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# Lucy's Cradle

## The Birth of Wonder

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| The Hubble telescope orbits above the earth; turns around and lens cover opens.<br><br>1 | **The Burke Baker Planetarium Presents**<br>**Lucy's Cradle,**<br>**The Birth of Wonder**<br><br>For as long as humans have walked the Earth, we've contemplated the starry night sky … seeking to understand the connection between the heavens and ourselves.<br><br>Today modern tools like the Hubble Space Telescope provide us with a view of the universe unparalleled in human history.<br><br>Our vision now extends into the farthest regions of space and to the earliest moments of time.<br><br>*We wonder why we've found life only on Earth and when our ancestors first became aware of the universe. To understand why some worlds bear life, we will visit the barren worlds in our solar system. To discover when life became intelligent, we will journey to the grasslands of East Africa over three million years ago.*<br><br>**Act 1: Where Life Began** |

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| Flyby of Saturn | Over a hundred planets and moons of all sizes orbit the sun, yet only one has intelligent life or perhaps any life at all. Many of the outer planets, like Saturn, lie so far from the sun that the sun looks like a bright star in their cold eternal night. These are frozen worlds without enough energy from sunlight to fuel the birth of life. Distance from the sun is the first critical factor in the development of life. |
| NO VIDEO<br>Jupiter approach<br><br>Cross fade to Horizons cloud tops section. | Solar energy increases as we move sunward toward Jupiter. This is a world that produces its own energy by shrinking – generating heat as gravity reduces its size. Turbulent windstorms race through the cloud tops at hurricane speeds, creating bright zones and dark belts in Jupiter's atmosphere. Life is most unlikely in this violent toxic floating world without a solid surface. |
| The surface of Io with volcanic eruptions | *But Jupiter's large moons could harbor life. For instance, Io, closest of the large moons, is an amazing world of dramatic change. Its surface is always active with erupting volcanoes that constantly resurface the moon. But on Io, change is too violent and destructive and the surface is too unstable for life to develop.* |
| Camera tracks over Callisto limb | *Callisto possesses the most ancient surface. With highly eroded canyons and ice valleys, this world has changed very little since its birth billions of years ago. Although violence destroys life, life cannot develop and evolve on a world without any change. The barren Callisto is as poorly suited for life as the violent Io.* |
| Camera pans down Europa limb<br><br>2 | *Jupiter's moon Europa looks more like a cracked ice ball than a moon. It is a much less violent place than Io, but much more dynamic than Callisto. On its surface, long fissures mark fracture lines in the icy crust. Underneath could be a liquid ocean and possibly life.* |

