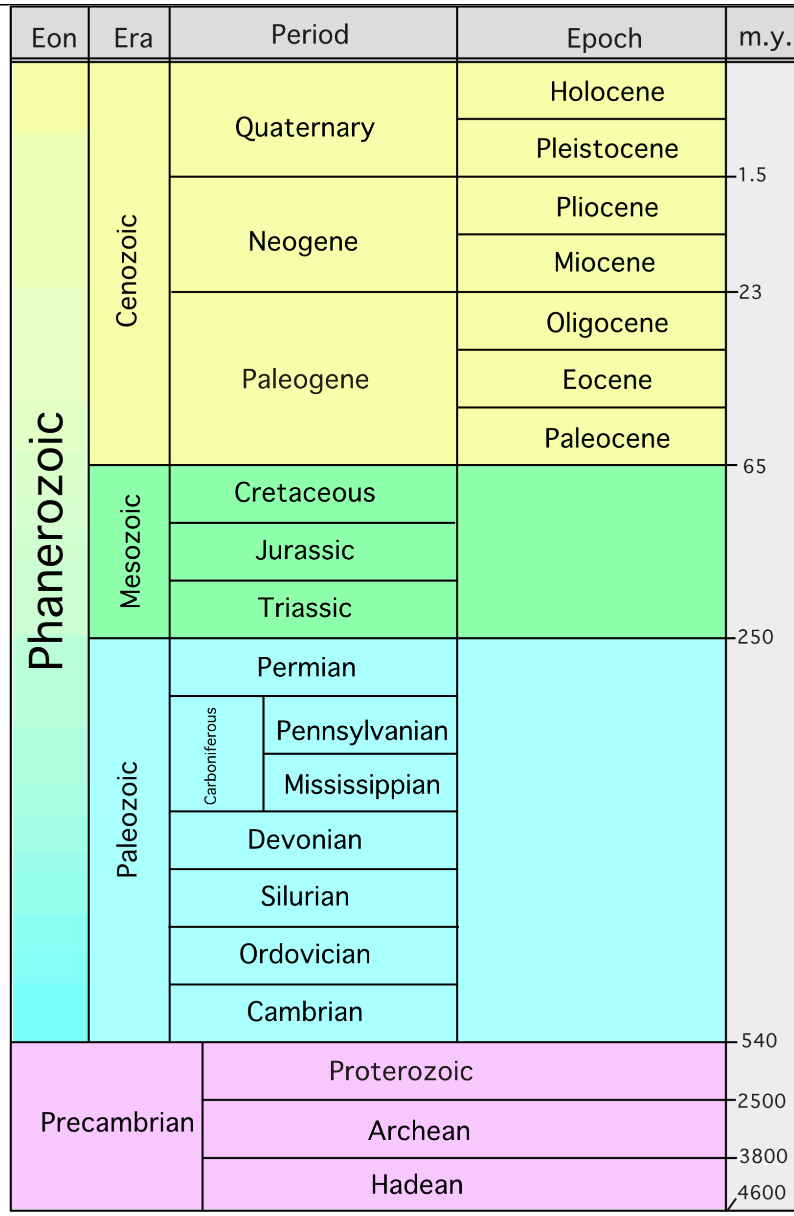
“Geologic Time Scale”
Newcomer Academy
Visualization Three

