Vyv Antimicrobial LED Technology and Viruses

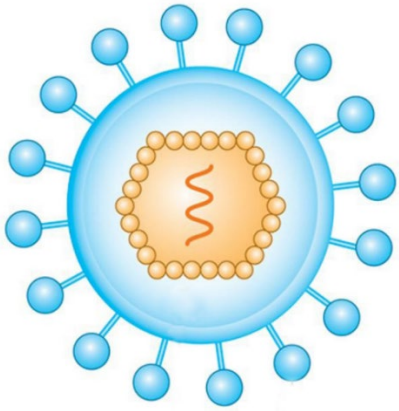
Frequently Asked Questions

Vyv recently announced the efficacy of its antimicrobial light technology for inactivation of viruses. The antimicrobial effects of visible light (405nm) on bacteria, mold, fungi, and yeast have been well-studied and documented for many years. Only recently have active investigations been conducted on the effects of these antimicrobial lights on non-enveloped viruses and enveloped viruses. The results of these tests have verified the antimicrobial impact on multiple classes of viruses. Below are frequently asked questions about Vyv's impact on viruses with Vyv's responses:

1. **What is the difference between a non-enveloped virus and an enveloped virus?**
   Viruses can infect human, animal plant or bacterial cells, and they can be classified based on two criteria: their type of genetic material (DNA or RNA) and their structure, like being enveloped or non-enveloped. The structure of all viruses includes a protein shell called a "capsid".

   Enveloped Viruses
   Enveloped viruses have an additional layer that covers the capsid. This membrane is composed of lipids and proteins it "stole" from the host cells and viral glycoproteins (sugars combined with proteins). The bumps, knobs, and spikes that artists use in images of enveloped viruses like SARS-CoV-2 depict structures on the viral envelope. These types of viruses need both an intact capsid and the envelope to infect cells. The envelope also helps avoid detection by the host immune system because it makes the virus look like just another host cell. But the envelope can also provide a soft target for destroying the virus when it is outside the host. Common disinfectants, and even alcohol, detergents or soap can disrupt the oily envelope and its components, destroying the ability for the virus to infect host cells.

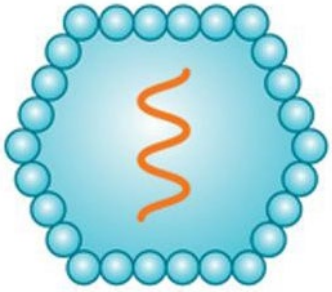
   Enveloped viruses can cause persistent infections and must be transferred from host to host. Examples of enveloped viruses include ones that cause diseases in humans, such as COVID-19, Influenza, Hepatitis B and C, and Hemorrhagic Fever (Ebola Virus Disease).



Enveloped Virus

Non-enveloped Viruses

Non-enveloped viruses do not have a lipid covering, but their effects on humans can be just as devastating. These "naked" viruses only need their protein-based capsid and host detector proteins to infect host cells. However, because they lack a lipid envelope and have a touch exterior protein shell, they are more resistant to many disinfectants and other stresses like drying out or heat exposure. Examples of non-enveloped viruses include types that can cause dysentery (Norovirus), common colds (Rhinovirus) and Polio (Poliovirus).



Non-Enveloped Virus

2. **What is 'irradiance' and why is it important?**

Irradiance is a measure of the amount of antimicrobial energy that is hitting the viruses. The higher the irradiance, the more antimicrobial effect. At lower irradiances, the same antimicrobial impact will take a longer time. Because some viruses will disintegrate over the longer time course of Vyv's tests, a higher irradiance may be used to make the testing faster. To make sure that overhead light levels are effective at inactivating viruses, if possible the tests are performed at an irradiance equivalent to 500 lux (as an irradiance this is 0.05 mW/cm^2). 500 lux is the target irradiance in a space to ensure antimicrobial effects will be productive.

3. **What tests were performed that indicate 405 nm visible light can inactivate viruses?**

Performed through certified third-party testing labs, Vyv's studies were done using non-enveloped and enveloped viruses. Non-enveloped viruses were chosen for the first studies primarily because these viruses are harder to destroy or inactivate than enveloped viruses. However, enveloped viruses cause significant infections in humans: so Vyv tested against SARS-CoV-2, which causes COVID-19.

Recent studies performed by several independent labs and institutions have shown that light in the 405 nm region was additionally able to inactivate enveloped viruses in simple salt solutions with no additives. These results converge to demonstrate efficacy, in various testing conditions, on both enveloped and non-enveloped viruses. This will also encourage more research to enhance the understanding of the effects of 405 nm light on viral components.

4. **What were the results of Vyv's third-party tests?**

- After 4 hours at 1.0 mW/cm^2 irradiance, SARS-CoV-2 achieved a 1.81-log (98.45%) reduction. This is an important validation of the pre-print data from Mount Sinai (see below) as it was done using the dried sample technique called for in the EPA-accepted standard methodology for antimicrobial testing (Mt. Sinai was not). This result means that we have third party results

for both non-enveloped an enveloped viruses at overhead light levels, strengthening Vyv's claims using standard test methods at light levels commonly seen in real world use.

