PROFESSOR: So now let's talk about viruses, which is our main focus in these lectures.

So viruses are very different from bacteria, because they are pathogens which infect the cells of your body.

And so they themselves are not large cellular organisms, but in fact have a different biology.

So they consist of virions, which are a capsid form of the virus, which contains a strand of RNA, which is some genetic material that, when this capsid is then integrated into the host cell, the RNA can basically activate to infect that cell, and also replicate itself and make some more virions, which can spread out and infect additional cells.

So the basic entity that we're worried about here is really a small object, which is often shaped like a sphere, or maybe it's an ellipsoid, the virion.

And it's much, much smaller.

So the typical size is really on the order -- the radius, let's say -- is on the order of 100 nanometers.

So that is 0.1 micron or less, so much smaller than even the smallest aerosol droplets that we can easily observe.

So they're extremely tiny.

There's a couple examples we can think about, which are famous examples.

So one class of viruses cause the disease measles.

And measles has a virus shape, as you can see here, which is not quite spherical but usually a little bit elongated, like an ellipsoid, and has a typical size of 100 to 300 nanometers in diameter.

So measles is still a very active disease, which we have been controlling for a long time with vaccinations.

But despite that, there were still, in 2018, 114,000 deaths worldwide from measles.

And it's estimated that in the eight years before that -- actually, in the 20 years before that, excuse me -- that the vaccine has saved around 23 million lives that would be lost otherwise if this virus were allowed to propagate.

And measles -- it is known to be airborne.

So this is the classic example of an airborne transmission.

It's been studied by, for example, Riley in the 1970s, who demonstrated measles transmission in schools and in other settings.

And from our perspective, in this lecture, it's not surprising.

These viruses or virions are so small, they can be contained in the smallest droplets, which are easily present in the air for hours, and so they are not settling out.

So what's of much more interest to us today is the family of coronaviruses.

So coronaviruses look very similar to this one, but they have these proteins that stick out, which we've all seen, that look a bit like a crown, or a corona.

And they still have an RNA on the inside.

And there's lots of different human coronaviruses.

So there are the standard human coronaviruses, which cause the common cold.

And there are four typical human coronaviruses that cause common colds that we all experience, and more serious pneumonias, but generally not life-threatening illnesses.

But there are variations of the coronavirus mutations, which are constantly coming into contact with humans and can cause much more serious diseases.

So in recent memory, we've had the Severe Acute Respiratory Syndrome coronavirus.

And there was a big outbreak, reasonably big outbreak around 2003, that started also in China.

And it infected around 8,000 people, and about 800 died.

So It was a fairly lethal disease, about 10% mortality, but fortunately, it didn't spread too widely.

More recently, there was the Middle East Respiratory Syndrome coronavirus, which was in 2012.

And this led, over the couple of years after that as well, to around 2,500 cases and around 850 deaths.

So again, an outbreak that was potentially very serious but remained controlled and was primarily in Saudi Arabia.

And then we come to SARS-CoV-2, which, we all know the story.

So this is the novel coronavirus, which appeared in Wuhan, China, in December 2019, and then led to the present global pandemic, which so far has claimed almost a million deaths.

So as of today, which is September 24, it's around 976,000 deaths worldwide.

And the confirmed cases are currently at about 3.8 million, which is a reasonable fraction of the world's population, around 7 billion.

So what we can understand from all this is that these are very small objects.

They cannot swim.

And so they are just sort of floating in droplets.

And so, of course, they can be in small droplets.

And as we'll discussed next, you can imagine that they're actually more infectious in those small droplets, because they can more easily get out and reach host cells when they're transmitted.

Moreover, small droplets are much easier to get deep into your respiratory system, into the smallest cavities of your lungs, where there's a high surface area for that interaction to take place.