GEOLOGIC TIME AND PROCESSES

Unit 6: Science

A trip through geologic time: 8.1 Fossils

- A **fossil** is: the preserved remains or traces of prehistoric organisms. They show evidence of how and when and where the organism lived. ~ **10,000** yrs old
- How does a fossil form?
- When an organism dies and is buried under soft sediment which eventually hardens, an imprint of the organisms hard parts (bone, shell, beak, tooth, wing, . . .) can remain. This empty cavity is called a **MOLD** fossil. When a mold is filled in with hardened rock material and found as an intact bone, shell, beak, tooth, . . . and a solid copy remains it is called a **CAST** fossil**.**
- A **PETRIFIED** fossil occurs as minerals replace all of the living parts. Ex. Petrified forest in Arizona


Petrified Wood

Fossils:

- In swampy regions, large volumes of decaying plant matter accumulate and are buried over millions of years. They are carbonized forming **COAL**.
- Sometimes original remains are frozen in ice or preserved in amber. This could be include an intact insect exoskeleton, wooly mammoth, . . .These are called **PRESERVED REMAINS.** When animals' tracks, footprints, burrows or trails are found, these are called **TRACE FOSSILS.** They are not the remains of living things but of the behaviors of a living organism. A **CARBON FILM (or impression)** occurs when the carbon outline or impression of a leaf or other plant matter remains behind.

Fossils:

- ***What does the fossil record tell us about the earth's history?***
- Fossils tell us how life has changed and become complex over time. It also explains how climate, environments, and landforms have changed over time. They provide a picture of the past. It includes all of the living past of the earth both found and not found evidence.
- What theory currently provides evidence to explain earth's history? Evolution is the gradual change in living things over long periods of time.
- Two major ideas emerge:
- life changes over time and
- if organism cannot adapt and change over time, it becomes extinct.

Organism Dies

- Covered
- Decomposed
- Destroyed
- _____
- Destroyed
- Fossilized
- _____
- Destroyed
- Stays Buried
- Discovered?
- _____

8.2 The Relative Age of Rocks

- Rock position:The laws of **Stratigraphy** are what scientist use to estimate the age of a rock or fossil based on how the rocks are layered
- Most of the rocks near or on the surface are sedimentary, which are formed by action of wind and water breaking rock into smaller particles. These small particles are cemented together over time by mud or chemical action.
- Sedimentary rocks settle by size and density with largest settling to the bottom and form layers.
- Relative Dating is used to **compare** the age of a rock to the age of other rocks.
-

Relative Age:

This sequence of layers led Nicholas Steno to surmise:

- **The Law of Superposition:** ***a given rock layer is older than the rock layer above it.***
- He also realized that most rocks were layered horizontally but over time these layers are disturbed so when sedimentary rocks are found at angles, they have been moved by mountain building, faults, . . .
- **Unconformities** occur when a very young rock layers meets a much older layer due to eroded/ missing rock layers.
- **The Law of Original Horizontality:** when originally formed, sediments were laid down in horizontally.
- Igneous rock layers are often found vertically cutting up through the sedimentary strata. These **intrusions** are younger than the layers they cut through.

Relative Age:

- **The Law of Cross Cutting Relationships**: *The intrusion is younger than all the rock layers it cuts through but older than the layer on top.*
- An **unconformity** is a buried erosional or non-depositional surface separating two rock masses or strata of different ages, indicating that sediment deposition was not continuous.

Relative Age

- An **INDEX FOSSIL** is a useful tool for a paleontologist piecing together evidence about geologic time. An index fossil is found abundantly across a wide geographic region. They key is they only lived for a short period of time so they are used to relatively date the age of the rock layer where they are found.
- **Principle of Uniformitarianism-** The “present is the key to the past.”

Grand Canyon and the Flintstones

- https://www.youtube.com/watch?v=xf4pUZPaz5k

- View of Grand Canyon from Skywalk
- https://www.youtube.com/watch?v=dn-ZuF-eirw

Grand Canyon, Arizona

Colorado River cut the Canyon

Note horizontal layers of different Sedimentary Rocks

Zion Canyon, Utah

Bryce Canyon, Utah

Index Fossils in the Western Canyons

- When you get the 3 canyons matched up by Relative Age, write a 3 sentence summary explaining the ages of each canyon. Use relative dating and laws of relative dating to explain your answers.
- Call me over when summary and canyons are complete. I will give you a 100 lab grade. Then work on analysis questions on front side of assignment.

8.3 Radioactive dating

- Absolute Age- is the number of years since the rock formed based on the number of Radioactive isotopes that remain. This tool is used to date fossils and igneous rocks.
- Radioactive decay: Henri Becquerel found that the element Uranium changed to lead through a process called ***radioactive decay***. This is the first step in calculating the numeric age of rocks. By measuring the ratio of the radioactive parent isotope to the stable daughter isotope of the element, the age of the rock can be calculated.

