1491: The Untold Story of the Americas Before Columbus
Episode 106 - SCIENCE & TECHNOLOGY

Opening Title Sequence – Narrator - 00:12

We are the first people of the Americas. We have been here from the beginning. Our ancestors navigated by the wind and stars... crossing vast oceans and mountain ranges, searching for new lands. Over thousands of years, our ancestors became astronomers and architects... philosophers and scientists... artists and inventors. We created distinct societies and built vast trade systems that covered two continents. In 1492, our world was changed forever, but we did not disappear. Today, the languages and teachings of our ancestors remain, and these are the untold stories of the Americas before Columbus.

The Americas were home to ground-breaking achievements in science and technology long before 1491. In Mesoamerica, Indigenous people developed a complex writing system, calendars, and books. In South America, a precise accounting machine was created more than 5,000 years ago. Throughout the Western Hemisphere, sophisticated knowledge and the use of plants as medicine has been practiced for thousands of years. Some achievements, like the earliest use of the number zero, and brain surgery, were among the most advanced in the world for their time. Indigenous men and women gathered, studied and administered thousands of species of plants for healing purposes. These skilled ethnobotanists adapted plants for use as sedatives, painkillers, and other types of medicines.

Dr. Ruben Mendoza – 02:30

Native peoples had a very ancient and traditional practice... But there were multiple dimensions to it. Some of it was as essential as herbs and ethnopharmacology, as we call it, in other words, a botanical repertoire of things that are medical. The reality is, much of the medical tradition we have here in the Western tradition is born precisely of those herbs and their alkaloids and the way in which we've extracted them.

Narrator – 03:02

Indigenous medicine was not simply a process of preparing plants and offering them to a sick person. Healers had a deep knowledge of plant chemistry and how different plants interacted as medicines.

Dr. Ruben Mendoza – 03:15

In the Western tradition, there's a tendency to engage in a primitivist rhetoric about Native American medicine, the idea that, "Oh, well, it's about superstition, and it's about evil spirits, and it's about herbs..." because some of the people could literally walk through a forest and identify plants and their curative properties simply from visual inspection alone such that the chemovars, which are the active ingredients that allow for the healing or the relieving of symptoms, could be relieved, and they knew which plants those were.

Dr. Eldon Yellowhorn – 03:48

One of the more common plants that was used is a plant known as yarrow, and yarrow is... it's a very good example of a curative plant, because this was one that was put on wounds and cuts because if you take a yarrow plant and then just chew it up, you masticate it, you release all the alkaloids that are in there, and you put it onto an open wound, it actually has properties that will cause the blood to clot faster, but other plants such as sweetgrass, these are plants that are used

more in ceremonial uses, where if you were starting a ceremony, and you put sweetgrass on there, coal, and the smoke from the sweetgrass has the properties that you're looking for.

Dr. Ruben Mendoza - 04:41

For those who don't buy the idea that herbs can cure us, the reality is much of the medical tradition we have here in the Western tradition is born precisely of those herbs and their alkaloids and the way in which we've extracted them.

Narrator – 05:00

Today, many modern pharmaceuticals trace their origins to medicines developed by Indigenous people.

Dr. Eldon Yellowhorn – 05:09

Aspirin, you know? Acetylsalicylic acid, which comes from willow or aspen, the bark. This was a very common one that was used from ancient times, and the active ingredient was isolated and was then used to become aspirin in modern times.

Dr. Ruben Mendoza – 05:30

And many of those plants and many of these people were being used by the medical industry to find those very substances, and many of those have been introduced into our medical tradition, but in the forms of capsules and pills and injections, and thereby, the American Indian is taken out of the equation, though they are the discoverers and innovators of these medicines. One of the ancient manuscripts that came down to us had an entire listing of plants used by the Aztecs, and there was an incredible period in which, after having examined that book and its curative properties, or the properties of the plants identified, one of them spoke of a disease that basically engaged the withering of the human body, and ultimately, the death of the individual, and it was supposed to be a means by which to relieve the symptoms and/or cure the disease, and those that were studying this document came to the conclusion that it was a plant that had curative properties to defeat cancer.

Narrator – 06:31

There's a range of treatments for cancer and other diseases in use today that are based on medicines originally developed by Indigenous people.

