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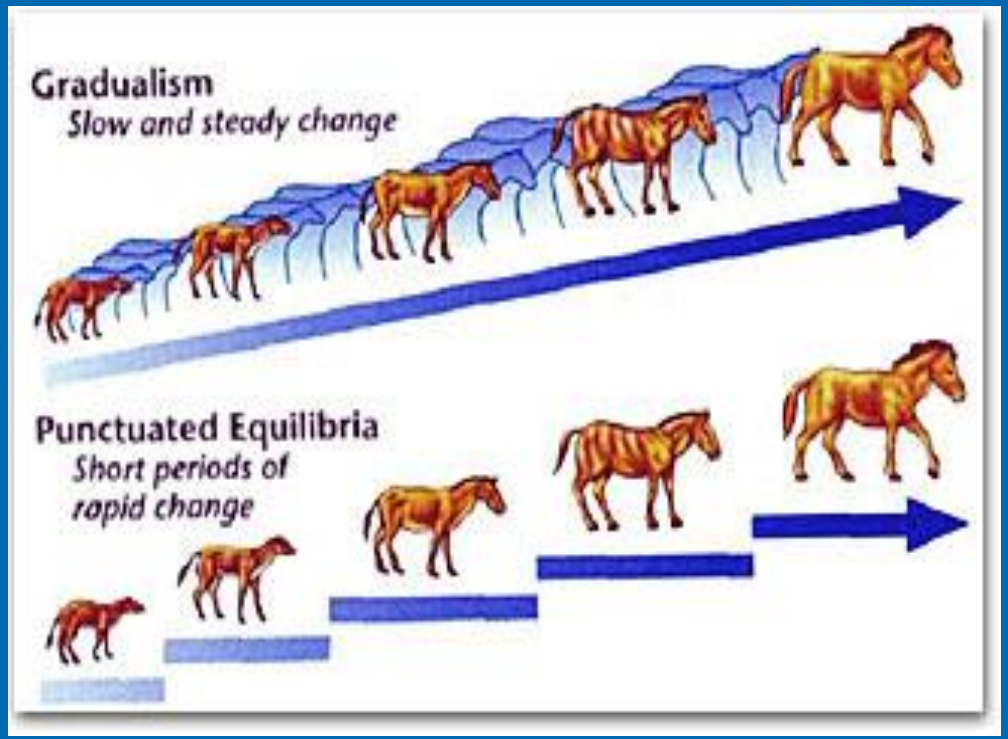
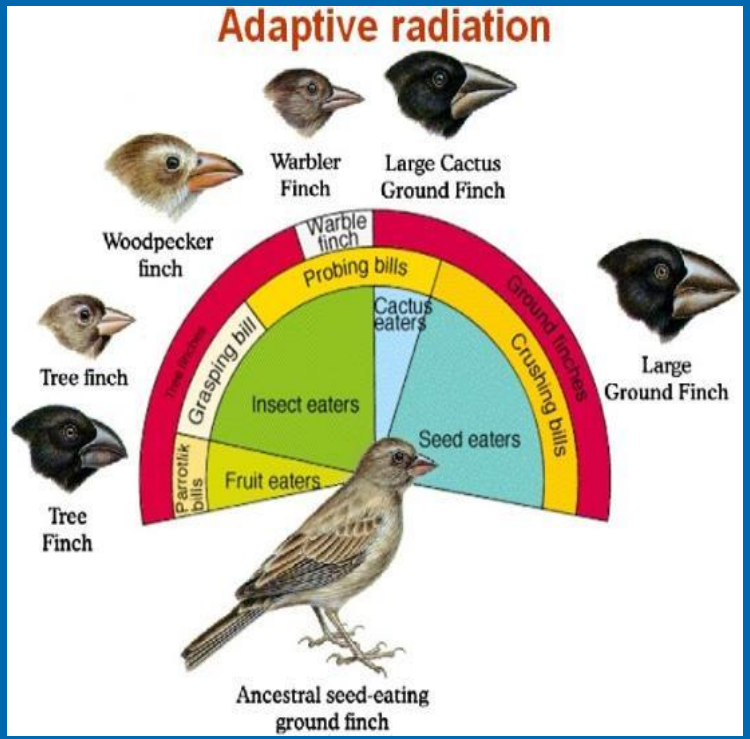
Click on "Play from Beginning"

Chapters 17 - 19
Creation & Evolution

Gradualism, Natural Selection





WARM-UP

Dealing with Creation/Evolution

Name and define 6 types of fossils.

Where does one find fossils? Be specific.

Name a major issue with gradualism based on the fossil record.

What is the cell theory related to living cells?

What is the scientific view of spontaneous generation?

How are traits passed on from generation to generation?

WARM-UP

Dealing with Creation/Evolution

Name and define 6 types of fossils.

Mold (leave a mark or imprint),

Cast (fills in a mold),

Petrified (minerals replace organic material)

Preserved (amber, ice, asphalt, ash, sediment)

Carbonized (carbon remains as an impression on the sediment)

Trace (provides evidence of activity or behavior: footprints, burrows, eggs)

Where does one find fossils? Be specific.

Fossils are buried in sedimentary rock which is formed from deposition on the earth's surface. Sedimentary rock goes ~30,000 feet deep.

Name a major issue with gradualism based on the fossil record.

Lack of "intermediates"

WARM-UP

Dealing with Creation/Evolution

What is the cell theory related to living cells?

Cells arise from pre-existing cells (living things produce living things).

What is the scientific view of spontaneous generation?

Abiogenesis does NOT occur. It was disproven by many scientists (Pasteur being the most well received).

How are traits passed on?

Traits are passed on genetically through DNA (genes).
Environmental factors are NOT passed from generation to generation.

Lesson Objectives

By the end of this lesson, you should be able to:

- Identify scientists who advocate evolution and are held in high esteem in the world.
- Define gradualism and punctuated equilibrium, understanding their components. Explain each theory and why it exists.
- Discuss a major problem with gradualism.
- Define and give examples of natural selection, Hardy-Weinberg Principle, Genetic Drift, and Gene Flow.
- Recognize the Geologic Time Scale (Eon, Epoch, Period, Era).

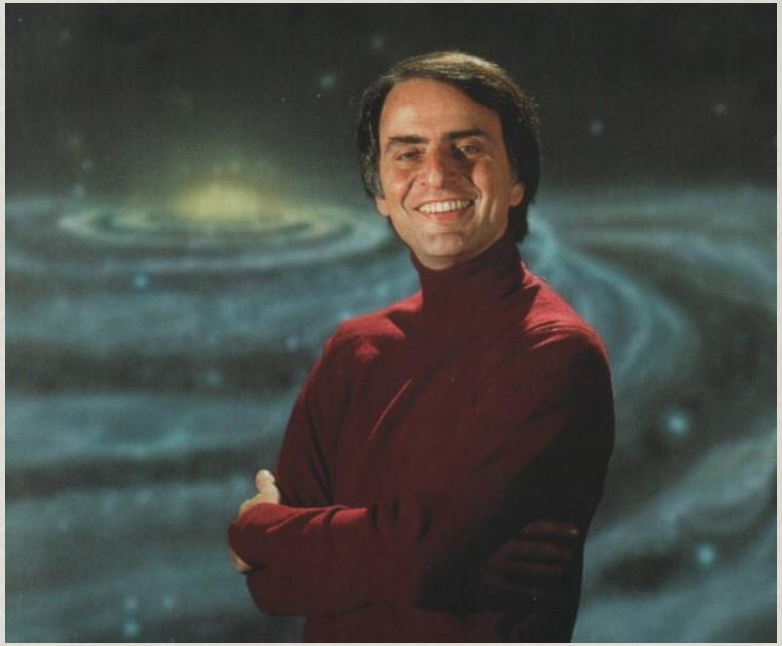
Science Practice: **Reference Materials on Darwin and Natural Selection**

Voices of Naturalism

- **Darwin:** Naturalist, Biologist, **Father of the Theory of Evolution**
- **Carl Sagan:** Astronomer with NASA
- **Richard Dawkins:** Outspoken atheist who promotes evolution and a denial of God. Evolutionary biologist. Wrote *The God Delusion.*
- **Stephen Hawking:** "I think the universe was spontaneously created out of nothing, according to the laws of science."

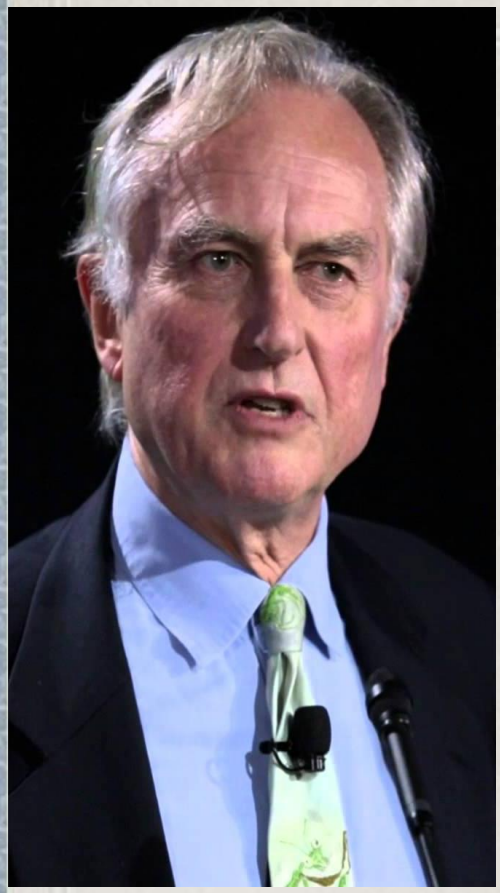
Carl Sagan

Sagan wrote *The Dragons of Eden* (where human intelligence came from), *Cosmos* (where life came from), Which turned into a TV series.



"The Cosmos is all that is, or ever was, or ever will be. Our contemplations of the cosmos stir us. We know that we are approaching the grandest of mysteries."

Richard Dawkins



"When you consider the beauty of the world and wonder how it came to be, you are naturally over-whelmed with a feeling of awe, a feeling of admiration, and you almost feel a desire to worship something.

I feel this, I recognize that other scientists such as Carl Sagan feel this, Einstein felt it. We all of us share a kind of religious reverence for the beauties of the universe, for the complexity of life, for the sheer magnitude of the cosmos, the sheer magnitude of geological time.

It is tempting to translate that feeling of awe and worship into a desire to worship some particular thing, a person, an agent. You want to attribute it to a maker, to a creator.

