

**BIG BANG**

**BIG BANG PLUS TINIEST  
FRACTION OF A SECOND  
( $10^{-43}$ )**

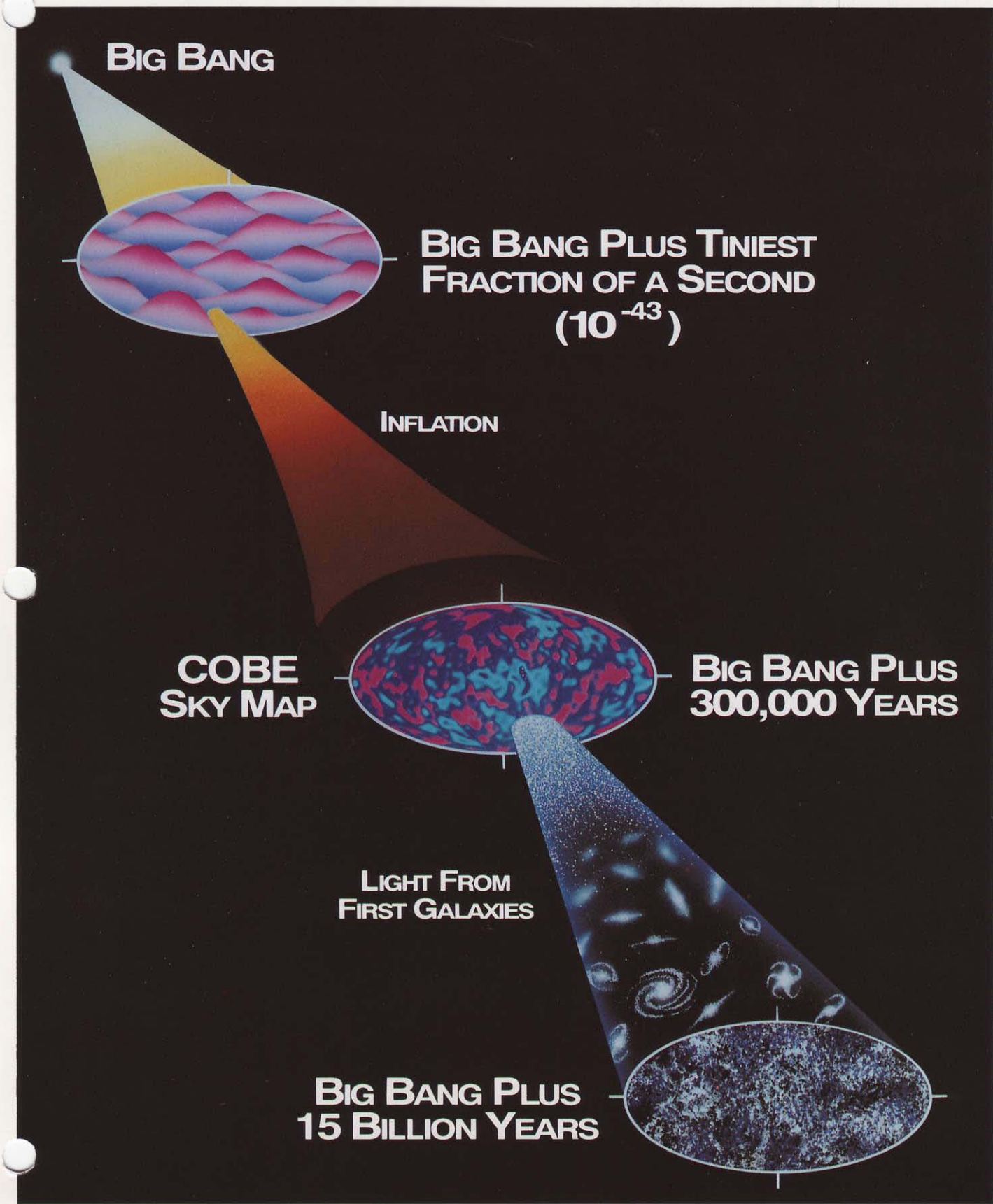
**INFLATION**

**COBE  
SKY MAP**

**BIG BANG PLUS  
300,000 YEARS**

**LIGHT FROM  
FIRST GALAXIES**

**BIG BANG PLUS  
15 BILLION YEARS**



This artist's concept represents crucial periods in the development of the Universe according to inflationary cosmology, beginning with a tiny fraction of a second after the Big Bang—the primeval explosion that began the Universe—and going through the way it looks today—15 billion years later.

The top left of the image illustrates the Universe just after the Big Bang, when the universe was much smaller and hotter. It contained extremely small irregularities in the structure of space. The Universe then rapidly expanded. This expansion is referred to as inflation.

The center of the image shows a sky map taken with the Differential Microwave Radiometer (DMR) instrument on NASA's Cosmic Background Explorer (COBE) satellite. The sky map was created using one year's observations. It pictures the universe less than half a million years after the Big Bang. At that time, the Universe cooled down enough to become transparent to radiation after the fog of ionized matter cleared. Galaxies and stars began to form.

The bottom right part of the image shows a 15-billion-year-old fossil of conditions in the early Universe, created by measurements taken with the DMR. Cosmology theory predicts that small fluctuations in the universe 15 billion years ago would have caused variations in the cosmic background radiation and, ultimately, caused galaxies to form. Analyses of DMR data show a pattern of fluctuations that supports predictions of the "inflationary Big Bang" theory. This theory explains the birth and growth of galaxies using large amounts of invisible material called dark matter, which scientists know very little about and which has never been seen directly. In this theory, dark matter makes up most of the matter in the universe.

COBE was launched November 18, 1989, from Vandenberg Air Force Base, Calif., aboard a Goddard-managed Delta launch vehicle. COBE was designed to study the Big Bang and to measure the diffuse infrared and microwave background radiation, which includes the primary remnant of the explosion. The Goddard Space Flight Center, Greenbelt, Md., manages COBE for NASA's Office of Space Science and Applications.

## For the Classroom

1. What is the theory that scientists refer to as the "Big Bang Theory"?

2. How is cosmic background radiation special?

3. COBE's Differential Microwave Radiometer (DMR) will map the sky at three wavelengths: 3.3, 5.7, 9.6 millimeters. Using a ruler, draw these lengths to the nearest millimeter. How would you describe these lengths? Why do you think scientists chose these particular units of measurement?

4. Scientists believe the Big Bang occurred 15 billion years ago.

Write the number for 15 billion \_\_\_\_\_.

Write 15 billion using scientific notation \_\_\_\_\_

How much is 15 billion???

Remove two cards from a deck of cards (leaving 50 remaining). With a ruler, measure the thickness of the cards. How thick is the stack of cards in centimeters?

How high would a stack of one billion cards be in centimeters? \_\_\_\_\_  
in meters? \_\_\_\_\_

How high would a stack of 15 billion cards be in centimeters? \_\_\_\_\_  
in meters? \_\_\_\_\_

in kilometers? \_\_\_\_\_