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opening extract from

Ask Me Anything

published by

Dorling Kindersley Publishers Ltd

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The Universe is everything we can see, and a lot that we can't see. It was created in the Big Bang explosion and has been changing and expanding ever since.

How old is the Universe?

The Universe is about 13.7 billion years old. At its beginning it looked nothing like it does today. Yet, everything in today's Universe did exist in some form back then. It all started with the Big Bang, a kind of explosion that would not only go on to produce all the matter in the Universe but also marked the start of time.

Elements in the Sun

The top ten chemical elements that make up the Sun are:

01: hydrogen	71%
02: helium	27.1%
03: oxygen	0.07%
04: carbon	0.4%
05: nitrogen	0.09%
06: silicon	0.009%
07: magnesium	0.076%
08: neon	0.058%
09: iron	0.14%
10: sulphur	0.04%

FAST FACTS

Creation of the Universe

01: At the start, the Universe was a hot and dense ball of radiation energy.

02: **In one-thousandth of a second, tiny radiation particles produced tiny particles of matter. These combined to form the first ever chemical elements, hydrogen and helium.**

03: Some regions of the young Universe contained slightly more hydrogen and helium than others. These shrank to form the first stars.

04: **Nuclear reactions inside the stars produced many other chemical elements, including carbon and oxygen.**

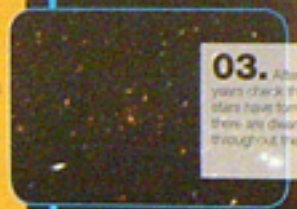
05: The elements in the Universe today were produced from elements created in the Big Bang.

How to: create the Universe



01. Start time with a Big Bang – a massive explosion that lasts for less than one trillionth of a second that will create tiny particles of radiation smaller than the size of a full stop.

02. Wait 380,000 years for the first atoms to form a mix that is 76 per cent hydrogen and 24 per cent helium.



03. After 1 billion years check that the first stars have formed, and there are distant galaxies throughout the Universe.



05. When 9 million years old, form our Solar System in the Milky Way Galaxy.



04. When the Universe is 3 billion years old, merge small galaxies to form massive ones.

Everything in the Universe produces energy – you produce energy when you exercise, and light energy is produced by nuclear reactions inside stars.

WHAT'S IN A NAME?

The term **"Big Bang"** was coined by Fred Hoyle in 1950 to illustrate to his radio listeners the difference between it and his own theory, "Steady State", where the Universe has no beginning.

Hot stuff!

10000000000000000000000000000000000

In the first trillionth of a second of its creation, the temperature of the Universe was **ten billion trillion trillion degrees Celsius**

Looking back

We see objects in space because of their light. Stars produce their own but others, such as the Moon and planets, shine by reflecting light.

Light travels at 299,800 km per second (186,287 miles per second) – faster than anything else.

Distant stars are seen as they were in the past – when the light left them.

The most distant galaxies we see are about 13 billion light years away, and as they were in the early Universe.

The Universe is expanding by about 70 km (43 miles) every second.

Blasts from the past

1931

1948

1955

1965

1980



Australopithecus skull

Human origins

5 billion years ago
The Sun formed from hydrogen and helium and small amounts of other elements.

4.5 billion years ago
Some of the material not used up in the Sun joined together to form Earth.

About 3.7 billion years ago
Carbon-containing molecules in young Earth's oceans evolved into bacteria-like cells, the first forms of primitive life.

1 million years ago
The first humans walked on Earth.

Near, far... and really far

Depending on how far away objects are, distances in the Universe are calculated using a variety of measuring units.

★ **Kilometres or miles**
Used for measuring the distance of relatively near objects in our Solar System, such as the planets, moons, and asteroids.

★ **Astronomical units**
Used for measuring distances within the Solar System. The distance from the Sun to Earth equals one astronomical unit (AU).

★ **Light years**
This measurement is used for distances within our galaxy, the Milky Way, and across the Universe. One light year is the distance light travels in one year – equal to 9.46 million million km (5.88 million million miles).

What about me?

All the elements on Earth, including all the elements in your body, were produced in stars.

Bigger and bigger



Planets
Earth may feel big to us, but at 12,756 km (7,926 miles) across, it is just a speck in an expanding Universe.