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| | *Jupiter's moon Ganymede also has an icy crust. On Europa and Ganymede, water provides the medium and tidal forces with Jupiter could provide the energy. But any life below these icy surfaces would certainly be simple and primitive. The necessary conditions are present, but they cannot guarantee the emergence of life.* |
| Mars approach | Moving sunward we reach the red planet Mars. Although just half the size of Earth, Mars is a world of gigantic features like volcanoes larger than Mt. Everest, canyons the width of the United States, and ancient dried up riverbeds. Billions of years ago this world was much wetter with a thicker atmosphere that allowed liquid water on its surface. Life could have begun here long ago, but today's dry and cold Mars cannot support the development of life. Any life on Mars now hides below the planet's parched surface. |
| Venus approach | The Martian atmosphere is too thin to support life, but what about the much thicker atmosphere of Venus? Venus has sometimes been called Earth's sister world. But a closer look by Russian landers reveals a nightmarish planet of intense pressures, extreme temperatures, and sulfuric acid rain. This is a world of the right size and distance from the sun for life. Yet its atmosphere is poisonous and its surface too hot and oppressive for life to form. The RIGHT atmosphere is also critical for life. |
| Earth approach | *At last we approach the third planet, Earth, covered with fertile land and life-bearing oceans. Solar energy, atmosphere, liquid water, and moderate temperatures – all are here for the development of life. On Earth, life not only exists, but also has become intelligent and aware of its place in the universe. Once life appeared in the oceans of Earth, what conditions caused it to develop into organisms of many cells, complex designs, and eventually, self-awareness?* |
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| Comet fragments fall into the atmosphere of Jupiter | On Earth, the changing environment forces life to adapt or die. The most dramatic changes affecting life on Earth may have come from space. In 1994, a fractured comet plunged into Jupiter, releasing the energy of a thousand atom bombs. Any one of the comet's twenty fragments could have caused major damage on Earth, but Jupiter's gravity captured this comet, thus protecting the inner solar system. Development of life, especially intelligent life, may require a planet like Jupiter to protect inner planets from devastating impacts. |
| Footage for asteroid impact | Earth's last great impact occurred 65 million years ago. A 10-kilometer wide asteroid slammed into the southern Gulf of Mexico. Its fiery plunge created temperatures hotter than the sun's surface. Soot and floating ash could have blotted out the sun for months, possibly years. Dominant animals, like the *Triceratops* and *Tyrannosaurus rex,* could not adapt to the drop in temperature and loss of food supply. Up to 70% of all species perished, including all of the non-flying dinosaurs. |
| Ethiopian scene of lush vegetation – no signs of civilization fading into a world map | Afterward, the smaller mammals adapted to the new environments, claimed the land that had belonged to the giant reptiles, and flourished. But where on the planet would intelligence appear? And When? What conditions would create the cradle of humanity? |
| | **Act 2: When Life Became Self-Aware** |
| Large modis map<br>- 11 seconds<br><br>4<br>Add a DNA coil | *Today Homo sapiens sapiens is a worldwide species. Lights of human civilization cover the modern globe, showing humans living in all climates and conditions. The spread of modern civilization provides few clues about when and where humans first appeared. The answer may lie in a special molecule found in the nucleus of human cells. Humans are all one species sharing 99.9% of the same genetic code, written in this long strand molecule called DNA.* |

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| coming out of East Africa with the night sky ghosted in the background. Audience flies through the DNA molecule. | Three billion chemical building blocks called bases form the rungs of this DNA ladder. The chemical structure of these 3 billion bases is almost identical in every human of every race on every continent. Only about 3% of these bases actually determine our characteristics. The remaining sequences are never used by our cells, but help us track the migration of humans over the planet. |
| Fade to a stylized DNA – perhaps many strands that look different filling the dome. (Spaghetti effect) Zoom out a circle with many different DNA strands over Africa. Show circles with fewer strands according to script. | These colored bars represent the base pairs in a DNA sequence. Small changes occur when a DNA strand replicates these base pairs during cell division and when DNA is passed from parents to children. With each generation, the number of these differences increases. Human groups that have been together the longest show the most DNA differences from person to person.<br><br>*Tribes of southern Africa have the greatest genetic diversity and have therefore lived together the longest. The differences within the DNA of indigenous people in the middle East are much less. The genetic diversity is still lower in Europe, the Far East and Australia. The native tribes of North and South America have the fewest differences in their DNA. These variations in the amount of genetic diversity show the migration pattern of humanity. The lineage of all modern humans can be traced to a group of a few thousand adults living in East Africa, perhaps as recently as 60,000 years ago.* |
| Global animation<br><br>5 | Africa is a place of great geologic stability and of dramatic geologic change. It also contains the largest well-watered tropical landmass on the planet. About 20 million years ago, East Africa's Great Rift Valley began to form. This rift is an ocean being born, as land masses pull apart, leaving a sinking basin behind. First the Arabian Peninsula pulled away from |

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| Globe centered on Africa<br><br>Animation of changing geology of Africa. Show animation of motion Show flooding that takes Africa's horn | Africa, creating a valley that soon filled with water to make the Red Sea.<br><br>The Afar Depression is a triple conjunction where the spreading ridges that are forming the Red Sea and the Gulf of Aden emerge on land to meet the East African Rift. The Afar is slowly rifting apart as earthquakes create fissures that lower and widen the valley floor. Over millions of years, the Red Sea may erode through the highlands and flood this valley. In about 10 million years, the whole East African Rift could be submerged, forming a new sea as large as the Red Sea and leaving Africa without its horn. We are fortunate to be excavating this cradle of humanity when tectonic rifting has revealed so many buried early human fossils, but before these same forces flood this area forever. |
| Finding Lucy<br><br>Ethiopian Museum | *On November 24, 1974, archeologists Donald Johanson and Tom Gray were mapping the Hadar site in the Afar Depression. After a morning of surveying, they spotted a forearm bone in a nearby gully. Soon they saw a fragment of the skull bone and then a thighbone, some ribs, a pelvis, and the lower jaw. After two weeks of excavation, the team recovered several hundred fragments, representing 40% of a single skeleton called Australopithecus afarensis. This fossil became the most famous inhabitant of the Ethiopian National Museum in Addis Ababa. The skeleton was named Lucy from the popular Beatles song – "Lucy in the sky with Diamonds". Ethiopians call the famous fossil Dinkenesh, meaning "you are wonderful".* |
| A much greener Africa<br><br>6 | A dramatic change in Earth's global climate may have produced conditions that favored the development of humans in East Africa. For most of geologic time, the world's climate was warmer and more stable than it is today. The Sahara Desert in North Africa was much greener and more fertile. |