Dr. Eldon Yellowhorn – 06:40

One of the plants, common plants that was used in the pharmacopoeia of traditional healers was the yew tree, and that bark of yew tree has also been used in breast cancer treatment, because that's where the active ingredient of Taxol is taken from, that plant.

Narrator – 06:57

Through a holistic approach to healing, Indigenous medicine men and women of the Americas combined herbology with spiritual care.

Dr. Eldon Yellowhorn – 07:08

When people used them traditionally, they would be used in a complex with prayers and ceremony, and, you know, you can't underestimate the power of the ceremony.

Surgery - Narrator – 07:45

Brain surgery was being practiced throughout the ancient world as far back as 7,000 years ago. In both North and South America, thousands of skulls with evidence of surgical treatment have been found, which demonstrates that this specialized medical practice was widely used to treat injuries and sickness. The precision of these operations and their high success rate is evidence of advanced surgical skills by Indigenous people.

Dr. Ruben Mendoza - 08:25

The archaeological evidence makes clear, from mummy bundles in Peru to excavated burials in Mesoamerica, that cranial trephining, or the surgical removal of bone plates from the skull, for the purposes of brain surgery or the surgical removal of tumours and the relief of blunt force trauma was a reality.

Dr. Eldon Yellowhorn – 08:36

It was very common. You find skulls in archaeological sites here on the coast, and they've obviously done trepanation, and the person survived, because there's been healing around the scars on the bone.

Dr. Ruben Mendoza – 08:50

In a survey of over 10,000 crania with evidence of trepanning, it is clear from the surgical practices that were conducted that over 70% of the individuals who had suffered blunt-force trauma and then had the blunt-force trauma relieved by virtue of cranial trepanning survived. You might say, "Well, yes, you have 70% of some 10,000 crania showing healing..." osteitis, as we call it... "but what does that mean?" If you look at it from the perspective of forensics and osteology, it was a practice engaged in when you were dealing with the potential death of a casualty of blunt-force trauma or other illnesses. The Inca emperor would have the equivalent of six physicians carry his litter. These physicians were known as yauyo, and the yauyo were all trained in skull surgery. We can no longer contend that this practice does not have a medical correlation. It wasn't witchcraft. It was medical innovation that came into play thousands of years ago.

Narrator – 10:00

Head trauma wasn't the only serious injury treated surgically by Indigenous medical specialists.

Dr. Ruben Mendoza - 10:06

The Aztecs engaged in something that involved compound fractures... for example, to the arm or leg. Individuals on the battlefield were often subjected to this treatment. Individuals who had compound fractures were likely to lose the limb unless something could be done immediately, and so surgeries were conducted in which, for example, the sutures would be made of hair. Urine was used to wash the wounds, and they would open up the arm or the leg, and the long bones that were broken would actually be reattached by virtue of an intramedullar nail. This is basically the equivalent of a spur of bone or wood that would be inserted into the bone itself, and they would be reconnected, thereby allowing for the long bone to be healed, and eventually, the individual to fully

recover. That's a system that was only reintroduced in the 20th century. These are traditions that appear all over South America, Mesoamerica, North America, and I would contend the fact that they exist, and they exist so broadly and through such remote antiquity, would contend that ancient Native Americans had an incredible grasp on science, technology, and medicine well into the remote past.

Astronomy - Narrator – 11:43

The oral histories of Indigenous peoples throughout the Americas include references to the sun, moon, stars, and planets. Solar and lunar eclipses often coincided with political and cultural events that continue to be commemorated hundreds of years later. In Mesoamerica, the planet Venus was central in the development of the world's most sophisticated ancient calendar systems, while in Central North America, the Blackfoot and other Plains Nations relied on the stars and planets to time their hunting and harvesting seasons and to interpret the forces of nature.

Dr. Eldon Yellowhorn – 12:25

Ancient people had a lot of knowledge about stars and the movement of stars and the night sky. If it's clear skies, you go out and you look at the stars, and people were able to make sense out of all of this, and one of the things that I've seen over and over again is how people used lunar calendars, devised lunar calendars. Traditional calendars always had 13 moons that they recognized, and that would be equivalent to months for us. We also have to calibrate your lunar calendar with the solar year, and people recognized that there is certain number of moons within a solar year, so how do we know when we've left winter, the winter part of the calendar, into the summer? Well, they used the Pleiades, because there's only one season where the waxing crescent moon and the Pleiades will share the same part of the sky, and when they see this, they know that that's the start of the first moon of summer, so this would be a way of calibrating their lunar calendars.

