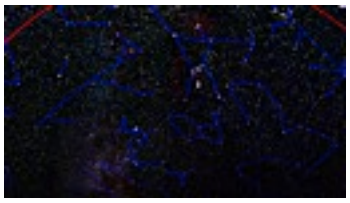
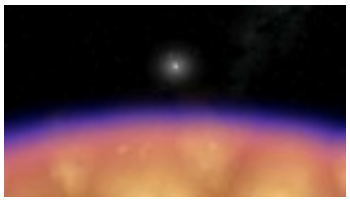
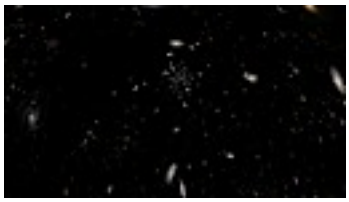
THE SEARCH FOR LIFE IN THE UNIVERSE

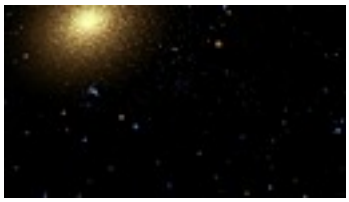
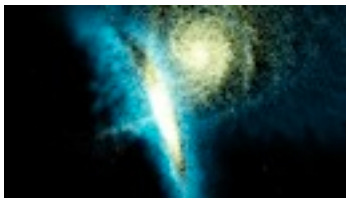
VERSION (SUBTITLES) REVISED: JULY 26, 2013

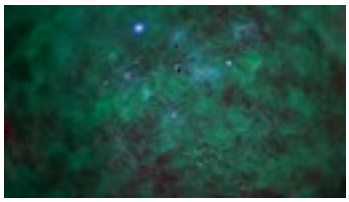
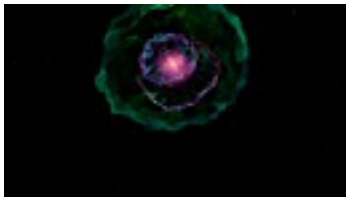
SCENE	TIME	SCRIPT
INTRO		**INTRODUCTION**
	00:03	Sunset in a city or suburb brings new lights, that outshine all but the brightest stars, leaving just a few stars scattered over the urban sky. If our atmosphere had always been this opaque, we might never have looked up and wondered about the size and shape of the cosmos or our chances of finding companionship there. *But far from city lights, the sky is the same as our ancestors saw, filled with stars, and rich in sky lore. For thousands of years, our ancestors worshiped sky gods, seeking to understand the connection between the stars and ourselves.*
	00:41	Throughout the world, different cultures connected the starry dots to recognize their mythical heroes. In Greek sky lore, this rectangle of 4 bright stars marked the hunter Orion's body and surrounded his distinctive 3-starred belt. In India, this was the warrior Skanda, son of Shiva. For the Native American Tewa tribe, Orion was Long Sash, who led his people to freedom. In Egyptian mythology, Orion was the home of Osiris, a pharoah-god who conquered death. His wife Isis, was the bright star Sirius.
	01:23	*Long before telescopes and modern astronomy, our ancestors saw living patterns in the starry night. The search for life in the universe is ancient - part of our human nature, our longing for companionship, our need to bring meaning and order to the cosmos, our desire to find other intelligent life among the stars.*
TITLES		**OPENING TITLES**
	01:46	The Search For Life In The Universe Narrated by Jim Bratton and Cecilia Ottenweller Score by Shai Fishman
	02:07	Our search for life in the universe begins with the Sun's orbiting planets. We will explore these alien worlds looking for life, past life, and for clues about why Earth is the most habitable planet in the solar system.

	02:21	Planets and moons of all sizes orbit the Sun, yet only one has intelligent life or perhaps any life at all. Why have these other worlds failed to foster life? What can they tell us about conditions for life to flourish?
	02:37	*Neptune is the most distant giant planet in our solar system. Although this methane-rich planet has the molecules necessary for life, they are in a deep freeze, without the energy of sunlight to fuel the birth of life.*
	03:20	Unlike any other planet, Uranus rotates on its side as it orbits the Sun, resulting in uneven heating of the planet's atmosphere, making the development of life less likely.
	03:43	*Saturn's famous rings are enormous; spanning over 175,000 kilometers from edge to edge.*
	03:58	*Saturn's rings are not solid, but contain billions of chunks of ice and ice-covered rock, ranging in size from pebbles to boulders. Their brilliance suggests that these rings are very young, created perhaps out of a cataclysmic event, or continuously resupplied by Saturn's icy moons.*
	04:21	*The solar system's most distant place to look for life may be Saturn's huge moon, Titan. The robot lander Huygens dropped through Titan's thick smog of nitrogen, methane, and ammonia to reveal the surface below. Titan has the atmosphere and chemical composition needed for life, but lacks an energy source to fuel its birth.*
	05:00	Solar energy increases as we move sunward toward Jupiter, a planet so large, it produces its own energy as it continues to shrink. Even with this energy source, life is most unlikely in Jupiter's violent toxic atmosphere.
	05:17	But Jupiter's large moons could harbor life. Io is an amazing world of dramatic change. Erupting volcanoes blasting material hundreds of kilometers into space, constantly resurface the moon. On Io, change is too violent and destructive and the surface is too unstable for life to develop.