But what science has now achieved is an emancipation from that impulse to attribute these things to a creator... *It was a SUPREME ACHIEVEMENT OF THE HUMAN INTELLECT to realize that there is a better explanation for these things. That these things can come about by purely **NATURAL CAUSES**."*

Romans 1:18-25

18 *For the wrath of God is revealed from heaven against all ungodliness and unrighteousness of men, who by their unrighteousness suppress the truth.*

19 ***For what can be known about God is plain to them****, because God has shown it to them.*

20 *For his invisible attributes, namely, his eternal power and divine nature, have been clearly perceived,* ***ever since the creation of the world****, in the things that have been made. So they are without excuse.*

21 *For although* ***they knew God, they did not honor him as God*** *or give thanks to him, but they became futile in their thinking, and their foolish hearts were darkened.*

Romans 1:18-25

22 Claiming to be wise, they became fools…

23 *…and exchanged the glory of the immortal God for images resembling mortal man and birds and animals and creeping things.*

24 *Therefore God gave them up in the lusts of their hearts to impurity, to the dishonoring of their bodies among themselves,*

25 *because* ***they exchanged the truth about God for a lie and worshiped and served the creature rather than the Creator****, who is blessed forever! Amen.*

Darwin's Theory of Evolution

A sea voyage helped Darwin frame his theory of evolution

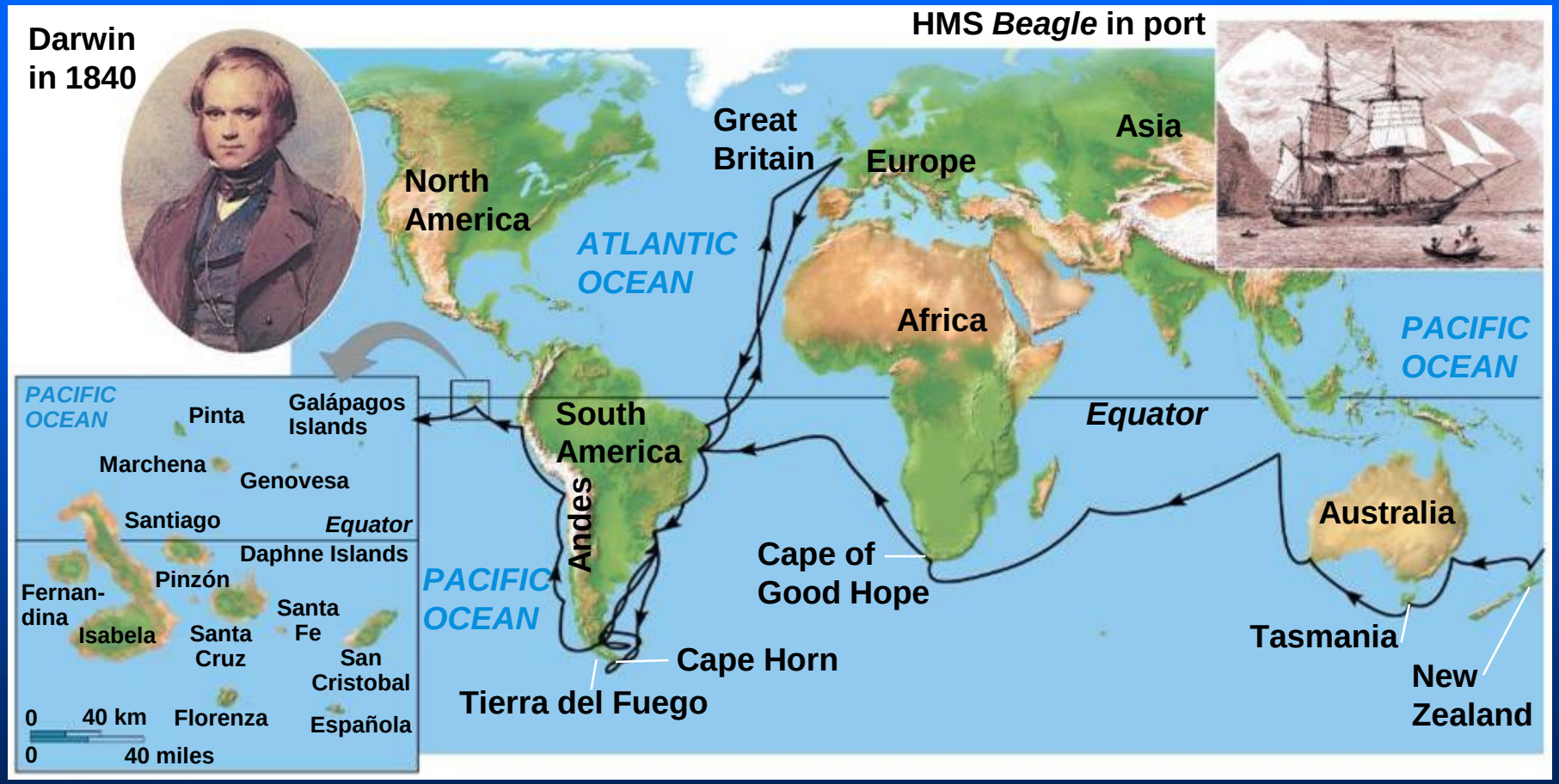
- **Charles Darwin** is best known for his book *On the Origin of Species by Means of Natural Selection*, commonly referred to as *The Origin of Species*, which launched the era of evolutionary biology.
- Darwin's early career gave no hint of his future fame.
  - He enrolled in but left medical school.
  - Then he entered Cambridge University to become a clergyman.

A sea voyage helped Darwin frame his theory of evolution

- The cultural and scientific context of his time instilled Darwin with a conventional view of Earth and its life.
  - Most scientists accepted the views of the Greek philosopher Aristotle, who generally held that species are fixed, permanent forms that do not change.
  - Most Christian churches taught that each form of life was individually created in its present-day form.
- Thus, the Traditional View of his time: Young Earth Inhabited by Unchanging Species.

A sea voyage helped Darwin frame his theory of evolution

- At the age of 22, Darwin took a position on *HMS Beagle*, a survey ship preparing for a long expedition to chart poorly known stretches of the South American coast.
- As the ship's naturalist (field biologist), Darwin
  - spent most of his time on shore collecting thousands of specimens of fossils and living plants and animals and
  - kept detailed journals of his observations.


Darwin in 1840
HMS *Beagle* in port
North America
Great Britain
Europe
Asia
ATLANTIC OCEAN
Africa
PACIFIC OCEAN
Equator
South America
Andes
PACIFIC OCEAN
Cape of Good Hope
Australia
Tasmania
New Zealand
Cape Horn
Tierra del Fuego
PACIFIC OCEAN
Pinta
Galápagos Islands
Marchena
Genovesa
Santiago
Equator
Daphne Islands
Pinzón
Fernan-dina
Isabela
Santa Cruz
Santa Fe
San Cristobal
Florenza
Española
0 40 km
0 40 miles

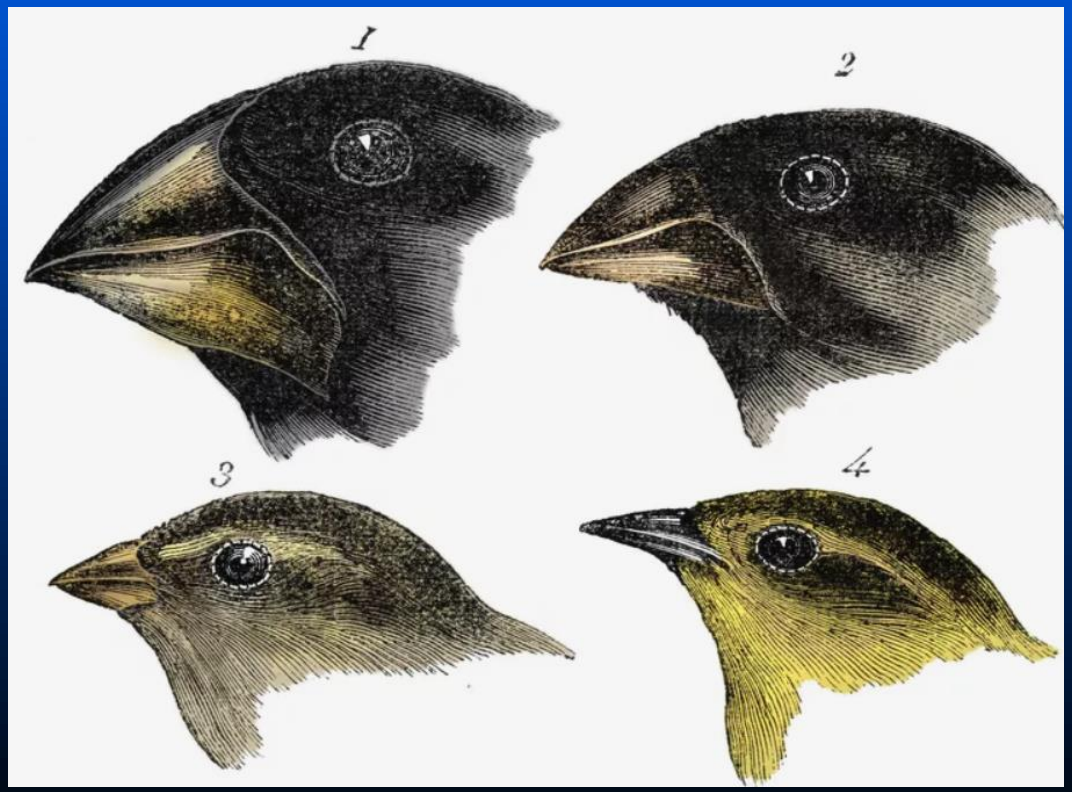
A sea voyage helped Darwin frame his theory of evolution

