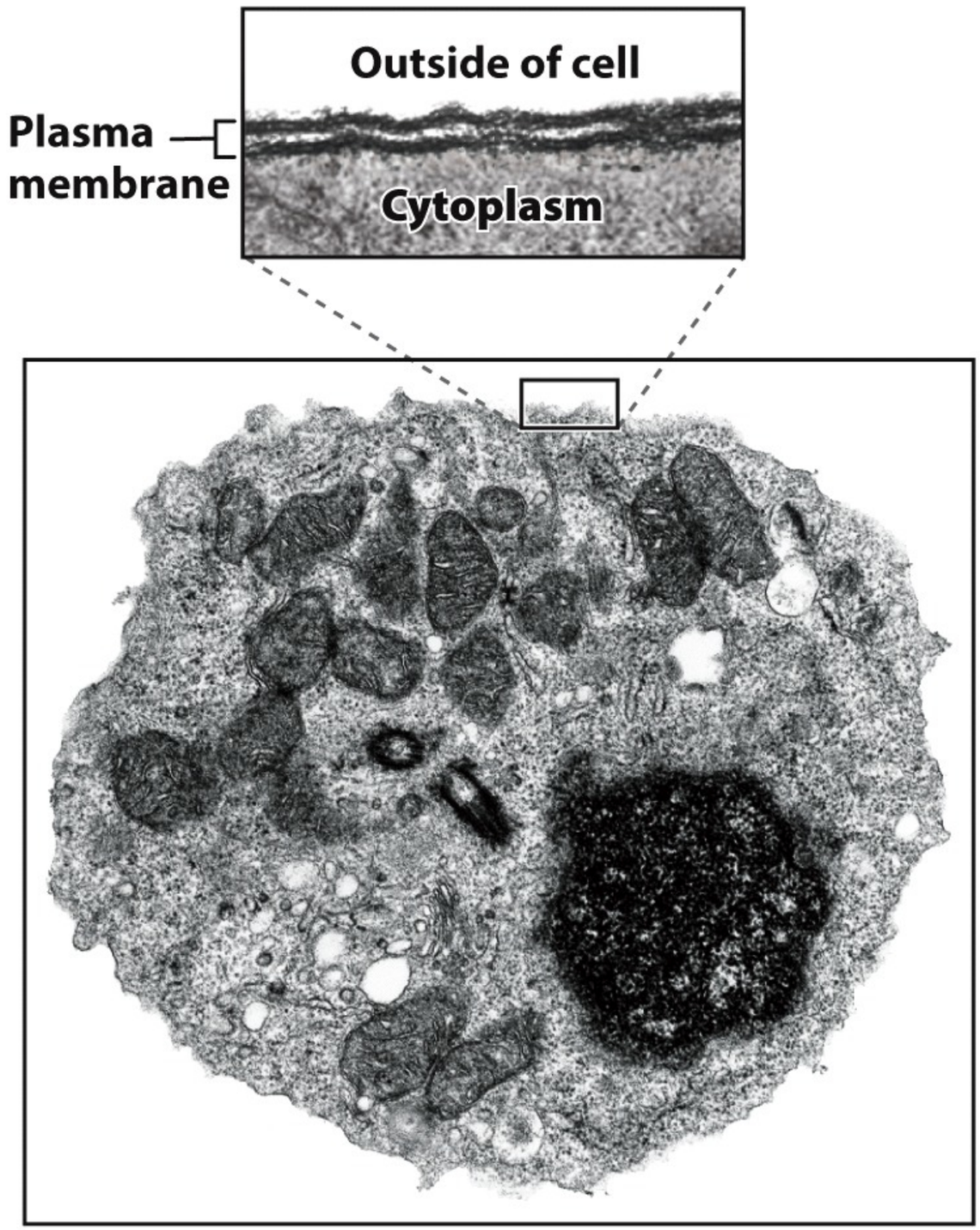
BIOL2107, Fall ’23

Lecture 3



Transmission electron micrograph of a cell

Figure 1.14
Biology: How Life Works

Some of the “facts” of Life…?

(a) Living organisms do exist -subject to the laws of chemistry and physics,

(b) One of the central characteristics of living organisms (but clearly not the only one, is the presence and maintenance of some type of reproducible boundary.