	05:40	These long fissures are fracture lines in the icy crust of Jupiter's moon Europa. Any life that might be swimming below this icy surface would be simple and primitive. On Europa, the necessary conditions are present and there is a slim chance that life has developed below the ice.
	06:07	The scarred surface of Ganymede tells the story of impact on a vast scale. Ganymede has large cracks and linear scars that may be evidence for a slushy ocean trapped beneath and another place to search for primitive life.
	06:25	Callisto, outermost of Jupiter's four largest moons, possesses the most ancient surface. Although violence destroys life, life will probably not develop and evolve on an unchanging world like this.
	06:50	*In 1994, a fractured comet plunged into Jupiter, releasing the energy of a thousand atomic bombs. Any one of these comet fragments would have caused major damage on Earth, but Jupiter's gravity captured them, thus protecting the inner solar system. Development of life, may require a giant planet like Jupiter in the outer solar system to protect inner planets from life-threatening impacts.*
	07:34	The red planet Mars is at the outer edge of the Sun's habitable zone - the region where water can exist as a liquid. Ancient dried up riverbeds indicate that long ago, Mars was much wetter, with an atmosphere thick enough to support water as a liquid on its surface. Life might have developed here then, but today's dry and cold Mars cannot support the emergence of life.
	08:17	*Venus is Earth's neighbor, marking the inner boundary of the Sun's habitable zone. It has been called Earth's sister world, but a closer look reveals a nightmarish planet of intense pressures, extreme temperatures, and sulfuric acid rain. Unmanned Russian spacecraft landed on Venus, but survived only a few hours. Venus is the right size and distance from the Sun for life. Yet its atmosphere is poisonous and its surface is too hot for life to form.*
	08:51	Mercury, closest to the Sun, is a tiny desolate world of craters, cliffs and impact sites. Mercury is too close to the Sun's heat and high-energy radiation to be a habitable planet.

	09:24	*Comets can come closer to the Sun than Mercury. There are millions of these dirty snowballs in an enormous halo, far beyond the planets. While the tail of a comet may stretch for millions of kilometers, its solid nucleus is only a few tens of kilometers across. Comet impacts might have brought water and carbon compounds to the early Earth, and may also provide insights into the origin of life.*
	10:04	With its large habitable zone and 10 billion year life span, our Sun is an ideal star to have life bearing planets. In our search for habitable worlds we should look around other Sun-like stars.
	10:22	*Our solar system belongs to the Milky Way galaxy with hundreds of billions of stars and their families of planets. The Sun lies in a safe region between two spiral arms, far from the galaxy's center. Here stars are far apart and rarely pass close enough to dislodge comets or disrupt planet formation. We live in a place of long-term calm, within a galaxy that has a violent core, and very active spiral arms.*
	10:53	The Milky Way is just one of hundreds of billions of galaxies strewn across the universe in groups, clusters, and super clusters - almost all rushing away from one another. To understand the timeline of the universe and to discover when and where life might appear, we need to follow the motions of these galaxies backward in time to a point when all matter and energy were in one place at one time.
	11:25	Almost 14 billion years ago, everything we see today was concentrated in one super-dense region, heated to an incredible temperature by compression.
	11:38	Suddenly the expansion began in a burst of energy, called the Big Bang, creating our time and space.
	11:55	As the universe rapidly expanded and cooled, there was a critical time when the soup of elementary particles could combine into the matter we recognize today - mostly hydrogen and a little helium, in stable atoms made of protons, neutrons, and electrons
	12:17	*Over hundreds of millions of years, these vast clouds of gas gradually began to fall in on themselves, condensing under their own gravity, and producing enough heat and pressure in their cores to become stars. These newborn stars filled the universe with starlight, and began fusing the heavier elements that would be needed for life.*