Radioactive Dating

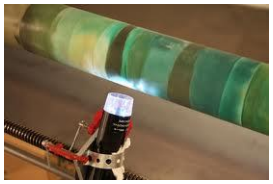
- Determining absolute age:The amount of time for the radioactive (parent) isotope to decay to a stable (daughter) isotope is called **half-life**. In dating rocks and fossils, Potassium-argon dating is used for igneous rocks and Carbon 14 to Nitrogen 14 for fossils. Remember all living things have carbon!!

Radioactive Dating:

Half Life	Do the math	Ratio
1	½ x ½	1:1
2	¼ x ¾	1:3
3	1/8 x 7/8	1:7
4	1/16 x 15/16	1:15
5	1/32 x 31/32	1:31
6	1/64 x 63/64	1:63

Core sampling

https://www.youtube.com/watch?v=VjTsj-fi-p0



- *If you want to go back 300,000 years to find out what the climate was in Canada or what came out of the Indonesian volcano, Toba, blew its top, what would you do?*
- Scientist use the time machine of _**core**__ sampling. Usually scientists are collecting cores of ice which would trap _**dust**_, ash, atmospheric gases, and_**radioactivity**_. Cores of ancient _**mud**__below lakes may offer evidence as well. A __**mass**__ spectrometer would analyze the chemicals present in the sample.

8.4-8.6 The Geologic Time Scale

- What is time in relation to the earth's history?
- Scientists have divided geologic time into chunks based on common evidence. Shells are always found in the oldest layers. Eons are the longest division of time. Eras are long spans of time based on the type of life that existed. Periods are shorter time spans based on major actions in the Earth's crust. Ex. Cretaceous period is named for English chalk beds which were laid down at this time. Epochs are subdivisions of periods.

Early Earth

- What was the early earth like?
- Scientists think the earth began as a mass of dust, rock & ice. Gravity pulled the mass together and more rock and ice struck the earth at high speeds increasing the thermal energy. As it became hotter, the densest materials melted and formed the core of the earth as they sank to the center. Space is cold so the outer layers of the earth cooled hardening the crust of the earth.
- In the Precambrian time, an atmosphere and the oceans formed. As the rocks on the earth's surface cooled and hardened large landmasses formed.