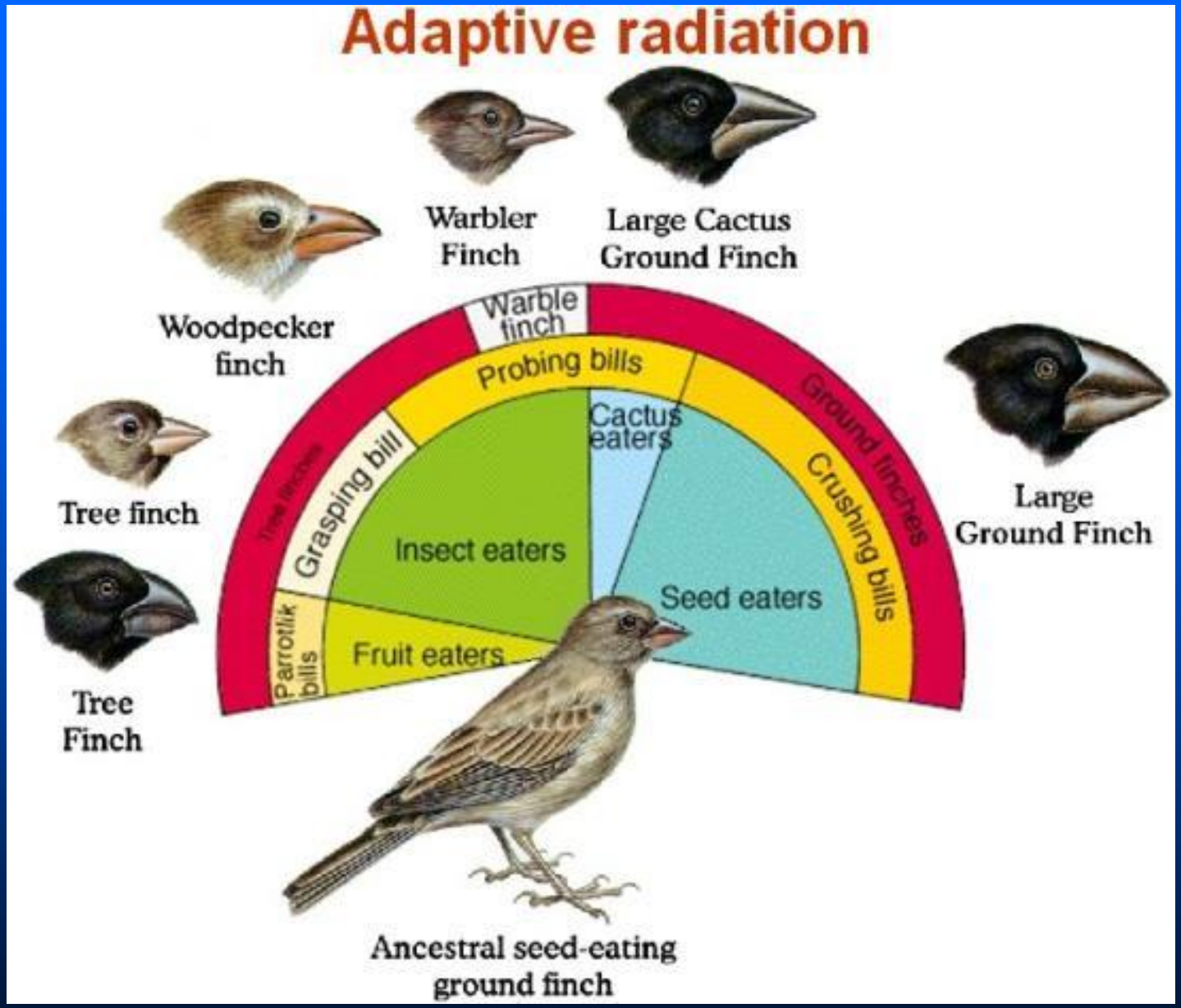
- Darwin was particularly intrigued by the geographic distribution of organisms on the Galápagos Islands, including
  - marine iguanas
  - giant tortoises

Darwin in a Nutshell

- Darwin observed finches and noticed 7 different kinds of beaks based on adaptation for various foods (competition).

- Eventually, he extrapolated that organisms arose from a COMMON ANCESTOR.

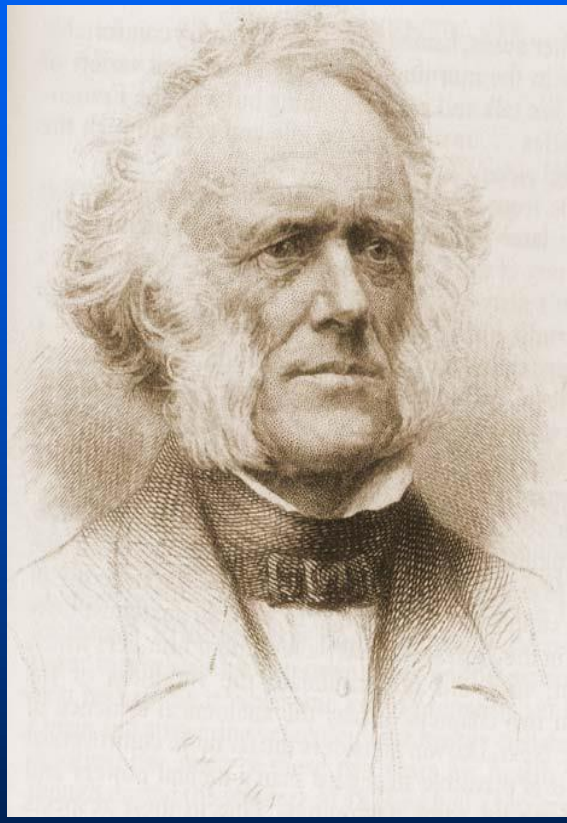




Galapagos Finches

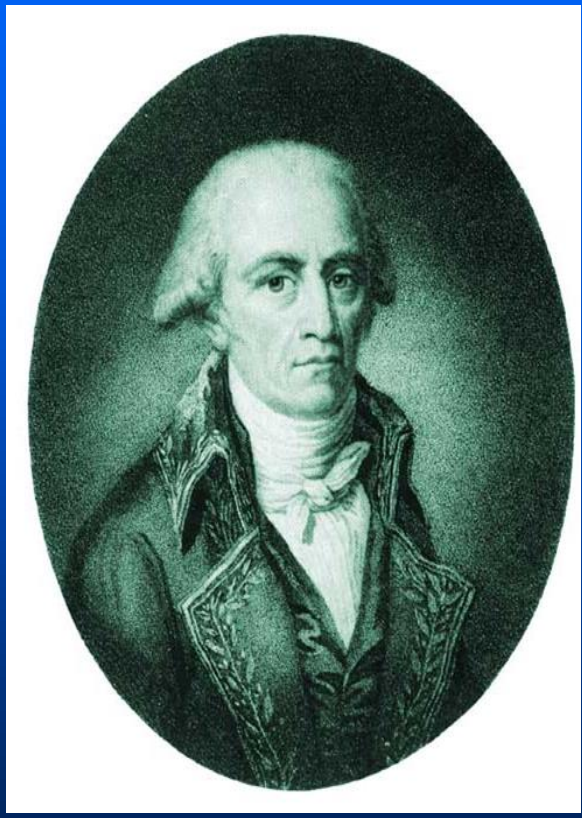
A sea voyage helped Darwin frame his theory of evolution

- While on his voyage, Darwin was strongly influenced by **Lamarck's** ideas and the newly published *Principles of Geology*, by Scottish geologist **Charles Lyell**.
- The book presented the case for an ancient Earth sculpted over millions of years by gradual geologic processes that continue today (**Uniformitarianism**).

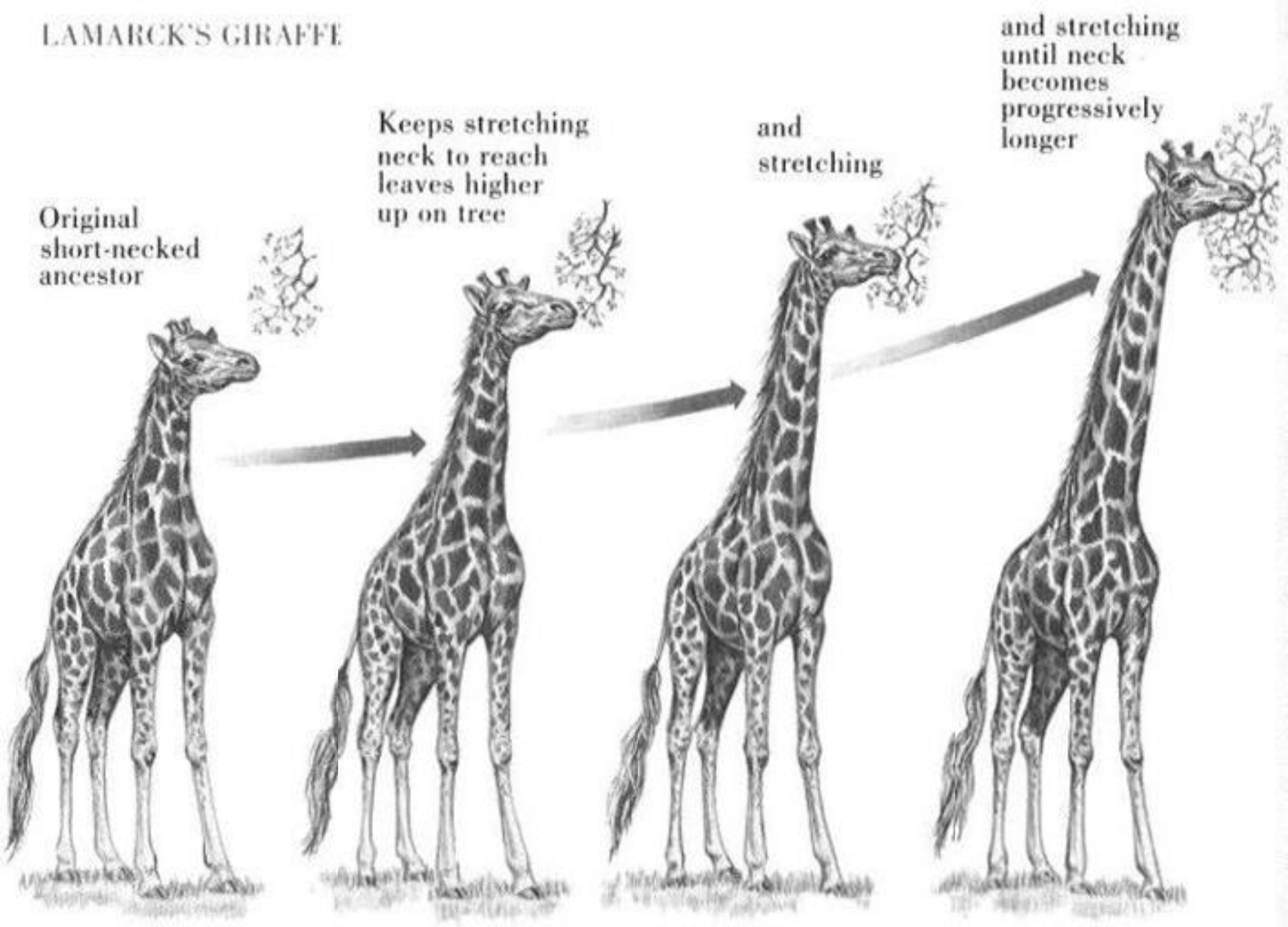


Jean-Baptiste Lamarck

- Tried to explain how change occurs over time (evolution?).
- Stated that changes are adaptations to environment ACQUIRED in an organism's lifetime.
- Proposed that by selective USE OR DISUSE of organs, organisms acquired or lost certain traits during their lifetime.
- These acquired changes were passed to offspring.
- Over time this led to new species.