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| Roll down to Antarctica | But the climate became dryer and more seasonal when Antarctica drifted over the South Pole. Enormous ice sheets trapped water from Earth's oceans, leading to the dryer global climate. |
| Roll upward to the Arctic | While Antarctica drifted over the South Pole, the North Pole was also in a state of change.<br><br>Drifting continents in the northern hemisphere were gradually changing ocean circulation patterns in this hemisphere as well. Over time, the Arctic Ocean became almost land-locked at the North Pole. |
| European ice age<br>-- stop with view of Africa on horizon. | Continents and islands surrounding the Arctic Ocean were also ice covered, trapping even more water. These Arctic and Antarctic conditions blocked the flow of warm water from the equator to the poles and encouraged the accumulation of ice at both poles.<br><br>With the appearance of ice caps, global temperatures dropped and ice periodically covered northern Europe. These ice ages brought drier and more severe seasonal weather to the planet. In Africa, they caused many tropical forests to become grasslands. At this time our distant ancestors gradually left the trees and learned to thrive in the new open savannas and in the new more extreme seasonal climates. |
| Lucy skeleton standing upright and then walking in grassland pan | *Lucy embodies these early human ancestors. She lived over three million years ago and was about the height and weight of a young girl today. She was fully bipedal – walking upright on two legs. By standing upright she could look over the grassland, cover longer distances, spot predators, and regulate her body temperature more efficiently.* |
| Lucy's skeleton hand and then skull | *Lucy's hands were humanlike, but her fingers were slightly more curved. Her brain was less than a third the size of a modern human brain and she* |

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| Fade walking lucy and begin pan sequence | *had an ape-shaped head with a forward-thrusting jaw. Because she walked on two legs, she would probably have recognized the sun and the cycles of day and night – or at least reacted to changes in light level. Although she walked on two legs with her hands free, there is no evidence that she made or used stone tools.* |
| Exhibit pan sections A and B, | Based on the fossil record of East Africa, we can show the changing appearance and environment of our human ancestors, beginning 5 million years ago. Ardipithecus is an early proto-human who walked upright, but probably made his home in shady forests, rather than open savannahs. |
| Section C<br><br>Lucy section - D | Australopithecus afarensis appeared almost 4 million years ago as the environment of East Africa was changing from tropical forest to open grassland. Lucy is an Australopithecus afarensis. She could retreat to the trees to protect her young, but walking upright helped her gather food and avoid predators on the open plains. |
| Australopithecus Garhi section – E and F | Australopithecus garhi lived less than three million years ago. He was taller than Lucy, but had her protruding apelike facial features. Crude stone tools discovered nearby indicate that this proto-human was a scavenger and could butcher meat, providing a diet rich in protein and fats. |
| Homo habilis section G and H | Homo habilis, the first species of the Homo genus, lived about two million years ago. His jaw was less protruding and his increased brain capacity was about half that of a modern human's. Homo habilis was probably both a scavenger and a hunter whose larger brain enabled him to track the flights of vultures toward an animal carcass or follow the triumphant laughs of a feeding hyena. |
| P.boisei section - I 8 | Paranthropus boisei lived at the same time as Homo habilis, but was much more muscled and had massive teeth designed for chewing grubs and hard- |