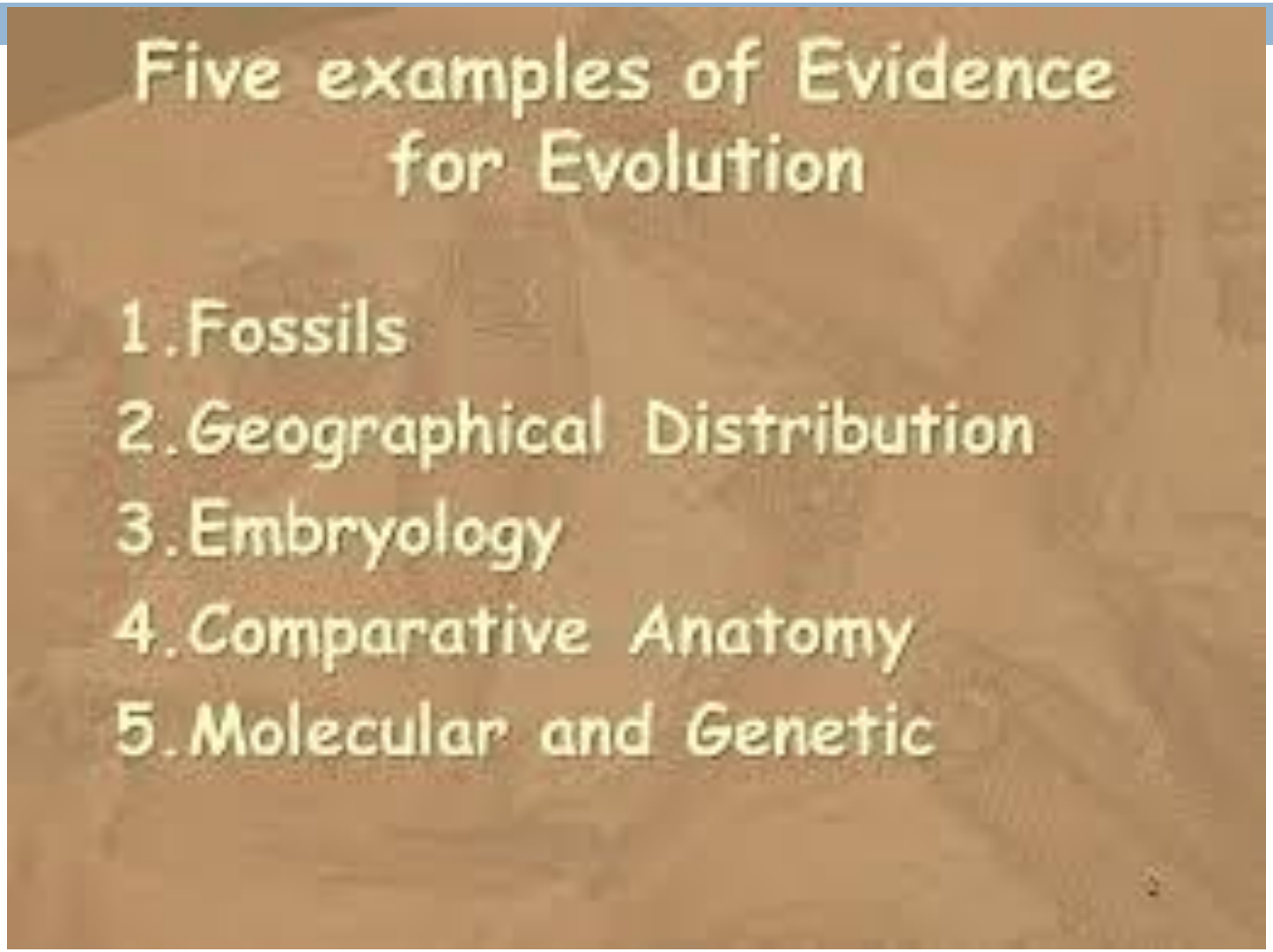
Change over time

- How has the earth changed biologically and geologically?
- The oldest fossils dating to this time were single- celled organisms similar to present day bacteria. As organisms began to use the sun's energy to make food, the amount of oxygen in the air increased forming a dense ozone. This made it possible for animals to live on land so organisms became more complex.
- Since the early earth was primarily oceans, marine invertebrates are the oldest animal fossils found. As seas receded and more land surfaced, amphibian fossils were found.

Natural Selection

- **What is Darwin's idea of natural selection?**
- Process by which organisms with the best or most favorable genetic adaptations (changes) out COMPETE other organisms in the community.
- **What does 'survival of the fittest' mean in terms of species survival vs. extinction?**
- Organisms that are most successful in the environments will also be most successful in reproduction and therefore better adapted to reproduce at a greater rate so survival of the species is guaranteed.

Evidence for Theory of Evolution



Comparative Anatomy

Comparative Anatomy

- **Homologous structures:** are anatomical resemblances between organisms that represent variations on a structural theme that was **present in a common ancestor**