Narrator – 13:33

These lunar calendars were vital for predicting the shifting of the seasons, the migrations of herd animals, and the emergence of berries and plants that Indigenous peoples harvested.

Dr. Eldon Yellowhorn – 13:47

Or if you know that a certain constellation is only visible in the wintertime, you can then make plans about, "When this constellation disappears, we're moving into a new season." By knowing the relative position of the stars, the Seven Siblings, in relation to the North Star, they can determine, you know, things such as travelling, navigation, or using them for calendrics. So knowing these types of movements of the stars, they were able to develop star lore about it, and in this way, they can make plans. They can avoid travelling at certain times, or maybe using certain seasons. Lunar calendars are so common, you know. Everywhere you go in the world, you'll find lunar calendars. That's the most common form of calendar that people devise, because if you have devised a lunar calendar, then you can start making plans several moons in advance.

Narrator – 14:54

The Blackfoot weren't the only Indigenous people to depend on the night sky for guidance. In the far north, during the darkness of winter, the stars provided clues to the passage of time.

Dr. Eldon Yellowhorn – 15:12

Inuit people who had to deal with the fact that parts of the season, there is no sun, how do you know morning from night, or afternoon from morning, if you have no sun in the sky? Well, they recognized that certain stars parallel the sun, so even if the sun is not in the sky, they can distinguish whether they're in the a.m. hours or in the afternoon hours by being able to make the association between a certain star and where the position of the sun is.

Maya Calendar - Narrator – 15:46

The most advanced calendar systems developed in ancient times had their origins in Mesoamerica. Believed to have been developed first by the Olmec, it was later refined by the Maya and Aztecs.

Dr. Ruben Mendoza - 16:01

With settled village life, you have a demand for produce, agriculture. All of these things have to be set on a calendar. The Maya did that to a level of accuracy that's almost unheard of. They were able to calculate the solar year to 365.252 days. They were able to do this by virtue of the so-called Metonic calendar, *calendario metonico*. This system was used by very few world civilizations, and those who did were able to calibrate the solar year by using the lunar cycle. In order to record time, the Maya went one step further. They had a Venusian calendar, or a Venus-based calendar, they had a lunar calendar, they had the Tonalpohualli, which is essentially the agricultural or Sacred Almanac, and then they had the solar year. Each of these was being calibrated, and in looking at these different systems, what they were able to do was they took a fixed point in time, and having set that point in time, August 13th of 3114 B.C., they began counting forward in time. Every day from that point constituted the beginnings of what we might call the Long Count.

Narrator – 17:17

Besides being central to their calendar system, Venus played a prominent role in the cosmology and spiritual world of the Maya culture.

Dr. Ruben Mendoza - 17:25

It was often, for the Maya, referred to as the Wasp Star. It was this creature, and it's often identified with war and conflict, and if you've ever travelled in areas like Guatemala or the Yucatan Peninsula, at night, the stars come out, and what you see cresting the canopy of the sky is this massive K'awiil Vision Serpent. It is literally, if you look at it carefully... the Milky Way looks like it has an open maw at one end and a tail at the other, and that is what they saw, and every so often, the planet Venus, as the morning and evening star, as we call it, will appear at one point, and then it goes into retrograde motion and disappeared below the horizon, and then it reappears in another place, so it was deemed the divine twin. So the twins appear in the mythologies of virtually all Mesoamerican peoples.

Narrator – 18:19

The Maya are recognized for more than their advanced calendar. They were the first civilization in the world to use the number zero in their counting system.

Dr. Ruben Mendoza – 18:30

There was an early finding back in the 1930s of a monument that dated back to about 150 A.D. Once the fragments were brought together and other glyphs were found, they realized that they

had a bar-and-dot numeral system, and what made it or completed it as a system that was something more than just finger-counting was the concept of the zero. They invented the zero, and the zero allowed to create numerals that extended well beyond the billions, at a time when we have to wonder why they would be counting into the billions and the trillions, and even beyond. It was invented independently in the New World by the American Indian, by either the Maya or other Mesoamerican peoples. It extends well before the Common Era, so at least three centuries prior, so we're looking at about 2,300 years ago, this system... if not at that point, perhaps earlier... had already been invented... the zero, the bar-and-dot numerals, and the founding of the calendrical system.