Chapter	Subtopic/Media	Key Points of Discussion	Notes/Vocabulary
Introduction	**Title** Various Pictures of Geologic Time	NA	NA
It’s About Time	**Personal Timeline** Baby Toddler Child Teen Adult Middle Age Elder Death	Create a personal **time line** from birth to present. Begin the time line at birth and end it at death. Discuss how using time increments such as seconds, minutes, hours, days are almost useless. Use months and years to set the increments. This leads to the next discussion, where time is measured in huge chunks (millions of years).	Time line
	Video Clip: Life Cycle of a Human (or other organism?)		
	Getting a handle on a Million Varied Stills from examples on the right	**Million** grains of sand (510 cc) = 31.1 cubic inches Million millimeters = 1 km = 2.5 laps around track 1000000 seconds = 11.5741 days 1000000 minutes = 694.44 days 1000000 hours = 114.079553 years 1000000 days = 2737.90926 years 1000000 $1 bills = 2204.622621 pounds (1 ton = 2200 pounds)	Million
	Video Clip: Visualizing One Million		
	A Long Time Ago Geologic Time Line Pictures Pictures from each Eon and Era Pictures of the great mass extinctions	Geological time extends from the Earth’s origin to the beginning of human history. The geological time scale is an arrangement of geological events, most often presented as a chart. An **eon** is the largest division of geological time. **Eras** are broad spans of time based on the general character of life that existed. Eras are tens to hundreds of millions of years in length. **Paleozoic** – Ancient Life, such as trilobites, corals, brachiopods, early fishes, and early amphibians. **Mesozoic** – Middle Life, known as the age of the dinosaurs. **Cenozoic** – Recent Life, Mammals are the predominant life form. The end of an era is marked by a great **extinction** of many species.	Eon – roughly 1 billion years Eras – 10 to 100’s of millions of years Zoic - Life Paleozoic - Ancient Mesozoic - Middle Cenozoic – Recent Extinction

		 A **<u>period</u>** is a shorter period of time determined by evidence of major events in Earth's crust and/or on general characteristics of the rock formations. Periods are named for geographic areas where the rocks appear or the characteristics of the rocks themselves. An **<u>epoch</u>** is a subdivision of the Tertiary and Quaternary periods. Earth's history is measured in millions of years.	Period Epoch
	Relative Time Scale Fossils found in strata	Using fossils in rock strata can determine the age of that rock layer. This information with the fact that older rocks are the lower **<u>strata</u>** provides a reference to determine the **<u>relative time scale</u>**. Therefor if a layer of rocks from two different areas have the same type of **<u>fossils</u>**, then it can be inferred that both layers are the same age.	Relative Time Scale *Strata* *Fossils* Absolute Time Scale

<table>
<tr>
<td rowspan="2"></td>
<td>Absolute Time Scale

Half-Life Pictures

Radioactive Decay</td>
<td>Using <u>radioactive decay</u>, scientists can determine an actual/<u>absolute time scale</u> for rocks. (the time it takes a <u>parent isotope</u> to emit less radiation and become a <u>daughter isotope</u> = half-life)

The elements used to determine the age of rocks must have very long half-lives and decay very slowly (e.g. uranium).

<table>
<tr><td>Parent Isotope</td><td>Daughter Isotope</td><td>Half-Life</td></tr>
<tr><td>Carbon 14</td><td>Nitrogen 14</td><td>5730 years</td></tr>
<tr><td>Potassium 40</td><td>Argon 40</td><td>1.25 billion yrs</td></tr>
<tr><td>Uranium 238</td><td>Lead 206</td><td>4.5 billion yrs</td></tr>
</table>

Two common methods are potassium-argon dating and carbon-14 dating. Potassium is an element found in many rock-forming minerals. Geologists have found that quantities of argon 40 can be identified in minerals of nearly all ages and can be measured accurately, even in small quantities. <u>Potassium-argon dating</u> can be used on rocks as young as a few thousand years as well as on rocks over 2 billion years old.

<u>Carbon 14</u> has a relatively short half-life and is often used by archaeologists and others researching the Quaternary period of the last 500,000 years.

Carbon 14 is constantly being produced in the Earth's upper atmosphere and eventually finds its way into all living things. After a plant or animal dies, carbon 14 decays, creating nitrogen 14. By measuring the amount of remaining carbon 14, scientists can calculate the time of death. (e.g. A piece of old wood has half as much carbon 14 as wood from a living tree, the age of the old wood is estimated as 5730 years.)