LAMARCK'S GIRAFFE



Lamarck's Mistakes

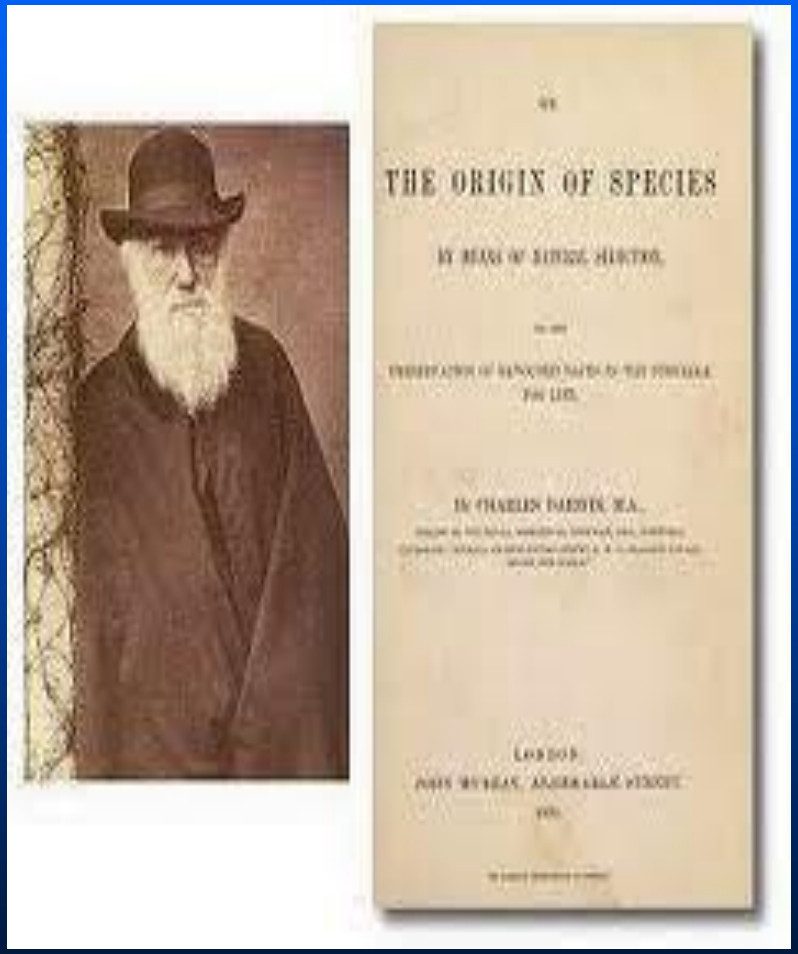
- Proposed Mechanism for Evolution: Inheritance of Acquired Characteristics.
- Lamarck did NOT know how traits were inherited (traits are passed through genes in gametes).
- Genes are NOT changed by activities in life.

A sea voyage helped Darwin frame his theory of evolution

- By the early 1840s, Darwin had composed a long essay describing the major features of his Theory of Evolution by **Natural Selection**.
- But he delayed publishing his essay, continued to compile "evidence" in support of his hypothesis, and finally released his essay to the scientific community when learning of the work of another British naturalist, **Alfred Wallace**, who had a nearly identical hypothesis.

Publication of "On The Origin of Species"

Alfred Wallace



A sea voyage helped Darwin frame his theory of evolution

- Darwin's **Theory of Evolution**:
  - the idea that living species are descendants of ancestral species (common ancestors) that were different from present-day ones (speciation).
  - that **Natural Selection** is the mechanism for evolutionary change.

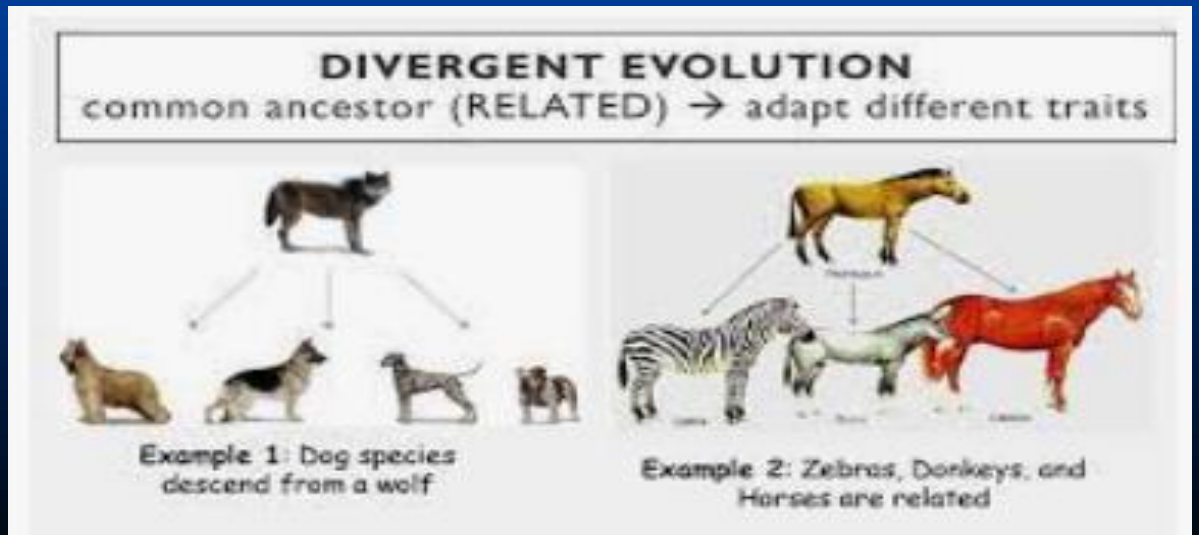
Convergent Evolution

- Occurs when unrelated species develop similarities as they have adapted to similar environmental challenges…
- …NOT because they "evolved" from a common ancestor but due to environmental pressures.
- The likenesses that result are **Analogous** (not Homologous).
- Ex. The presence of **Wings** on insects, birds, and mammals (bats).
  - These species are completely unrelated, but all 3 have the ability to fly **(Analogous Structures)**.

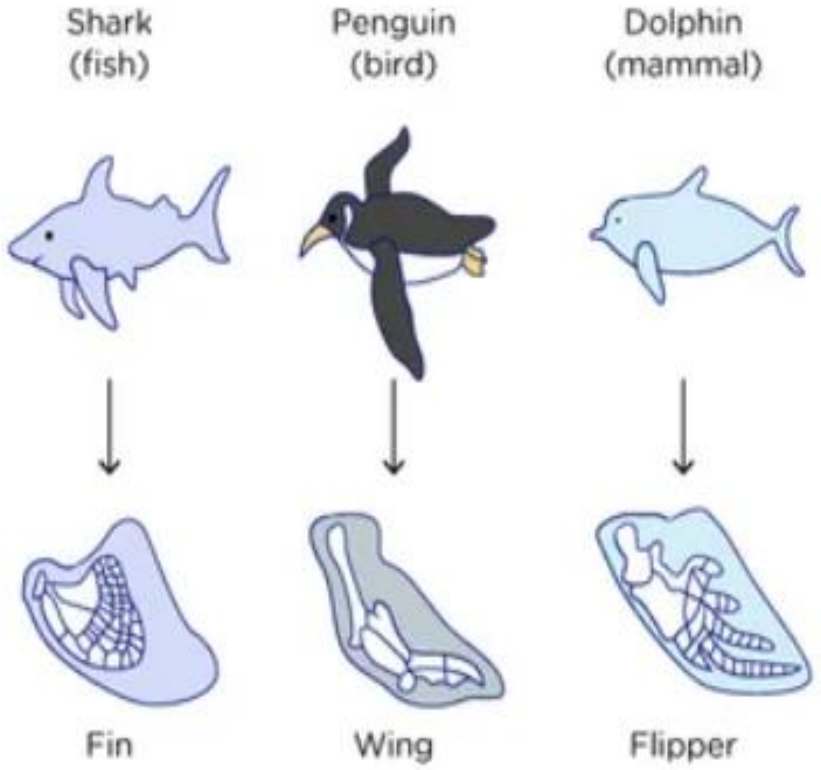
Convergent Evolution

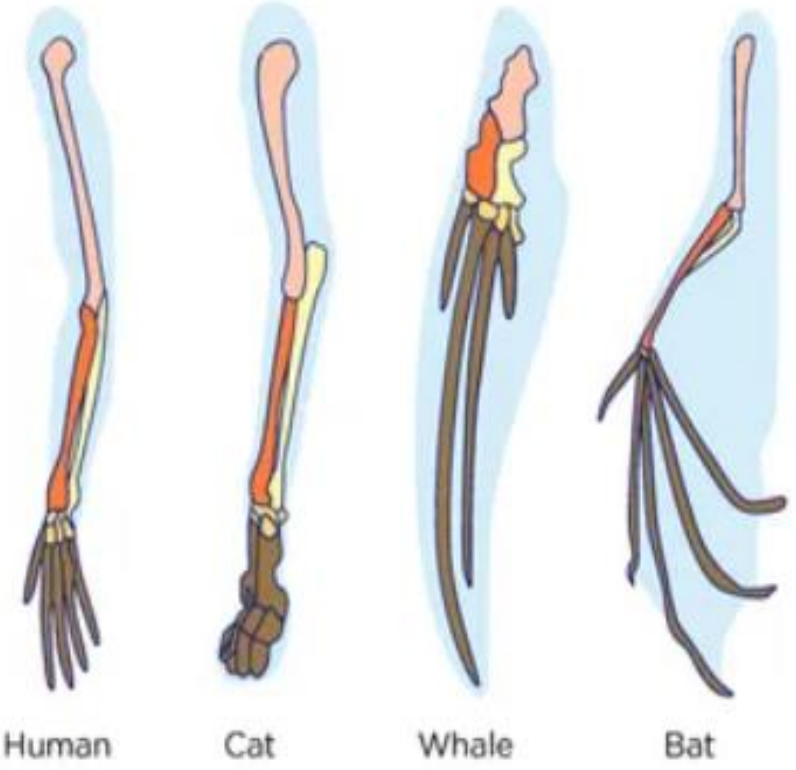
Divergent Evolution

- Species gradually become increasingly different from their ancestors.
- Often attributed to migration or geographic isolation.
- Development of homologous structures.



