

FSC 111

EVOLUTION OF LIVING THINGS (ORGANISMS)

BY

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Lecture 1

What is evolution?

- Evolution is the development of life in **geological time**.
- It happens when the **genetic composition** of a population changes over successive generations.

What is Geological time scale?

- Record of the life forms and geological events in Earth's history.
- Scientists (**GEOLOGISTS**) developed the time scale by studying **rock layers** and **fossils** world wide



What are Fossils



Preserved remains or traces of an organism that lived in the past.

- Fossils are formed when organisms die and are buried in sediment.
- Sediments are pieces of solid material that have been deposited on Earth's surface by wind, ice, gravity, or chemical precipitation.
- Paleontologist-scientist who study the remains of organisms in the rock record.

Kinds of fossils

- **Petrified** - when minerals replace the remains and they become rock things like wood.
- **Mold** - when the shell remains and the contents dissolve (hollow) like in art class you use a mold to get the correct shape of a bowl.
- **Cast** - when the mold becomes filled with minerals that are not a part of the original organism.

PETRIFIED



MOLD



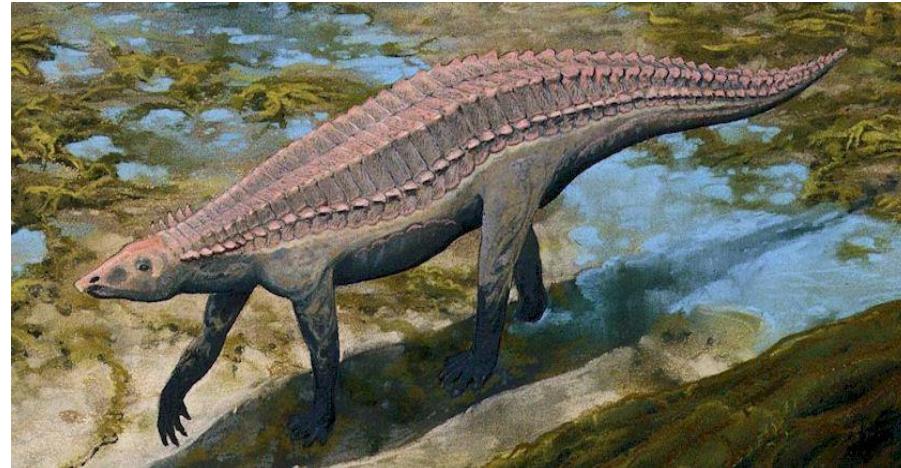
CAST



- Preserved animal intact. If an organism is surrounded by ice or tar they might be discovered looking much the same as they did when they died. E.g.

AETOSAUR

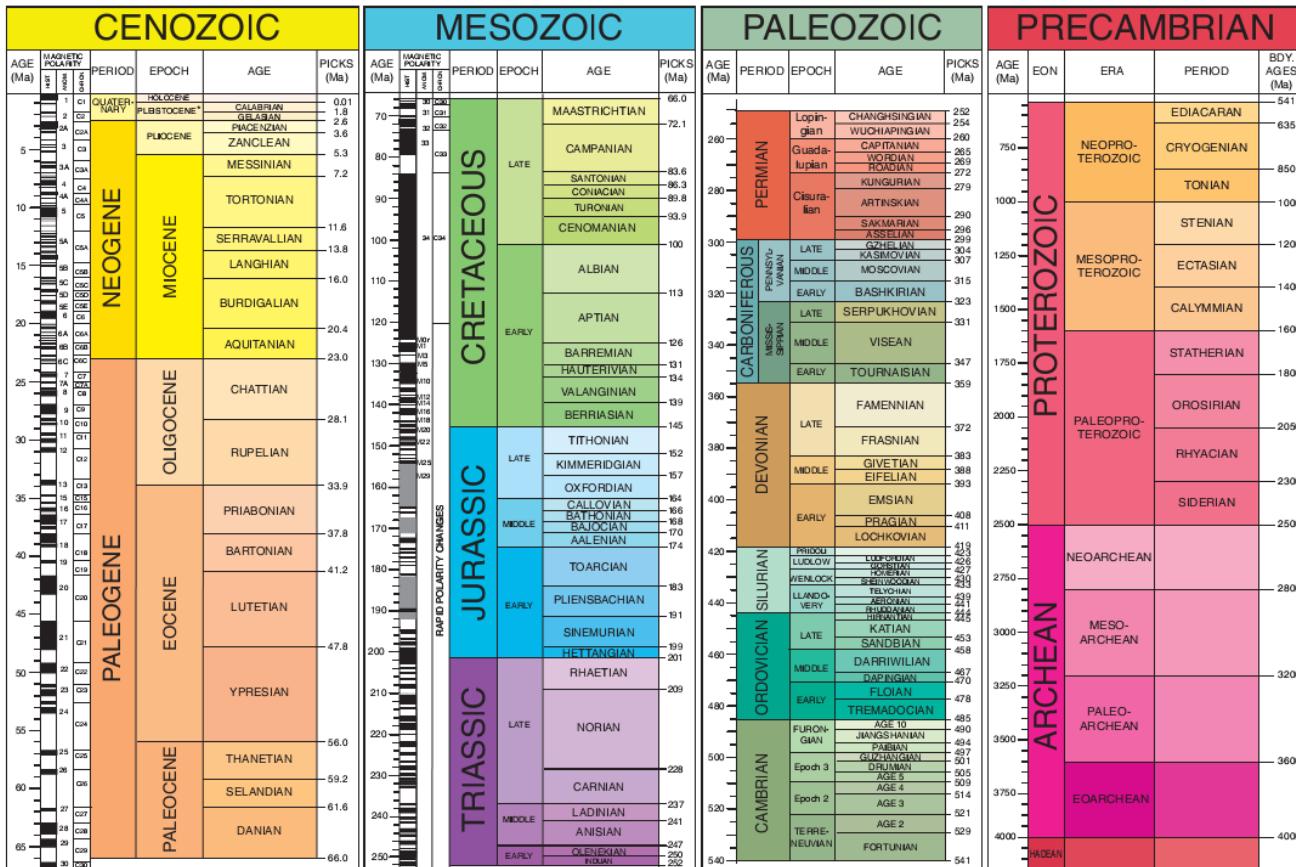
**FOUND IN
THE
NATIONAL
PETRIFIED
FOREST**



Geologic time scale divisions

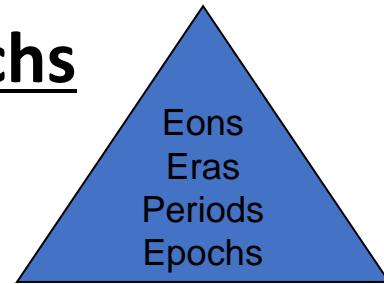
- The geologic history of the Earth is broken up into hierarchical chunks of time.
- From **largest to smallest**, this hierarchy includes
- **EONS, ERAS, PERIODS, AND EPOCHS.** All of these are displayed in the portion of the geologic time scale as shown below

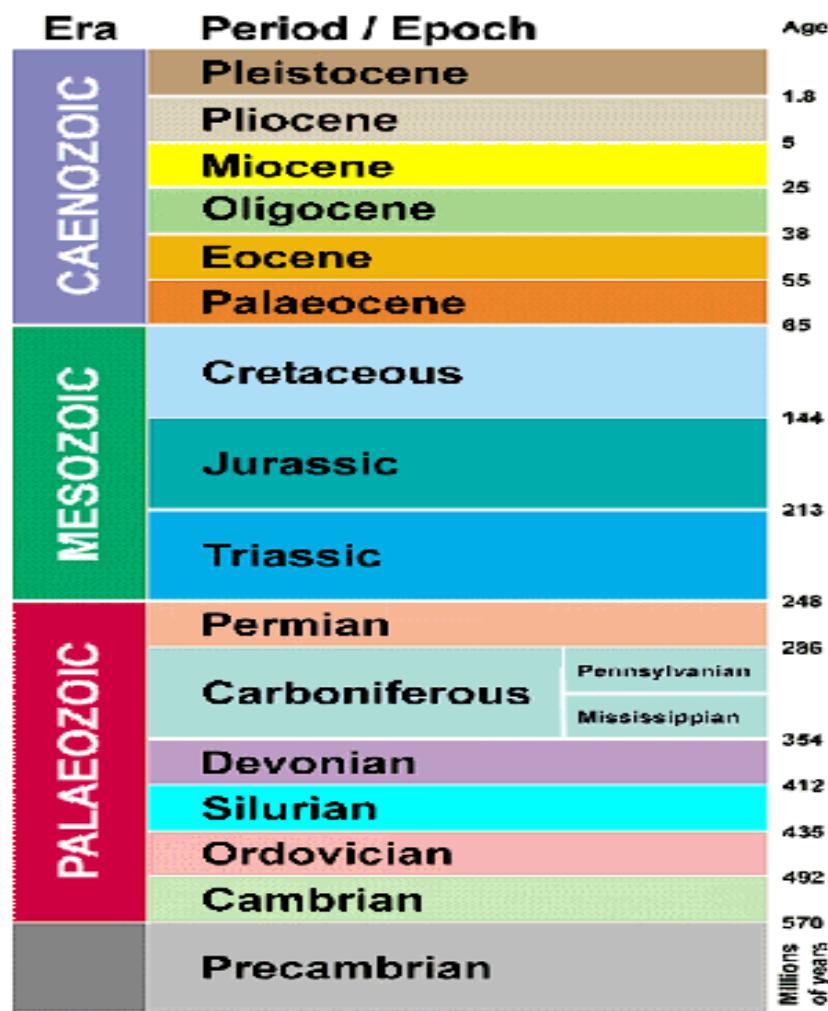
Geological Time Chart



- The **Phanerozoic Eon** is subdivided into three major divisions: the **PALAOZOIC, MESOZOIC, AND CENOZOIC** Eras. The "-zoic" suffix comes from the root "zoo," which means **animal**.
-
- "**Cen-**" means **RECENT**
- "**Meso-**" means **MIDDLE**
- "**Paleo-**" means **ANCIENT**

- The geologic time scale divides Earth's long history into units of time: There are 4 major subdivisions of Geologic Time
- Eons which subdivides into eras
- Eras which subdivides into periods
- Periods which subdivides into epochs