Not all rocks can have an absolute time determined. Only igneous rocks that crystallized directly from molten rock or magma provide the unmodified samples needed for accurate dating. Sandstone and shale cannot be given an absolute age; scientists must use relative-age techniques by examining surrounding rocks.</td>
<td>Radioactive Decay

Parent Isotope

Daughter Isotope

Half-Life

Potassium-argon dating

Carbon 14</td>
</tr>
<tr>
<td colspan="3">Video Clip: Radioactive Decay and Dating</td>
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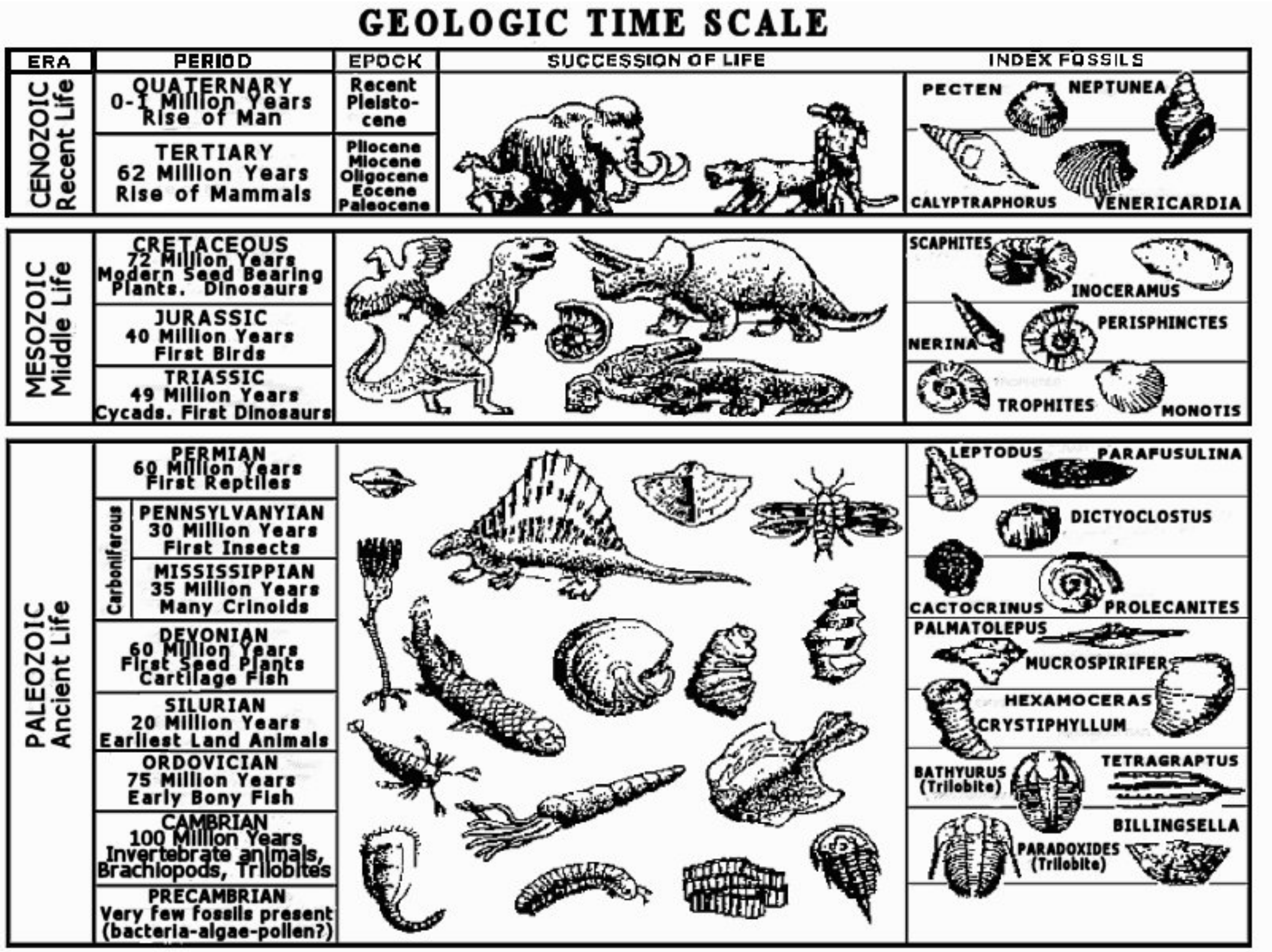
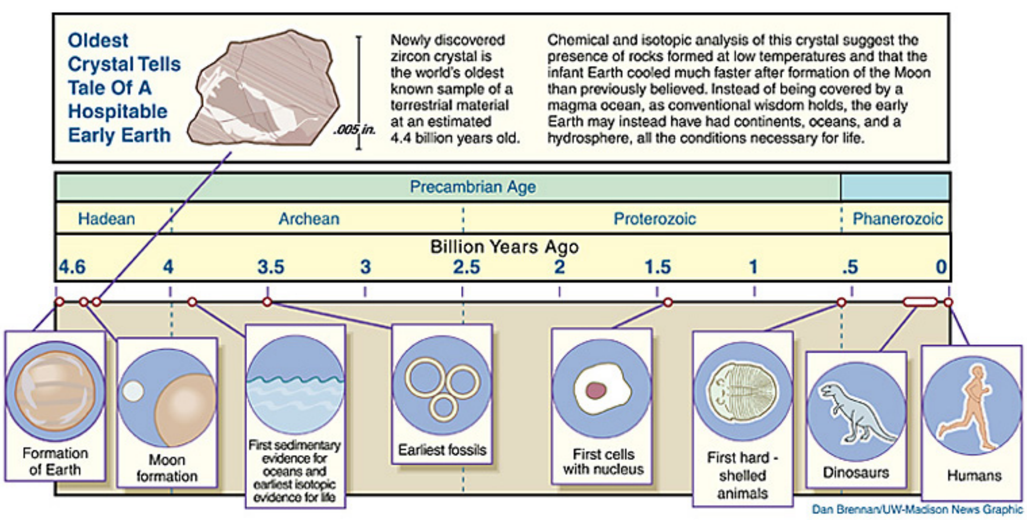
<tr>
<td>Fossils and Time</td>
<td>Index Fossils