Narrator – 19:35

The Aztec civilization developed their own dual calendar system. Their lunar calendar had 13 twenty-day months, and was used for agricultural purposes. The Aztec also had a sacred solar-based calendar.

Dr. Ruben Mendoza - 19:50

The solar year was also charted, and that solar year consisted of 18 months of 20 days, and so for 360 days, with five days that the Aztecs referred to as nemontemi.

Narrator – 20:02

The Aztec Day Count calendar and the Maya Short Count calendar each had 260-day cycles.

Dr. Ruben Mendoza - 20:09

The Short Count is really something that developed after the Long Count. Those are two systems that we know from contact with the Aztecs, but we also know that the Maya were able to introduce a level of precision that we don't see in the later systems.

Mesoamerican Writing - Narrator – 20:23

By studying the sun, moon, stars, and planets, our ancestors developed advanced calendar systems and planned their lives around the changing seasons.
The origins of a written language in Mesoamerica can be traced to a 3,000 year-old Olmec stone tablet found in eastern Mexico. Hundreds of years later, the Maya developed a complex writing system that used symbols to represent sounds and words found in the Maya spoken language. Most Indigenous peoples in the Americas recorded their history by passing it down orally from one generation to the next. Mesoamerica had the only written language, and it was recorded using 800 unique hieroglyphs.

Dr. Ruben Mendoza - 21:30

The glyph system is an amazing contribution. Bear in mind that there were only five world civilizations that produced literate traditions, and contrary to what one of my professors used to tell me in graduate school, that the Maya did not write histories, the Americas were a place non-literate and prehistoric, the reality is, the Maya completely dispensed with that whole thing, and it wasn't so much that the Maya were a non-literate tradition, it was that we Western scholars were incapable of understanding this literate tradition. We couldn't read it, and therefore, it was irrelevant.

Narrator – 22:06

Maya writing was painted on walls and pottery, carved in stone, and written down on bark paper in books known as codices. While many of these books were destroyed by the Spanish after 1491, some murals and sculptures still exist that describe day-to-day life and important events like battles and conquests. The language used to record the Maya world reveals a culturally rich, storied civilization that placed a significant value on preserving its history for future generations.

Dr. Ruben Mendoza – 22:40

We now know it to have been a fully literate tradition with over 800 characters, and it was not only logographic, but it was also phonetic. Just as we write in block letters and italics, they had more fonts than you can imagine.

Narrator – 22:57

Today, close to 90% of Maya glyphs have been deciphered, revealing a wealth of knowledge about this civilization. About 2,000 years before the birth of a written language in Mesoamerica, a unique system of information storage was invented in South America. The discovery of a knotted string device called a quipu in the 5,000-year-old city of Caral makes it one of the oldest record-keeping instruments in the world. Quipu was a coded accounting system for both small and large societies in South America. Information and data was recorded using multiple strands of knotted string or rope strung together along a main cord.

Dr. Henry Tantaleán - 23:40

It's an accountability device. It's an artifact for to get numbers, recording quantities, and qualities, of products. It's like a computer. Because a society so complex as Caral needs to have organization about the work that you need to build a pyramid. You need to have organization of the numbers of the sharing people and the products that you are taking or sharing.

Narrator – 24:16

Almost 4,000 years after quipu was used by the people of Caral, they were still an important record keeping tool in Andean cultures, including the Inca Empire. One of the main functions of quipu was to record numbers such as population, tributes, and levels of crop and art production.

Dr. Ruth Shady – 24:40

We found a quipu that dated to 700 before Christ. We deduced that the quipu was not Inca because it was from an earlier period and it had certain characteristics that differed from the Inca ones.

Narrator – 24:56

But another quipu sample found at the Caral site proved to be far older.

Dr. Ruth Shady – 25:02

When we found the quipu in Caral, it was the same as the quipu we found in the huaca at San Marcos University. There was no doubt that it was a quipu with all its knots and everything. We talked to quipu specialists to confirm the finding. Then we took two strings as samples and sent them to an American lab so that we could get the quipu dated. The date came back as 2,560 to

2,580 years before Christ. This coincided with the Caral dates. They invented the quipu, which later became more sophisticated and was widely used during the Inca times.

