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Review Article

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Corona Virus and Soap: The Supramolecular Chemistry

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Abstract A virus is made up of nucleic acid genome (RNA or DNA), Protein, and outer fatty layer. All these three structure forms the complete structure of virus. These all are attached too weakly with each other. The attachment is non- covalent in nature and interacts with protein, RNA and lipids. Together these act together like a Velcro so it is very hard to break up the self-assembled viral particle. But the soap makes it easy to break this bond by dissolving the lipid layer and also weakening the other bonding within the virus molecule and thus the virus dies and falls apart. Soap contains amphiphiles, which are fat-like compounds and are similar to the lipids found in the membrane of virus.

Keywords Genome, Non-covalent interactions, Virus, Corona, Amphiphiles

Introduction

Corona virus disease (COVID 19) is an infectious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Coronaviruses are a large family of viruses that can causes illness like common cold to more severe disease. Soaps work very efficiently to get rid from the novel corona virus (nCovid-19). Soaps acts on the fat layer present in virus and virus becomes inactive or we can say the virus becomes dead. Outside of the host body the virus can remain active for several hours [1].

Before going through the action of soaps and the chemistry involved on its action we must have a quick look on the structure of virus.

Almost all viruses consist of three main building blocks: RNA, proteins and lipids. The RNA is the viral genetic material and it is similar to DNA. The proteins have several roles, which includes, breaking into the target cell, assisting with virus replication and basically being a key building block in the virus structure. The lipids form a coat around the virus, both for protection and to assist with its spread and cellular invasion.

The lipids then form a coat around the virus, both for protection and to assist with its spread and cellular invasion. The RNA, proteins and lipids self-assemble to form the virus. Critically, there are no strong "covalent" bonds holding these units together. Instead, the viral self-assembly is based on weak "non-covalent" interactions between the proteins, RNA and lipids. Together, these act together like Velcro, so it is hard to break up the self-assembled viral particle.

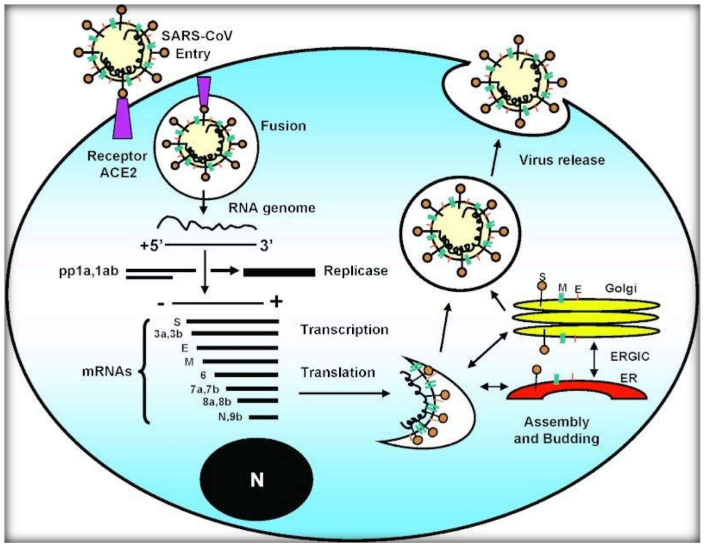

Figure 1: The SARS-CoV life cycle in host cells and its S protein structure

Corona virus and almost all the virus are having the size of 50-200 nm and can be considered as nanoparticles. And it is the property of nanoparticles to have complex interactions with the surface they are attached, and the same thing happens with viruses. And the extent of interaction varies according to the nature of surface. Hence the virus interacts differently with skin, steel, timber, fabric, paint, and porcelain. When any virus enters a cell, it hijacks all its components and machinery and acts just like computer virus and it forces the cell to replicate its own RNA and all other proteins that are necessary for the virus structure and growth. The new copies of proteins and the RNA and the lipid molecule then reassemble to form new viruses.

All those new viruses eventually damage the cell, and it dies or explodes, releasing viruses that then go on to infect more cells. In the lungs, viruses end up in the airways and mucous membranes. Such patients when sneezes and coughs the virus spread in air in the form of fine droplets and get attached to the new surface and infect other individual and the same process continuous [2].

Supramolecular Chemistry

Supramolecular chemistry has been defined by phrases such as 'chemistry beyond the molecule', 'chemistry of molecular assemblies and of the intermolecular bond', and 'non-molecular chemistry'. The main objective of supramolecular chemistry is to design and develop novel functional systems by joining multiple chemical components through non-covalent interactions [3].

The tiny droplet containing the virus dries out rapidly but the virus remains alive and the then comes the supramolecular chemistry which explains how the virus interacts with the surface. As mentioned before the virus is a nanoparticle and it is important to know the chemistry of nanoparticles.