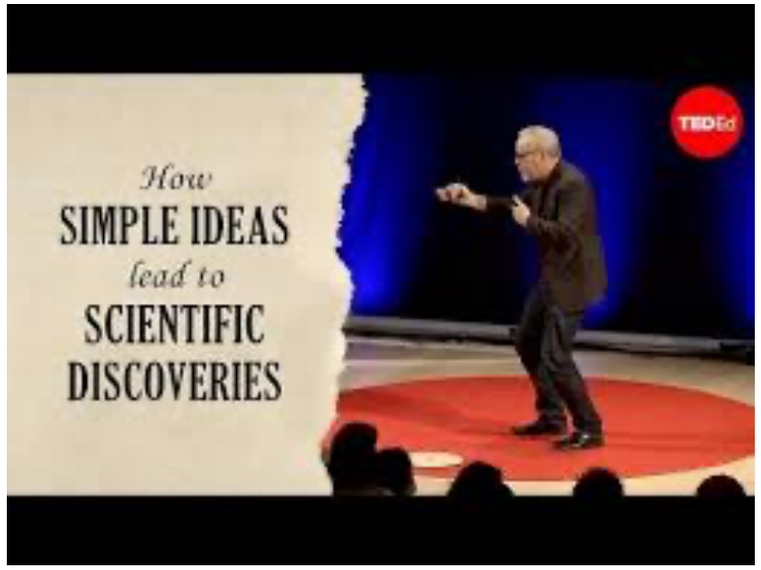
(c) the very act of living requires energy. But according to the "laws of physics.....energy can neither be created nor destroyed", so.....

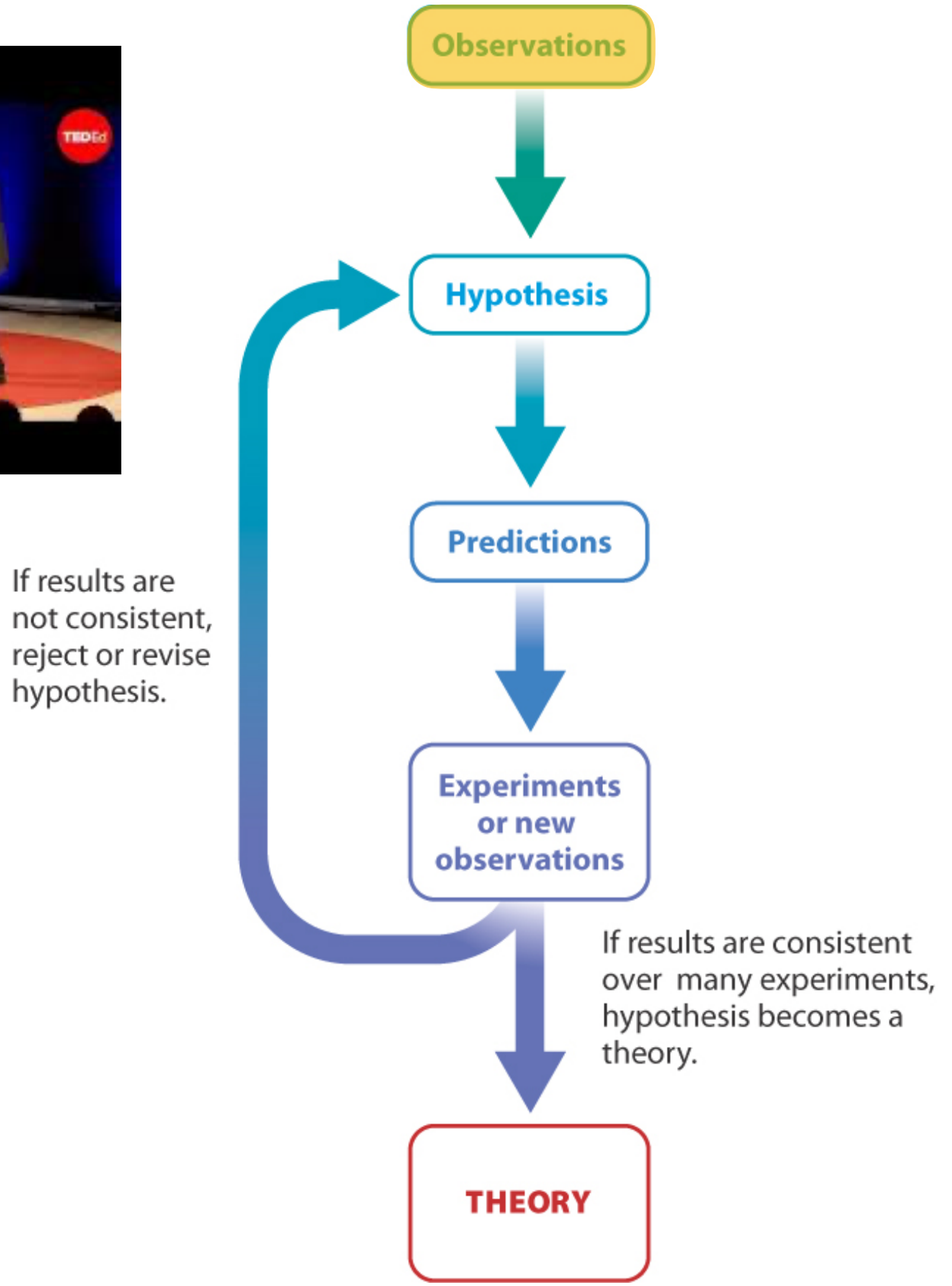
(d) to survive -at least in our world- living organisms use organic elements..."CHONPS " to effectively cycle and recycle the available energy in all its forms.....at the expense of the local environment.

