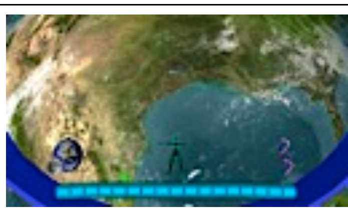
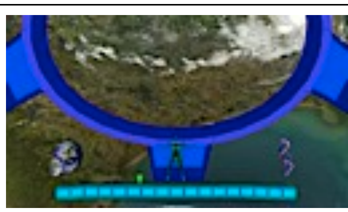
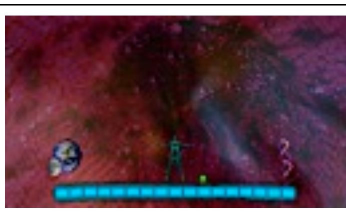
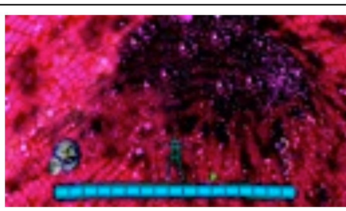
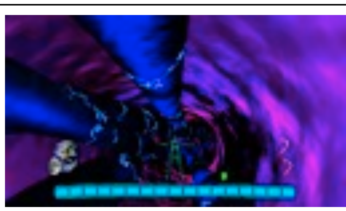
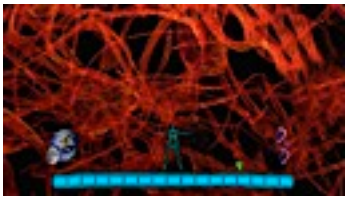
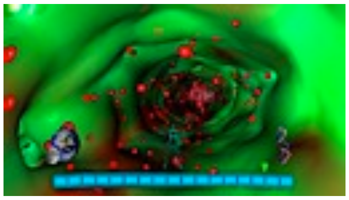
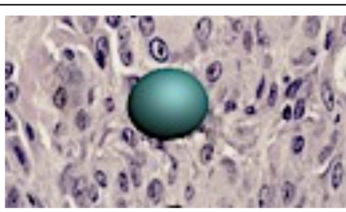
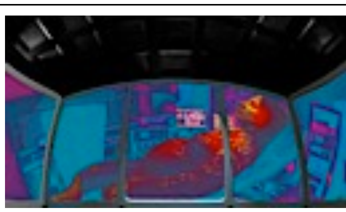
MICROCOSM

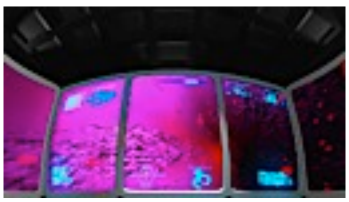
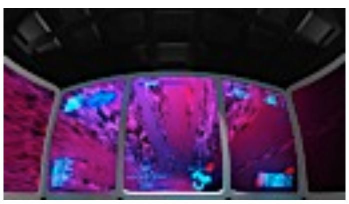
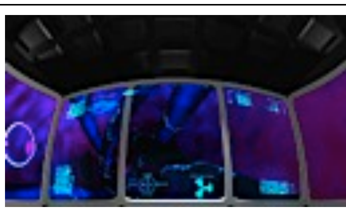
VERSION (SUBTITLES) REVISED: JULY 26, 2013

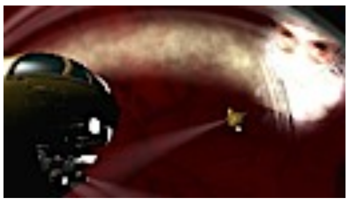
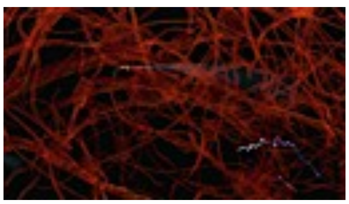
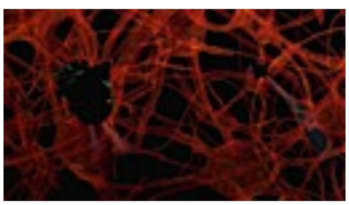
SCENE	TIME	SCRIPT
INTRO		**INTRODUCTION**
	00:01	We measure distance in units of ten - beginning with a human who is between one and two meters tall. Imagine a distance scale to show how big or how small things are compared to this person. The farthest we have traveled is 400 million meters - the distance from the Earth to the Moon. That is a number with eight zeros. The smallest objects we have seen through a microscope are the coils of DNA within the nucleus of a cell. This is a number with the decimal point moved eight places to the left. The scaled distance is the same - to the surface of the Moon or to the nucleus of a cell. A green arrow will show our size as we make this incredible journey.
	00:48	From the Apollo 17 landing site at Taurus Littrow, we must shrink distance by eight powers of ten to return to human scale.
	01:02	To the full Earth over 10 million meters in diameter.
	01:15	To a continent 5 million meters across.
	01:25	To a state over a million meters wide.
	01:32	To a city 100,000 meters across.