The concept of supramolecular chemistry effectively says that the similar surfaces interact more strongly with each other and dissimilar surfaces are less likely to interact with each other. Wood, fabric and skin interact fairly strongly with viruses. Contrast this with steel, porcelain and at least some plastics, such as Teflon. The surface structure also matters. The flatter the surface, the less the virus will "stick" to the surface. Rougher surfaces can actually pull the virus apart [4].

The virus is held together by the hydrogen bond and the lipophilic attachment as well. The surface of wood, skin and fabric provide more opportunity to the virus for such bonding and the porcelain, still, or Teflon does not provide such bonding. So, the stability of virus varies according to the surface to which it is attached. The novel coronavirus is thought to stay active on favorable surfaces for hours, possibly a day. There are some factors that make the virus less stable, for example Moisture (It dissolves), sunlight (UV light) and heat (molecular motions).

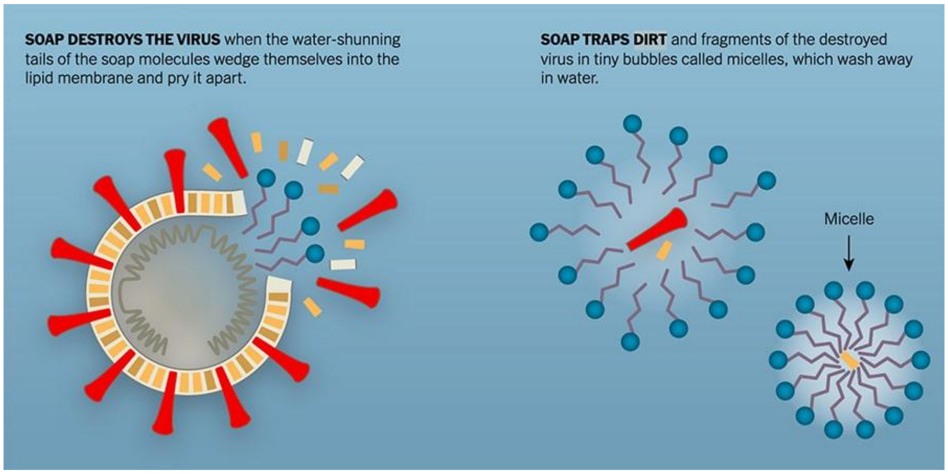

Figure 2: How soap works

The skin of humans is an ideal surface for the virus, because it is organic and it contains the dead cells of the skin which provides the proteins for the attachments and the fatty acids for the lipophilic attachment or bonding. So when we touch the steel surface the virus gets attached to our hands and we often touch our hands to the face and then only we get infected with the virus, unless our immune system kills it [5].

Soap Action

Soapy water is totally different from the normal tap water. Soap contains fat-like substances known as amphiphiles, some structurally similar to the lipids in the virus membrane. The soap molecules present a strong competition with the lipids in the virus membrane. That is more or less how soap also removes normal dirt of the skin as well as from the fabrics. The molecule of the soap also competes with a lot other non-covalent bonds that help the virus proteins, RNA and the lipids to stick together. The soap is effectively "dissolving" the glue that holds the virus together. The soap also provides a tough competition to the attachment of virus to the human skin and virus fails to remain attach and falls apart very quickly. The surface of the skin is very rough and wrinkly so it needs a proper rubbing and time to reach the soap to the entire surface of the hands [6].

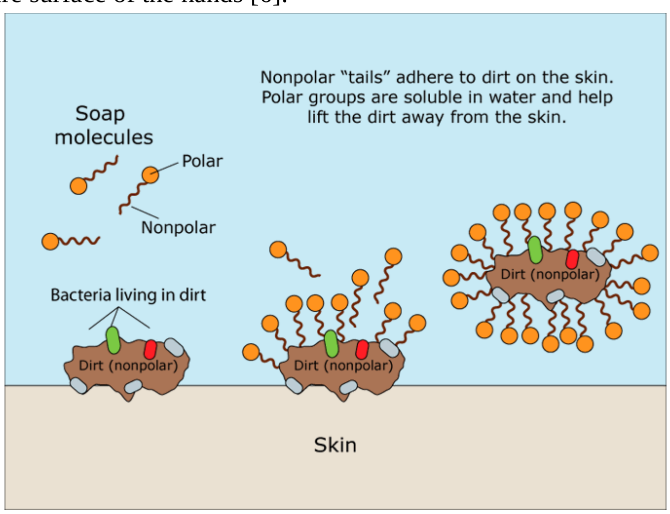

Figure 3: Interaction of soap with surface and other particles

Conclusion

Supramolecular chemistry and nanoscience tell us not only a lot about how the virus self-assembles into a functional, active menace, but also how we can beat viruses with something as simple as soap. The formation of non-covalent directional interactions, such as hydrogen or halogen bonds, is a central concept of materials like soaps to interact with the surfaces.

Figure 4: Proper Hand Washing with soap

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