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| | shelled nuts. His restricted diet may have led to his extinction while early humans survived on a variety of plants and animals. |
| H. erectus section J | The very adaptable Homo erectus had a brain about 75% of a modern human's. With stone axes and cleavers, he could make his own clothing and shelter. Mastering fire he could also tolerate colder temperatures and cook a greater variety of foods. His complex social groups required language to communicate feelings and expectations. |
| H Idalto section of pan - K | The first modern human, called Homo sapiens idaltu, lived 160,000 years ago, near the shore of a fresh water lake, along with hippos and buffalos, which he hunted and killed using advanced stone tools made from volcanic rocks and glasses. These early humans may have had funeral rituals using fire to cremate their dead. |
| Modern Humans - L | Fossils found along the East African Rift Valley, have allowed modern humans, Homo sapiens sapiens, piece together an ancestry shaped by adaptation to a dramatically changing environment – a condition that favored the development of intelligence, problem solving, communication, and community. |
| Volcanic super-eruption | About 74,000 years ago, a mega-colossal volcanic eruption, called the Toba Event, covered the Earth in ash, ejecting 2,000 times as much material as the 1980 Mount St. Helens eruption. Ash and sulfuric acid, carried westward by prevailing monsoon winds, destroyed life across India, the middle east and northern Africa. The eruption lasted perhaps two weeks, but the resulting volcanic winter significantly altered global climate for the next thousand years, causing both drought and famine. |
| 9 | This eruption may have caused a global human population crash with perhaps only a few thousand humans surviving. Under the severe |

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| Pull back to show death pan | environmental stress caused by the cold and dark volcanic winter, the surviving humans had to develop new levels of cooperation and greater technical skills and tools – skills of invention and collaboration that would eventually empower them to expand and dominate the planet. |
| | **Act 3: When Life Learned to Wonder** |
| Dome filled with constellation artwork<br>Highlight Orion | *Sky myths and patterns show how surviving human civilizations around the world have adapted to different environments and developed a heritage of legends and heroes.* |
| Add mammoth tusk beside Orion in sky.<br><br>Dead Sea Cave with Orion pattern | *The oldest known star map is an image of a hunter scratched on a mammoth tusk over 30,000 years ago. This figure with arms and legs outstretched is posed like the Western constellation Orion, including the hunter's sword. The hunter Orion is also mentioned in the Biblical texts of the Dead Sea Scrolls found in caves at Qumran on the Dead Sea's northern shore.* |
| Rural Ethiopian pan | *Farming and settled civilizations led to regular observations of the sky. In Ethiopia, the ancient land of Lucy, farmers used the appearance of specific stars in the Orion region to set their annual calendar. As agriculture became more efficient, there was time for science, religion, calendar making and watching the heavens.* |
| Show Axum<br>Show obelisks<br><br><br>Obelisk close up<br>10 | In the architecture of Ethiopia, we also find modern expressions of the complex relationship between humans and the stars. Stone monoliths dominate Axum, the capital city of the ancient Axumite kingdom over 2,000 years ago. These obelisks have a rectangular base with a false door carved on one side. Elements like small windows and disk patterns decorate the shaft. These obelisks were erected as funerary markers and their structure may symbolize a tower leading to heaven. |

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| Show church in distance, zoom to close up of church<br><br>Show inside with ceiling filling dome | Within the ancient city of Gondar in the Ethiopian highlands, lies the 300-year-old Debre Berhan Selassie Church, its name meaning "Trinity at the Mountain of Light". Two arched doors lead into the rectangular sanctuary. A monk painted the interior of this small Sistine Chapel. He gathered the colors for his paintings from local rocks, soil, plants and the blood of animals. ~~Inside~~ the faces of angels appear in rows between the ceiling beams. They stare down with large eyes etched in kohl, a black substance Africans use to darken their eyelids. Each of his faces has a different expression and all eyes appear to follow you around the room. Here the connection between the Earth below and legends of the sky above is very real and personal. |
| Observatory animation | *Modern astronomers search for a new relationship between humans and the universe beyond. They travel to mountaintop observatories to explore the cosmos – looking far beyond constellation patterns – seeing farther with each larger telescope. They also watch the motions of stars for evidence of planets beyond our solar system that could harbor life.*<br><br>*These astronomers are continuing a magnificent journey of human vision that began over 3 million years ago when a young female peered over the grassland of East Africa and saw the distant horizon beyond her fingertips.* |
| Credits | |
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