Stars
Planets orbit stars – our star is the Sun. Without it there would be no life. It measures 1.4 million km (870,000 miles) across.



Galaxies
Stars exist in galaxies, colossal star systems that come in a range of sizes and shapes. Earth is in the Milky Way Galaxy.



Cluster
Galaxies exist in clusters – the Milky Way Galaxy is in the Local Group cluster, stretching 10 million light years across.



Supercluster
Galaxy clusters are within superclusters – we are in the Virgo Supercluster, 200 million light years from one side to the other.

Voids
The largest structures of the Universe are chains of superclusters that are separated by huge empty voids.

Why were some dinos so huge?

With necks as long as 11 m (36 ft) and bodies the size of buses, sauropods were the most distinctive dinosaurs to roam throughout the Jurassic and Cretaceous Periods, 200 to 65 million years ago. These giant vegetarians were able to browse leaves high up in trees and their huge size deterred predators.

Sauropod myths

MYTH: It was once believed that sauropods lived in water because they were so heavy they would not have been able to support their weight on land.
TRUTH: Scientists can tell now from their footprints that they did not live in water, but were land-living animals.

MYTH: It was once thought that their necks could have been used as snorkels, so they could breathe while submerged under water.
TRUTH: The long neck as snorkel idea would never have worked, as water pressure would not have allowed the lungs of the submerged animal to expand, leading to breathing problems.

In numbers

53 The number of bones in the tail of the sauropod *Camarasaurus*

2.45 m (8 ft) The length of the largest shoulder blade fossil found. It belonged to the sauropod *Brachiosaurus*

1.8 m (6 ft) The length of the largest neck vertebra found. It came from a *Diplodocus*

1 m (3 ft) The size of the first sauropod embryo fossil ever discovered

RECORD BREAKER

Mamenchisaurus had the **longest neck** of any of the Jurassic sauropods. It measured 11 m (36 ft), and consisted of 19 vertebrae bones.

SAUROPOD SALAD

(crunchy) **conifers**
(low-calorie) **cycads**
(glorious) **gingko**
(sumptuous) **seed ferns**
(mushy) **moss**

How to: survive as a Jurassic plant-eater

Dinosaur skulls are made up of delicate bones which do not often fossilize. Scientists did not find a skull of the most famous sauropod, *Apatosaurus* (or *Brontosaurus* as it was known then) until a hundred years after the first skeletons had been found.

01. Grow thick skin like *Barosaurus* – it will help protect you from predators.

02. You will need a long, muscular, whip-like tail for balance and protection.

03. Large, elephant-like feet will help support your heavy body.

04. Your intestinal system needs to be extensive enough to digest large amounts of low-quality leaves. Swallow stones to help mash up the food inside the stomach.

05. Use your long neck and lightweight head to browse very high parts of trees for food.

06. You need peg-like teeth. You won't be able to chew, but they are perfect for raking leaves from branches.

I don't believe it!

The sauropod *Diplodocus* used a long whip-like tail for defence. When thrashed, the tip of the tail could break the sound barrier, producing a thunderous crack to signal to other dinosaurs.

Mind your step

As the smallest Jurassic dinosaur, the tiny *Compsognathus* had to be careful it was not squashed in the land of giants. It was about the size of a chicken and may have travelled in groups to scavenge the kills of larger animals.

Sauropod enemies

Allosaurus was a fearsome 12-m- (38-ft-) long predator. It walked on two legs, had a massive tail, and a bulky body. It had sharp claws up to 15 cm (6 in) in length.

Ceratosaurus could grow up to 6 m (20 ft) long. It had large, powerful jaws and sharp teeth.

Megalosaurus grew up to 9 m (30 ft) long. As well as hunting sauropods, it is likely that it also scavenged already dead animals.

Super sauropods

Camarasaurus 18 m (59 ft)
Probably fed by swinging its strong neck stiffly sideways and down to strip tough leaves from shrubby trees

Brachiosaurus 30 m (98 ft)
Long, spoon-shaped teeth capable of pulling twigs and needles from the highest conifer trees

Paralititan 27 m (89 ft)
Its neck accounted for one-third of its entire body length; estimated to have weighed 80 tonnes

Saltasaurus 27 m (89 ft)
Like many of the later sauropods, *Saltasaurus* had thick, armour-like skin along its back

How many people live in cities?