Narrator – 25:55

The oldest quipu from Caral were made from cotton, while those from the Inca period were usually made from alpaca wool. Information was recorded on the device through variations in the cord colour, length, type of knot, location on the string, and even how the cord was twisted. The quipu had a base-ten numeric system. The knots were made at specific intervals to indicate groups of tens, hundreds, and thousands. The Inca had highly trained information-keepers who recorded the data and also memorized the stories connected to it. Some researchers have suggested that the quipu was also used to record oral histories and genealogies, but if this is true, it would be challenging to decipher these stories today.

Dr. Ruth Shady - 26:50

In social aspects their system was also very complex such as political and social hierarchies. And they created the basis of what would become an organized system that would be used all throughout the Andes until Inca times.

Intuit Technology - Narrator – 27:06

The fact that quipu was in use in South America for several thousand years demonstrates the important economic and record-keeping role this device had in successive Andean societies.
The ancestors of today's Inuit people have lived in the Arctic region for about 5,000 years. To adapt to one of the world's harshest climates, Northern peoples developed a wide range of innovations for hunting, shelter, and clothing that ensured their survival.

Michael Kusugak - 27:59

We lived in igloos and sod huts, you know, all winter long, and we would travel mostly out on the sea ice hunting seals all winter, because that's what we lived on, seals. We would travel, and when we stopped, we would build an igloo, and we would, you know, spend the night and go travelling the next day, or if the hunting was good, we would stay for a while, but mostly in the winter, we lived on the sea ice.

Narrator – 29:18

Seals were the staple food source of the Inuit, but caribou and other game were hunted for meat and hide.

Michael Kusugak - 29:30

In the winter, we wore coats that were made of caribou skins. The inner coat we wore with the fur on the inside, right up against our skins, and on top of that, if we were going to be outside for long periods, we wore another coat, qulittuq, which is a coat with the fur on the outside, sealskin. These coats were made in a very special way, so that, you know, they weren't too bulky under your arms, and they gave you, you know, free movement, and... they'd been designed, you know, a long, long time ago, and they're still used that way today.

Narrator – 30:21

One of the necessities of Arctic survival was a dependable source of transportation, which included sled dogs.

Michael Kusugak – 30:29

We made all our sleds. We made all our own harnesses for the dogs, and even the little booties. In the spring, when the ice was really sharp, they would, you know, cut the pads on their feet.

Narrator – 30:41

The origins of domesticated dogs in the Arctic dates back more than 4,000 years. Historically, their primary role was to work with hunters to track seals and other prey. The earliest archaeological evidence of sleds with dog harnesses dates back about 800 years.

Michael Kusugak – 31:00

When we had regular sleds, you know, which are maybe 12, 14, 16 feet long, we would have about eight, nine, ten dogs to pull the sled. A lot of the runners of our sleds used to have caribou antler that was shaped to be thin and flat, and that's what we would use on our little sleds, you know, little sleds about this big.

Narrator – 31:28

To protect their eyes from the harsh glare of the sun and snow, the Inuit devised a unique type of snow goggles.

Michael Kusugak – 31:36

They're mostly made of bone, like caribou antler, you know, and with a little slit, and the nice thing about them is that they don't fog up, you know? Unlike regular sunglasses, you know, they don't fog up, because they're just slits, and they're, they're really good for, you know, getting rid of the glare, because in the spring, where we come from, you know, the sun is up all the time in the summer, and we get glare off the ice and snow.

Narrator – 36:14

In the summer months when the Arctic ice would melt, dog sleds were replaced by small skin boats.

Michael Kusugak – 36:22

We built qajaqs, and the qajaq was invented because we have so little wood, you know. Where I grew up and where I come from, we don't have any trees, so wood was very, very scarce. To build a qajaq, you use very little wood, you know. The ribs are made out of wood, of course, usually, and I suppose, in the old days, you know, they were built... a lot of them were built out of bone, you know, like whale bone and seal bones and caribou bones, caribou antlers, and that kind of thing. I think it's absolutely amazing how people can survive, you know, in this very harsh land for thousands of years. To live, we have invented all these amazing things, you know. We have invented the qajaq, we invented sleds, and we invented this incredible structure called an igloo, and, skin tents and all this stuff, and sod huts, and we survived because we learned how to get along with each other. We have a great camaraderie with all the other Arctic peoples of the world,

because, you know, we were nomads. Like, we travel, you know, to Alaska, Greenland, all over the North, and then we have all these stories, you know, these incredible legends that teach us how to live with each other. A lot of us really don't think of it as surviving. We think of it as living, you know, because even though it's really cold, it's the most incredible part of the world.