Pictures of various fossils mentioned to the right</td>
<td><u>Fossil</u> is defined as any remains, trace, or imprint of a plant or animal that has been preserved in Earth's crust during prehistoric times. The conditions have to be just right for fossilization to occur. When an organism dies, the remains must be buried quickly by sediments before decomposition erases the evidence. It can take millions of years for the sediments, holding the organism, to turn to rock. The oldest</td>
<td>Fossil</td>
</tr>
</table>

		fossils to be discovered are stromatolites in Western Australia (3.5 billion years old). FYI: Fossils can be hollow molds, cast (duplication by a filler mineral) by a process called replacement. Major Fossils: Corals, Bivalves, Brachiopods, Gastropods, Cephalopods, Trilobites, Crinoidsd, Plant Fossils (Hermit Shale)	
	Pictures of index fossils and comparative evidence to draw inferences	Introduce students to the concept of **index fossil**, an organism that lived for a relatively short time in many places around the world. Index fossils are used as **indicators** for the age of a sedimentary rock layer. The best index fossils had a wide geographic range during a brief period of existence, are abundant, and are easily identifiable. (e.g. Tetragraptus – early Ordovician. Marine organism with four branches suspended from a thin filamentous support, which allowed it to float) Fossil evidence supports the law of **fossil succession**: the kinds of animals and plants found as fossils change over geological time. Look at index fossils from two locations (Grand Canyon and Bryce Canyon) correlate/determine relative age of rock layers.	Index Fossil Indicator Fossil Succession
Closure	**Earth History Sequence**	Formation of Earth to Today… Geologic Time Line of Earth Using fossil evidence, rock strata, carbon 14 dating, and potassium-argon dating, scientists have determined a geological time line for our planet. Hadean Eon: Archean Eon: Proterozoic Eon/Precambrian: **MAJORITY OF EMPHASIS…** Phanerozoic Eon:	
Reinforcement Movie Clip in the Closure Chapter: Fossils, Strata, Dating result in quick history of the planet Earth and the life that has existed on its surface and in its waters.			