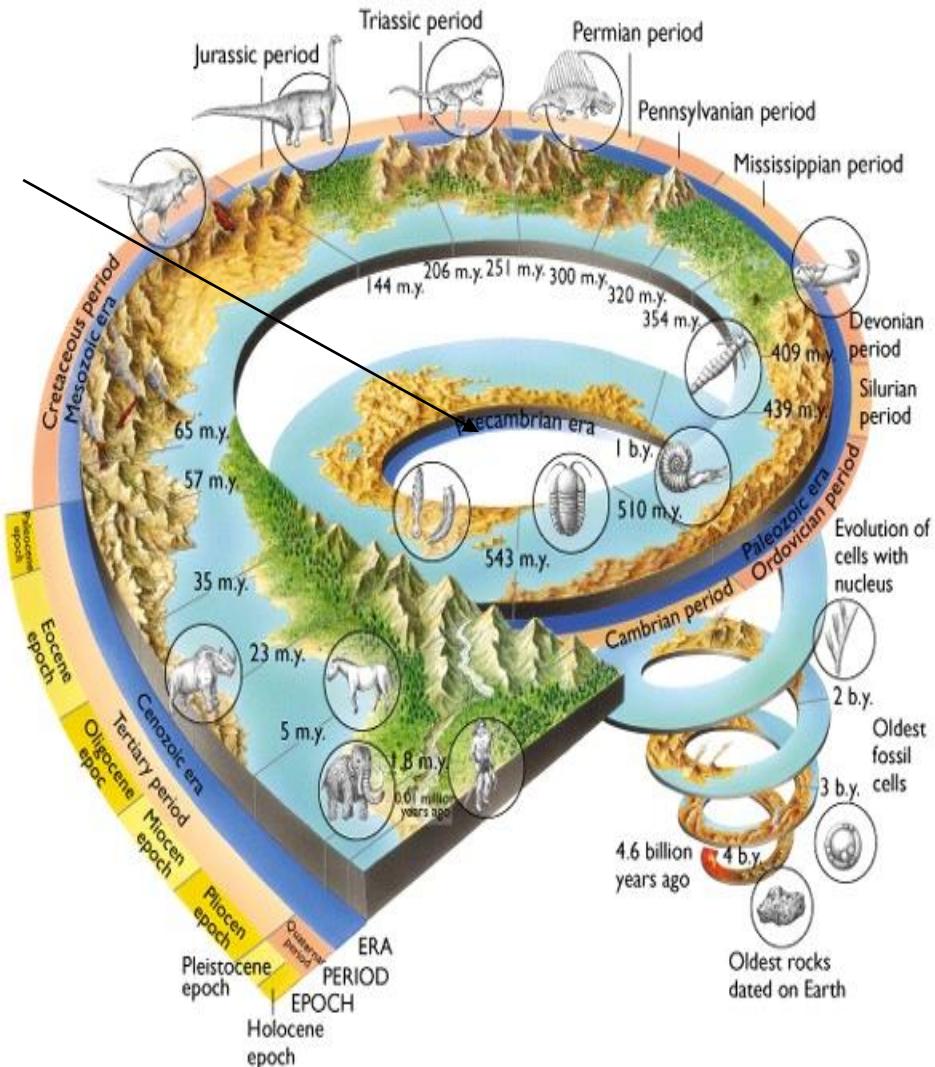




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Pre-Cambrian

- Began with the formation of the Earth 4.6 billion years ago.
- Bacteria appeared 3.5 billion years ago, followed by algae and fungi.



Precambrian Timeframe & Facts

- 4.5 billion to 544 million years ago
- Is the longest part of Earth's history

Precambrian Era Events?

- Earth formed
- Life arose
- First tectonic plates arose and began to move
- Eukaryotic cells evolved
- Atmosphere became enriched in oxygen
- And, just before the end of the Precambrian, complex multicellular organisms, including the first animals, evolved.

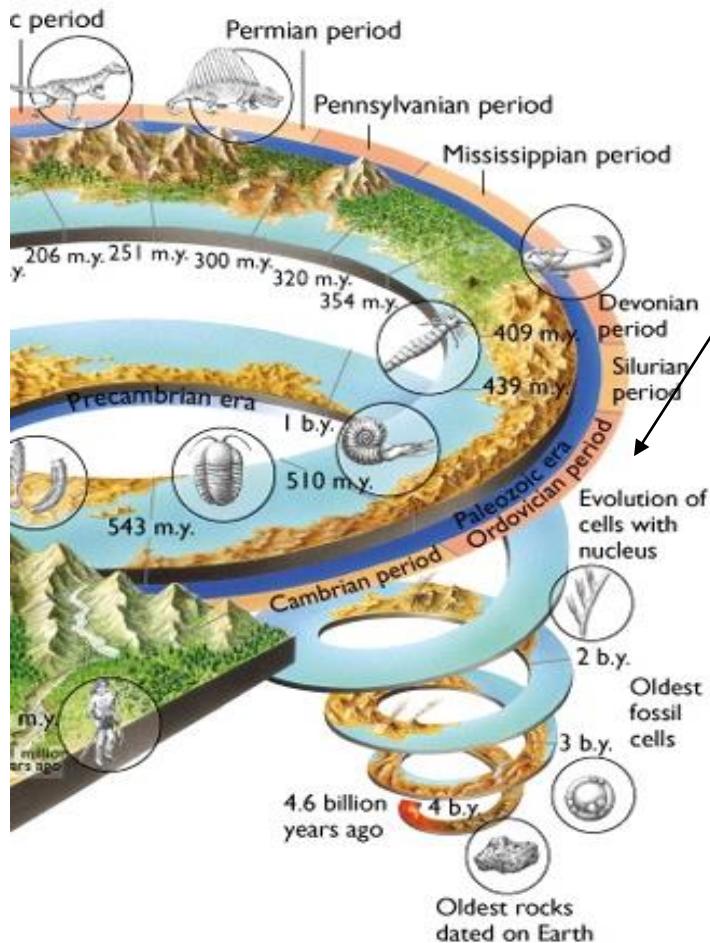
Precambrian Animals

- Most organisms had **soft** bodies which looked like modern jellyfish and worms
- **Invertebrates (animals with no backbone)** appeared near the end of the Precambrian Time

MASS EXTINCTION

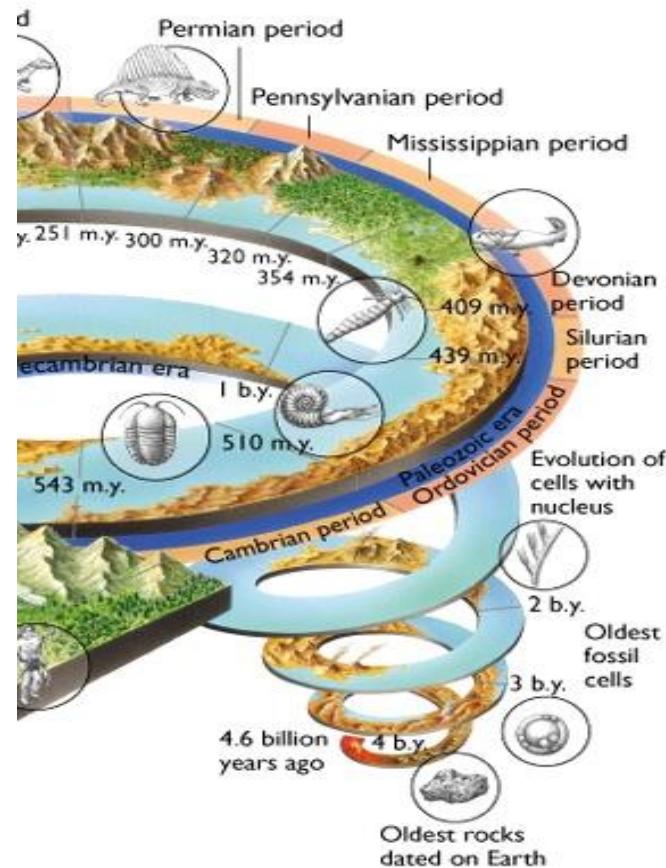
- MASS EXTINCTION IS THE EVENT THAT ENDED PRECAMBRIAN TIME.
- * glaciation event
- Precambrian time were marked by a prolonged global ice age.
- This may have led to widespread extinctions.

Paleozoic Era



- Divided into 6 periods:
- **Cambrian period** - Sponges, snails, clams and worms evolve
- **Ordovician period** - First fishes evolved and other species become extinct
- **Silurian period** - Land plants, insects and spiders appear

- **Devonian period** -
Amphibians evolve
and cone-bearing
plants start to appear.
- **Carboniferous period**
- Tropical forests
appear and reptiles
evolve.
- **Permian period** -
Seed plants become
common and insects
and reptiles become
widespread. Sea
animals and some
amphibians begin to
disappear.



Major Events during Paleozoic Era

- “Age of the Trilobites” (Invertebrates were dominate)
- Explosion of life in the oceans began during this era.
- Most of the continents were covered in warm, shallow seas.
 - Fish emerged during this time
 - Fish led to the arrival of amphibians
 - The end of the Paleozoic era is called the “Age of Amphibians”
 - Early land plants including mosses, ferns and cone-bearing plants.

Major Events during Paleozoic Era

- The Cambrian (beginning) opened with the breakup of the world-continent **Rodinia** and closed with the formation of **Pangaea**, as the Earth's continents came together once again.
 - This event is thought to have caused the climate changes that led to mass extinction event.

