[Narrator] You wake up with a cough, a fever, and feeling achy all over. No school for you today! Your mother insists a trip to the doctor is needed. When you get there, the doctor thinks you have an infection – but which one?

Different infections have different treatments and some, if left untreated, can cause serious illness. In addition, some infections are very contagious, so you might need to stay home for a few days. Your doctor might want to identify the specific infectious agent causing your symptoms by collecting a sample from your body and sending it to a laboratory for diagnostic testing.

Diagnostic laboratory tests are used to help diagnose or identify which, if any, infectious agent is causing illness. Samples of body fluids or tissues, like cell samples swabbed from the nose or throat, can be used to test for different infectious agents, such as bacteria, viruses, parasites, or fungi.

Let's meet Lily, a laboratory scientist, who has the knowledge and tools to find out which infectious agent, if any, you might have.

Lily might use a PCR test or an antigen test for diagnostic purposes, that is, to see if there is evidence of a particular infectious agent inside your body.

A PCR test – PCR stands for polymerase chain reaction-- looks for genetic material of an infectious agent. A positive PCR test indicates a current infection. This test is usually done in a laboratory and is extremely good at detecting the agent, even if it is present in small amounts.

An antigen test looks for molecules called antigens found on the surface of, or produced by, infectious agents. A positive antigen test indicates a current infection. Results from an antigen test are quick, usually available in about 15 to 30 minutes. However, the antigen test may not detect the infectious agent as well as a PCR test.

Because no tests are perfect, and may produce a false result, sometimes both tests are done — the antigen test with rapid results followed by a PCR test to confirm.

A test result is called "positive" if either genetic material or antigens for a specific infectious agent are detected.

A negative test result can mean that the infectious agent is not present in the sample, or the amount of infectious agent is too low to be detected by the test.

Doctors are not the only people concerned with who tests positive for an infectious agent. Public health experts monitor laboratory test results to identify potential public health problems in a community. Lab results can help public health experts spot increases, trends, and patterns in the spread of disease. Lab results can also reveal when an infectious agent is becoming resistant to recommended treatment.

Resistance is when medicines we normally use to treat a disease are no longer effective against the disease-causing agent. Lab results can show that an agent is changing or evolving over time. The influenza virus, for example, experiences changes in its antigens over time. This is why flu vaccines are recommended each year. The virus that causes COVID-19 also experiences changes over time, resulting in new variants.

Finally, lab results can show that the same type of infectious agent is causing illness in multiple communities, suggesting a common exposure.

For many diseases, not everyone who is infected feels sick. People who don't show symptoms are called asymptomatic.

Asymptomatic people can be problematic for public health because they can spread their infection without knowing they have it. Screening testing can be used to look for people who are infected but asymptomatic. The same types of tests used for diagnostic purposes, PCR and antigen tests, can also be used for screening purposes.

Examples of screening testing include checking donated blood for infectious agents before it is used or screening people for an infectious disease before participating in certain activities. In 2020, many people were screened to see if they were infected with SARS-CoV-2, the virus that causes COVID-19, before participating in sports, traveling on an airplane, or even going to school.

Screening helps to identify asymptomatic people who may pose a risk to others. Public health experts can use this information to understand the extent of the problem and to take measures to reduce the spread of disease.

Data from diagnostic and screening testing also help public health experts calculate the incidence of disease and understand the extent of the problem. Incidence refers to the number of new instances of disease, also called "cases", in a population over a specific time period. People who test positive for a disease are counted as new cases.

Incidence is a measure of the probability of someone in the population developing the disease during a specific period.

Incidence is calculated as a fraction with a numerator and a denominator. The numerator is the total number of new cases in a specific time period– usually a week, month, or year. The denominator is the total size of the population at risk for that same time period.

Incidence of an infectious disease can be expressed as a percentage or a proportion per unit of population.