Analogous Structures *(Streamline Appendages)*	**Homologous Structures** *(Pentadactyl Limbs)*
Due to common selection pressures Arise via convergent evolution **Example:** Wings in insects, birds and bats	Due to common ancestry Arise via divergent evolution **Example:** Pentadactyl limb in vertebrates





Adaptive Radiation

- ***Process of many related species originating from one common ancestor.***
- Ex. Galapagos Finches
  - » There are 13 "species" found on the Galapagos Islands.
  - » Evolutionists say that all the finch species descended from one mainland finch species.
  - » Through natural selection they became more different from one another and formed into 13 different species.

Major Problem: No Intermediates

"There are all sorts of gaps: absence of graduationally intermediate "transitional" forms between species, but also between larger groups -- between say, families of carnivores, or the orders of mammals. In fact, the higher up the Linnaean hierarchy you look, the fewer transitional forms there seem to be."

"New species appeared abruptly in the fossil record with no smoothly intergradational intermediates between them and their ancestors." Eldredge, Niles, *The Monkey Business: A Scientist Looks at Creationism*, 1982, pp. 65-67.

Both schools of thought (Punctuationists and Gradualists) despise so-called scientific creationists equally, and both agree that the major gaps are real, that they are true imperfections in the fossil record. The only alternative explanation of the sudden appearance of so many complex animal types in the Cambrian era is divine creation and (we) both reject this alternative." Dawkins, Richard, *The Blind Watchmaker*, W.W. Norton & Company, New York, 1996, pp. 229-230)

Major Problem: No Intermediates

Archaeopteryx:

Is still falsely promoted (in textbooks, journals, etc.) as the "transitional form" between a reptile and a bird to support gradualism although it is NOT genetically transitional to living birds.

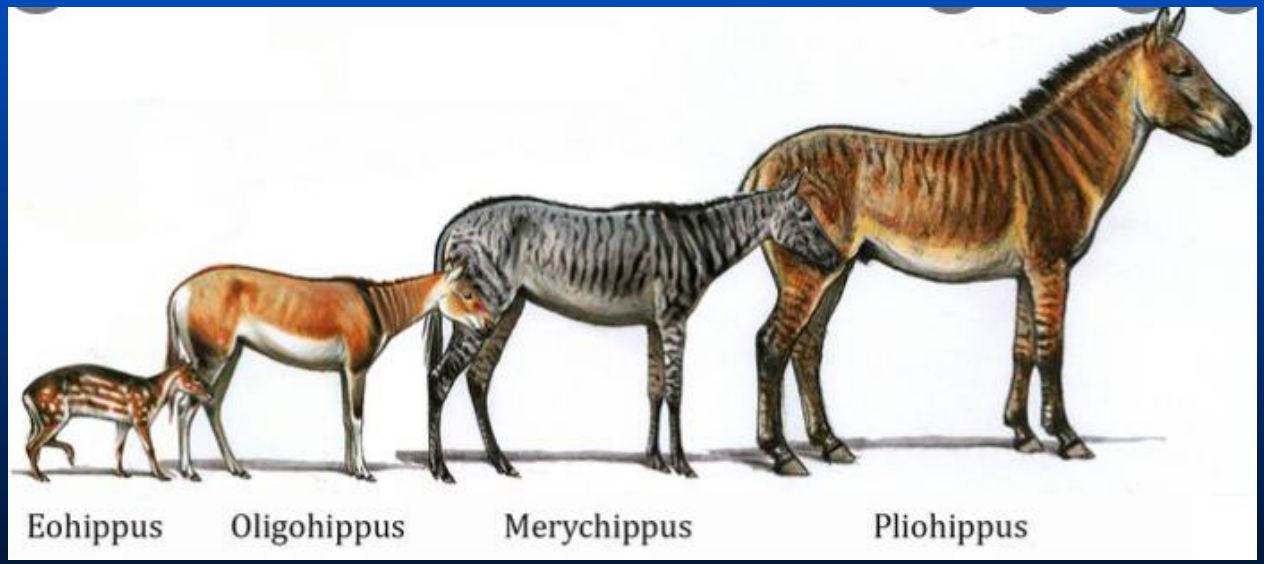
So evolutionist changed semantics to using the phrase "transitional features."

Major Problem: No Intermediates

Eohippus:

Is still falsely promoted (in textbooks, etc.) as the "common ancestor" of the horse is remarkably similar to the modern hyrax, a rock badger.

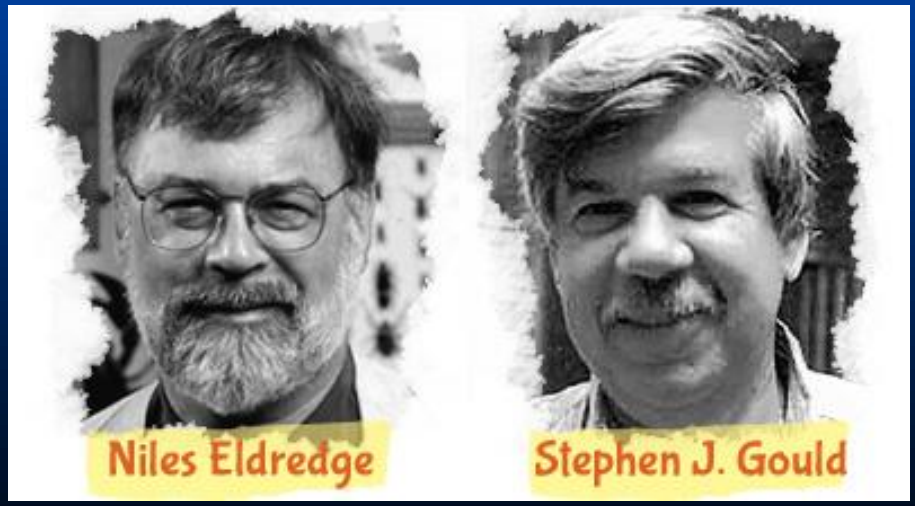
Most individual categories of genus are known only from their teeth. It is hard to see any evolutionary sequence here.