Major Events during Paleozoic Era

- At the end of the Paleozoic, the ***largest mass extinction in history*** wiped out approximately 90% of all marine animal species and 70% of land animals.
 - Possible causes of this Mass Extinction Event
 - Lowering of sea levels when the continents were rejoined as Pangaea (convergent boundary)
 - Increased volcanic activity (ash and dust)
 - Climate changes – cooler climate

Trilobites



- Extinct before the dinosaurs came into existence

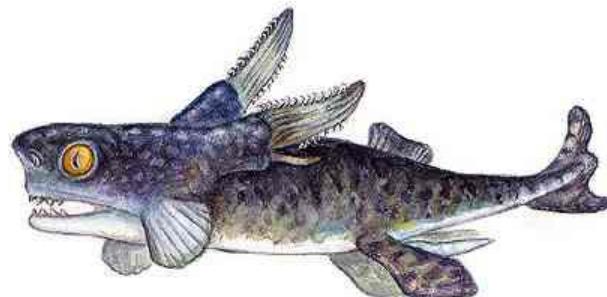
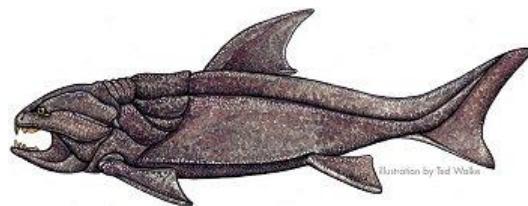
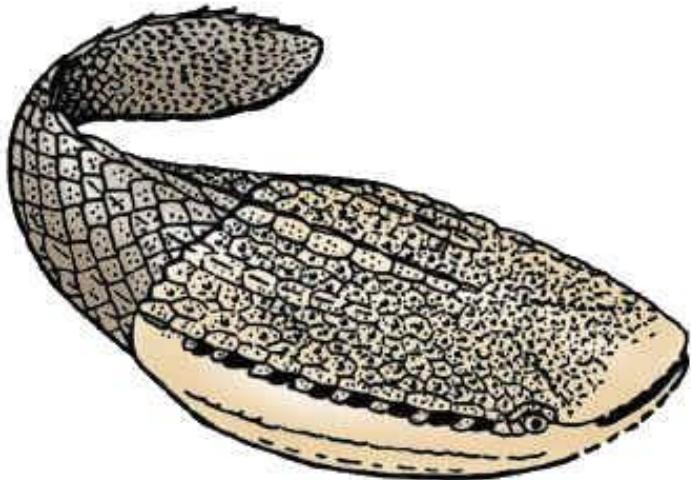


***Sphaerocoryphe robusta* Walcott 1875**

M. Ordovician, Trenton Grp., Rust Fm.
Trenton Falls, New York, USA

image courtesy Sam Stubbs & Neal Immega

Early Fish



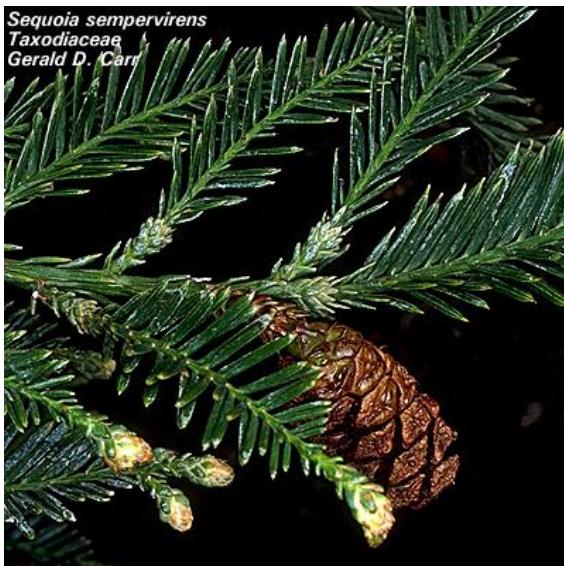
Early fish did not have jaws.

Some species of sharks were in existence at this time.



Frilled Shark that was found in Japan in January 2007. This shark was considered a “living fossil”

Early Land Plants



Cone bearing plants



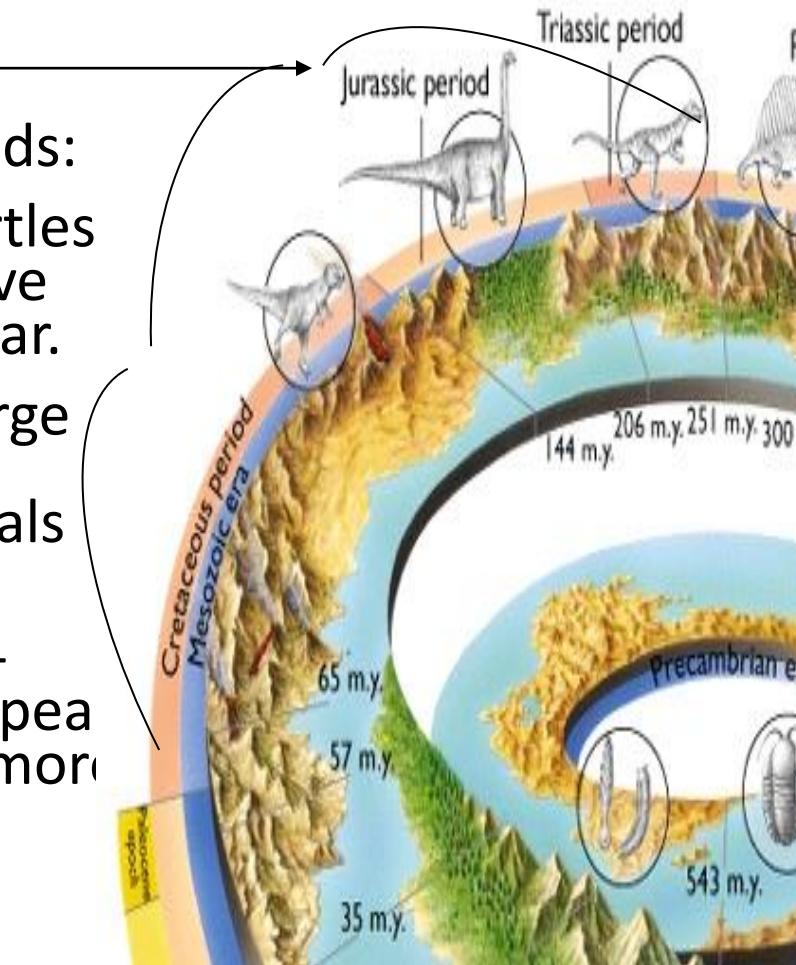
Ferns

Mosse
s

Mesozoic Era

Divided into 3 periods:

- **Triassic period** - Turtles and crocodiles evolve and dinosaurs appear.
- **Jurassic period** - Large dinosaurs roam the world. First mammals and birds appear.
- **Cretaceous period** - Flowering plants appear, mammals become more common, dinosaurs become extinct.



Mesozoic Era – Middle Life

- At the beginning of this era the continents were joined as Pangaea.
- Pangaea broke up around the middle of this era.
- Reptiles became the most abundant animals because of their ability to adapt to the drier climate of the Mesozoic Era.

Major events during Mesozoic Era

- At the beginning of this era Pangaea formed and during the Triassic Period, Pangaea **began to break up** (**Pangaea split into 2**)
-
- Ended when most of the land and ocean species became extinct when an asteroid collided with Earth
- Known as the **Age of Dinosaurs or the Age of Reptiles**

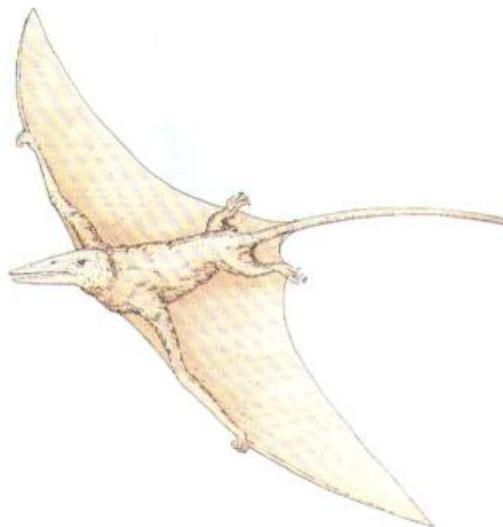
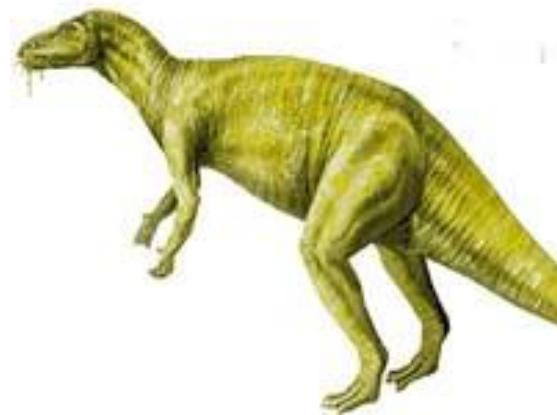
Major events during Mesozoic Era

- During the Triassic Period, a tiny, mouse like animal was the first mammal to appear (**Small mammals and birds** appeared during this era)
- Modern bird appeared
- **Gymnosperms** dominated the land.

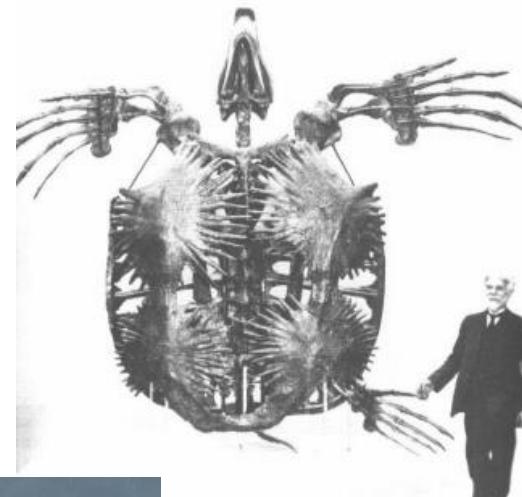
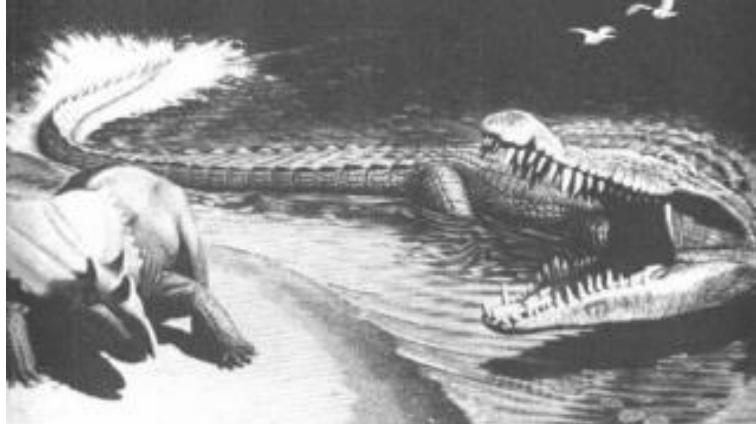




Dinosaurs



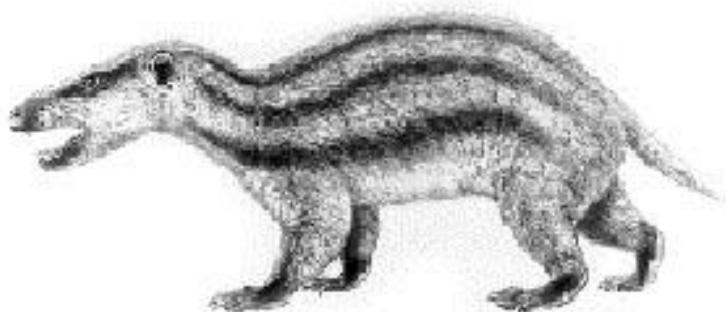
Mesozoic Reptiles



Mesozoic Mammals



Morganucodon



Akidolestes cilicium reconstruction on fallen ginkgo branch.
Illustration: Mark A. Klingler / CMNH





Mesozoic Plants

Flowering plants evolved towards the end of the Mesozoic Era.