	01:40	To a neighborhood 10,000 meters in size.
	01:51	To a city park 1,000 meters wide.
	01:57	To a rooftop 100 meters across.
	02:04	Into a small observatory less than 10 meters in diameter.
	02:11	To a woman over 1 meter tall, watching the Moon.
	02:27	With today's technology, we can make a journey traveling inward by the same eight powers of ten.
	02:33	Shrinking two orders of magnitude, we're inside a human vein less than a centimeter wide.
	02:39	A millimeter spans the optic nerve carrying distant images from the eye to the brain.

	02:46	After shrinking ten thousand times, we're inside the brain, in a sea of nerve cells, some as short as 100 microns. We're half way down to the scale of a DNA molecule.
	03:00	An individual cell is only 10 microns wide, one hundred thousand times smaller than the human body.
	03:07	Inside the cell we find the nucleus - only one micron in diameter. Within the nucleus, are chromosomes, filled with strands of DNA only 10 nanometers wide.
	03:18	We are now one hundred million times smaller than the human body We've reached the genetic code that has programmed humans to journey to other worlds. We're in the Microcosm.
TITLES		**OPENING TITLES**
	03:56	MICROCOSM The Adventure Within
	04:05	At Rice University's Center for Nanoscale Science and Technology, there's a microscope that can see inward as far as a telescope sees outward. This transmission electron microscope takes us inside cells to the atoms making up the complex molecules of the human genetic code.
	04:23	Scientists can construct tiny designer molecules at this scale. Rice University has pioneered in the production of nanoshells or tiny glass spheres - smaller than the nucleus of a cell and coated with gold. These nanoshells absorb and reflect different colors of light. They can be tagged to attach to tumors or perhaps viruses. By absorbing external energy from infrared lasers, these nanoshells can overheat, and destroy a tumor or virus.

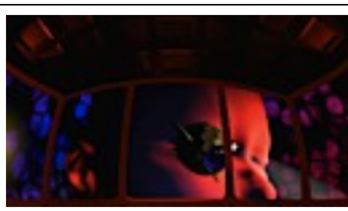
	04:52	Meanwhile scientists at the Texas Center for Superconductivity at the University of Houston using very sensitive superconducting magnetometers to detect weak magnetic fields produced by tiny electric impulses inside the heart and brain.
	05:05	In the future these technologies may lead to inner space experiences as real as our robotic voyages to other worlds.
	05:15	**ADAMS**: Welcome to the future. I'm Dr. Adams, your tour guide through the human body. All this equipment can turn a routine visit to the doctor into a body tour. We have recently installed viewing screens to watch our voyage from all directions. Behind the glass, with the patient is Dr. Butler.
	05:32	**BUTLER**: Hello, Dr Adams and welcome to the lab everybody. Mellissa's here for a pregnancy checkup. This is a simple procedure; we should be in for a smooth ride. I'm now scanning in high resolution mode.
	05:43	**ADAMS**: Once we used ultrasound to show mothers their babies. Today, this mother will fee like she's flying around her child.
	05:50	**BUTLER**: As you can see, Mellissa is in perfectly good... **ADAMS**: Is everything OK Dr. Butler? **BUTLER**: Look at the hot spots near her eye, ear, and heart. I think they could be sites of a serious infection. **ADAMS**: Yes, I see it. Should we evacuate everyone from the viewing area?
	06:03	**BUTLER**: No, there isn't time! I must inject the patient with nanoshells to locate and destroy the virus.
	06:11	**ADAMS**: Well, ladies and gentlemen, it looks like this will be more than a baby tour. Our projection screens show the inside of Dr. Butler's syringe with nanoshells tagged to find the virus. I'll show the location of our scanners by a yellow submarine. The submarine is designed to give you a feeling of presence inside the body. Dr. Butler, the simulation software is running. The viewing audience is

