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How long ago did the Big Bang occur?

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How long ago did our solar system begin?

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How old is Earth estimated to be?

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How long ago did Earth cool enough for the outer layers of the planet to solidify and for oceans to form.

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How long ago did life emerge on our planet?

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Where were the first forms of life that we know about found?

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What does DNA do?

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What does RNA do?

<p>Our solar system began 4.6 billion years ago.</p>	<p>The Big Bang occurred 13.7 billion years ago.</p>
<p>By 4 billion years ago, the Earth had cooled enough for the outer layers of the planet to solidify and for oceans to form.</p>	<p>Earth is estimated to be 4.55 billion years old.</p>
<p>The first forms of life that we know about produced well preserved microscopic fossils that were found in western Australia. These fossils, which are 3.5 billion years old, resemble photosynthetic bacteria called cyanobacteria that live today.</p>	<p>The period between 4.0 and 3.5 billion years ago marked the emergence of life on our planet.</p>
<p>RNA acts as an intermediary in the process of protein synthesis</p>	<p>DNA stores the information for the amino acid sequence of proteins</p>

<p>9 - Chapter 22</p> <p>What do proteins do?</p>	<p>10 - Chapter 22</p> <p>What are the stages that occurred during the origin of life?</p>
<p>11 - Chapter 22</p> <p>Describe the Reducing Atmosphere Hypothesis.</p>	<p>12 - Chapter 22</p> <p>What was Stanley Miller's contribution to the Reducing Atmosphere Hypothesis?</p>
<p>13 - Chapter 22</p> <p>Describe the Extraterrestrial Hypothesis.</p>	<p>14 - Chapter 22</p> <p>Describe the Deep-Sea Vent Hypothesis.</p>
<p>15 - Chapter 22</p> <p>protobiont</p>	<p>16 - Chapter 22</p> <p>coacervates</p>

<p>The four overlapping stages of the origin of life:</p> <p>Stage 1: Nucleotides and amino acids were produced prior to the existence of cells.</p> <p>Stage 2: Nucleotides and amino acids became polymerized to form DNA, RNA, and proteins.</p> <p>Stage 3: Polymers became enclosed in membranes.</p> <p>Stage 4: Polymers enclosed in membranes evolved cellular properties.</p>	<p>Proteins form the foundation for the structure and activities of living cells</p>
<p>In 1953, Stanley Miller, a student in the laboratory of Harold Urey, was the first scientist to use experimentation to test whether the prebiotic synthesis of organic molecules is possible. His experimental apparatus was intended to simulate the conditions on primitive Earth that were postulated in the 1950s. Water vapor from a flask of boiling water rose into another chamber containing H₂, CH₄, and NH₃. Miller inserted two electrodes that sent electrical discharges into the chamber to simulate lightning bolts. A condenser jacket cooled some of the gases from the chamber, causing droplets to form that dropped into a trap. He then took samples from this trap for chemical analysis. In his first experiments, he observed the formation of hydrogen cyanide (HCN) and formaldehyde (CH₂O). Such molecules are precursors of more complex organic molecules. These precursors also combined to make larger molecules such as the amino acid glycine. Later experiments by Miller and others demonstrated the formation of sugars, many types of amino acids, and nitrogenous bases found in nucleic acids (for example, adenine).</p>	<p>It's part of Stage 1 of the Origin of Life.</p> <p>Based largely on geological data, many scientists in the 1950s thought that the atmosphere on primitive Earth was rich in water vapor (H₂O), hydrogen gas (H₂), methane (CH₄), and ammonia (NH₃). These components, along with a lack of atmospheric oxygen, produce a reducing atmosphere because methane and ammonia readily give up electrons and thereby reduce other molecules.</p>
<p>It's part of Stage 1 of the Origin of Life.</p> <p>In 1988, the German organic chemist Gunter Wachtershauser proposed that key organic molecules may have originated in deep-sea vents, which are cracks in the Earth's surface where superheated water rich in metal ions and hydrogen sulfide (H₂S) mixes abruptly with cold sea water. These vents release hot gaseous substances from the interior of the Earth at temperatures in excess of 300°C (572°F). Supporters of this hypothesis propose that biologically important molecules may have been formed in the temperature gradient between the extremely hot vent water and the cold water that surrounds the vent at the bottom of the ocean.</p>	<p>It's part of Stage 1 of the Origin of Life</p> <p>Many scientists have argued that sufficient organic carbon would have been present in the asteroids and comets that reached the surface of early Earth to make them instrumental in stocking the prebiotic soup. Modern evidence in support of this idea comes from the study of these fallen bodies, called meteorites. A significant proportion of meteorites belong to a class known as carbonaceous chondrites. Such meteorites contain a substantial amount of organic carbon, including amino acids and nucleic acid bases. Based on this observation, scientists have postulated that such meteorites could have transported a significant amount of organic molecules to primitive Earth.</p> <p>However, opponents of this hypothesis argue that most of this material would have been destroyed by the intense heating that accompanies the passage of large bodies through the atmosphere and their subsequent collision with the surface of the Earth.</p>
<p>Droplets that form spontaneously from the association of charged polymers such as proteins, carbohydrates, or nucleic acids.</p>	<p>The term used to describe the first nonliving structures that evolved into living cells.</p>

