A new virus emerges and spreads like wildfire. In order to contain it, researchers must first collect data about who's been infected. Two main viral testing techniques are critical:

one tells you if you have the virus and the other shows if you've already had it.

So, how exactly do these tests work? PCR, or polymerase chain reaction testing, targets the virus's genetic material in the body and is used to diagnose someone who is currently infected.

Yet, this genetic material may be present in such imperceptible amounts that actually detecting it is difficult. This is where PCR comes in:

it's widely used to amplify genetic information to large enough quantities that it can be readily observed. To develop a PCR test for a never-before-seen virus, researchers first sequence its genetic material, or genome, and identify regions that are unique to that specific virus.

PCR then targets these particular segments. A PCR test begins by collecting a sample:

this can be blood for hepatitis viruses, feces for poliovirus, and samples from the nose or throat for coronaviruses. The sample is taken to a central laboratory where PCR is performed to test for the presence of the virus' genome. Genetic information can be encoded via DNA or RNA. HPV, for example, uses DNA, while SARS-CoV-2, the cause of COVID-19, uses RNA. Before running the PCR, the viral RNA— if present— must be reverse transcribed to make a strand of complementary DNA.

Researchers then run the PCR. If the virus is present in the sample, its unique regions of genetic code will be identified by complementary primers and copied by enzymes.

One strand of DNA becomes hundreds of millions, which are detected using probes marked with fluorescent dye.

If the PCR machine senses fluorescence, the sample has tested positive for the virus, meaning the individual is infected. Immunoassays, on the other hand, tap into the immune system's memory of the virus, showing if someone has previously been infected.

They work by targeting virus-specific antibodies generated by the immune system during infection. These are specialized classes of proteins that identify and fight foreign substances, like viruses. Immunoassays may detect IgG antibodies, the most abundant class, and IgM antibodies, the type that's first produced in response to a new infection.

The presence of IgM antibodies suggests a recent infection, but since it can take the body over a week to produce a detectable amount, they're unreliable in diagnosing current infections.

Meanwhile, IgG antibodies circulate for an extended period after infection; their presence usually indicates that someone was exposed and recovered. Before the immunoassay, health professionals draw blood from an individual.

This sample then comes into contact with a portion of the virus of interest. If the body has, in fact, been exposed to the virus in the past, the body's virus-specific antibodies will bind to it during the test. This reaction produces a change in color, indicating that the sample tested positive and that the individual has been exposed to the virus. Immunoassays are especially important when it comes to retroactively diagnosing people who were infected but went untested. And there's exciting potential for those who have developed immunity to a virus:

in some cases, their blood plasma could be used as treatment in people who are currently fighting it. PCR and immunoassays are always in the process of becoming more accurate and efficient.
For example, innovations in PCR have led to the use of self-contained testing devices that relay results within one hour. Digital PCR, which quantifies individual pieces of target DNA, shows promise in further boosting accuracy. And although immunoassays are difficult to develop quickly, researchers in Singapore were able

to create one for SARS-CoV-2 even before COVID-19 was declared a pandemic.

These tests— along with the scientists who develop them and the health professionals who administer them— are absolutely essential. And when deployed early, they can save millions of lives.

English