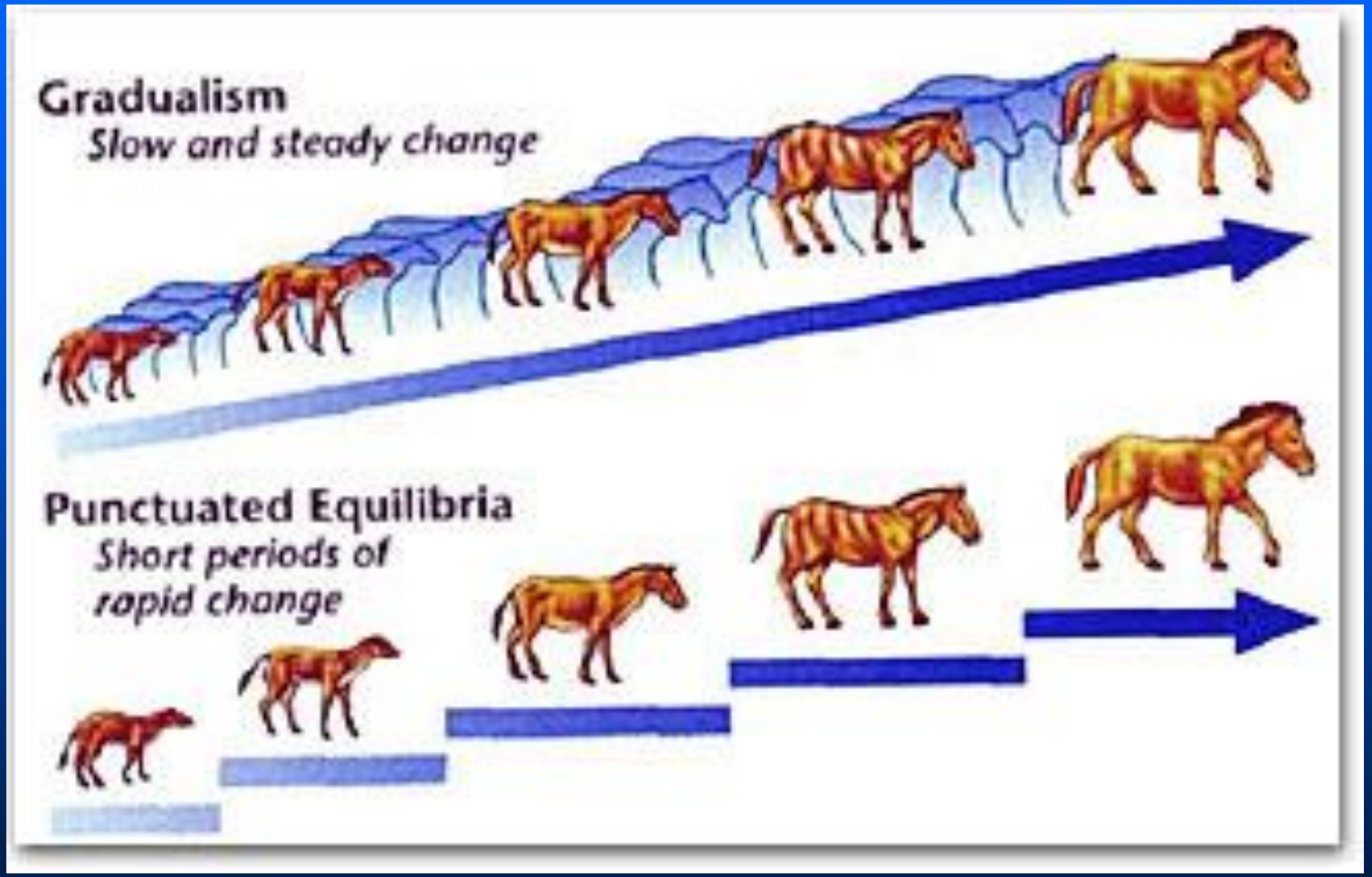
Rate of Speciation

PUNCTUATED EQUILIBRIUM

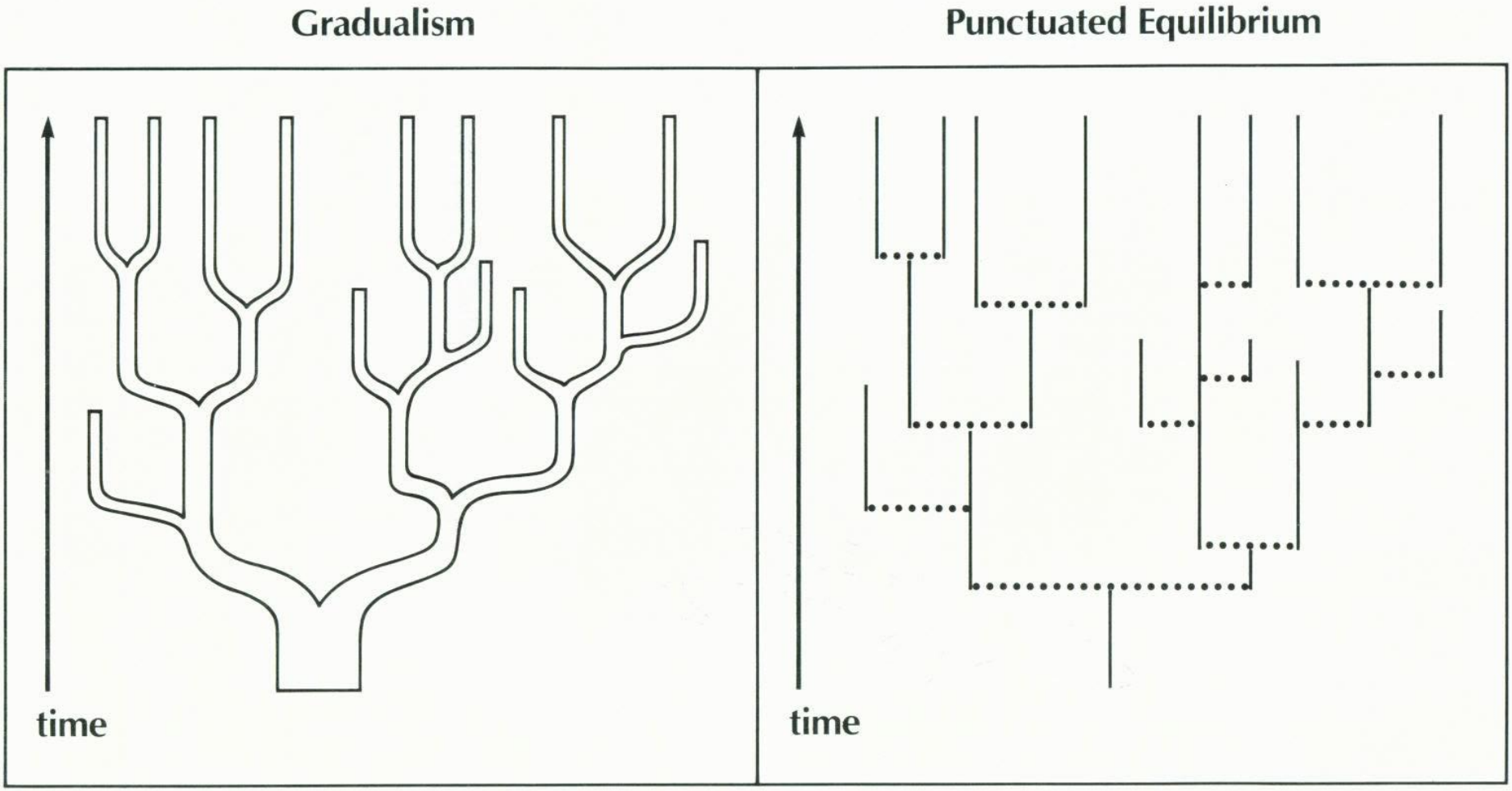
- Tries to explain the long periods of apparent stasis punctuated by sudden explosions of new and fully-developed life forms with no intermediates from an evolutionary point of view
- Proposed by Stephen Gould and Niles Eldredge (1971)



Rate of Speciation



Major Problem: No Intermediates



"MICROevolution"

- Defined as a change in the genetic composition of a population from generation to generation.
- **MICROevolution** is the observed effects of natural selection due to genetic variation on populations.
- Creationists and Evolutionists (both) believe this process does happen in nature.
- Nevertheless, Creationists believe it does NOT create new or previously non-existent genetic information or kinds of organisms.
  - In other words, it does NOT lead to Macroevolution.

NATURAL SELECTION

- Creationists believe that all organisms are created with much genetic potential to adapt to its environment as a result of Natural Selection.

- Natural Selection simply acts through the built-in genetic variability of all organisms.

- In other words, Natural Selection works upon the genetic variation that is present in the organism at the moment it is created.

Natural Selection

The fundamental goal of all species is to reproduce and survive, passing on the genetic information of the species from generation to generation.

- Sexual Reproduction
- Overpopulation
- Hereditable Traits (NOT acquired)
- Variation
  - Adaptation
  - Competition
  - Survival of the Fittest

Hardy-Weinberg Principle

- To understand how MICROevolution works, we need to start with a simple population in which microevolution is not occurring and thus the gene pool is not changing.

- In this kind of population the FREQUENCY OF EACH ALLELE in the gene pool will remain constant.

- This equilibrium is the Hardy-Weinberg Principle.

Stable Gene Pool

- The frequency of an allele in the gene pool of a population will NOT change IF:
  1. The population is large.
  2. The population is isolated (no immigration or emigration).
  3. There is no mutation.
  4. Mating is random.
  5. All individuals survive and produce the same number of offspring (no Natural Selection).

This is known as Hardy-Weinberg Equilibrium.

Hardy-Weinberg Principle

- Few populations in nature meet all 5 conditions, therefore most populations are NOT in genetic equilibrium.
- Thus alleles and genotype frequencies often DO change.
- Violations to any of these 5 conditions are considered mechanisms of evolutionary change (MICROevolution), but the 3 main mechanisms are:

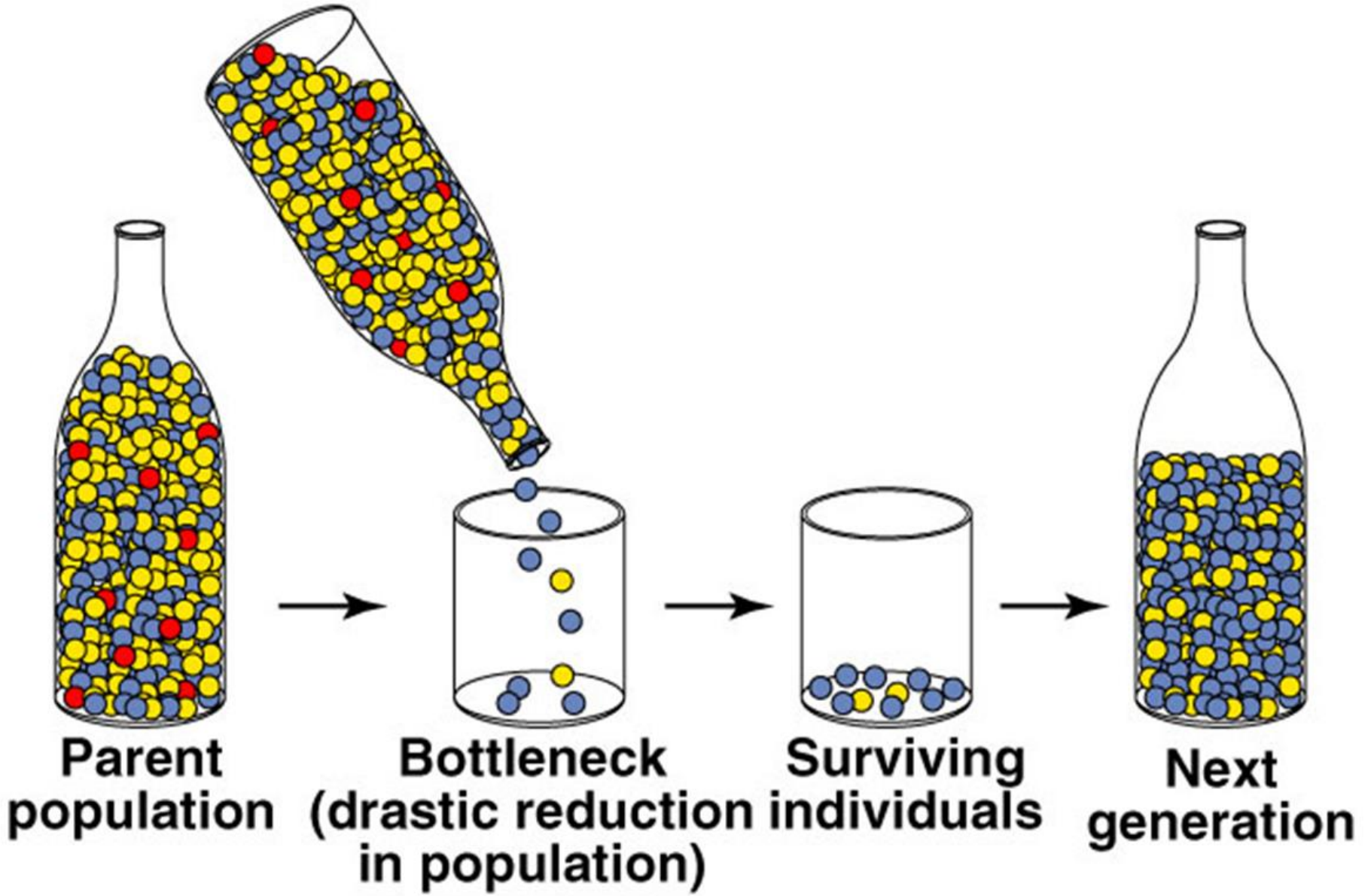
1) **Genetic Drift**
2) **Gene Flow**
3) **Natural Selection**

Genetic Drift

- In this process chance, random events can cause allele frequencies to change unpredictably from one generation to the next.
- The smaller the population, the more impact genetic drift is likely to have.