Mesozoic Era – Mass Extinction Event

- Asteroid or Comet collides with Earth.
 - Huge cloud of smoke and dust fills the air
 - Blocks out sunlight
 - Plants die
 - Animals that eat plants die
 - Animals that eat plant-eaters die.
- However, not all forms of life died during this event. Many animals that you see today are descendants from the survivors of this extinction event.



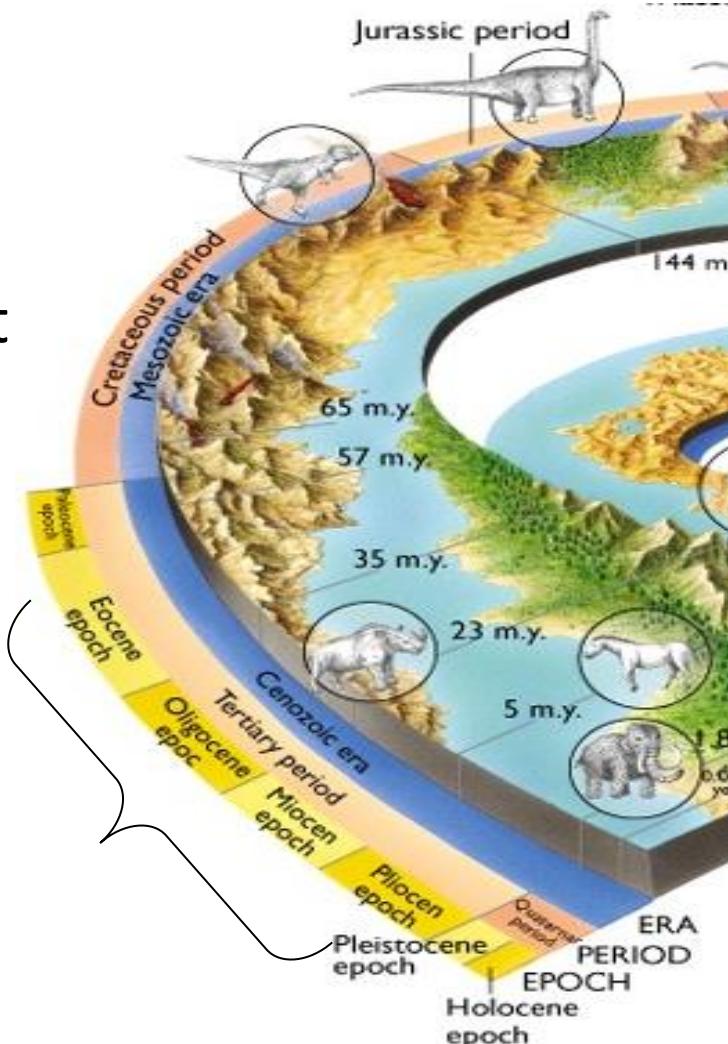


CG4TV.com



Cenozoic Era

- Divided into 2 periods:
 - **Tertiary period** - First primates appear and flowering plants become the most common.
 - **Quaternary period** - Humans evolve and large mammals like woolly mammoths become extinct.



Cenozoic Era – Recent Life

- Began about 65 million years ago and ***continues today!!!!***
 - Climate was warm and mild.
 - Marine animals such as whales and dolphins evolved.
- Mammals began to increase and evolve adaptations that allowed them to live in many different environments – land, air and the sea.
 - Grasses increased and provided a food source for grazing animals
- Many mountain ranges formed during the Cenozoic Era
 - Alps in Europe and Himalayas in India; Rocky Mountains in the USA

Cenozoic Era

- Growth of these mountains may have helped to cool down the climate
 - Ice Ages occurred late in the Cenozoic Era (Quaternary Period).
- As the climate changed, the animals had to adapt to the rise and fall of the oceans caused by melting glaciers.
- This era is sometimes called the “Age of Mammals”

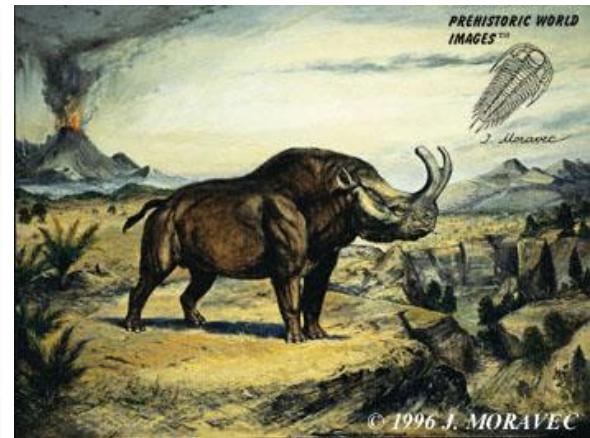
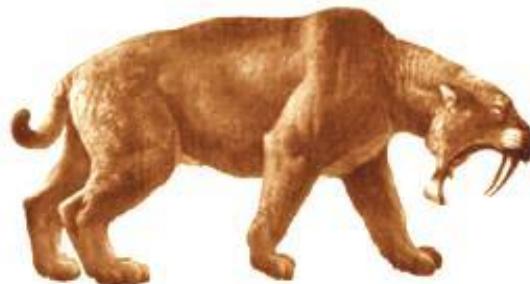
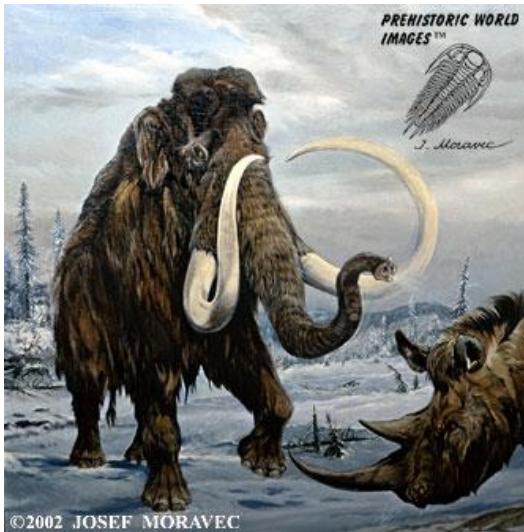
Cenozoic Era



- Marine animal examples:
 - Algae, Mollusks, Fish and Mammals
- Land animal examples:
 - Bats, Cats, Dogs, Cattle and Humans
 - Humans are thought to have appeared around 3.5 million years ago (***during the most recent period – Quaternary***).
- Flowering plants were now the most common plant life.



Cenozoic Mammals

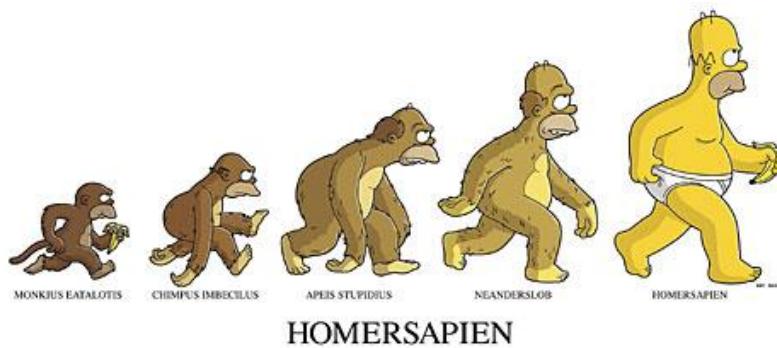


Flowering Plants were common during the Cenozoic Era



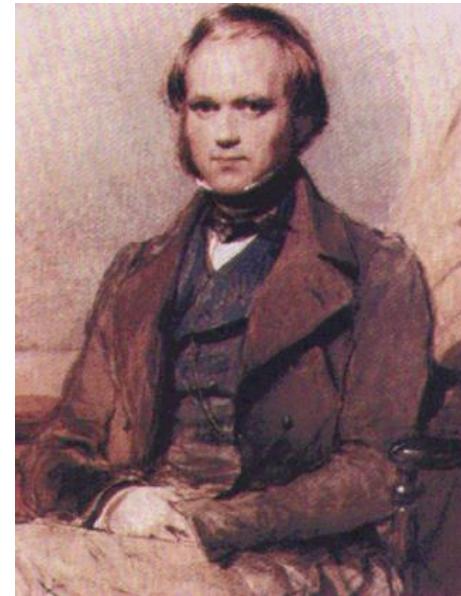
Darwin & Natural Selection

Evolution



Charles Darwin

- Father of Evolution
- Proposed a mechanism for evolution, **natural selection**
- Darwin went on a 5-year trip around the world on the ship, the HMS Beagle
 - As the ship's naturalist, he made observations of organisms in South America and the Galapagos Islands
 - Wrote a book, “*Origin of the Species*”



Charles Darwin

- Natural Selection: Organisms that are best adapted to an environment *survive* and *reproduce* more than others

Natural Selection

- Darwin's Theory of Natural Selection occurs in four steps:
 1. Overproduction
 2. Variation
 3. Competition
 4. Selection

1. Overproduction

- Each species produces more offspring than can survive



2. Variation

- Each individual has a unique combination of inherited traits.
 - **Adaptation:** an inherited trait that increases an organism's chances of survival





Betty
Cummings

Why is Variation Important?

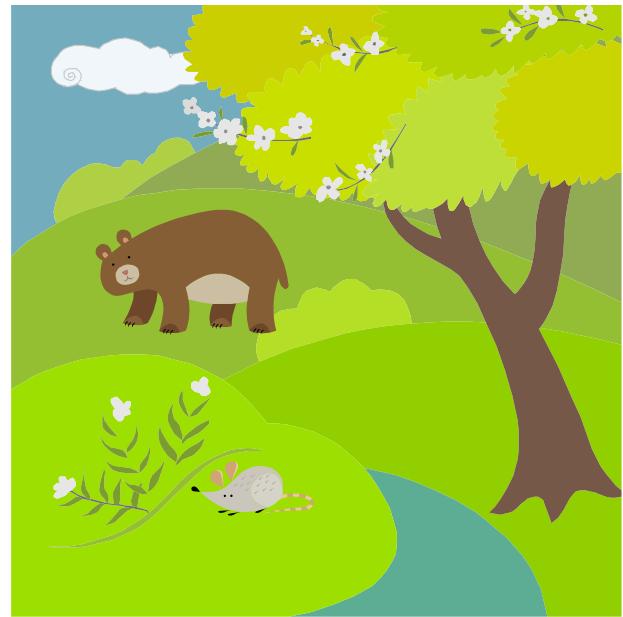
- Because the environment changes.
- The more **variation within a species**, the more likely it will **survive**
 - EX: If everyone is the same, they are all vulnerable to the same environmental changes or diseases
- The more **variation of types of species** in an habitat, the more likely at least **some will survive**
 - EX: Dinosaurs replaced by mammals

Which community has a better chance of surviving a natural disaster?