17 - Chapter 22 microspheres	18 - Chapter 22 liposomes
19 - Chapter 22 RNA World	20 - Chapter 22 geological timescale
21 - Chapter 22 extinction	22 - Chapter 22 List the major environmental changes correlated with biological changes and extinctions.
23 - Chapter 22 mass extinctions	24 - Chapter 22 fossils

<p>A vesicle surrounded by a lipid bilayer.</p>	<p>A small water-filled vesicle surrounded by a macromolecular boundary.</p>
<p>A time line of the Earth's history from its origin about 4.55 billion years ago to the present.</p>	<p>A hypothetical period on primitive Earth when both the information needed for life and the enzymatic activity of living cells were contained solely in RNA molecules.</p>
<p>The major environmental changes correlated with biological changes and extinctions are:</p> <ul style="list-style-type: none">• climate/temperature• atmosphere• landmasses• floods• glaciations• volcanic eruptions• meteorite impacts	<p>The end of the existence of a species or group of species.</p>
<p>Recognizable remains of past life on Earth.</p>	<p>When many species become extinct at the same time.</p> <p>5 large mass extinctions near end of Ordovician, Devonian, Permian, Triassic, and Cretaceous periods. Geologic time periods are often based on these events</p>

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paleontologists

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radioisotope dating

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half-life

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anaerobic

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heterotrophs

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autotrophs

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stromatolite

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aerobic

<p>A common way to estimate the age of a fossil by analyzing the elemental isotopes within the accompanying rock.</p> <ul style="list-style-type: none"> • Half-life – length of time required for exactly one-half of original isotope to decay • Measure amount of a given isotope as well as the amount of isotope produced when the isotope decays • Fossil record underestimates actual date species came into existence 	<p>A scientist who studies fossils.</p>
<p>Refers to a process that occurs in the absence of oxygen; a form of metabolism that does not require oxygen.</p>	<ol style="list-style-type: none"> 1. In the case of organic molecules in a cell, refers to the time it takes for 50% of the molecules to be broken down. 2. In the case of radioisotopes, the time it takes for half the molecules to decay and emit radiation.
<p>An organism that has metabolic pathways that directly harness energy from either inorganic molecules or light.</p>	<p>Organisms that cannot produce their own organic food and thus must obtain organic food from other organisms.</p>
<p>A form of metabolism that requires oxygen.</p>	<p>A layered calcium carbonate structure in an aquatic environment produced by cyanobacteria.</p> <ul style="list-style-type: none"> • Autotrophic cyanobacteria were preserved when heterotrophic ancestors were not • Form stromatolites- layered structure of calcium carbonate • Cyanobacteria produce oxygen as a waste product of photosynthesis • Spelled doom for many prokaryotic groups that were anaerobic • Allowed the evolution of aerobic species

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symbiotic

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endosymbiotic

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invertebrates

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Cambrian explosion

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chordates

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vertebrates

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vascular plants

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seed plants

<p>Describes a relationship in which one organism lives inside the other.</p>	<p>Describes a relationship in which two or more different species live in direct contact with each other.</p>
<p>An event during the Cambrian period (543 to 490 mya) in which there was an abrupt increase (on a geological scale) in the diversity of animal species.</p>	<p>An animal that lacks vertebrae.</p>
<p>An organism with a backbone.</p>	<p>An organism with a spinal cord.</p>
<p>The informal name for gymnosperms and angiosperms.</p>	<p>A plant that can transport water, sugar, and salts throughout the plant body via xylem and phloem tissues.</p>

<p>40 - Chapter 22</p> <p>tetrapods</p>	<p>41 - Chapter 22</p> <p>mammals</p>
<p>42 - Chapter 22</p> <p>flowering plants</p>	<p>43 - Chapter 22</p> <p>hominids</p>
<p>44 - Chapter 22</p> <p>hominin</p>	<p>45 - Chapter 22</p> <p>Phanerozoic Eon, Paleozoic Era (543-248 mya)</p>
<p>46 - Chapter 22</p> <p>Phanerozoic Eon, Mesozoic Era</p>	<p>47 - Chapter 22</p> <p>Phanerozoic Eon, Cenozoic Era</p>

