1a. Humanity has always been drawn to the night sky. We draw pictures in the stars, track the planets, see signs and portents in celestial objects.

1b. But so much of the universe is beyond our reach.

1c. Vast distances separate us from the sights that might answer some of our biggest questions.

1d. How do galaxies form?

1e-f. How do stars and planets come to be?

2a. Do distant planets have the conditions necessary for life?

2b. To construct and test our theories, we need to see what's happening.

2c. So we build tools to extend our vision.

2d. They get bigger.

2e. More powerful.

2f. More advanced.

3a. As time goes on, astronomy stops relying on the light we can see only with our eyes.

3b. TITLE SEQUENCE

3c. When you look at the world, you're seeing something we call "visible light."

3d. But visible light is really only a certain form of radiation. Our universe is full of many different types of radiation.

It surrounds us.

3e. Our bodies evolved to detect visible light with our eyes.

3f. But they also evolved to detect another kind of radiation, called infrared light. Our bodies feel infrared light as heat.

4a. This "infrared radiation" was discovered by the astronomer Frederick William Herschel.

4b. Herschel knew that a prism could be used to break white light into colors.

4c. He wanted to know whether the colors had different temperatures.

They did.

4d. But then Herschel measured the empty space just beyond the red light. Though no sunlight was visible, it was hot.

4e. Herschel had just discovered invisible infrared radiation.

4f. Humanity now knew there were forms of radiation that could not be seen.

5a. They could be anywhere. All around us.

5b. How many were there? What were they up to? What were they hiding?

5c. Obviously, we had to find out.

5d. A type of energy that travels through the universe in the form of waves is called electromagnetic radiation. The entire range of it, from high-energy gamma rays to low-energy radio waves, is called the electromagnetic spectrum.

5e. Although our eyes can see only visible light, we can build tools, like infrared-detecting cameras, to see other forms of radiation.

5f. These tools are man-made “eyes” that view invisible radiation for us, and transform it into pictures.

Objects can emit all kinds of radiation. Observing the entirety of that radiation gives us a true picture of an object.

6a. When we turn these tools on space, they open up the entire cosmos to us, in its full glory.

When we look at the night sky, we see stars and planets, galaxies and nebulae, in the form of visible light.

6b. But if we could see in infrared light, the sky would appear very different.

6c. For one thing, infrared light’s long wavelengths penetrate clouds of gas and dust.

6d. The shorter wavelengths of visible light are stopped and scattered as they fight through collections of particles.

6e-f. So by detecting infrared light, we can see through clouds of gas and dust to warm objects inside -- like just-forming stars.

7a-b. Objects that don't glow with any visible light of their own -- like planets -- are still often warm enough to radiate infrared light, perhaps allowing us to glimpse them.

7c. And by observing how infrared light from a planet's star passes through its atmosphere, we acquire clues about the planet's composition.

7d. The dust left behind by distant planets as they form will also glow in infrared, helping to show us how planets are born.

7e. So infrared helps us see objects like these in our own galactic backyard. But it can also help us observe the first objects that formed in the universe after the Big Bang.

8a. Imagine you gave a letter to the post office in a galaxy billions of light-years away, and addressed it to Earth.

It would travel for an incredibly long time.

8b. When it finally arrived at its destination, the person who opened it would be getting news from billions of years earlier.

The light from the first stars to shine in the universe is something like that. It left the stars ages ago and is still out there in space, traveling the vast distances between galaxies.

8c. If we could see it, we could see those galaxies as they were in the early universe. Essentially, we would be seeing back in time.

8d. But we haven't been able to see it. Why? Because the universe is expanding. As light travels across space, it's stretched like taffy by the expansion.

8e. The first stars gave off mostly visible and ultraviolet light, but the stretching changes those waves into infrared light. This is called "redshifting."

8f. The only way to see that light as it arrives in our region of the universe is to look for that faint infrared glow. By capturing it, we will be able to create images of the first galaxies to form in the universe.

By witnessing the birth of the first stars and galaxies, we deepen our knowledge of how the universe as we know it came to be.

9a-b. How did we get from those first blazing stars to the islands of billions of stars we see today?

9c. What will we learn about how galaxies grow and evolve?

9d. How did the chaos of the early universe transform into order and structure?

9e. NASA is currently building the James Webb Space Telescope. With its huge, infrared-capturing mirror and distant orbit far beyond the Moon, Webb will allow us to view the cosmos as we've never seen it before.

9f. Webb will search for signs of water vapor on planets around other stars.

10a. It will take pictures of the universe's infancy.

10b-c. Webb will reveal the hidden stars and solar systems forming within cocoons of dust.

10d. The answers to some of the universe's biggest mysteries – and more questions we haven't thought yet to ask – are waiting out there for us, in the form of infrared radiation.

10e. All we have to do is look.