For example, if 100 people ate at a local restaurant and 30 of them came down with salmonella food poisoning, public health experts could calculate the incidence or risk of illness as 30 divided by 100 which equals point three zero. To get a percentage, multiply point three zero by 100, which equals 30%. So, the incidence of salmonella food poisoning among people who ate at the restaurant is 30%.

In another example, we might find out that in Metropolis with a population of 500,000 people, 70 cases were detected each day, on average, during the past 2 weeks. To calculate the daily incidence per 100,000 population, divide 70 by 500,000, then multiply by 100,000, which is 14 per 100,000 people.

In nearby Suburbia with a population of 10,000 people, an average of only 7 cases were reported each day during the same 2 weeks, but that gives a daily incidence of 70 per 100,000, which is five times higher than the Metropolis incidence!

Public health experts use incidence to track the number of new cases of disease over time or to identify groups of people or areas, called “hot spots”, with especially high risk for infection. Public health experts often use data from diagnostic and screening testing to calculate the incidence of disease. However, there are also situations where it is important to know who may already have some protection against getting a disease even if they are not currently infected. This protection, also known as immunity, may be because they have already had the disease or because they have been vaccinated.

For example, individual healthcare workers might want to know they have protection against certain diseases because they often come into contact with infected people at work. Some colleges might require proof of this protection against certain diseases because many students live close together and can easily spread disease. And people who want to become pregnant might need to know if they are protected against certain diseases that could negatively affect their pregnancy.

Luckily, Lily can perform tests to look for this protection against a disease. One test is called an antibody test and looks for the presence of antibodies in a person’s blood. Antibodies are proteins the immune system creates to fight off an infectious agent. Different antibodies are produced to fight different infectious agents. These antibodies stick to the antigens on the surface of the infectious agent to help a person’s body find and destroy it. During this process, a person might feel symptoms such as fever, tiredness, or body aches as the body fights off infection. Even after the infectious agent has been defeated in the body, the antibodies stick around for months or even years afterwards just in case the person is ever reinfected by the infectious agent.

An antibody test can determine if a person has antibodies against a particular infectious agent. For many infectious diseases, the presence of antibodies suggests that an individual’s immune system can fight off that infectious agent if exposed in the future.

If an entire population is screened using antibody tests, groups with relatively high levels of antibodies suggest a high incidence of infection at some time in the past.

Vaccines activate a person’s immune system by imitating an infectious agent to cause protective antibodies to be created. This protects you from disease, without causing severe illness. Since your body is still fighting this imitation of the agent, you might still feel symptoms such as fever, tiredness, or body aches after you receive a vaccine.

This does not mean that you are sick with an infection; it is a sign that the vaccine is doing what

it's designed to do and that your body is building protection! It is also possible to still build protection from a vaccine even if you don't feel any symptoms—some people do not experience these symptoms, but are still protected, after being vaccinated.

Antibodies can stick around to protect you from getting that same disease again, but the amount of time this protection lasts is different for each disease and each person.

Laboratory tests can detect antibodies created within the body– these antibodies are the same whether they are produced after vaccination or when a person is actually infected with a virus, bacteria, or other agent.

As a quick recap, we can now answer the question "Why do laboratory testing?" Laboratory tests can tell doctors and public health experts who is currently infected with an agent and who might have some protection against the agent due to past infection or vaccination.

Laboratory testing can be used to diagnose a current infection in symptomatic or exposed people, or to screen for disease in asymptomatic people. PCR tests check for the presence of infectious agents by looking for the agent's genetic material while antigen tests use antigens to identify the agent.

Public health experts can use diagnostic and screening results to calculate incidence. Incidence refers to the number of new cases of a disease in a population over a specific time period. It is calculated by dividing the number of new cases of disease by the size of the population at risk.

Antibody tests look for antibodies produced by the immune system to fight a disease. Antibodies can be created during an active infection or in response to vaccination.

Public health experts use laboratory test results to track disease spread and make science-based decisions and recommendations to reduce the spread of disease and protect communities.