<p>A vertebrate that is a member of the class Mammalia that nourishes its young with milk secreted by mammary glands. Another distinguishing feature is hair.</p>	<p>A vertebrate animal having four legs or leglike appendages.</p>
<p>Life-forms that include modern humans, chimpanzees, gibbons, gorillas, orangutans, plus all their recent ancestors.</p>	<p>The angiosperms, which produce ovules within the protective ovaries of flowers; when ovules develop into seeds, angiosperm ovaries develop into fruits, which function in seed dispersal.</p>
<p>The Paleozoic Era saw the diversification of invertebrates and the colonization of land by plants and animals</p> <p>Cambrian Period (543 to 490 mya) Ordoician Period (490 to 443 mya) Silurian Period (443 to 417 mya) Devonian Period (417 to 354 mya) Carboniferous Period (354 to 290 mya) Permian Period (290 to 248 mya)</p>	<p>Either an extinct or modern form of humans</p>
<p>The Mesozoic Era saw the rise and fall of the dinosaurs.</p> <p>Triassic Period (248 to 206 mya) Jurassic Period (206 to 144 mya) Cretaceous Period (144 to 65 mya)</p>	<p>Mammals and flowering plants diversified during the Cenozoic Era</p> <p>Tertiary Period (65 to 1.8 mya) Quaternary Period (1.8 mya to Present)</p>

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chemical selection

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continental drift

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prebiotic soup

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ribozyme

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radioisotopes used for geological dating

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Biases to the fossil record

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Archeon Era

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Origin of Eukaryotic cells

The phenomenon whereby, over the course of billions of years, the major landmasses, known as the continents, have shifted their positions, changed their shapes, and in some cases have become separated from each other.

The result of when a chemical within a mixture of different chemicals has special properties or advantages that cause it to increase in number compared to other chemicals in the mixture.

A biological catalyst that is an RNA molecule.

The medium formed by the slow accumulation of molecules in the early oceans over a long period of time prior to the existence of life.

More likely to be fossilized:

- Organisms with hard body parts
- Larger organisms
- Those that existed in greater numbers
- Those that lived in a marine environment
- Geological processes may favor the fossilization of certain organisms
- Human error: search for only certain organisms

Radioisotope	Decay product	Half-life (years)	Useful dating range (years)
Carbon-14	Nitrogen-14	5,730	100-30,000
Potassium-40	Argon-40	1.3 billion	100,000-4.5 billion
Rubidium-87	Strontium-87	47 billion	10 million-4.5 billion
Uranium-235	Lead-207	710 million	10 million-4.5 billion
Uranium-238	Lead-206	4.5 billion	10 million-4.5 billion

- Nuclear genome – both bacteria and archaea contributed substantially
 - Symbiotic relationship – 2 species live in direct contact
 - Endosymbiotic – one organism lived inside another
 - Data supports this origin

Prokaryotic cells arose during Archaeon Eon

- Diverse microbial life flourished in primordial oceans
- First known fossils 3.5 bya
- All life forms prokaryotic during Archaeon Eon
- Hardly any free oxygen so organism were anaerobic
- First cells were heterotrophs
- Autotrophs evolved as supply of organic molecules dwindled

<p>56 - Chapter 22</p> <p>Proterzoic Eon</p>	<p>57 - Chapter 22</p> <p>Phanerzoic Eon</p>
<p>58 - Chapter 22</p> <p>Phanerzoic Eon, Paleozoic Era, Cambrian Period</p>	<p>59 - Chapter 22</p> <p>Phanerzoic Eon, Paleozoic Era, Ordovician Period</p>
<p>60 - Chapter 22</p> <p>Phanerzoic Eon, Paleozoic Era, Silurian Period</p>	<p>61 - Chapter 22</p> <p>Phanerzoic Eon, Paleozoic Era, Devonian Period</p>
<p>62 - Chapter 22</p> <p>Phanerzoic Eon, Paleozoic Era, Carboniferous Period</p>	<p>63 - Chapter 22</p> <p>Phanerzoic Eon, Paleozoic Era, Permian Period</p>

