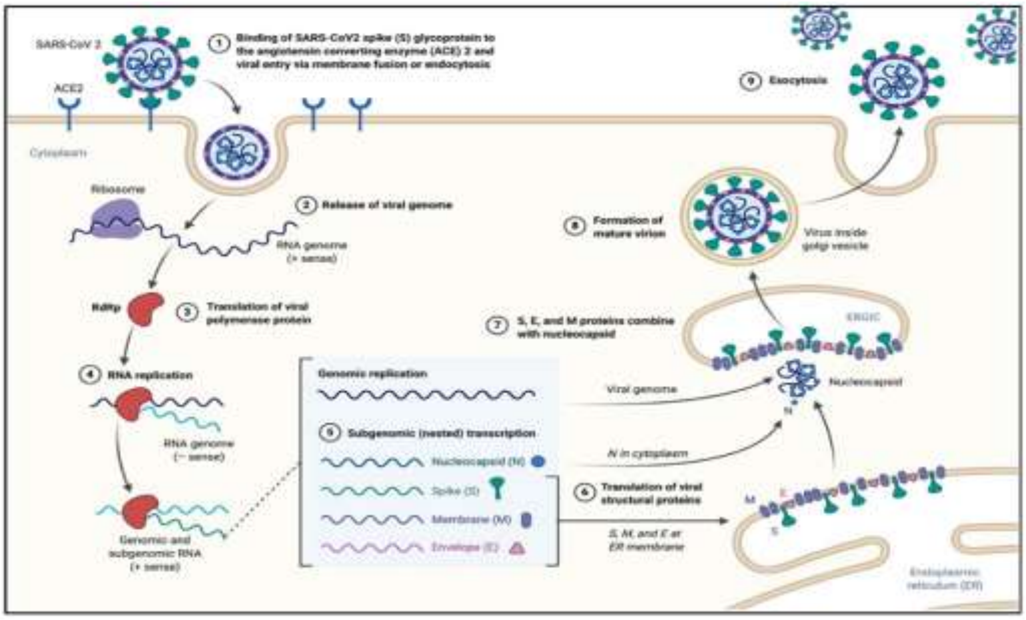

Figure 2. The life cycle of SARS-CoV-2 in the host cells
(figure created with biorender.com)

At this level many drugs act as "false locks" that block the key or membrane protein of the virus, preventing them from binding to the host cell. The drugs currently available for the treatment of viral infections have the following limitations: the drug's dependence on the patient's metabolism and immune system status; the ineffectiveness of the drug on mutated strains of the virus for which it was designed; and the imperfect selectivity of the drug, which can cause unwanted side effects in the patient. There is a clear need for a novel approach that overcomes the limitations of drug-based antiviral treatments (31).

Currently, drug-based antiviral treatments have as their priority objectives to mitigate the symptoms due to viral infection and reduce the rate of transmission of the virus. These objectives are achieved, in general terms, by stopping the viral cycle in some of its stages (reception, fusion, release, replication of viral genetic material, synthesis of viral proteins, assembly or budding), but not by mechanical destruction or inactivation of the viral pathogen (3).

These drug-based antiviral treatments present three main problems: a) dependence of the effectiveness of the drug to the state of the patient's immune system (3), b) usually the drug is effective only against specific strains of the virus for which it was designed, in other words, the drug is unable to respond to specific mutations that lead to the formation of new viral strains (3); c) many antiviral drugs have significant side effects, an example of this phenomenon is the mitochondrial toxicity generated by antiretroviral drugs, such as nucleoside analogues used in treatments against human immunodeficiency virus (HIV) (11).

Recently, it has explored a novel method of viral inactivation based on the physical phenomenon of forced oscillations. This procedure overcomes the limitations of conventional antiviral treatments, since viral pathogens can be destroyed mechanically in a selective way, that is, without damaging mammalian cells, regardless of the specific mutations that occur between strains (27) and completely independent of the state of immunosuppression of an infected patient.

Currently, one of the most accepted hypotheses about the pathway by which these posible antiviral treatments (even in theoretical and experimental phases) achieve the inactivation of the pathogen, dictating that by irradiating the virus with waves with frequencies corresponding to the lowest natural frequencies of its capsid (protein body containing the material genetically infectious), there is a resonance phenomenon in which its atoms move with such amplitudes that there is the rupture of a large number of intermolecular links, which leads to the disassembly of the pathological agent, inactivating it and making the execution of the viral cycle impossible (10).