	12:40	*The collapsing gas clouds that ignited the first stars, also formed galaxies of stars bound together by gravity.*
	12:49	Elliptical galaxies, like giant footballs, can contain a trillion stars with very little gas and dust left over for further star formation.
	13:01	Disks of starry arms and dark dust lanes characterize spiral galaxies. These stellar whirlpools contain tens or hundreds of billions of stars with vast areas of gas and dust condensing into new stars. Stars born more recently in these spiral galaxies are more likely to have the heavier elements needed for the development of life.
	13:28	*Galaxies tend to cluster in groups where their relative motions can cause a collision. Within galaxies, stars are so far apart that there is little contact during such a collision and any life forming processes may proceed without interruption.*
	14:01	Finally, we approach our home galaxy, the Milky Way. The Milky Way spiral has lanes of young hot blue stars mixed with clouds of gas and dust - regions with an abundance of heavier elements, but perhaps too young for life to have had time to develop or intelligence to appear.
	14:25	In the Milky Way galaxy, we can watch stars at birth and death, showing the past and future of our solar system. We can also discover when stars create the chemical building blocks of life.
	14:45	*The Triffid Nebula is in our own stellar neighborhood. Deep within this nebula, stars are forming in collapsing clouds of gas and dust. Our region of the galaxy has many such stellar nurseries - places of beauty, but probably too young for life. Our Sun was in such a birth cloud, 5 billion years ago.*
	15:17	*The Eagle Nebula is home to tremendous pillars of dust and gas that serve as a nest for newly forming stars. Here we can also watch as stars form from gas and dust.*

	15:36	Within the nearby Orion Nebula, we can see a reddish glow revealing the presence of hydrogen. Greenish hues indicate oxygen created by an earlier generation of stars - and now becoming part of the nebula's newborn solar systems. This stellar recycling and rebirth is the forge that creates all the basic elements from which planets and life develop.
	16:04	Passing deeper into the nebula, we encounter a spinning disk of gas and dust - a protostar. Such protostars not only house the slowly warming balls of gas that will someday ignite into new stars, but are themselves surrounded by clouds of material that may one day become orbiting planets.
	16:29	*A star produces energy by fusing its own hydrogen into helium and other heavier elements. When the hydrogen runs out, the star begins to collapse and die. One such star, Eta Carinae, is in its death throes and may destroy itself in the most violent of stellar deaths, a brilliant supernova. When a massive star like Eta Carinae exhausts its hydrogen, the fusion process shuts down and the outer layers collapse onto the core, rebounding in a shock wave that literally tears the star apart.*
	17:19	*While the bulk of the star is blown outward, the core itself implodes into a superdense sphere of neutrons, called a pulsar. This rapidly spinning core concentrates energy into beams, that flash by us like a lighthouse beacon - a signal created naturally, but like one we might expect from an advanced civilization.*
	17:46	Not all stars die so violently. When less massive stars like our Sun run low on hydrogen, they shed their outer layers into disks or lobes of expanding gas. The rest of the star collapses into a white dwarf, slowly cooling into a cold black cinder. At this point, the star can no longer support life on any of its planets. This is our Sun's fate in 5 billion years.
	18:28	Earth has orbited its stable Sun for 5 billion years and we can look forward to 5 billion more. Elements forged in long-dead stars are here in Earth's land, water, and air. Solar energy, a nitrogen atmosphere, liquid water, and moderate temperatures - are here as well to support the development of life.
	18:52	Telescopes search for planets orbiting other stars. Thus far a few hundred planets have been found, but most are giant worlds as large or larger than Jupiter. It is much more difficult to identify the gravity tug of a smaller Earthlike planet. We assume that where gas giants form, smaller rocky worlds may also exist.

	19:21	*With radio telescopes, we mount a more sophisticated search - looking for radio signals not made naturally, signals indicating the presence of intelligent life beyond Earth. Since the 1960's we have been listening and the Search for Extraterrestrial Intelligence, or SETI, continues. Searching nearby likely stars in specific radio wavelengths has yielded much data, but no unequivocal evidence of extraterrestrial intelligence. Yet the sky is large, and the search has just begun - continued by research centers, by amateurs with small radio telescopes, and by a worldwide network of volunteers, providing their computers to analyze data over the Internet.*
	20:08	We suspect that there may be millions of stars at the right age, composition, and location in the galaxy, to have planets where intelligent life has emerged. We wonder why we haven't detected a signal from these more advanced aliens. Perhaps we need more sensitive equipment, or perhaps we're not listening at the correct wavelengths. Perhaps Earth is more rare than we thought and intelligence does not occur often on planets, even on life-bearing worlds. Perhaps intelligence is common, but civilizations do not survive long enough to be detected at our unique time and place. Or perhaps intelligence develops, but turns inward, deciding to stay at home, rather than exploring the cosmos.
	20:57	Based on our own brief history, any one of these theories could be correct. Regardless, we are certain of one truth: our search for companionship in the cosmos will tell us much more about ourselves, and our own place in the Universe.
CREDITS		**ENDING CREDITS**
Copyright	21:21	2009, The Houston Museum of Natural Science
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