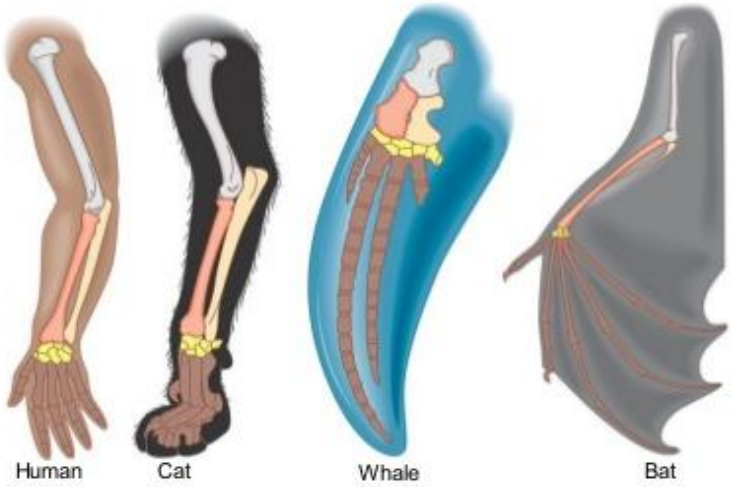
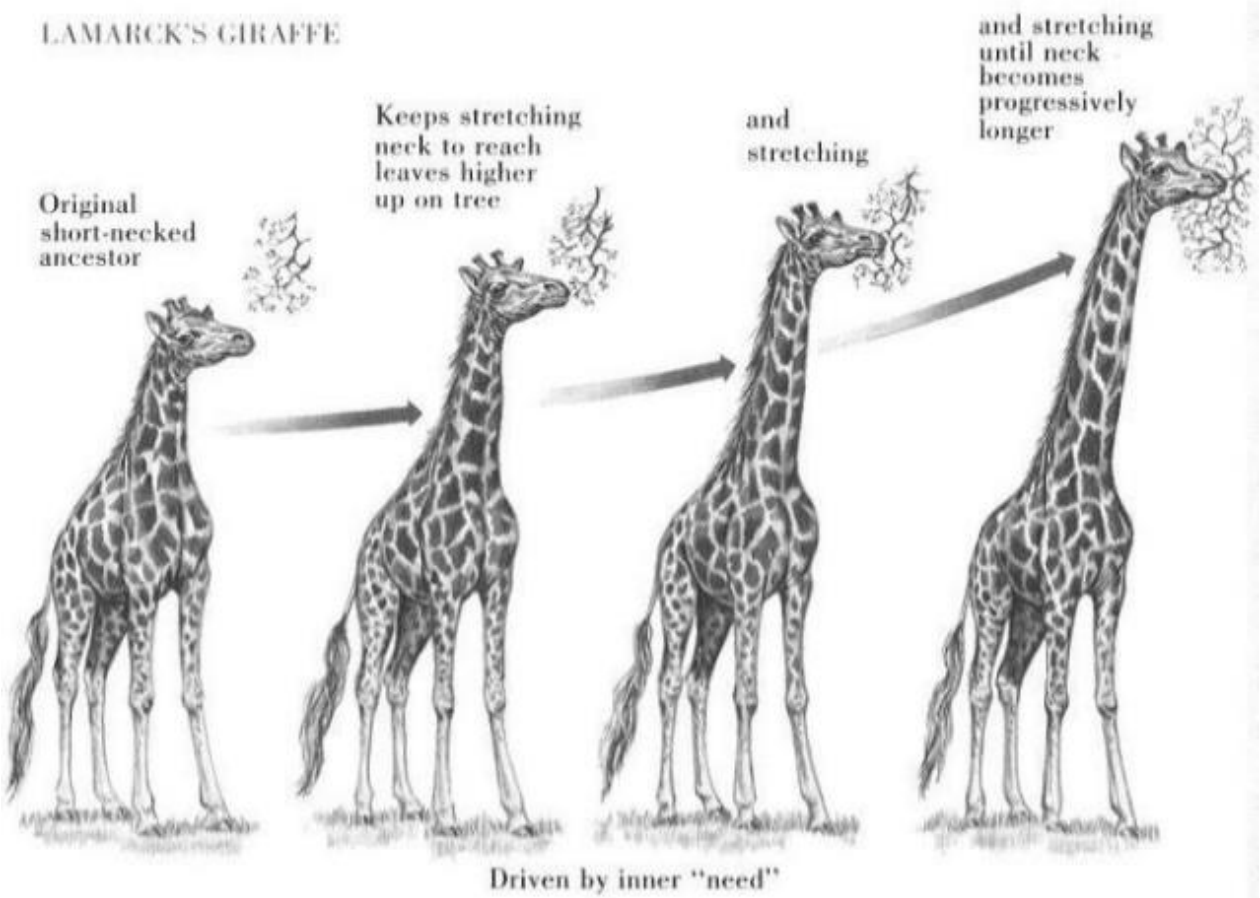
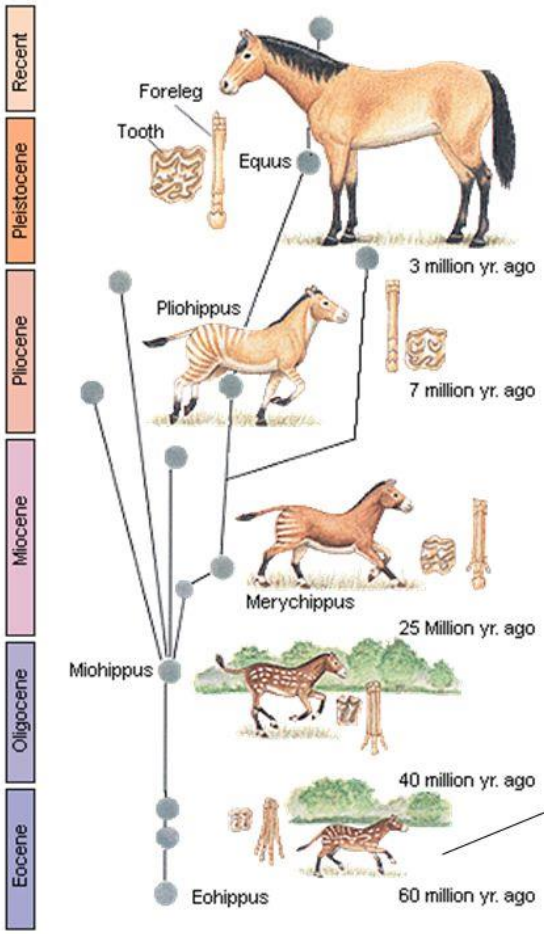


Figure 22.14

Comparative Anatomy



Comparative Anatomy



Fossil Record Evidence: *Horse evolution*

one toe on ground (#3),
long teeth good for eating
tough blades of grass

four toes on ground (#2-5),
short teeth good for eating
soft leaves on shrubs & trees

Comparative Anatomy