Community A



Community B



3. Competition

- Individuals COMPETE for limited resources:
 - Food, water, space, mates
- Natural selection occurs through “**Survival of the fittest**”
 - **Fitness:** the ability to survive and reproduce
- Not all individuals survive



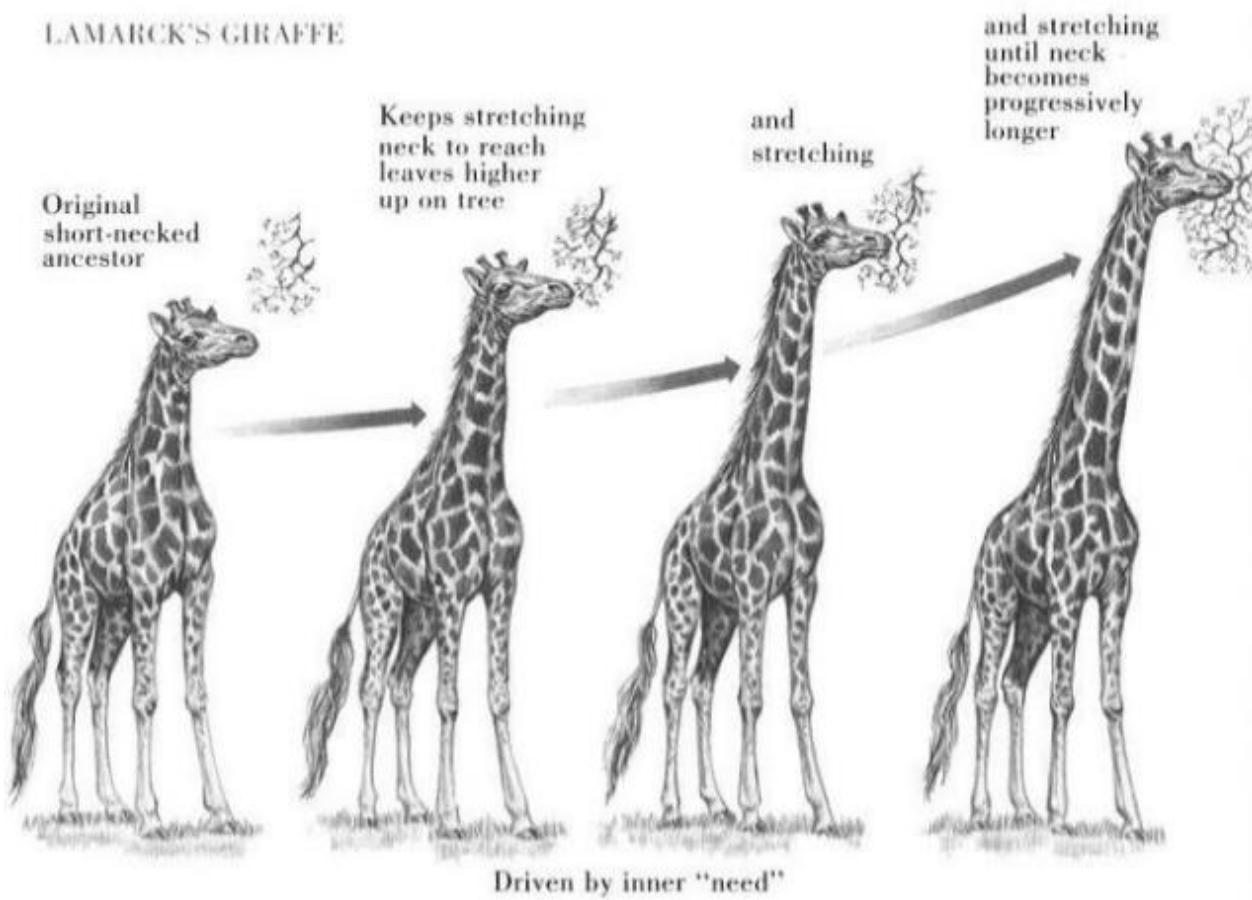
4. Selection

- The individuals with the best traits / adaptations will survive and have the opportunity to pass on its traits to offspring.
 - Natural selection acts on the phenotype (physical appearance), not the genotype (genetic makeup)
 - Ex: When a predator finds its prey, it is due to the prey's physical characteristics, like color or slow speed, not the alleles (BB, Bb)

Selection

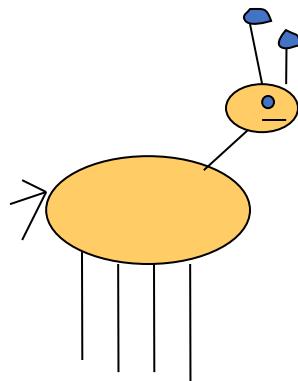
- Individuals with traits that are not well suited to their environment either die or leave few offspring.
- Evolution occurs when **good traits build up in a population** over many generations and **bad traits are eliminated by the death of the individuals**.