- Testing was conducted against MS2 bacteriophage, a non-enveloped virus, at levels that are equivalent to overhead light levels (0.05 mW/cm^2), and a higher, "close-up" level (2 mW/cm^2). After 8 hours at overhead light levels, a 1.54-log reduction (97.12%) was achieved. At the higher light level, a greater than 3.82-log reduction (99.985%) was achieved.

5. **How does 405nm light kill/inactivate viruses?**
   Based on currently available research literature and experimental data, the differential effects on RNA and DNA viruses suggest, as expected, that the effect is probably NOT on nucleic acids (DNA or RNA). Rather, the likely target of 405 nm light is external facing proteins that allow viruses to 'dock' with or bind their target cells. Damaging or altering the shape of these proteins can make it impossible for viruses to infect cells, effectively killing them. However, further studies specifically aimed at the mode of action need to be undertaken to determine if this hypothesis is correct.

6. **Does Vyv kill viruses on surfaces and in the air?**
   Based on the results of Vyv's testing, it is confirmed that Vyv antimicrobial lights directly impact viruses on surfaces. As the exciting data are rapidly accumulating on the effectiveness of 405 nm light on both non-enveloped and enveloped viruses, Vyv anticipates expanded research with its proprietary antimicrobial light technology and inactivation of viruses in a growing set of environmental conditions, including air. Important data on the effectiveness of viral destruction in aerosol form are needed to understand how overhead light levels impact enveloped viruses like SARS-CoV-2 in the air. Non-enveloped viruses like those that cause the common cold are often transferred by surface contact. Research will continue in this area to accumulate a greater understanding of various test environments as well as various room light intensities.

7. **How long can viruses live on surfaces?**
   Virus-laden droplets may remain infectious for several hours, depending on where they fall. Viruses generally remain active longer on stainless steel, plastic, and similar hard surfaces than on fabric and other soft surfaces. Other factors, such as the amount of virus deposited on a surface and the temperature and humidity of the environment, also determine how long viruses stay active outside the body.

   It is possible to catch a virus, like the flu or a cold, after handling an object an infected person sneezed or coughed on a few moments ago. While each specific virus is different and unique, personal contact with an infected person —such as a handshake or breathing in droplets from a cough or sneeze —can be the most common way these viruses spread.

8. **How long does it take for Vyv antimicrobial LED lights to inactivate and kill viruses on surfaces?**
   After 6 hours dried from a saline solution, over a 3.82 log reduction (99.985%) was achieved on a non-enveloped virus (MS2). After 6 hours dried from artificial saliva, a 2.23 log reduction (99.41%) was achieved with this same virus. Results may vary depending on the amount of light that is reaching the surfaces in the space where Vyv's technology is installed and the length of time of exposure.

9. **Can people be exposed to Vyv antimicrobial light that impacts viruses?**
   Yes. Vyv antimicrobial lights fall within the visible light spectrum (400-420nm), outside the spectrum of potentially damaging UV (ultraviolet) light. Vyv LED technology meets international

standards (IEC62471) for continuous and unrestricted use around people, animals, and plants. These same lights are used when addressing viruses, bacteria, fungi yeast or mold.

10. **Are people safe from viruses when they are under these lights? Do we still need to social distance and wear masks while under these lights?**
    Many viruses are spread from host-to-host. Although viruses can be picked up from touching surfaces where the virus has been deposited, viruses like SARS-CoV-2 are mostly spread through airborne transmission. While under Vyv lights it remains important to follow CDC guidelines of mask wearing, social distancing and washing hands.

11. **What is the difference between a virus and a bacterium?**
    Bacteria and viruses are both small, but bacteria are in fact are very complex organisms that can and do adapt constantly to their environment, the available nutrients, and even the size of the bacterial crowd they inhabit. Viruses are extremely simple, lacking any means of energy production, environmental sensing, or response, and cannot reproduce without the taking over the machinery of a larger, complex living cell ("a host").

12. **What is a host?**
    A host is the living cell of an animal, plant, or bacterium that a virus uses as a factory to reproduce and spread itself. Viruses on their own are inert – but once inside a host cell they commandeer the cell's complex biological systems to make numerous copies of themselves and release them into the environment to continue their existence.

13. **Are viruses living microbes?**
    Most scientists would say no because viruses cannot reproduce (replicate) without a host or remain viable in the environment outside of a host. Being able to replicate oneself is generally accepted as a central tenet of the definition of life.

14. **Do I say prevent? Inactivate? Kill?**
    Strictly speaking if viruses are not alive, they cannot be killed. However, in common parlance killing viruses carries the same meaning as the more scientifically correct term "inactivate." You cannot prevent a virus any more than you can prevent a rock, but you can prevent viral infections and viral spread. Any change in the virus that renders it unable to infect its host cells "kills" it – without infectivity a viral particle is harmless protein and nucleic acid. Vyv and Vyv partners do not, however, make any claims specific to viral infections and viral spread. The simple answer is stick with inactivate and kill when discussing the technology's impact on viruses.