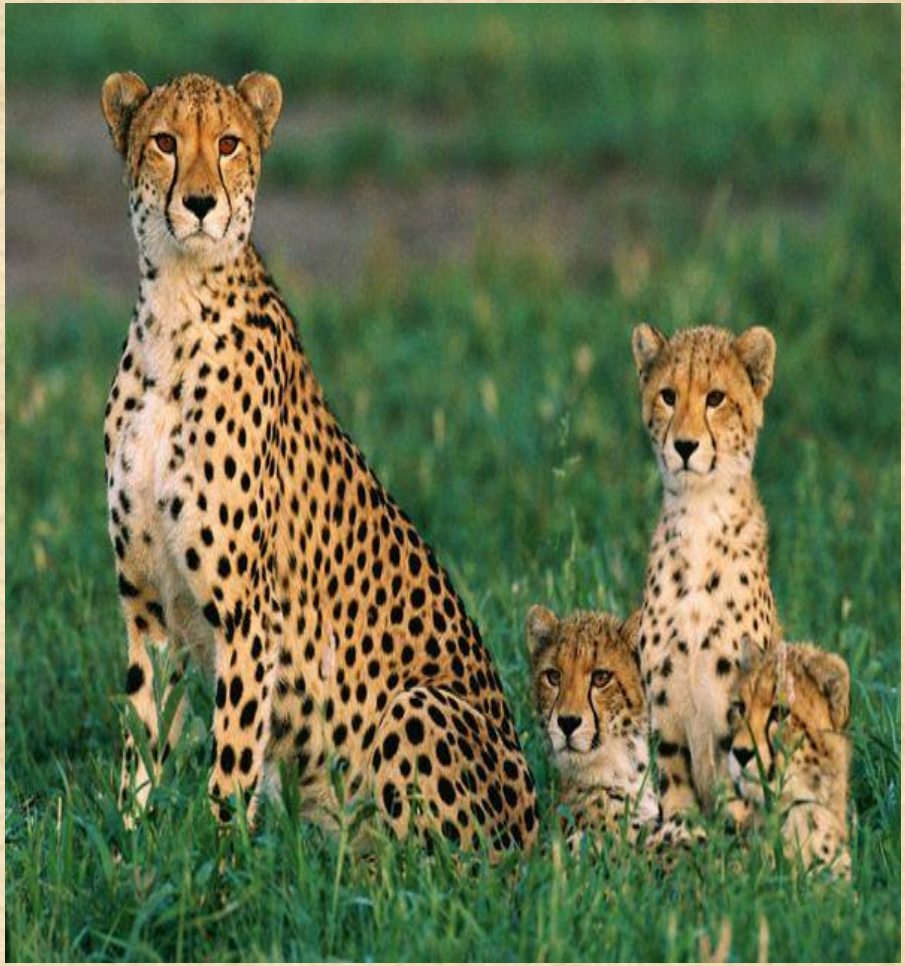
Bottleneck Effect

- a drastic reduction in population (volcanoes, earthquakes, landslides …), followed by rebound.
- Reduces genetic variation.
- Smaller population may not be able to adapt to new selection pressures (changes in environment).


Parent population
Bottleneck (drastic reduction in population)
Surviving individuals
Next generation

Loss of Genetic Variation

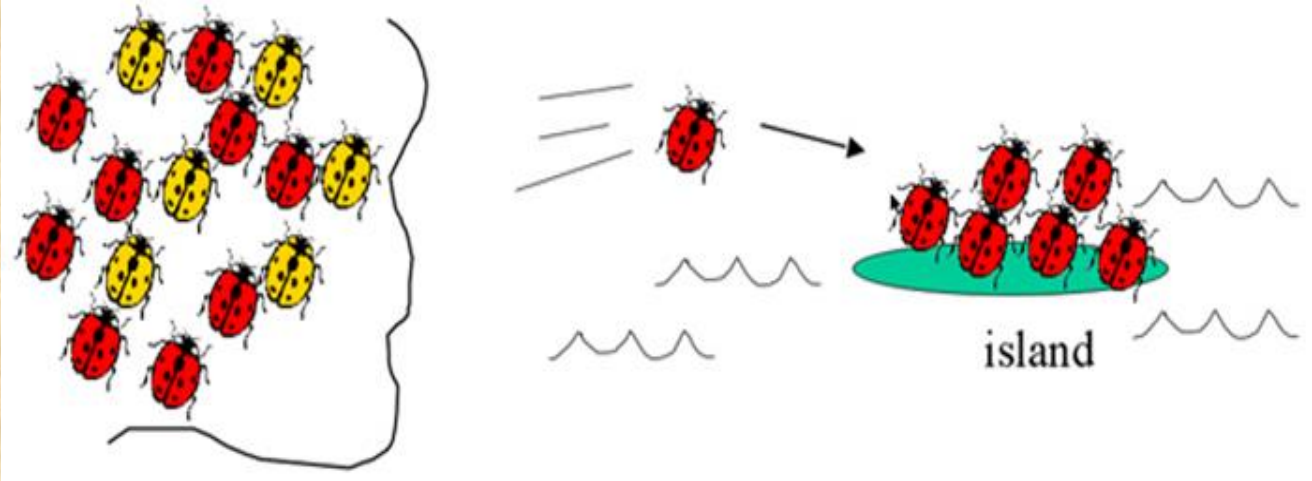
- Cheetahs have little genetic variation in their gene pool.
- This might contribute to the potential extinction of this endangered species.
- This can probably be attributed to a population bottleneck they experienced, barely avoiding extinction.



Genetic Drift

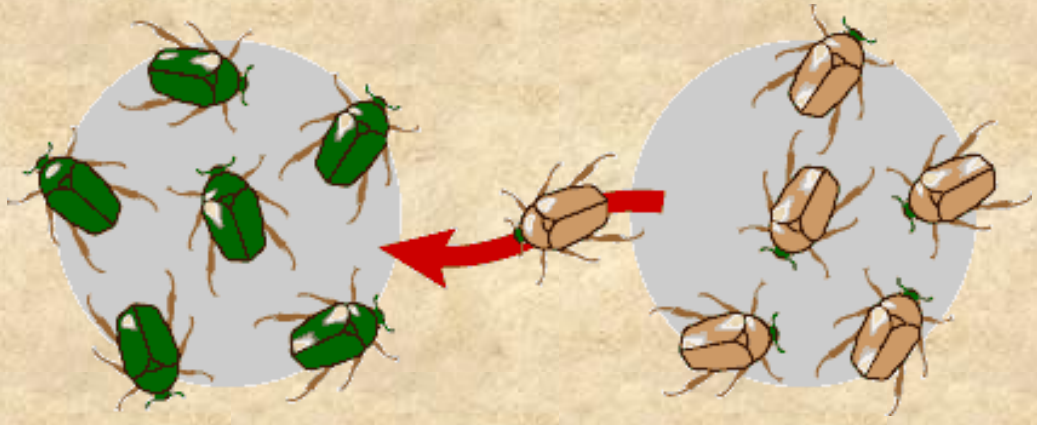
Founder Effect

- occurs when a new colony is started by a few members of the original population.
- The smaller the group, the less likely the genetic makeup of the colonists will represent the gene pool of the larger population they left.
- Reduces genetic variation.



Gene Flow

- A population may gain or lose alleles when fertile individuals move into or out of a population or when gametes (such as plant pollen) are transferred between populations.
- Gene Flow tends to reduce differences between populations, thus making them more similar



Natural Selection

- Results in alleles being passed to the next generation in proportions different from the ones in the present generation.
- Individuals with variations that are better suited to their environment tend to produce more offspring (have more Reproductive Success) than those with variations that are less suited.

GEOLOGICAL TIME SCALE

- The geological time scale is a way in which the age of the earth is broken into subdivisions of Eras, Periods, Epochs, and others.
- These subdivisions are determined by events that supposedly took place during the times indicated.
- Developed using radioactive decay methods.

Origin of Life
(Evolution)

Conditions on Early Earth

(According to Evolutionary Theory)

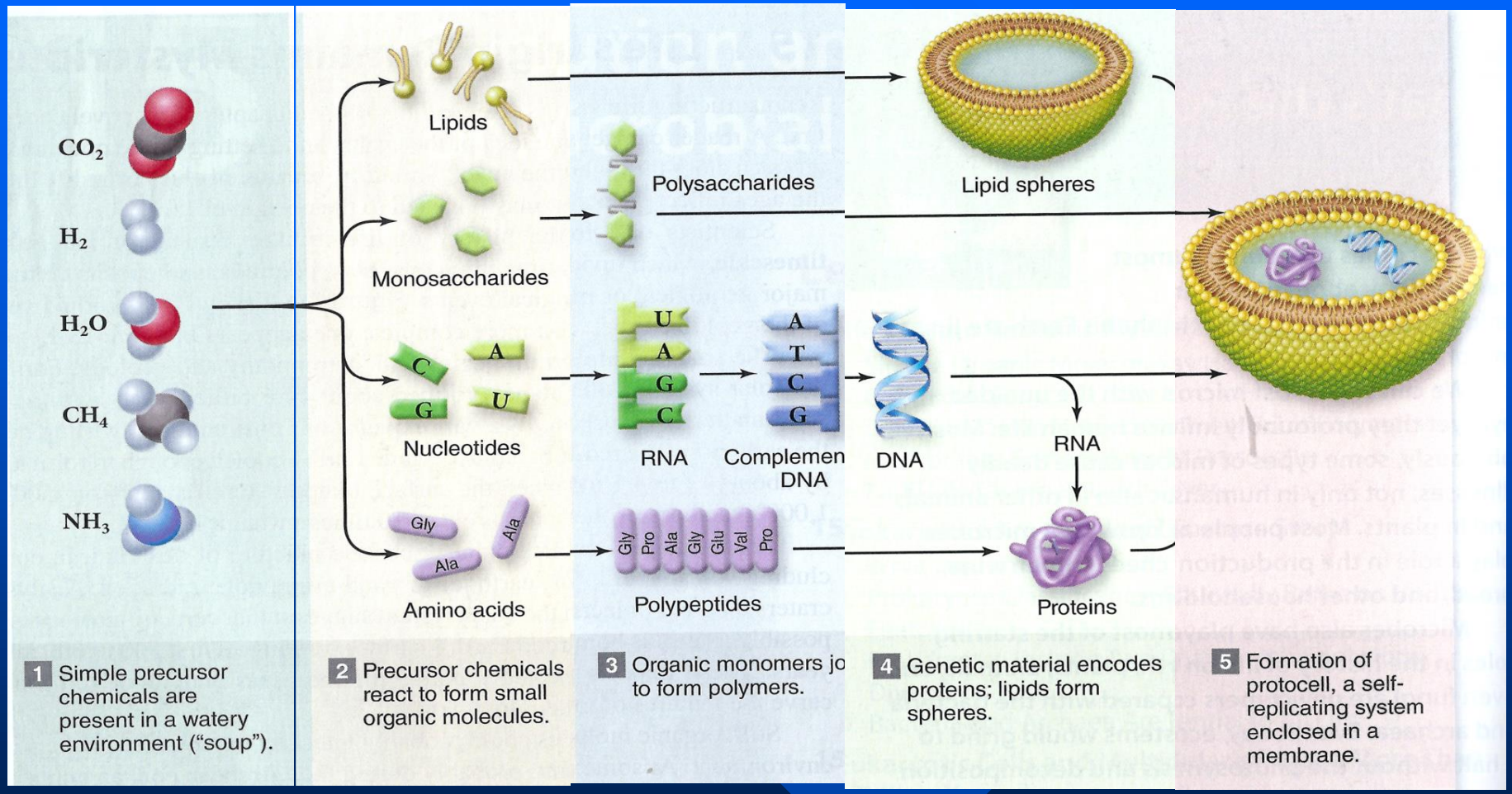
- The Earth formed about **4.6 billion years ago**.
- As the Earth cooled and the bombardment slowed about **3.8 billion years ago**, the conditions on the planet were extremely different from those today.
  - The first atmosphere was probably thick with **water vapor** and various compounds released by **volcanic eruptions**, including **nitrogen** and its oxides, **carbon dioxide, methane, ammonia, hydrogen,** and **hydrogen sulfide**.

