All life forms are born with some way of keeping track of time, but humans do it in more ways and with greater precision than any other species.

**Why bother to keep time?**

Why do we need clocks and calendars? Looking at our lives today, some of the answers may seem obvious. To survive in this complex society, you need to track what others are doing and when they're doing it. You also need to know what's happening in the natural world (what season it is, for example). If you didn't know the time or date, you'd be seriously out of sync with your world. You'd miss a train or walk in late to your Big History class.

But it's not just modern humans who need to keep track of time. All living things must know the time to adjust to their environment as it changes. Bears know when to hibernate. When winter is over, they know when to wake up. Plants know when to blossom. Many birds know when it's time to head south for the winter.
In fact, keeping track of time is so important that evolution has given us internal clocks in our body. Some of them are especially in tune with the differences in daylight hours caused by the change in seasons. These are known as "circadian rhythms." Your body clock will tell you that it's not a good idea to get up at 2 am, when it's pitch dark, unless you have to.

What's different about human time?

We humans track time differently than other creatures. And, as human societies have become larger and more complex, we have gotten more precise at marking the time. We can mark time from the stopwatch precision of the Olympic games to our daily schedules of work. We can even date geological events that happened millions or billions of years ago. To do this, modern humans have had to devise increasingly sophisticated clocks, calendars, and timetables. It wasn't always this way.

Keeping time in the Paleolithic era

If you were a Paleolithic forager living 100,000 years ago, how would you have kept track of time? We have little direct evidence about Paleolithic time-tracking. However, we can study modern foraging societies for hints.

In a foraging society, the rhythms of the natural world are critical. You need a pretty good sense of the changing seasons and of the schedules that other species keep. Then you can decide when to move to a new campground, what plants to collect, and what animals to hunt. Modern foragers sense such changes with a precision no modern city dweller can match.

Keeping track of the time of day and the time of year was not difficult in early societies. Ancient people typically spent most of their time outdoors. They could find out all they needed to know by the positions of the Sun and the stars. And aligning your activities with those of your family and friends was much less complicated than it is today. Back then, people lived in small groups and met face to face.

Meetings with other communities often happened based on the season. There was no need for precise scheduling. If a group normally met with a neighboring tribe "when the reindeer returned," it didn't really matter if their schedules were a few days off. Foraging societies were much more forgiving about appointments than we are.

So no special instruments were required for timekeeping. But there are clues that even Paleolithic foragers didn't rely entirely on their memories and their senses to keep track of time. South Africa's Blombos Cave was lived in by humans perhaps as early as 100,000 years ago. Inside, archaeologists have found chunks of ochre with strange marks on them. Scientists date them to about 70,000 years ago. These are the oldest known "artworks." It's possible that the engravings were used to mark the passing of time. Perhaps they were lists of the cycles of the Moon or dates of important rituals.
More serious evidence of calendars of some kind comes from about 40,000 years later. The American archaeologist Alexander Marshack (1918–2004) became fascinated by marks on Paleolithic objects. He was sure that some of them were simple calendars. Paleolithic people seemed to have been tracking the movements of the Moon. In a 1984 lecture, Marshack talked of his 1964 visit to Les Eyzies, a prehistoric site in France:

As [the Sun] was going down, the first crescent of the new Moon appeared in the sky as a thin silver arc, facing the sinking Sun. It was instantly apparent that the Les Eyzies horizon formed a perfect natural "calendar" and that the first crescent would appear over those hills at sunset every 29 or 30 days...that the Sun was sinking at its farthest point north on that horizon, its position at summer solstice, and that it would now begin to move south.... There was no way that generations of hunters living on that shelf over a period of 18,000 years or more could fail to notice these periodic changes and movements of the Sun and Moon....

Keeping time in agrarian societies

Agricultural societies began to appear about 11,000 years ago. As they expanded, they linked up with their neighbors. Now they needed more reliable methods of keeping time. If you wanted to sell some vegetables in a nearby town or worship at a nearby temple, you had to know exactly when the markets and religious rituals were held — and you needed to know in advance. Drifting in a week or two later no longer cut it. Now you needed calendars that everyone agreed on and shared. If your village depended on irrigation, everyone needed to know exactly when the irrigation gates would be opened.

Similarly, seeds were planted at particular times. The harvest was also collected according to seasonal calendars. These early calendars were based on Earth’s orbit around the Sun and associated climate patterns.

