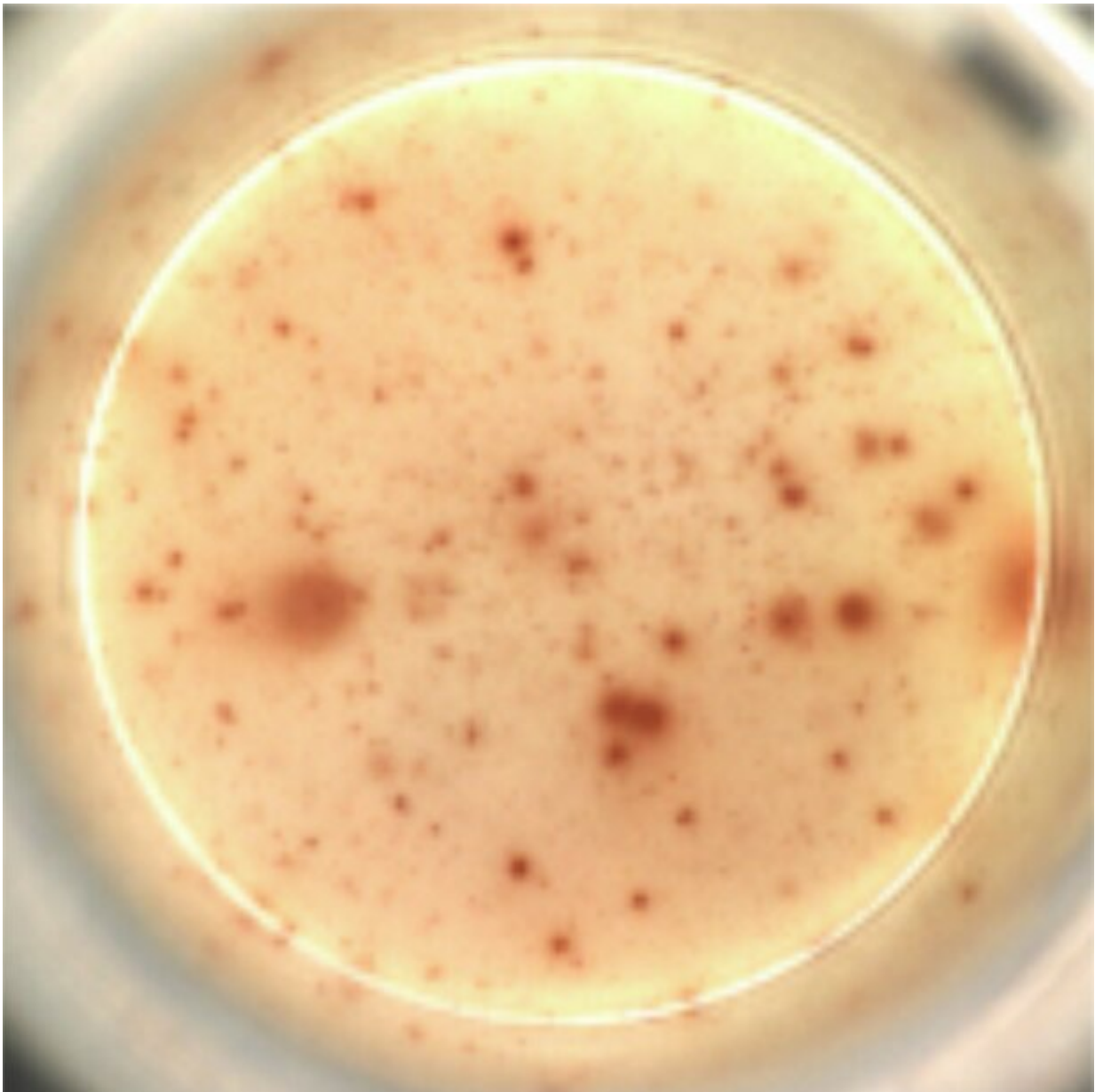


A new technology offers treatment for HIV infection through a single injection

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Staining for engineered cells that secrete the antibody against HIV. Credit: Tel Aviv University

