FOREVER AND A DAY

We've all dreamed of winning a lottery. A $5 billion one would be great! What would all that money look like? How long would it take to spend it? Can you imagine 5 billion years of time on Earth? What could happen in all that time?

Goal

To introduce geological history and a few of the major events that occurred during the Earth's 5 billion years.

Activity Time

90 minutes

Time to Get Ready

15 minutes

What You Need

Have the following for each team of 4:

4 3-foot lengths of cash register tape

1 12-foot length of cash register tape

1 roll of cellophane tape

1 set waterproof, colored markers

4 rulers

14 note cards

Getting Ready

- Cut 1 3-foot length of cash register tape for each participant.
- Cut 1 12-foot length of cash register tape for each group of 4.
- If cash register tape is not available, tape sheets of paper together to make the desired lengths.

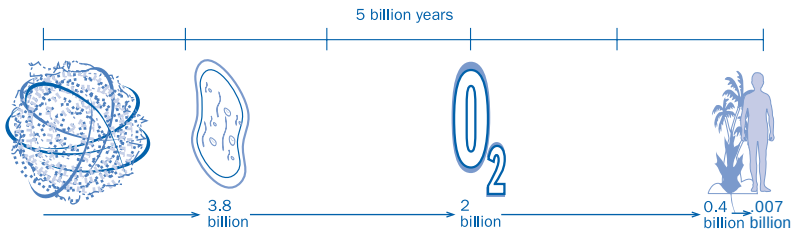


Figure 1. Simplified time line of the Earth.

Useful Information

The Earth has a long and eventful history. Scientists believe it was formed nearly 5 billion years ago. They know this date due to a process called radioactive decay. Naturally occurring radioactive materials break down into other materials at a known rate. The presence of various elements can be used to find the ages of rock formations.

A lot has happened in that 5 billion years. Understanding geological time and when things happened during that time is hard for most people. The numbers are just too large. Sometimes, it helps to place events in the order in which they happened. A time line is very useful for this. Some of the key events of the history of the Earth are shown in the following table. They can be used to help participants understand the concept of Earth's 5 billion years.

Suggestions to Modify the Activity for Those Who Are Exceptional

Specific modifications for this activity are found here. For common considerations when modifying activities for exceptional participants, see page V of the **Introduction**.

Blind or Visually Impaired

- Refer to the number of zeros in the year when discussing the "Time and Event" section in **Useful Information** to provide the participant with a better understanding of how large the number is.
- Divide and mark the sections on both time lines with pieces of yarn to enable the participant to understand the concept of time and the placement of events.

• Construct tactile diagrams of the Earth's time line when writing out the note cards for the events to provide the participant with a visual of the time line. Suggested materials may be found in the ***General Modifications*** section found in the **Introduction** on page V.

• Emphasize group discussion of the comparison between the time line of the history of the Earth and the life history of the participant.

Deaf or Hard-of-Hearing

• See the ***General Modifications*** for *Blind or Visually Impaired* listed in the **Introduction**, page V.

Mobility Impaired

• See the ***General Modifications*** for *Mobility Impaired* listed in the **Introduction**, page V.

Physically Impaired

• See the ***General Modifications*** for *Physically Impaired* listed in the **Introduction**, page V.

Cognitively Impaired

• See the ***General Modifications*** for *Cognitively Impaired* listed in the **Introduction**, page V.

Time Years ago	Billions of years ago (bya)	Event
4,600,000,000	4.6	Origin of the Earth
3,800,000,000	3.8	First cells (no nucleus) appear
3,700,000,000	3.7	Period of no free oxygen
2,200,000,000	2.2	Cyanobacteria (no nucleus) produce oxygen (a poison)
2,000,000,000	2.0	Oxygen accumulates in the atmosphere; cells evolve to use it
1,400,000,000	1.4	Complex cells (with a nucleus) appear
1,000,000,000	1.0	Advanced, more complex cells (with a nucleus) appear
700,000,000	0.7	Multicellular plants and animals appear
600,000,000	0.6	Marine invertebrates abundant
500,000,000	0.5	Earliest fish appear
380,000,000	0.380	Oxygen attains 20% level (current level)
360,000,000	0.360	First amphibians appear
350,000,000	0.350	Trees appear
300,000,000	0.300	First reptiles appear
235,000,000	0.235	First dinosaurs appear
220,000,000	0.220	First mammals appear
40,000,000	0.040	Flowering plants appear
65,000,000	0.065	Extinction of dinosaurs, birds appear
3,000,000	0.003	Human-like forms appear
50,000	0.00005	*Homo sapiens* (humans) appear

Table 1. Key events in the history of the Earth.