For the first time in history, more people live in cities than in rural areas, with 3 billion city dwellers. There are 22 megacities (with more than 10 million inhabitants) and upwards of 300 cities with a population greater than 1 million.

Top 10 megacities



01: Tokyo, Japan
34 million people



02: Seoul, South Korea
23 million people



03: Mexico City, Mexico
22.4 million people



04: New York City, USA
21.9 million people



05: Mumbai, India
21.6 million people



06: Delhi, India
21.5 million people



07: Sao Paolo, Brazil
18.3 million people



08: Los Angeles, USA
18 million people



09: Shanghai, China
17.5 million people



10: Osaka, Japan
16.7 million people

World's most polluted cities

Sumgayit Azerbaijan
Linfen China
Tianjing China
Sukinda India
Vapi India
La Oroya Peru
Dzershinsk Russia
Norilsk Russia
Chernobyl Ukraine
Kabwe Zambia

Do you know these capital cities?

1. Antananarivo
2. Bishkek
3. Bandar Seri Begawan
4. Dili
5. Nouakchott
6. Nuku'alofa
7. Ouagadougou
8. Port Moresby
9. Tbilisi
10. Tegucigalpa
11. Ulaanbaatar
12. Vaduz

(answers bottom right-hand page)

How the **world's urban population** has grown



1800
3 per cent of people live in cities; 1 city has a population of more than 1 million

1900
9 per cent of people live in cities; 13 cities have populations of more than 1 million

2000
50 per cent of people live in cities; 300 cities have populations of more than 1 million

In 1900 only **four Asian cities** had populations of more than **1 million**; today the number is 194, with the majority of them in China.

By 2015 there are predicted to be **253 cities in Asia** with more than **1 million** people, plus 65 in South and Central America, and 59 in Africa.

Cities with the most **skyscrapers**



Hong Kong China
New York City USA
Tokyo Japan
Shanghai China
Chicago USA
Bangkok Thailand
Guangzhou China
Chongqing China
Shenzhen China



High altitude cities

- Wenchuan in Tibet, China, is the **highest city in the world**, with an altitude of 5,100 m (16,730 ft).
- La Paz, Bolivia, is the **highest capital city in the world** at 3,600 m (11,811 ft).
- **Highest city in Africa** is Dinsho, Ethiopia, at 3,207 m (10,522 ft).
- **Highest city in the USA** is Alma, Colorado, at 3,156 m (10,355 ft).
- Andorra la Vella, Andorra, is **Europe's highest capital city** at 1,023 m (3,356 ft).

I don't believe it!

Nauru is the only country without a capital city, which is down to the centre of this tiny Pacific island being a phosphate mine. Its population of 13,000 lives on the narrow coastal strip fringing the shore.

Cities destroyed by major earthquakes



c.1400 BCE
1138
1755
1906
1923
1960
1963
1976
1995
2003

WHAT'S IN A NAME?

According to an old Malay legend, a prince was shipwrecked and washed ashore on an island. He saw an animal he mistook for a lion and called the place **Singapura** ("Lion city"). It's doubtful if the story is true, but today the national emblem of **Singapore** is a **lion**.

Think twice before moving to...



Istanbul, Turkey
Since it was founded (as Constantinople) in 330 BC, this city has been hit by 15 major earthquakes – the last was in 1999.



Naples, Italy
Some experts believe that Vesuvius, the volcano that buried Pompeii in 79 AD, will erupt again. Naples would be right in its path.



Mumbai, India
When it rains heavily in India's largest city, whole sections of the city flood as the drains cannot cope with the volume of water.



Shanghai, China
China's showplace city is sinking by 1.5 cm (0.5 in) a year due to the weight of skyscrapers built in the past decade.



Phoenix, USA
This city of 1 million people, built in the middle of the desert in Arizona, is in danger of running out of water.

Blasts from the past

3,500 BCE
First cities appear in Mesopotamia (Iraq)

1,600 BCE
First cities in China

1 CE
Rome's population reaches 450,000 people

500
Teotihuacan (Mexico) is the largest city in ancient America

800
Population of the city of Baghdad reaches 700,000

1800
London is world's first city to top a population of 1 million people

1950
New York is world's largest city with a population of 12.4 million

1965
Tokyo is first city to top 20 million

1985
The average living space in the crowded city of Shanghai, China, is the size of a small car