This is why new devices began to appear that could track time more precisely. One method of timekeeping was to watch the Sun’s shadow using sundials. A stick in the ground would often do the job — as long as the Sun was shining. But some sundials were extremely precise. Time was also measured by how long it took sand to move through a narrow hole in a glass container or by the rate at which water dripped from an urn.

More elaborate instruments were used to track the movements of the stars and planets. The famous Stonehenge rocks in England were constructed between 4,000 and 5,000 years ago. Stonehenge may have been designed partly to determine the exact dates of the summer and winter solstices. These events occur two times a year when the Sun reaches its highest and lowest points in the sky.

The most elaborate and precise of all agrarian-era calendars were probably those of Mesoamerica. This region hosted early civilizations appearing in Mexico and Central America in the first millennium BCE. The Mayan calendar included a 260-day cycle based on biweekly rituals. The
Maya also designed a 365-day version organized around the agricultural and solar phases. They even had a calendar measuring time from the beginning of their civilization. Meanwhile, the Romans developed a calendar with 10 months. The names they used should be mostly familiar. For example, Martius is our March. Eventually, the Romans refined their calendar. They added two more months and even included the concept of a leap day.

**Toward the modern era**

In his book *Time: An Essay*, the German scholar Norbert Elias argued that as societies became larger and more complex, people began to require more and more precise clocks and more accurate records. This was because individual schedules were getting linked together in networks of increasing complexity. As schedules began to interlace, people had to start thinking about time more carefully:

*Just as the chains of interdependency in the case of pre-state societies are comparatively short, so their members' experience of past and future as distinct from the present is less developed. In people's experience, the immediate present — that which is here and now — stands out more sharply than either past or future. Human actions, too, tend to be more highly centered on present needs and impulses. In later societies, on the other hand, past, present and future are more sharply distinguished. The need and the capacity to foresee, and thus considerations of a relatively distant future, gain stronger and stronger influence on all activities to be undertaken here and now.*

Improved methods of keeping time evolved in many different contexts. Monks needed to know when to pray, so they developed various methods, including the ringing of bells. Travelers needed to schedule their departures and arrivals more carefully. Increasingly, elaborate clocks were built. Some used carefully controlled drips of water. Others used falling weights.

Precise clocks were particularly important for navigators. They needed them to calculate their longitude, or how far west or east they had traveled. Ships began to travel around the globe from the late fifteenth century. With that came recognition of the need for accurate timekeeping. In 1714, the British government offered a prize of £20,000 (nearly $5 million in today's money) for the first person to build a clock that could stay accurate to within two minutes during long ocean voyages. Clockmaker John Harrison spent most of his life on the task. He finally won the prize in 1773, three years before he died.

In the nineteenth century, the invention of railways and steamships required entirely new levels of precision. Now many more passengers and important cargo could travel. On-time departures and arrivals were critical to the whole network. The first English train schedule was published in 1839. For the first time, different British cities needed to coordinate their clocks to the same national
clock, that of Greenwich Mean Time (GMT). But not until 1880 was Greenwich Mean Time adopted officially throughout Britain. In the United States, regional time zones were not systematized until 1918. At about the same time, the idea of daylight saving was introduced in numerous countries around the world.

International steamships required equally precise coordination across the entire globe. Not until 1929 did most countries begin to link their local time to Greenwich Mean Time. The nation of Nepal waited until the 1980s to do so.

In today's world of international plane schedules and electronic bank transfers, we need even greater precision. So, timekeeping today relies more on complex devices such as atomic clocks. These clocks measure time using signals emitted by electrons as they change energy levels.

One final breakthrough in timekeeping was particularly important for Big History. That was the invention of "radiometric" dating. This technique can date past events by measuring the breakdown of radioactive materials.

Before about 1950, the only way to be sure of the date of a past event was to use written records. Of course these don't exist for any date more than a few thousand years ago. The first workable method of radiometric dating was devised by American chemist Willard Libby in the early 1950s. It used the breakdown of an isotope of carbon, C14, to date materials containing carbon. Since then, a whole range of new dating techniques have been developed. They can now give us reasonably accurate dates for events reaching back to the Big Bang, 13.8 billion years ago.

Accurate timekeeping and recordkeeping are the foundation for histories of all kinds, including Big History. Next time you fly or take a bus, be grateful that your pilot or driver is not planning to arrive at your destination any old time in the next week or two!