LAMARCK'S GIRAFFE

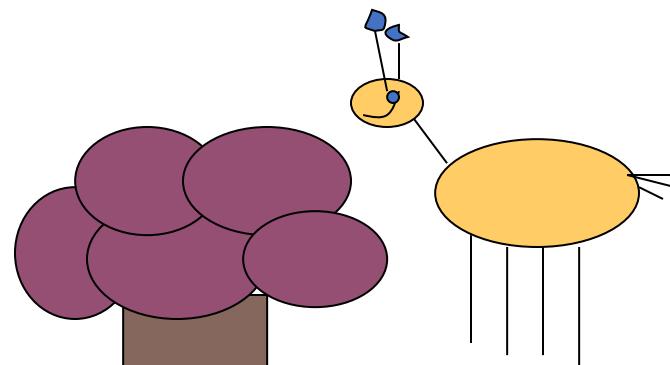


Selection

■ Good Trait

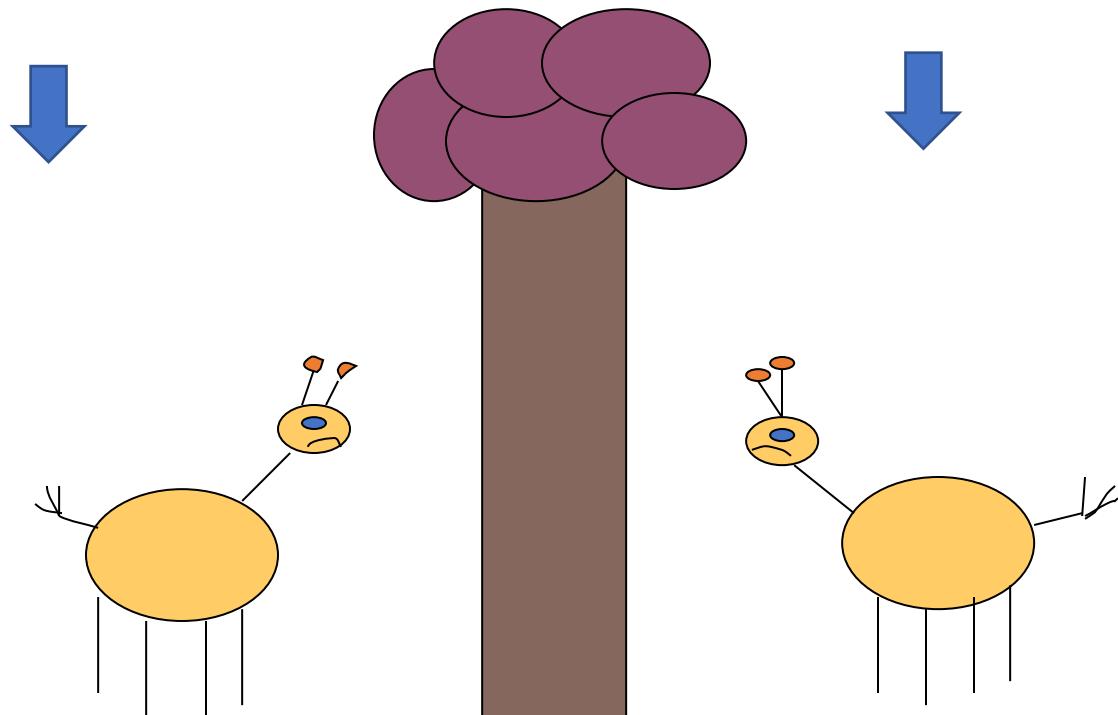


Bad Trait



Good traits build up in a population

■ Good Trait

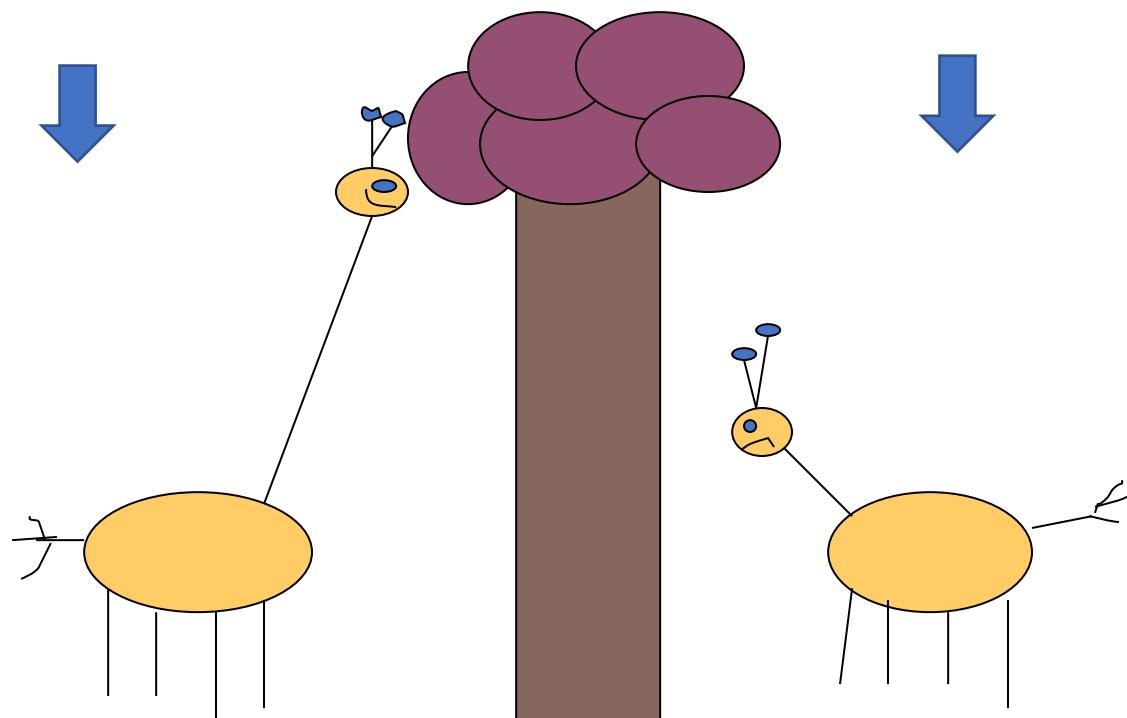


Bad Trait

Good traits build up in a population

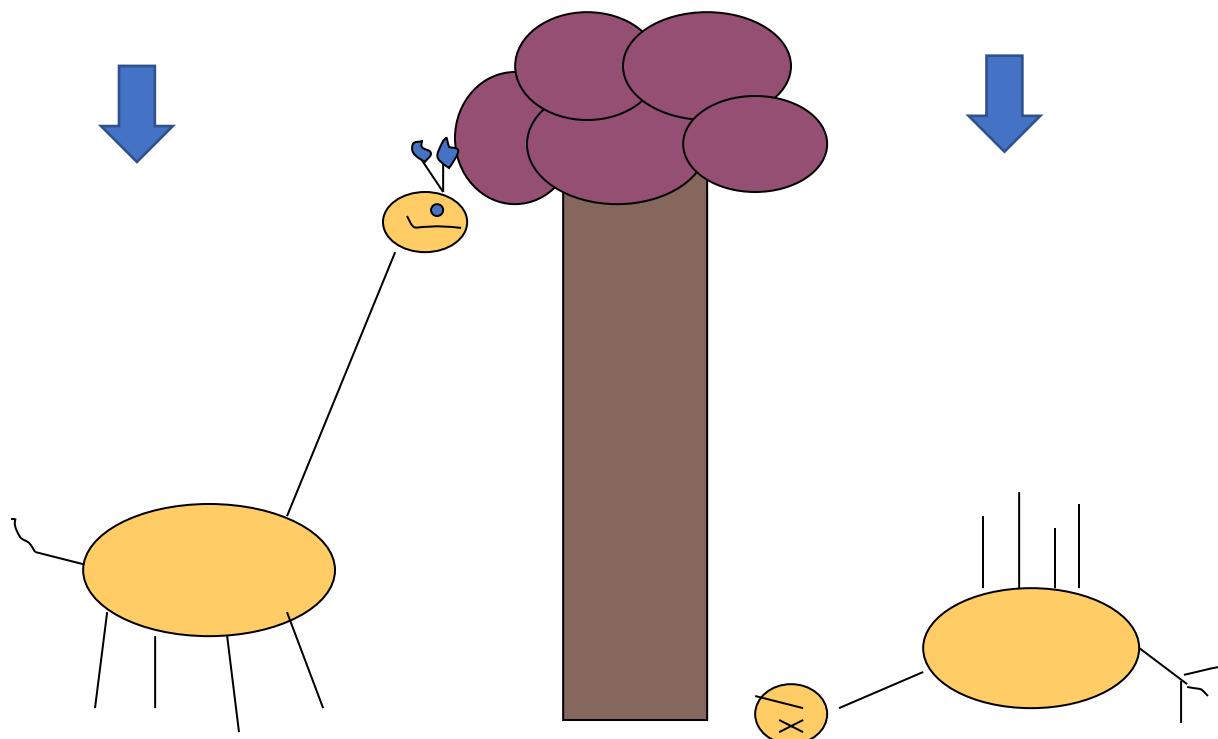
■ Good Trait

Bad Trait



Bad traits are eliminated by the death of the individuals.

■ Good Trait



Bad Trait

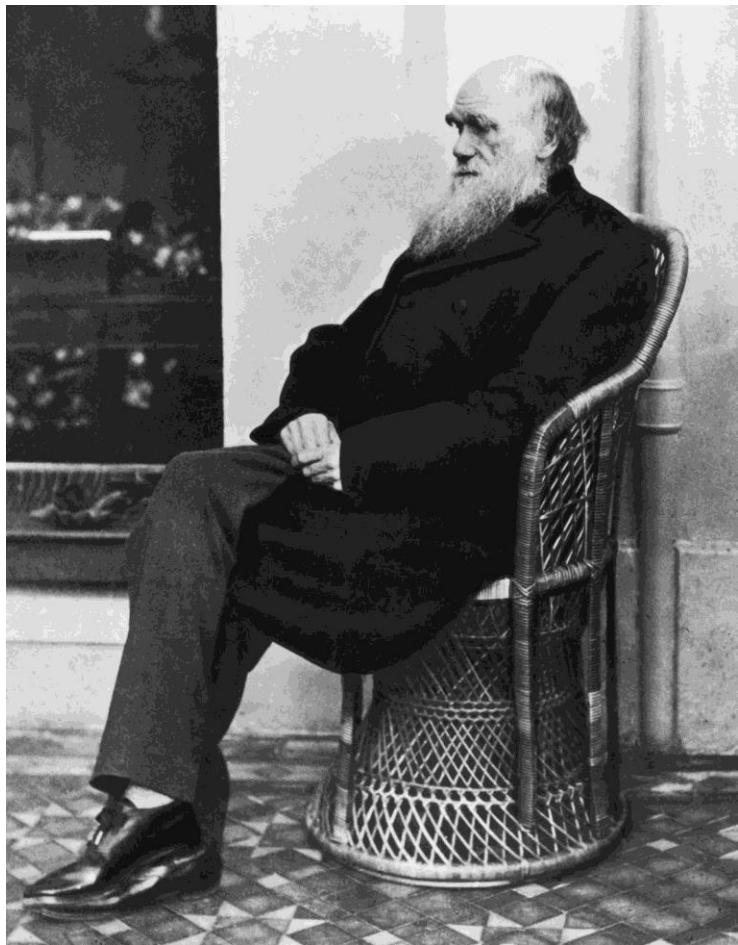
EVOLUTION OF HUMAN

The human evolution story begins in Africa about 6 million years ago.

Our ape-like ancestors evolved into upright walking, tool using and cultural modern humans, spreading out across the globe.



In 1871 Charles Darwin proposed in his book “The Descent of Man” that humans evolved in Africa and shared a common ancestor with great apes.





Old-World monkeys



Gibbon



Orangutan



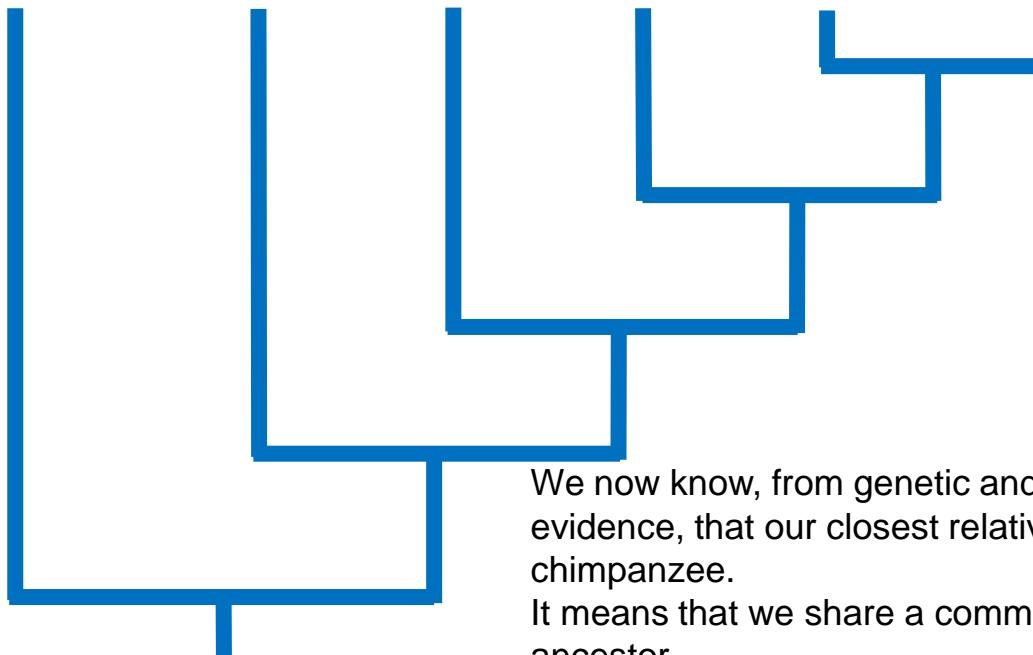
Gorilla



Chimpanzee

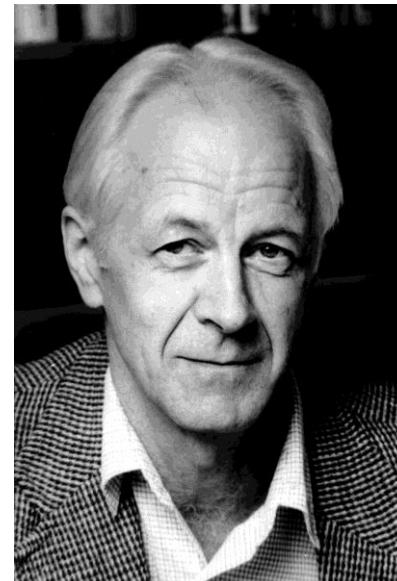
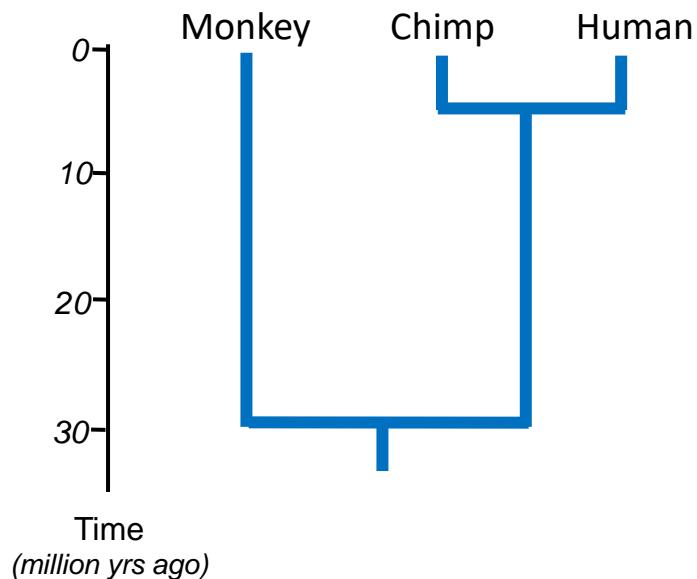