Boats and Navigation – Narrator - 38:37

Archaeological evidence and the oral histories of Indigenous peoples confirm that the earliest inhabitants of the Americas were seafarers with extensive knowledge of ocean navigation and marine lifestyles. Over the millennia, our ancestors developed different styles of boats to travel and fish the rivers, lakes, and coastlines of North and South America. Water travel offered greater access to fishing and hunting, and to trade with distant nations.

James Crippen - 39:12

These are people who may have been able to travel on the open ocean without much compunction. It's quite clear that plenty of people along the coast had perfectly good boat technology. In fact, the Unangan or Aleut people have some of the most extraordinary tradition of boating skills in tiny, incredibly fragile little craft made out of nothing but skin and driftwood, and yet, they would travel hundreds of kilometres over some of the world's most dangerous and difficult water routinely, going from island to island just to visit family. The coast off of Washington and Oregon has no sheltering islands, so without the inside passage, they must have been travelling out on the open water, yet there was nothing wrong with that. Likewise, Tlingit folks in recorded history have travelled extraordinary distances in open canoes.

Narrator – 40:10

Indigenous people developed a range of seafaring skills to safely journey along the coastlines, including celestial navigation and the use of landmarks. In the Pacific Northwest, the Tlingit devised a unique system of open ocean navigation that included an understanding of waves, tides, and winds.

James Crippen – 40:30

In fact, Tlingit culture has a story of Kaax'achgook, a man who, with his nephews, was blown out, in a terrible storm, out into the open ocean, and he washed up with his nephews on apparently a tropical island, because Tlingit maintains the word kaneilx'u for bamboo, and it's in this story that it's described how there wasn't any water on the island because there was no rivers, but they figured out that rainwater was caught in the broken-off stems of bamboo, and that's what they used to survive on while they killed seals and then filled the seal stomachs up with more water for their journey, so oral history even tells us that these folks not only travelled to some very remote island where bamboo grows, which could be Midway, or further south, but still quite far out in the open ocean, but then made it back using traditional navigation techniques, laying on the bottom of the boat to detect the rippling patterns of the North Pacific storms bouncing off of the islands, and each of these storms has its own pattern of waves that hit the shore and bounce back, and by studying how those waves cross over each other, you can use them to triangulate in the direction of the shore, and so this was a technique that the seal hunters and whale hunters out of Yakutat would use whenever they got blown so far off of shore that they couldn't find their way back.

Narrator – 42:06

Studying the patterns of storm waves wasn't the only navigational tools that Tlingit and other seafarers used for ocean travel.

Narrator - 42:14

Watching the birds, and we see the same story coming from the Polynesians, the birds that travel out during the day and always go back to shore at night. If you know what time of day it is, you know what direction the shore is, because of the direction that they're travelling.

Narrator – 42:30

By applying their intimate understanding of boat technology and the ocean itself, these ancient mariners mastered navigation over some of the most challenging waters in the world. From navigation to brain surgery, from snow goggles to accounting systems, the Indigenous peoples of the Americas are responsible for countless discoveries in science and technology. Innovations like the first use of the number zero and life-saving medicines are still in use today. These legacies are a tribute to our ancestors' ingenuity, and remind us that their accomplishments were as significant as those made by other societies in the world before 1491.

Credits

Dr. Katrina Claw - 44:16

I'm Dr. Katrina Claw. I'm Dine, from the Navajo nation. I'm originally from Many Farms, Arizona, and I grew up on the Navajo nation. I went to school at Arizona State University. I got two degrees in Biology and Anthropology, and I started working in a research lab. I grew up knowing my Creation story, and I feel like all of these can exist at a certain level. I see genetics more as a tool that people can use. I see different facets of science, like archaeology, when looking at Native American history, I see them as different tools that we can use, but we also have our culture.