The race for the knowledge and use of resonance in the field of viruses begins in 2007 when the vibrational spectrum of a virus capsid, specifically the bacteriophage M13, is available (8). Femtosecond lasers in the visible range (450-750 nm) and very low power lasers were used for virus inactivation. Light with a wavelength of 425 nm was used in pulsed mode with pulses of 100 fs width with a power equal to or greater than 50 MW/cm2. This procedure was called ISRS (Impulsive Stimulated Raman Scattering). By using a frequency in the near infrared (800 - 2,500 nm), damage to nucleic acids (DNA or RNA) and amino acids (proteins) is expected to be minimal.

In 2008 a study developed an atomic resolution model for the analysis of normal modes of viral capsules with icosahedral symmetry and in 2009 it was extended for other symmetries (9,10). Capsides are formed by proteins that are made up of their simplest molecular elements: amino acids and these in turn by atoms. The different sequences of amino acids and unions between them give rise to the different proteins and their conformations. It is demonstrated for the first time how the AIDS virus (human immunodeficiency virus or HIV) can be inactivated by irradiation with medium power laser pulses in the subpicosecond regime and often in the near infrared (11). In this inactivation work, a laser with a wavelength of 1.55 μm was used in pulsed mode at a repetition rate of 500 KHz and pulses of 5 μJ that is injected into a non-linear optical fiber that generates second output harmonics, that is, 776 nm frequency pulses of 1.4 μJ power with a width of 500 fs. The authors found that a sample (in vitro and removed) subjected to these ultra-short laser pulses lost about 80% of the virus load. This may not seem to us to be sufficient to overcome the standards of a therapeutic application, but it is a good principle that is sure to evolve in the coming years.

The study integrates a software where the data of the detailed atomic compositions of the capsides, their crystallographic structure, etc., are linked to provide mathematical solutions to the normal modes that allow us to know their resonance. That is, the resonance is not measured, it is calculated. At the experimental level in that year, 2009 by means of resonant excitation of biomolecules, they achieve the mechanical inactivation of bacteriophage M13, human papillomavirus, tobacco mosaic virus and HIV. (Yes, the virus that causes AIDS). It is also demonstrated that the mechanism of inactivation applied is selective and does not affect mammalian cells, (7).

In 2015, it is demonstrated in the Influenza A virus, that the transfer of resonance energy from microwaves can inactivate airborne viruses safely for the public and this is mainly due to physical fractures in the virus capsid (32). With microwave technology, the one we use in the antennas spread all over the globe, in our cell phones, etc. It is possible, in the laboratory, to inactivate airborne viruses (remember that the SARS-Cov-2, responsible for the Covid-19, is).

In 2016, in another study, simulations based on free electron laser pulse technology, managed to observe that the process of viral inactivation is triggered by the strong resonance between the vibrational modes of the virus and the adjusted frequencies of the laser (36). In fact, the free electron laser (FEL) has the widest frequency range of all types of lasers, being easily tunable. Wavelengths can be obtained in a wide part of the electromagnetic spectrum: from microwaves to X-rays.

In 2020, the Colombian researcher Santiago Restrepo creates a biophysical model with which to estimate the natural frequencies of a viral capsid.

It is based on the fact that the amino acids that constitute proteins have a central carbon called alpha carbon (Cα), independently of the carbons present in radicals and carboxyl groups.

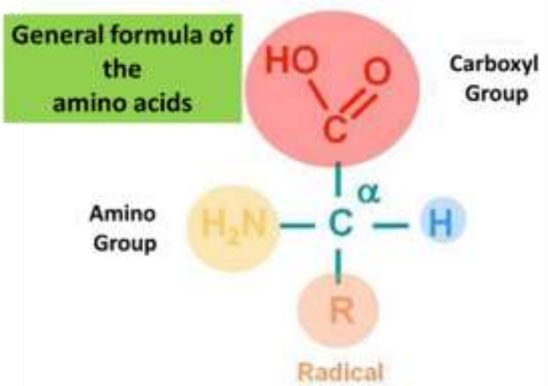

Figure 3. General formula of the amino acids

Santiago instead of using mathematical models with all the atoms uses the Cα, for the analysis of normal modes. With this, it achieves a minor treatment of data and with significant approximations to the real data and those obtained through more complete and laborious analysis. In a simile, it would be similar to the biomechanical studies where a series of points of the body is taken as reference to make a study of it.