<p>Proliferation of multicellular eukaryotic life extensive during Phanerozoic Eon (543 mya to today)</p> <ul style="list-style-type: none"> • Paleozoic Era • Mesozoic Era • Cenozoic Era 	<ul style="list-style-type: none"> • Multicellular eukaryotes arise 1.5 bya • 2 possible origins <ul style="list-style-type: none"> • Individuals form a colony • Single cell divides and stays stuck together • Volvocine green algae display variations in the degree of multicellularity • Multicellular animals emerge toward the end of the eon • First animals invertebrates <ul style="list-style-type: none"> • Bilateral symmetry facilitates locomotion
<ul style="list-style-type: none"> • 490-443 mya • Warm temperatures and atmosphere very moist • Diverse group of marine invertebrates including trilobites and brachiopods • Primitive land plants and arthropods first invade land • Toward end, abrupt climate change (large glaciers) resulting in mass extinction • Over 60% of existing marine invertebrates became extinct 	<ul style="list-style-type: none"> • 543-490 mya • Warm and wet with no ice at poles • Cambrian explosion – abrupt increase in diversity of animal species <ul style="list-style-type: none"> • Cause unknown – shell evolution, atmospheric oxygen? • All existing major types of marine invertebrates plus many other that no longer exist • Although new species have arisen since, no major reorganizations of body plans • First vertebrates 520 mya
<ul style="list-style-type: none"> • 417-354 mya • Generally dry across north but southern hemisphere mostly covered by cool, temperate oceans • Major increase in number of terrestrial species • Ferns, horsetails and seed plants (gymnosperms) emerge • Insects emerge • Tetrapods – amphibians emerge • Invertebrates flourish in the oceans • Age of Fishes • Near end, prolonged series of extinctions eliminate many marine species 	<ul style="list-style-type: none"> • 443-417 mya • Relatively stable climate • Glaciers largely melted • No new major invertebrates • Significant new vertebrates and plants • Many new fish • Coral reefs appeared • Large colonization by terrestrial plants and animals <ul style="list-style-type: none"> • Had to evolve adaptations to drying out • Spiders and centipedes • Earliest vascular plants
<ul style="list-style-type: none"> • 290-248 mya • Continental drift formed supercontinent Pangaea • Interior regions dry with seasonal fluctuations • Forest shift to gymnosperms • Amphibians prevalent but reptile became dominant • First mammal-like reptiles appeared • At the end, largest known mass extinction event <ul style="list-style-type: none"> • 90-95% of all marine species and large proportion of terrestrial species eliminated • Glaciations or volcanic eruptions blamed 	<ul style="list-style-type: none"> • 354-290 mya • Rich coal deposits formed • Cooler, land covered by forested swamps • Plants and animals further diversified <ul style="list-style-type: none"> • Very large plants and trees prevalent • First flying insects • Amphibians prevalent • Amniotic egg emerges - reptiles

<p>64 - Chapter 22</p> <p>Phanerzoic Eon, Mesozoic Era</p>	<p>65 - Chapter 22</p> <p>Phanerzoic Eon, Mesozoic Era, Triassic Period</p>
<p>66 - Chapter 22</p> <p>Phanerzoic Eon, Mesozoic Era, Jurassic Period</p>	<p>67 - Chapter 22</p> <p>Phanerzoic Eon, Mesozoic Era, Cretaceous Period</p>
<p>68 - Chapter 22</p> <p>Phanerzoic Eon, Cenozoic Era</p>	<p>69 - Chapter 22</p> <p>Phanerzoic Eon, Cenozoic Era, Tertiary Period</p>
<p>70 - Chapter 22</p> <p>Phanerzoic Eon, Cenozoic Era, Quaternary Period</p>	<p>71 -</p>

<ul style="list-style-type: none"> • 248-206 mya • Reptiles plentiful • First dinosaurs • First true mammals • Gymnosperms dominant land plant • Volcanic eruptions led to global warming and mass extinctions near the end 	<ul style="list-style-type: none"> • Permian extinction marks boundary between Paleozoic and Mesozoic eras • Age of Dinosaurs • Consistently hot climate, dry terrestrial environments, little if any ice at poles
<ul style="list-style-type: none"> • 144-65 mya • Dinosaurs still dominant on land • Earliest flowering plants, angiosperms • Another mass extinction at the end of the period • Dinosaurs and many other species died out • Large meteorite/asteroid or volcanic eruptions blamed 	<ul style="list-style-type: none"> • 206-144 mya • Gymnosperms continued to be dominant • Dinosaurs dominant land animal • Some attained enormous size • First known bird • Mammals present but not prevalent
<ul style="list-style-type: none"> • 65-1.8 mya • Mammals that survived expanded rapidly • Birds and terrestrial insects diversified • Angiosperms become the dominant land plant • Fish diversified • Sharks become abundant • Whales appeared • Hominids appeared about 7 mya 	<ul style="list-style-type: none"> • Spans most recent 65 million years • Tropical conditions replaced by a colder, drier climate • Amazing diversification of birds, fish, insects, and flowering plants
	<ul style="list-style-type: none"> • 1.8 mya to present • Periodic ice ages cover much of Europe and North America • Widespread extinction of many species • Certain hominids become more human-like • <i>Homo sapiens</i> appears 130,000 years ago

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