GEOLOGIC TIME SCALE
ERA
PERIOD
EPOCK
SUCCESSION OF LIFE
INDEX FOSSILS
CENOZOIC Recent Life
QUATERNARY 0-1 Million Years Rise of Man
Recent Pleisto-cene
TERTIARY 62 Million Years Rise of Mammals
Pliocene Miocene Oligocene Eocene Paleocene
PECTEN
NEPTUNEA
CALYPTRAPHORUS
VENERICARDIA
MESOZOIC Middle Life
CRETACEOUS 72 Million Years Modern Seed Bearing Plants. Dinosaurs
JURASSIC 40 Million Years First Birds
TRIASSIC 49 Million Years Cycads. First Dinosaurs
SCAPHITES
INOCERAMUS
NERINA
PERISPHINCTES
TROPHITES
MONOTIS
PALEOZOIC Ancient Life
PERMIAN 60 Million Years First Reptiles
Carboniferous
PENNSYLVANYIAN 30 Million Years First Insects
MISSISSIPPIAN 35 Million Years Many Crinoids
DEVONIAN 60 Million Years First Seed Plants Cartilage Fish
SILURIAN 20 Million Years Earliest Land Animals
ORDOVICIAN 75 Million Years Early Bony Fish
CAMBRIAN 100 Million Years Invertebrate animals, Brachiopods, Trilobites
PRECAMBRIAN Very few fossils present (bacteria-algae-pollen?)
LEPTODUS
PARAFUSULINA
DICTYOCLOSTUS
CACTOCRINUS
PROLECANITES
PALMATOLEPUS
MUCROSPIRIFER
HEXAMOCERAS
CRYSTIPHYLLUM
BATHYURUS (Trilobite)
TETRAGRAPTUS
BILLINGSELLA
PARADOXIDES (Trilobite)


Oldest Crystal Tells Tale Of A Hospitable Early Earth
.005 in.
Newly discovered zircon crystal is the world's oldest known sample of a terrestrial material at an estimated 4.4 billion years old.
Chemical and isotopic analysis of this crystal suggest the presence of rocks formed at low temperatures and that the infant Earth cooled much faster after formation of the Moon than previously believed. Instead of being covered by a magma ocean, as conventional wisdom holds, the early Earth may instead have had continents, oceans, and a hydrosphere, all the conditions necessary for life.
Precambrian Age
Hadean
Archean
Proterozoic
Phanerozoic
Billion Years Ago
4.6
4
3.5
3
2.5
2
1.5
1
.5
0
Formation of Earth
Moon formation
First sedimentary evidence for oceans and earliest isotopic evidence for life
Earliest fossils
First cells with nucleus
First hard - shelled animals
Dinosaurs
Humans
Dan Brennan/UW-Madison News Graphic

GEOLOGIC TIME SCALE

ERA	PERIOD	EPOCH	SUCCESSION OF LIFE
CENOZOIC *recent life*	**QUATERNARY** 0-1 Million Years Rise of Man	Recent Pleisto-cene	
	TERTIARY 62 Million Years Rise of Mammals	Pliocene Miocene Oligocene Eocene	
MESOZOIC *middle life*	**CRETACEOUS** 72 Million Years Modern seed bearing plants. Dinosaurs		
	JURASSIC 46 Million Years First birds		
	TRIASSIC 49 Million Years Cycads, first dinosaurs		
PALEOZOIC *ancient life*	**PERMIAN** 50 Million Years First reptiles		
	Carboniferous: **PENNSYLVANIAN** 30 Million Years First insects		
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	DEVONIAN 60 Million Years First seed plants, cartilage fish		
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