Infection

This is the virus SARS-CoV-2. Its name stands for severe acute respiratory syndrome coronavirus 2.

You may have heard it called just the “coronavirus” or COVID-19.

Coronaviruses are actually a family of viruses that includes SARS-CoV-2.

And COVID-19 is the name of the disease caused by it.

Coronaviruses infect humans and other animals. In humans, they cause the common cold and, in some cases, more serious respiratory diseases.

All coronaviruses, including SARS-CoV-2, have a genome made of a single strand of RNA, which is surrounded by a membrane made of lipids and proteins. This membrane is called an envelope.

Coronaviruses are named after what looks like a crown of protein spikes that stick out of their envelope.

Coronaviruses enter the body mainly through the mouth or nose. The virus then has to get inside a human cell. The protein spikes on the virus’s envelope attach to specific proteins on the surface of a cell.

This causes the virus’s membrane to fuse with the cell’s membrane, releasing the virus’s RNA genome into the cell.

The cell’s ribosomes translate the virus’s RNA into proteins, including viral RNA polymerase.

The RNA polymerase transcribes the virus’s RNA, making more RNA copies that are translated into proteins. It also makes more copies of the virus’s whole genome.

The new viral genome and proteins combine to make a new virus that is packaged into an envelope formed from the cell’s membranes.

Newly formed viruses travel to the cell’s surface and are released outside the cell.

These viruses can infect other cells, or leave the body in mucus and saliva droplets. This can all happen even if a person doesn’t feel sick or show symptoms of disease.

A fever or coughing are usually signs that the immune system is fighting the infection.

The production of new viruses continues, until the body’s immune system is able to eliminate the infection.

Evolution

The SARS-CoV-2 genome is a single strand of RNA, with genes that encode fewer than 30 proteins. This is less than 0.1% of the proteins encoded by the human genome.

The virus’s genome is made of about 30,000 building blocks called nucleotides, which are represented by the letters A, U, C, and G. The unique sequence of nucleotides in a genome determines the proteins it encodes.

When the virus infects a cell, its genome is replicated, or copied. First, the virus makes strands of complementary RNA called template RNAs. The template RNAs are used to produce copies that match the original virus’s genome.

This genome replication process is prone to errors. These errors are called mutations. Mutations can occur at random anywhere in the genome.

For example, in this mutation, a "U" was substituted with an "A."

A nucleotide can be substituted with a different nucleotide, added in the wrong place, or left out.

When the mutated virus infects another cell, all the new viruses replicated from it will have this same mutation, plus any new mutations that occurred.

Depending on the locations and types of mutations, they may or may not affect a virus's ability to spread in a population.

Viruses with mutations that help the virus replicate or infect cells have a selective advantage. These viruses usually become more common in a population over time.

Viruses with mutations that make them less effective at replication or infection have a selective disadvantage. These viruses usually become less common in a population over time.

Mutations that have no effect on the virus are called "neutral mutations." Viruses with neutral mutations replicate just as well as viruses without these mutations.

Tracking mutations in viruses can help determine where an outbreak started and how it spread. Understanding how virus populations change over time can also help scientists develop treatments and vaccines.

Detection

There are several ways to test whether someone has been infected with SARS-CoV-2. Some tests can detect if you have an active infection, or an infection that is happening right now, and others can detect if you've had an infection in the past and recovered.

To determine whether you have an active infection, doctors can look for the presence of the virus in your body.

One test uses RT-PCR, or reverse transcriptase polymerase chain reaction, to look for pieces of the virus's RNA genome. A swab is taken of the inside of your nose or throat to collect cells or saliva in which the virus is likely replicating. If the virus's RNA is in your cells, it will be detected by the PCR test and give a positive test result.

Another test for detecting an active infection looks for pieces of viral proteins recognized by the immune system, called antigens. If viral antigens are in your sample, they will be detected by the antigen test and give a positive result.

But what if you've already recovered and no longer have the virus in your body? In this case, a blood sample is taken to test for the presence of specific types of antibodies that recognize the virus. Antibodies are proteins produced by your body's immune system to fight off infections.

Studying people who have antibodies to the virus can help scientists understand where a virus is spreading and how our immune system fights the virus.

None of these tests are foolproof. Viral RNA, viral antigens, and antibodies are all produced at different times during an infection, and they won't always be detected. And, some tests are also less sensitive than others, resulting in false negatives. Doctors may use a combination of tests, or repeat tests at different times, if they're uncertain.