A new study from Tel Aviv University offers a new and unique treatment for AIDS which may be developed into a vaccine or a one time treatment for patients with HIV. The study examined the engineering of type B white blood cells in the patient's body so as to secrete anti-HIV antibodies in response to the virus. The study was led by Dr. Adi Barzel and the Ph.D. student Alessio Nehmad, both from the school of neurobiology, biochemistry and biophysics at the George S. Wise faculty of life sciences and the Dotan Center for Advanced Therapies in collaboration with the Sourasky Medical Center (Ichilov). The study was conducted in collaboration with additional researchers from Israel and the US. The study was published in *Nature Biotechnology*.

Over the last two decades, the lives of many AIDS patients have improved as a result of the administration of treatments that change the disease from lethal to chronic. However, we still have a long way to go before a treatment is found that would provide the patients with a permanent cure. One possible way to do it, with a one time injection, was developed for the first time in Dr. Barzel's laboratory. The technique developed in his lab utilizes type B white blood [cells](#) that would be genetically engineered inside the patient's body to secrete neutralizing antibodies against the HIV [virus](#) that causes the disease.

B cells are a type of [white blood cells](#) responsible for generating antibodies against viruses, bacteria and more. B cells are formed in bone marrow. When they mature, B cells move into the blood and lymphatic system and from there to the different body parts.

Dr. Barzel explains that "until now, only a few scientists, and we among them, had been able to engineer B cells outside of the body, and in this study we were the first to do this in the body and to make these cells generate desired antibodies. The [genetic engineering](#) is done with viral carriers derived from viruses that were engineered so as not to cause damage but only to bring the gene coded for the antibody into the B cells in the body.

"Additionally, in this case we have been able to accurately introduce the antibodies into a desired site in the B cell genome. All model animals who had been administered the treatment responded and had high quantities of the desired antibody in their blood. We produced the antibody from the blood and made sure it was actually effective in neutralizing the HIV virus in the lab dish."

The genetic editing was done with a CRISPR. This is a technology based on a bacterial immune system against viruses. The bacteria use the CRISPR systems as a sort of molecular "search engine" to locate viral sequences and cut them in order to disable them. Two biochemists who had figured out the sophisticated defense mechanism, Emmanuelle Charpentier and Jennifer Doudna, were able to reroute for the cleavage of any DNA of choice. The technology has since been used to either disable unwanted genes or repair and insert desired genes. Doudna and Charpentier earned international recognition when they became chemistry Nobel Prize winners in 2020.

The Ph.D. student Alessio Nehmad elaborates on the use of CRISPR: "We incorporate the capability of a CRISPR to direct the introduction of genes into desired sites along with the capabilities of viral carriers to bring desired genes to desired cells. Thus, we are able to engineer the B cells inside the patient's body. We use two viral carriers of the AAV family, one carrier codes for the desired antibody and the second carrier codes the CRISPR system. When the CRISPR cuts in the desired site in

the genome of the B cells it directs the introduction of the desired gene: the gene coding for the antibody against the HIV virus, which causes AIDS."

Currently, the researchers explain, there is no genetic treatment for AIDS, so the research opportunities are vast. Dr. Barzel concludes: "We developed an innovative treatment that may defeat the virus with a onetime injection, with the potential of bringing about tremendous improvement in the patients' condition. When the engineered B cells encounter the virus, the virus stimulates and encourages them to divide, so we are utilizing the very cause of the disease to combat it.

"Furthermore, if the virus changes, the B cells will also change accordingly in order to combat it, so we have created the first medication ever that can evolve in the body and defeat viruses in the 'arms race'. Based on this study we can expect that over the coming years we will be able to produce in this way a medication for AIDS, for additional infectious diseases and for certain types of cancer caused by a virus, such as cervical cancer, head and neck cancer and more."

More information: Alessio D. Nahmad et al, In vivo engineered B cells secrete high titers of broadly neutralizing anti-HIV antibodies in mice, *Nature Biotechnology* (2022). [DOI: 10.1038/s41587-022-01328-9](https://doi.org/10.1038/s41587-022-01328-9)

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