Human



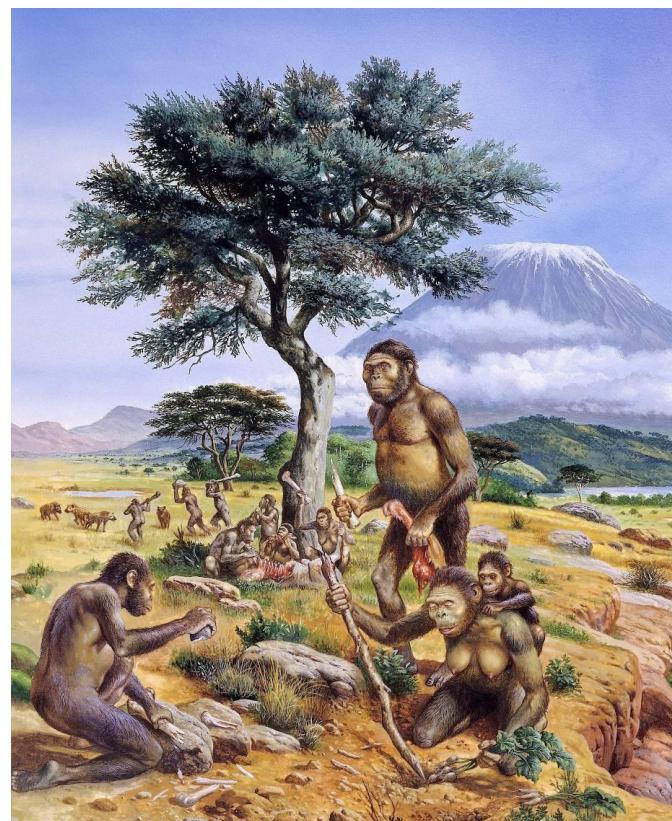
We now know, from genetic and fossil evidence, that our closest relative is the chimpanzee.
It means that we share a common ancestor.

Molecular differences show that humans diverged from chimpanzees 5-6 million years ago



Allan Wilson 1934 - 1991

The earliest human-like fossils have been found in Africa and date back to 4-8 million years ago. They show that our earliest ancestors walked upright, but had much smaller brains and did not yet use sophisticated tools or use fire.

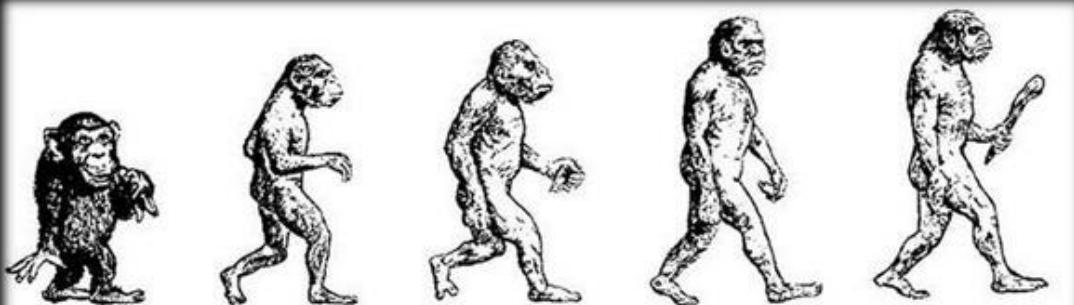


Homo erectus was the first
to migrate out of Africa 1.8



Evolution of man

- Many of the hominins around 4 and 2 mya were collectively called **Australopiths.**
- *Australopithecus anamensis* links the australopiths to older hominins such as *Ardipithecus ramidus*

**LUCY**

Nearly all experts agree Lucy was just a 3 foot tall chimpanzee.

HEIDELBERG MAN

Built from a jawbone that was conceded by many to be quite human.

NEBRASKA MAN

Scientifically built up from one tooth, later found to be the tooth of an extinct pig.

PILTDOWN MAN

The jawbone turned out to belong to a modern ape.

PEKING MAN

Supposedly 500,000 years old, but all evidence has disappeared.

**NEANDERTHAL MAN**

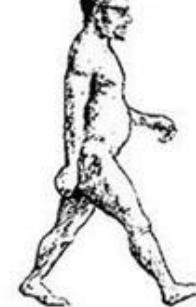
At the Int'l Congress of Zoology (1958) Dr. A.J.E. Cave said his examination showed that this famous skeleton found in France over 50 years ago is that of an old man who suffered from arthritis.

**NEWGUINEA MAN**

Dates way back to 1970. This species has been found in the region just north of Australia.

**CROMAGNON MAN**

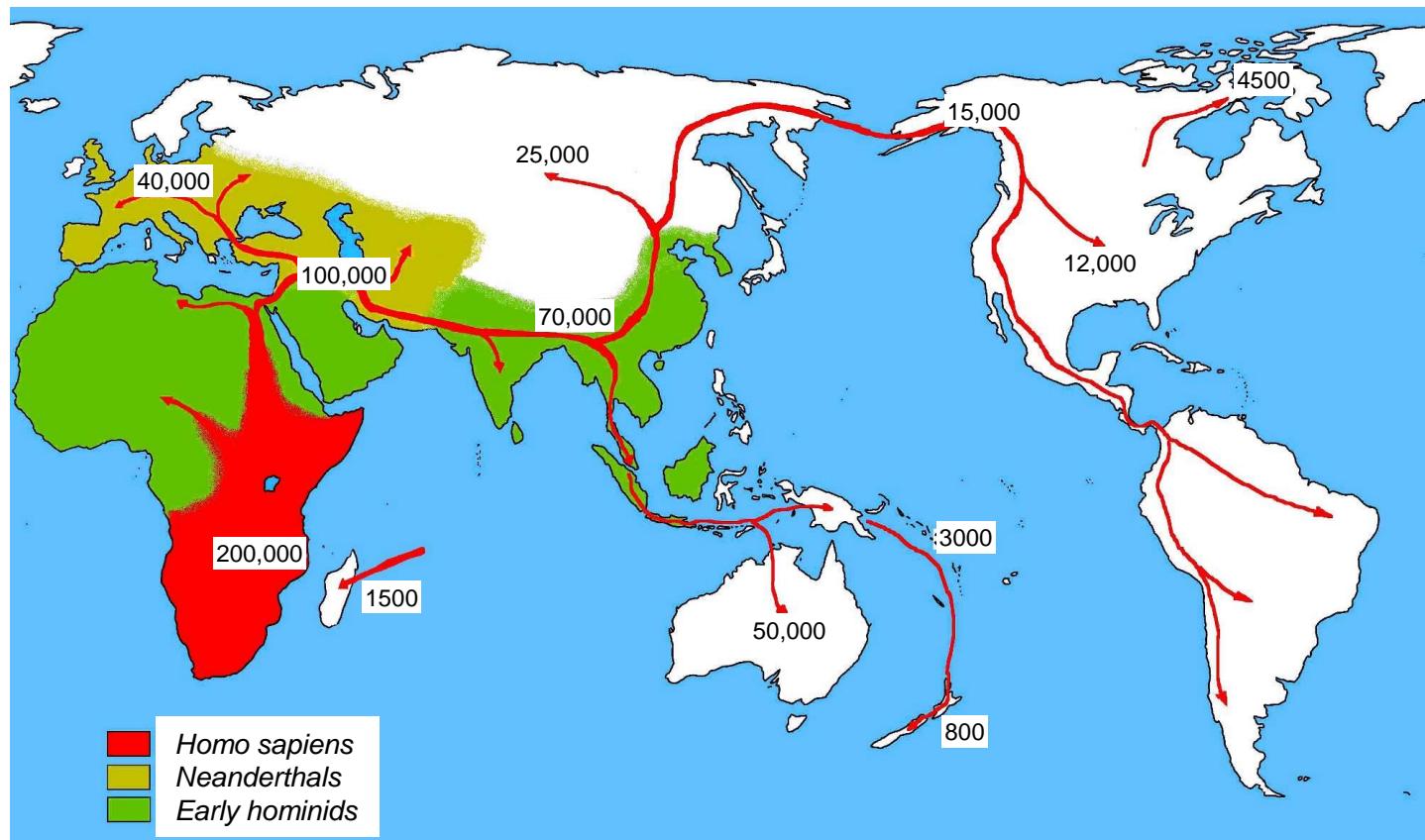
One of the earliest and best established fossils is at least equal in physique and brain capacity to modern man... so what's the difference?

**MODERN MAN**

This genius thinks we came from a monkey.