Lightning, volcanic activity, and **ultraviolet radiation** were much more intense than today.

Scientists hypothesize that these chemical and physical processes on early Earth, could have produced very simple cells through a sequence of four main stages:

1. The abiotic (nonliving) synthesis of small, organic molecules, such as amino acids and nucleotides.
2. The joining of these small molecules into macromolecules, including proteins and nucleic acids.
3. The packaging of these molecules into **"protocells"**, droplets with membranes that maintained an internal chemistry different from that of their surroundings.
4. The origin of **self-replicating RNA molecules** that eventually made inheritance possible.

From Chemicals to Cells

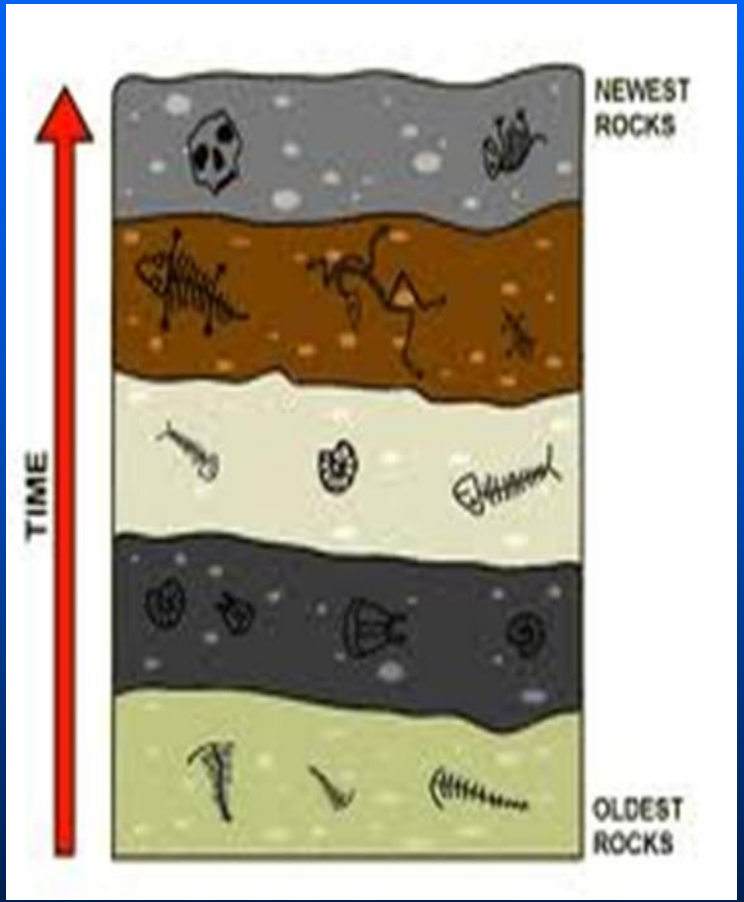


Note the insertion of abiogenesis (spontaneous generation) despite it being disproved!

The actual ages of rocks and fossils mark geologic time

RELATIVE DATING:

- Method used to determine the age of rocks by comparing them with those in other younger and older layers.
- Based on the **Law of Superposition**:
  - » Rock layers are deposited with the youngest undisturbed layers on top.
  - » Fossils are found within these layers.



GEOLOGICAL TIME SCALE

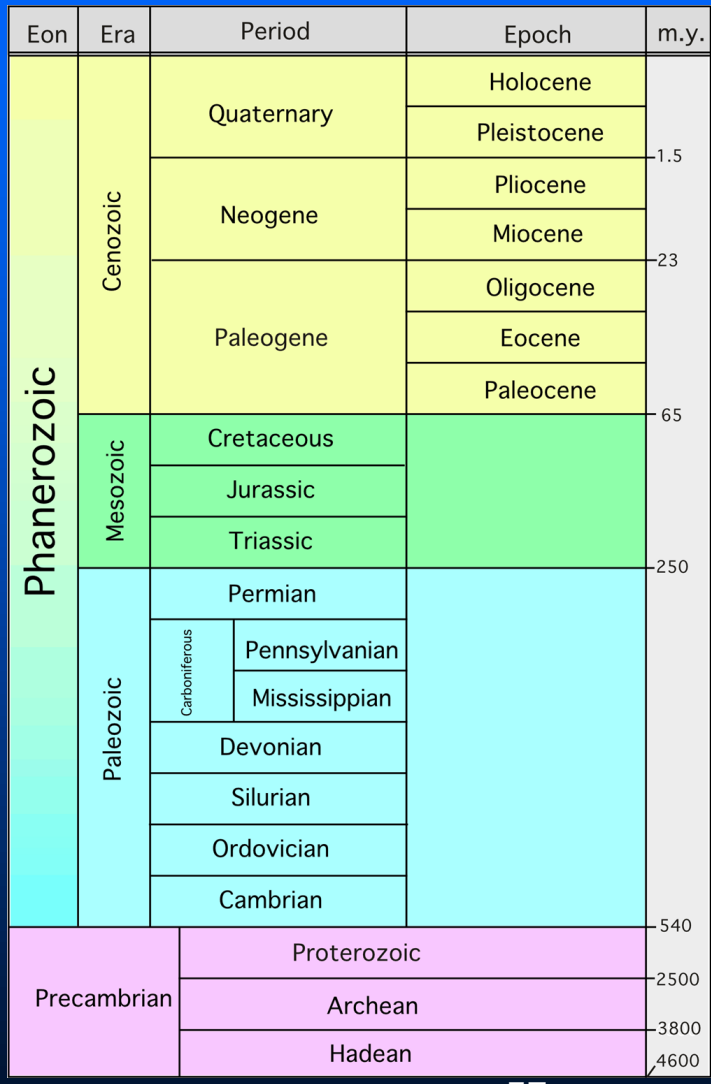
Phanerozoic Eon

Epochs smallest unit of geologic time

Periods consist of two or more epochs

Era consist of two or more periods

- » Boundaries between eras marked by Mass Extinctions
- » 3 Eras:
  - Paleozoic
  - Mesozoic
  - Cenozoic



Relative Duration of Eons	Era	Period	Epoch	Age (millions of years ago)	Important Events in the History of Life
Phanerozoic	Cenozoic	Quaternary	Holocene	0.01	Historical time
			Pleistocene	2.6	Ice ages; origin of genus *Homo*
		Tertiary	Pliocene	5.3	Appearance of bipedal human ancestors
			Miocene	23	Continued radiation of mammals and angiosperms; earliest direct human ancestors
			Oligocene	33.9	Origins of many primate groups
			Eocene	55.8	Angiosperm dominance increases; continued radiation of most present-day mammalian orders
			Paleocene	65.5	Major radiation of mammals, birds, and pollinating insects
Proterozoic	Mesozoic	Cretaceous		145.5	Flowering plants (angiosperms) appear and diversify; many groups of organisms, including most dinosaurs, become extinct at end of period
		Jurassic		199.6	Gymnosperms continue as dominant plants; dinosaurs abundant and diverse
		Triassic		251	Cone-bearing plants (gymnosperms) dominate landscape; dinosaurs evolve and radiate; origin of mammals
	Paleozoic	Permian		299	Radiation of reptiles; origin of most present-day groups of insects; extinction of many marine and terrestrial organisms at end of period
		Carboniferous		359	Extensive forests of vascular plants form; first seed plants appear; origin of reptiles; amphibians dominant
		Devonian		416	Diversification of bony fishes; first tetrapods and insects appear
		Silurian		444	Diversification of early vascular plants
		Ordovician		488	Marine algae abundant; colonization of land by diverse fungi, plants, and animals
		Cambrian		542	Sudden increase in diversity of many animal phyla (Cambrian explosion)
Archaean		Ediacaran		635	Diverse algae and soft-bodied invertebrate animals appear
				1,800	Oldest fossils of eukaryotic cells appear
				2,500	
Hadean				2,700	Concentration of atmospheric oxygen begins to increase
				3,500	Oldest fossils of cells (prokaryotes) appear
				3,850	Oldest known rocks on Earth's surface
				4,000	
				Approx. 4,600	Origin of Earth

Relative Duration of Eons	Era	Period	Epoch	Age (millions of years ago)	Important Events in the History of Life
Proterozoic	Paleozoic	Permian		299	Radiation of reptiles; origin of most present-day groups of insects; extinction of many marine and terrestrial organisms at end of period 
		Carboniferous		359	Extensive forests of vascular plants form; first seed plants appear; origin of reptiles; amphibians dominant 
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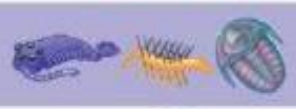
Archaean		Ordovician		488	Marine algae abundant; colonization of land by diverse fungi, plants, and animals 
		Cambrian		542	Sudden increase in diversity of many animal phyla (Cambrian explosion) 
		Ediacaran		635	Diverse algae and soft-bodied invertebrate animals appear 
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Relative Duration of Eons	Era	Period	Epoch	Age (millions of years ago)	Important Events in the History of Life
Phanerozoic	Cenozoic	Quaternary	Holocene	0.01	Historical time
			Pleistocene	2.6	Ice ages; origin of genus *Homo*
		Tertiary	Pliocene	5.3	Appearance of bipedal human ancestors
			Miocene	23	Continued radiation of mammals and angiosperms; earliest direct human ancestors
			Oligocene	33.9	Origins of many primate groups
			Eocene	55.8	Angiosperm dominance increases; continued radiation of most present-day mammalian orders
			Paleocene	65.5	Major radiation of mammals, birds, and pollinating insects
Proterozoic	Mesozoic	Cretaceous		145.5	Flowering plants (angiosperms) appear and diversify; many groups of organisms, including most dinosaurs, become extinct at end of period
		Jurassic		199.6	Gymnosperms continue as dominant plants; dinosaurs abundant and diverse
		Triassic		251	Cone-bearing plants (gymnosperms) dominate landscape; dinosaurs evolve and radiate; origin of mammals