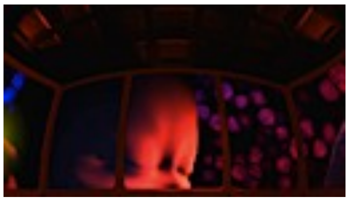
		prepared. Proceed with the injection.
	06:38	**BUTLER**: Injection in 3...2...1!! The nanoshells have successfully entered the blood stream. Now we must wait for them to reach the virus.
	07:05	**ADAMS**: Meanwhile we're going to do some virus hunting of our own. I've sent our scanners into the carotid artery.
	07:11	**BUTLER**: With the patient's elevated heart rate, prepare for a turbulent trip...
	07:15	**ADAMS**: You're right about that! But the scanners are holding their own. Our largest scanner is operating at the micrometer scale in an artery over five millimeters wide. To find the virus, we'll need scanners that are much smaller - ultimately down to the nanometer scale. The carotid artery is much larger than the viruses we're searching for. I'm powering our high resolution scanner now. To keep track of him, I'll project his position as a smaller submarine. The scout's high magnification images will appear on this holographic display above the main viewing screens.
	07:55	**BUTLER**: When your scanners are all operational, please proceed to the eye.
	08:22	**ADAMS**: Our scanners are now entering the optic nerve that leads from the eye to the brain's vision center. In the brain these electrical impulses are converted into highly detailed moving images.
	08:33	**BUTLER**: I just told the patient that we are imaging her eye, and she has just opened it. You should detect the light from the lab.

	08:39	**ADAMS**: Confirmed, yes we can see the light beam now. It's passing through the iris of the eye. And the eye's lens is focusing it into an image on the retina. Dr. Butler, we can see you looking down at our patient. Both you and the patient seem awake and alert. While we scan for the virus, we'll take a tour of the eye. Watch as light reaches the receptors of the retina. The retina has cells called rods to measure image brightness and other cells called cones to detect color. From the eye, image information travels along fibers of the optic nerve to the brain. There the image is identified and the patient can react to what she sees - all in a fraction of a second. What a fantastic system! Dr. Butler, I'm detecting no signs of infection here.
	09:28	**BUTLER**: Agreed. The eye looks healthy. I've just started a magnetometer scan on the cerebral cortex. Please proceed into the brain.
	09:41	**ADAMS**: We've entered the cerebral cortex. This is the command center for the entire body as well as the center of all creativity and intelligence - a super computer without equal. The brain is running the equivalent of 10 billion to one hundred billion micro-processes at the same time.
	10:08	**BUTLER**: The brain scan is normal; you can proceed to the ear.
	10:16	**ADAMS**: We've entered the inner ear, a labyrinth of fluid-filled canals. Some used for balance - others converting vibrations to electrical signals carried to the brain. We're preparing to cross the barrier between the inner and middle ear with the scout scanner going first. The ear drum lies directly ahead. You can see it moving in and out. As it vibrates, it shakes the three smallest bones in the body - the hammer, anvil, and stirrup. These bones transmit vibrations to the inner ear. This whole area appears to be free of infection.
	11:01	**BUTLER**: The patient says she had an ear ache last week. Perhaps you should look for signs of a past infection.

	11:08	**ADAMS**: The computers are scanning at high magnification: Wait ... look at this. Dr. Butler, you're hunch was right. We've found nucleic acid that does not match the patient's. These are virus fragments. The virus has been here, but the patient's immune system destroyed it and was probably weakened in the process.
	11:29	**BUTLER**: I'm analyzing the viral fragments in the lab, looking for a DNA signature. My analysis indicates that they were made in a cardiac cell. I recommend you proceed to the heart immediately. I suspect that you'll find the virus and the nanoshells there as well.
	11:46	**ADAMS**: I agree. We're preparing to leave the ear now - passing the ear drum and the hammer, anvil, and stirrup once again - then we'll go back through the inner ear on our way into the body. We've finally reached the superior vena cava. This vein carries blood to the heart from the head, neck and arms. The turbulence here is incredible, especially as we flow into the heart's right atrium. The tricuspid valve is opening and we're being pushed into the right ventricle. We can't go back, and we don't want to be pumped out to the lungs.
	12:48	**BUTLER**: Attach to the ventricle wall and hold on tight.
	12:50	**ADAMS**: We're trying. Our scanners are picking up a cell cluster on the wall near the apex. We've started looking for viral structures and nanoshells. We've definitely found the infection - and it's active.
	13:12	**BUTLER**: This is worse than I thought. The infection is in the mother's heart. And her vital signs are starting to drop. We can't risk waiting any longer. Please verify that the nanoshells are in place. Sending a laser into the heart is very dangerous without the nanoshell targets.
	13:30	**ADAMS**: I've increased the sensitivity of my scanners. We need much higher magnification to detect the nanoshells. The computer is initiating micro-miniaturization. Now we can see individual red disk- shaped blood cells. Our scan confirms the presence of a very large and aggressive virus. Dr. Butler, I can also confirm that there are nanoshells attached to the virus. You can safely engage the infrared laser to heat the nanoshells. Please hurry. The virus is multiplying and attacking our small scanners.