'Professing themselves to be wise they became fools.'
(Romans 1:22)

Migration of human



Evidence of Evolution

Evidence of Evolution

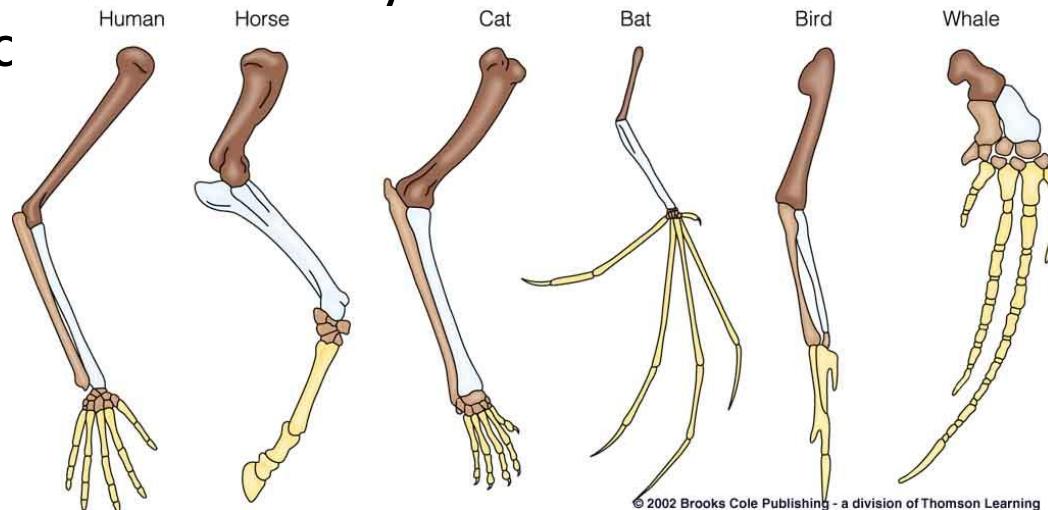
- Fossils
- Comparative Anatomy
- Vestigial Structures
- Embryology
- Biochemistry (Proteins & DNA)

Fossils showed that

- Organisms have appeared and disappeared, and have changed over time
- Extinction of species
- Reveals ancient climate & environmental conditions
- Indicates development of life from simple to complex
- Indicates life began in water

Comparative Anatomy

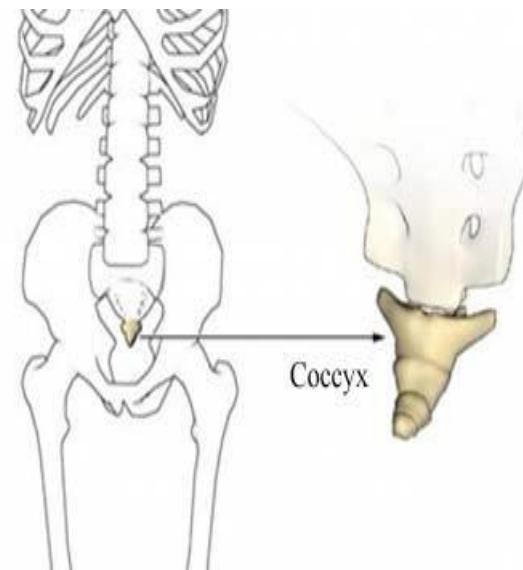
- Study of anatomical structures to find similarities and differences
 - **HOMOLOGOUS STRUCTURES** – parts with similar basic structure (derived from same structures in embryo—same common desc



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VESTIGAL STRUCTURES

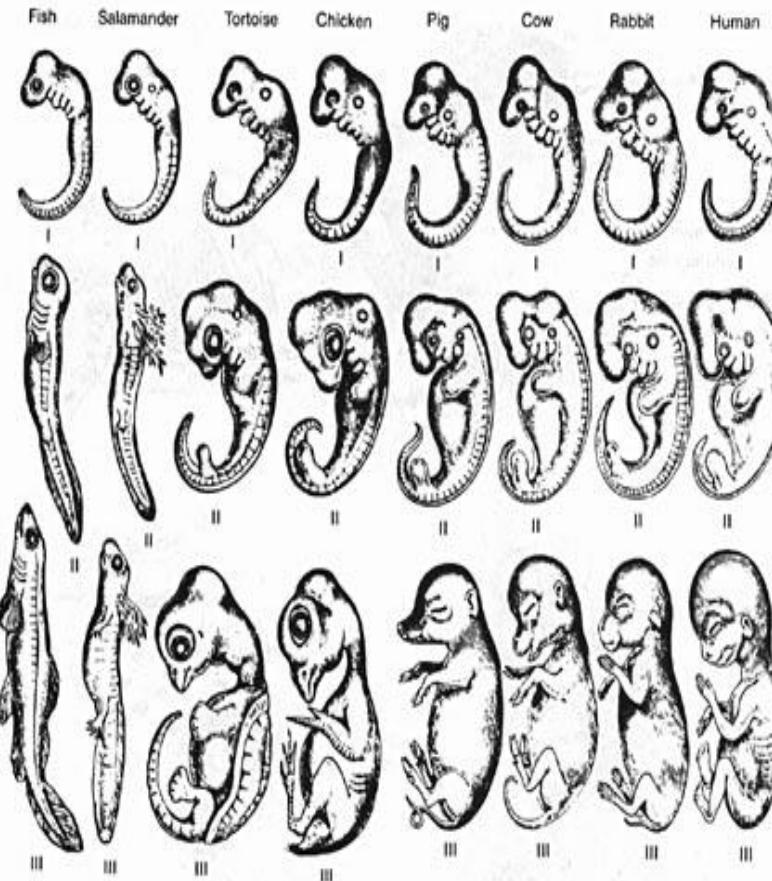
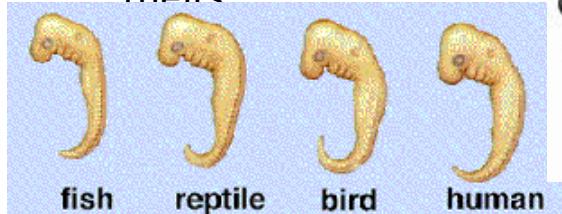
- **Reduced body parts** (in comparison to the same complex structure in other organisms) that have **little to no function**; remnant of an **ancestor**
 - Example:
 - Human **tailbone** (coccyx)



Embryology

- Patterns of embryological development can indicate a common ancestry

- Fish, birds, mammals & reptiles all have gills; only fish retain theirs
- Fish, birds, humans & reptiles all have tails; ALL but humans retain theirs



Biochemical Similarities

- Similarity of proteins, RNA & DNA molecules
- The more closely related organisms are, the more similar is the biochemical makeup
- Indicates common ancestor

Religious view

1 Biblical View (Genesis Chapter 1 Verses 1-26)

In the beginning God created the heaven and the earth.

The earth was without form and full of darkness and the spirit of God was moving on the sea surface.

Day 1

- God said: “Let there be Light and there was Light”

He separated Light from the Darkness because he saw it was good.

He called Light – Day and Darkness- Night

Day 2

- God Said: Let there be a firmament in the midst of the waters

He called the firmament Heaven

Day 3

- God Said: Let the waters under the heavens gathered into one place and let the dry land appear.

He called the **dry land –Earth** and waters that gathered – **Seas**

He said Let the earth put forth **vegetation**.

Day 4

- Creation of Moon and Stars
- Day 5: Creation of Birds and Fish
- Day 6: Creation of Animals and Man
- Day 7: Sabbath and He rested

What happened thereafter?

- Man placed in **Garden of Eden**
- The **Forbidden Tree**
- The **Creation of Woman**
- Man sent out of the Garden Eden after **disobedient caused by the serpent**

2 Quranic View

- Book of Tefsir: The power of Almighty Allah is whatever He wanted to be , will instantly be.
- Meaning: “Inamo amuru isaradaseha anyahu lalahu kunfayakun”
- Quran 54 v 7, Q32 v 5, Q41 v 11, Q21 v 30, etc.

Facts about quranic creation

- God created Heaven and earth in **6 days-** **Q 54 v7**
- First creation – **Sea (water)**
- Later – **Land and vegetation**
- Next – **Gins (Malaika) on the land**
- First Man – **Ibrahim** (Lived in Heaven –**Aljaina**)

3 Yoruba version of Creation

- In the beginning **Sky was above**, Water and marshland were below
- Chief god **olorun** ruled the sky while **Olokun** ruled the below
- Another god **Obatala** went to **olorun** for permission to create dry land for other creatures and was granted

Yoruba version of Creation

- He consulted Orunmila (god of prophecy and eldest son of ororun).
- Orunmila told him to get
 - Long Gold chain
 - Snail's Shell filled with sand
 - A white hen
 - A black cat
 - A palm nut
- All to be carried in a bag

Yoruba version of Creation

- Obatala hung the chain from a corner in the sky
- Placed the bag over his shoulder and started the downward climb
- Got to a place the chain could not get down
- He heard Orunmila telling him to pour the sand from the snail's shell and release the hen immediately.

Yoruba version of Creation

- Eventually the hen landed on the sand and began scattering it around
- Where the sand landed formed the dry land
- Bigger piles form Hills, smaller piles Valley
- Obatala jumped to the hill and named it Ile-Ife
- Which now extended everywhere

Yoruba version of Creation

- Dug hole and planted palm nut which grew
- Obatala settled down with the Cat and live
-
- After long period, he wanted more creature like himself
- Dug hole and found clay
- Mold figures like himself.

Yoruba version of Creation

- After long period, he got tired and took a break
- Made wine from the palm tree he planted
- Drank bowl after bowl and got drunk
- Because of the drunkenness he fashioned imperfect figures unknowingly
- Called on olorun to breathe life into his creatures
- When he realized what he has done he swore never to drink again and take care of deformed ones.

Yoruba version of Creation

- Becoming **Protector of the Deformed**
- Others gods were happy and visited obatala except Olokun
- Olokun was angry that Obatala had occupied her kingdom.
- When Obatala went to visit Olokun in the sky, Olokun summoned **great waves surging across the land.**

Yoruba version of Creation

- Much of the land were under water and many people drowned.
- When Orunmila heard of the news, he climbed the golden chain to the earth, commanded the flood waters to retreat and the dry land reappear.

- 1 Which part of the name *Homo sapiens* identifies the genus? A. *Homo* B. *sapiens* C. any of the above D. all of the above
- 2 In taxonomy, each level of classification is referred to as _____ A. taxon B. category C. hierarchy D. level
- 3 The group of organisms that can be larger than a kingdom is the _____ A. Domain B. Species C. Phylum D. Class
- 4 Pick the ODD one out. A. Plantae B. Fungi C. Protista D. Animalia
- 5 The five-kingdom system of classification was proposed by _____ in _____.
A. Linnaeus, 1753 B. Woese, 1980 C. Myer, 1924 D. Whittaker, 1968
- 6 The _____ study intraspecific variation. A. α -taxonomists B. β -taxonomists C. γ -taxonomistsD. tool makers
- 7 Which one is correct? A. Solanum lycopersicum B. SolanumLycopersicum C. Solanum Lycopersicum D. Solanumlycopersicum
- 8 The _____ is the basic unit of classification. A. Kingdom B. Phylum C. Genus D. Species
- 9 'Species Plantarum' written by Linnaeus contains of _____. A. 7300 species of animals B. 7300 species of plants C. 4200 species of animalsD. 4200 species of plants
- 10 α -taxonomy deals _____. A. descriptive taxonomy B. phylogeny C. chemotaxonomy D. experimental taxonomy

1.	A	6.	C	11.	C	16.	D
2.	B	7.	D	12.	B	17	A
3.	A	8.	D	13.	B	18.	D
4.	C	9.	B	14.	C	19.	C
5.	D	10.	A	15.	A	20.	B



**ITS OK FOR EXAM,
I WISH YOU THE VERY BEST IN YOUR EXAM
SEE YOU IN EXAM HALL.**