In the year 2020 a nanotechnological milestone takes place: it is possible to measure the vibrational frequency of a bacterium by means of an optomechanical device, leaving the door open to do it also with viruses (6).

Researchers from the CSIC (Spanish National Research Council) have managed to measure the resonance frequency of a single bacterium for the first time. To do this they have used optomechanical devices to measure light and movement, and have seen that the bacteria vibrate hundreds of millions of times per second. By managing to measure the resonance frequency of the microorganism, it provides a lot of information about its characteristics, so that it can be identified. This research has been published in the journal Nature Manotechnology (19, 20, 23, 34).

Conclusion

The inactivation of the virus has been treated by means of a laser because it induces the rupture of the protein capsule (capsid) of the virus, which in the case of the HIV virus has a diameter of 0.1 μm. This is compared to a red blood cell in the form of a filled doughnut which is about 10 μm in diameter and 2 μm thick, so the effect of the laser on this type of cell can be expected to be minimal (37, 39).

Work has been underway for some years in the European project VIRUSCAN, whose objective is the design and construction of a universal virus and bacteria detector based on the technology described above. It is expected that the first prototype will be ready by the end of 2021 and that it can be applied in hospitals in the near future. This, together with other modern methodologies such as the application of gamma radiation (14), opens up a range of hope for a future that we hope will be near.

Applications in the food sector could also be interesting. Sterilization and pasteurization processes have enormous lethality rates that do not completely eliminate microorganisms (although they do eliminate pathogens) and are responsible for the expiry date or best before date (together with the integrity of the packaging) of the treated food. Heat-resistant microorganisms persist causing alterations in products under certain storage and/or transport conditions. A first step is the use of this technology to eliminate this extremophile group by increasing the shelf life of the product. A second phase would be to be able to obtain fresh and preserved products without the need for heat treatment.

Discussion

Viruses are inert beings, formed by an RNA molecule, very weak and vulnerable, if left out in the open the sunlight destroys it. Around it there is a capsule that protects it and that is called capsid. In the case of the coronavirus, this capsule is made of fat. In addition, it has proteins in the form of hedgehog-shaped spines that are the ones that adhere to the walls of healthy cells and cause a gap to open, so the RNA enters the healthy cells and contaminates them and the infection continues. The goal is to destroy the capsule so that the RNA molecule is exposed, the goal is to destroy those particles before the healthy cells are infected.

This new methodology of application of biophysical methodologies based on the determination of the resonance frequency of the virus seems to be an interesting process. With this method, viruses that are free and have not yet infected the cells could be destroyed, but what about the cells already infected? Viruses adhere to healthy cells using that kind of hedgehog with its spines, if it is possible to make them vibrate, maybe it is possible to make the virus not to stick and not to damage the cells even if they are not destroyed. Virus frequencies have been measured for many years by engineer André Simoneton and it shows that all viruses vibrate at low frequencies, below 5000 angstroms (1angstrom=0.0001µm). The Covid-19 has a low vibration with a closed electromagnetic circuit structure, with a resonance frequency of approximately 5.5 Hz to 14.5 Hz. In the higher ranges it is not active, and from the ranges of 25.5 Hz and above the virus dies.

It seems to us that a frequency scanning device (multi-frequency generator) could be designed to cover the largest number of resonance frequencies and be as general as possible. But the manufacture of these devices is not trivial, it all depends on what the resonance frequency of the virus is, how the virus responds to that frequency and how much is needed to damage or break it. The idea of using microwaves used in cell phones and wifi is being considered.

If these methodologies go ahead and work, which seems to be the case, will pharmaceutical laboratories see this as a good thing?

At a macroscopic level, and at a health level so to speak, it should be taken into account that the human body is made up of elastic structures such as bones, so that in the world of occupational medicine, care should be taken to ensure that the frequency of work (tapping machines: drills, cutters, etc.) does not coincide with the natural frequency of some of the parts of the bone structure. When the human body is subjected to low-frequency vibrations, it moves as a whole, but at high frequencies the body's response is specific; so from 4 to 12 Hz hips and shoulders start resounding, between 20 and 30 Hz it is the skull that resonates, at higher frequencies from 60 to 90 Hz it is the eyeballs that can enter into resonance (17). Healthy people live in ranges of high vibrations and there the virus seems to arrive dead, they are not affected as much as sick people, who present important energetic balance disorders (fatigue, chronic diseases, nervous tension, etc.) and are more vulnerable to be attacked by the Covid-19.

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