	14:13	**BUTLER**: The low power laser is in place and targeting the nanoshells. The laser beam will pass harmlessly through the heart until it reaches the nanoshells. The patient should not feel any discomfort.
	14:38	**ADAMS**: Our sensors show the effect of your laser. Some viruses are being killed, but not nearly enough to cure the patient. We need a more powerful laser to heat up the nanoshells.
	14:47	**BUTLER**: I've switched lasers. The high-energy laser will pump a lethal amount of energy into the nanoshells. Move your scanners away from the viruses for safety.
	14:56	**ADAMS**: Confirmed. Fire the new laser at will. It's working. The new laser is cooking the nanoshells. No virus can withstand this heat. Unbelievable! We did it! That was really close! Dr. Butler, are we still in danger?
	15:50	**BUTLER**: It appears that the lasers didn't destroy any of the patient's healthy cells. She feels no pain. I'll continue to monitor her vital signs.
	15:58	**ADAMS**: We do need to confirm that the virus has not spread. While we're here, I'm going to take my tour group inside a cell. This cell is like a small factory. Floating in its cytoplasm are networks of interconnected tubes moving proteins and fats. Elongated mitochondria are the cell's power plants - producing energy as they absorb oxygen and digest sugar molecules. Round lysosomes, like garbage cans, convert old protein molecules into small pieces for the cell to recycle. Everything seems to be virus-free, but we still need to inspect the nucleus. This will require a higher magnification sensor. These coiled DNA molecules contain all the information about how a cell grows and divides. Hidden in the DNA cords are the most complex chemical structures we have ever discovered. One strand of DNA contains over 4 million bits of information. And all that information can be put together in almost infinite combinations. That's what makes everyone different. Dr. Butler, everything looks fine here.

	17:15	**BUTLER**: Then let's give our patient and your group the tour we promised a visit to the baby.
	17:20	**ADAMS**: That will require a shift to lower-magnification sensors. The baby is much larger than a single cell. Recalibration with the sensors turned on can be quite an experience. Hang on! We're entering the womb. Be sure the mother is watching. We're passing under the umbilical cord.
	18:00	**BUTLER**: We're receiving your transmission here in the lab. And the mother is seeing her baby for the first time - a beautiful healthy boy.
	18:08	**ADAMS**: While you introduce the mother to her child, we'll continue to scan for any signs of the virus. It could still be here and we're just too big to see it.
	18:17	**BUTLER**: Scan as long as you like. We have a very happy mother just watching and getting to know her new son.
	18:23	**ADAMS**: We're testing the amniotic fluid for signs of the virus. Prepare to receive our data.
	18:29	**BUTLER**: The viral load in the blood stream is beginning to drop below infectious levels. My sensors indicate that the amniotic fluid is virus-free.
	18:37	**ADAMS**: Now we're checking the baby's reactions to external stimuli, to see if his responses are normal. The mother will probably enjoy watching his movements.

	18:46	**BUTLER**: At the same time, I'll monitor the baby's brain activity. Magnetometer data indicate that the baby is developing normally. The mother is also much more alert - a combination of the infection dropping and the sight of her healthy child.
	19:00	**ADAMS**: Knowing what just happened near her heart, we are very relieved, and are enjoying these few minutes with the new baby.
	19:07	**BUTLER**: All the results are in. I can confirm that the baby has not been infected. Both mother and baby are well.
	19:13	**ADAMS**: Thank you for joining us in this future simulation. We just attacked a virus at the nano scale and won! Congratulations! Best wishes for our patient, and her family.
CREDITS		**ENDING CREDITS**
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