For More Information

Barker, N. & Foster, G. (1998). Ancient microworlds. *The Johns Hopkins Magazine, 50*(2), 18-23.

Broad, W.J. (1995). Clues to origin of life sought in hot-house microbes. *The New York Times, CXLIV*(50,056).

Wade, N. (1997). Experiments with lizards show evolutionary change can occur quickly. *The New York Times, CXLVI*(50,779).

Wade, N. (1998). Tree of life turns out to have complex roots. *The New York Times, CXLVII*(51,127).

How to Start the Activity

• Review the difference between 1 million and 1 billion so participants are aware that 1,000,000 is the same as 1000 multiplied by 1000; and that 1 billion equals 1000 millions.

• Help participants realize just how large the numbers used in geological time are. A good way to do this is to have them place the significant events of their own lives on a human time line. The time line can be measured in both years and seconds. After participants have done their own time lines, they will place the major geological events of the Earth on a time line.

Let's Make a Hypothesis

After participants have made their time lines, you may want to discuss questions that lead them to ask more questions to help them understand the concept of large numbers. The following questions are only suggestions.

• What can we learn from a time line?

• Did all living things appear on Earth at the same time?

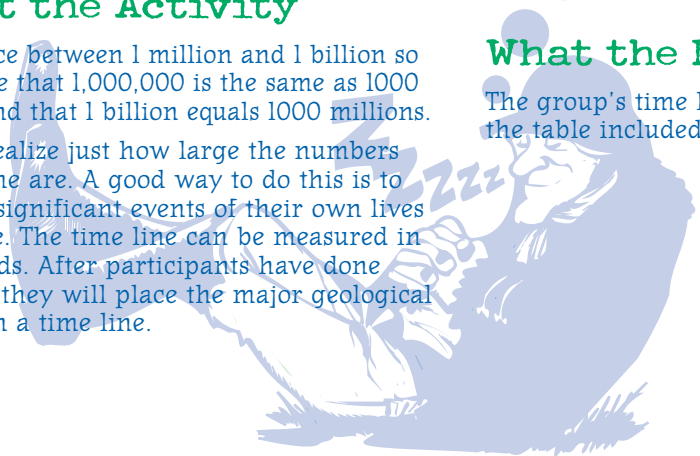
• Why do you think so much time separates the major events?

• Why is the appearance of oxygen so important?

• How does the length of time living ferns have been on Earth compare with the age of the Earth itself?

What the Data Mean

The group's time line sequence should ultimately match the table included in the **Useful Information**.



Forever and a Day

Questions to Think About

Scientists estimate the Earth was formed about 5 billion years ago (bya), but humans appeared only 50,000 years ago. How long did it take before life on Earth resembled what we know today? Did the events occur quickly? Were they evenly spread over time, or were they clustered at various points? How can you illustrate this?

Safety Notes

- Keep scissors away from eyes.

What to Do

1. We often use time lines to help us better understand a sequence of events. Think about your own life. How long have you been on Earth? Suppose you are 16 years old and the 3-foot piece of cash register tape represents your life. How would you show each year of your life using the paper? One way you could do this is to make a time line. First, roll the paper backward to keep it from curling. Next, fold the paper in half lengthwise and then in half again. Put a mark on each of the creases. Divide each of the marked sections into 4 equal sections. Each section represents 1 year of your life. Finally, label the bottom left hand side of the tape as 0 years and then label the first section as 1 year and so forth until the last section labeled is 16 years. See Figure 1.

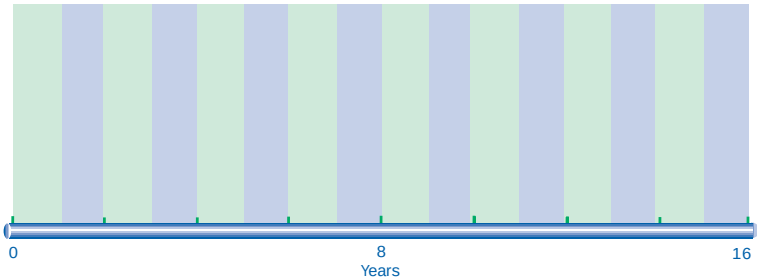


Figure 1. Human time line in years.

This will give you a time line for your life. Think about what important events have happened in your life, such as your birth, first bicycle, first plane ride, starting school, learning to swim, major illnesses, special awards, first date, trips, and new siblings. Mark where these events took place on your time line. Now, you should have a time line of your life in years. What do you think this same time line would look like in seconds?

2. Can you predict how old you are in seconds? Hint: 1 year = 30,000,000 seconds and 10 years = 300,000,000 seconds. Above the 1-year mark, write 30,000,000 seconds. Mark each section of your time line at the top in seconds for each year as shown in Figure 2.

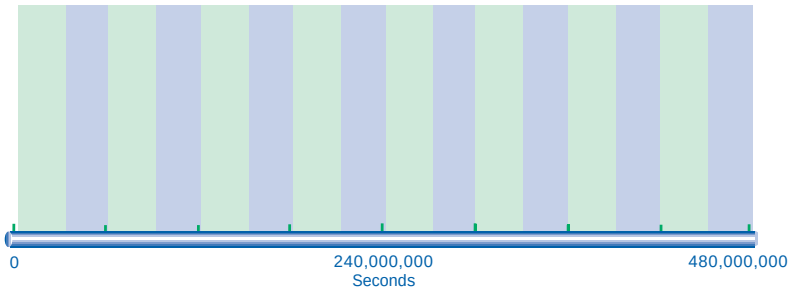


Figure 2. Human time line in seconds.

How old were you in seconds when you got your first bicycle? When you started school? What do you think about these numbers compared to using years?

3. When scientists deal with the history of the Earth, they must work with numbers even bigger than the number of seconds in your life. Do you know the oldest age that any human has ever attained? Do you know how to tell the ages of trees, people, fish, horses, turtles, rocks, cars, computers, or oranges? Do you know what the longest living tree is? If you do not know these answers, how can you find out? How do scientists determine the ages of rocks and fossils? If fossils are unearthed along the height of a mountain bed, how can scientists tell which of the fossils is older and which is more recent?

4. As a group, write each of the following on a separate note card.

- Origin of the Earth
- First cells without nuclei appear
- First birds appear
- Oxygen in the atmosphere
- Trees appear
- Dinosaurs appear
- Mammals appear
- Humans appear
- First cells with nuclei appear
- First multicellular organisms appear

5. Tape the 12-foot piece of cash register tape to the wall. It represents 5 billion years of the Earth's history. Figure out how many inches are in one-fifth of the tape. How many years does this length represent? Mark the tape into 5 segments of 1 billion years each.

6. Discuss the events you wrote on the note cards with the members of your group. Brainstorm about the possible sequence in which they occurred over 5 billion years. Be sure that your group can support the sequence of events that you develop.

7. The events on your cards occurred during the following time periods: 4.6 bya, 3.8 bya, 2 bya, 1.4 bya, 0.7 bya, 0.065 bya, 0.35 bya, 0.235 bya, 0.220 bya, 0.00005 bya. Mark those points on your time line. Now tape the event cards in sequence above the time line.

8. Look at how each of the other groups sequenced the same events. Are they the same as your group's? Discuss the similarities and differences among the members of your group and with the other groups. Do you think you should change your group's time line? If so, make adjustments that you can support. Your facilitator will help the large group decide on a single time line.

9. Now that you have decided on a time line for the geological events, compare it to your own time line. How many times larger is the number of years the Earth has been around than your age in seconds? Are all the events evenly spaced over the years? If the events of your life occurred in clusters similar to those of the Earth's, when would they have occurred?

What Did You Find Out By Doing the Activity?

Before doing "Forever and a Day," did you know:

- what fossils are?
- about the age of the dinosaurs and other major events in Earth's history?

From this activity, did you discover:

- what factors have separated major Earth events?
- how scientists determine the age of the Earth?
- why the appearance of oxygen in the Earth's atmosphere is so important?
- the major divisions of time in your personal time line?
- how you could determine the age of an old toy if you didn't know when it was used?
- why determining the age of the Earth is important?
- what kinds of artifacts can be used to determine the age of the Earth?