(e) Paradoxically, as a consequence of all these "requirements", I would suggest that a single living organism cannot exist
(for any protracted length of time) by itself… ?

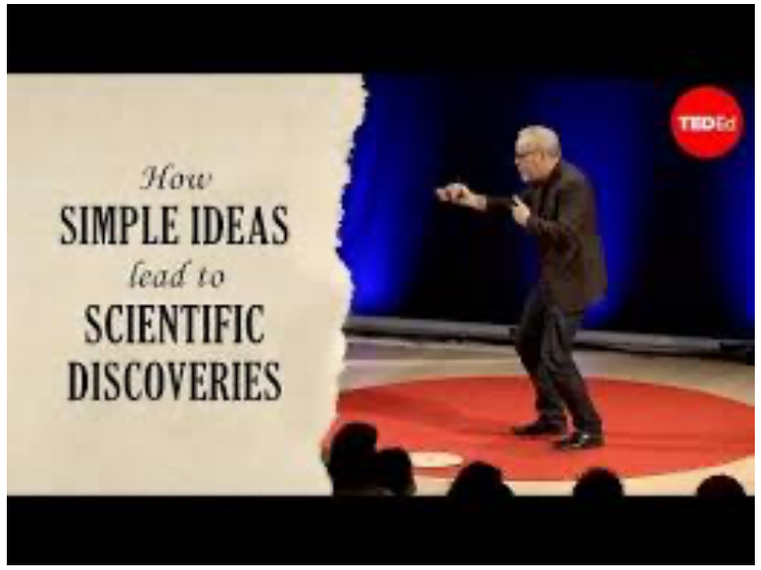

MYTHBUSTERS

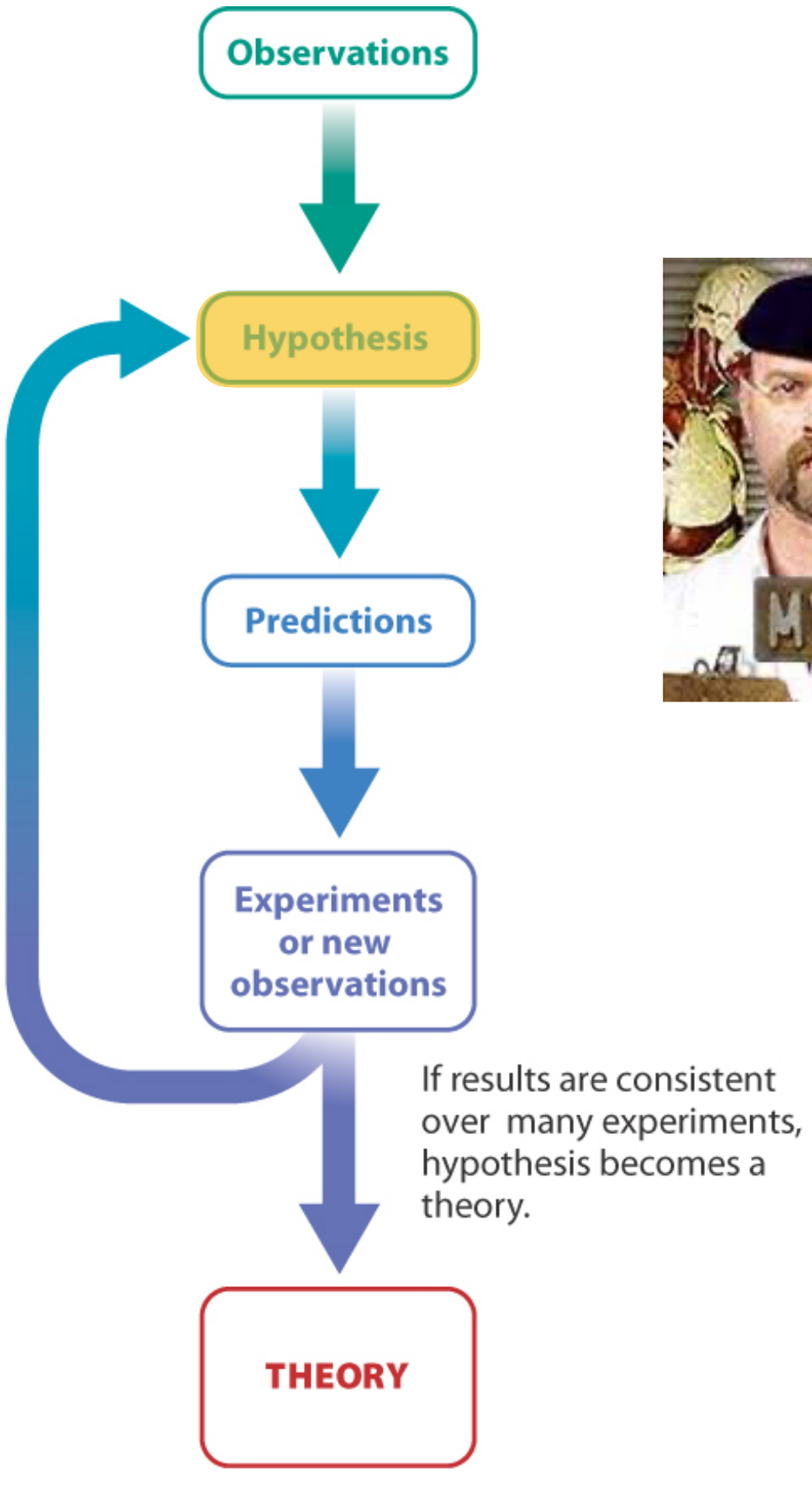
Scientific Method /approach



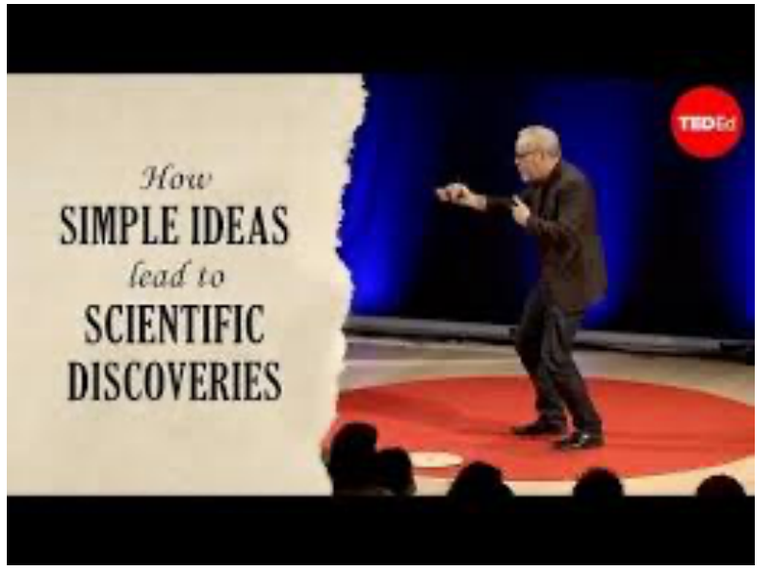


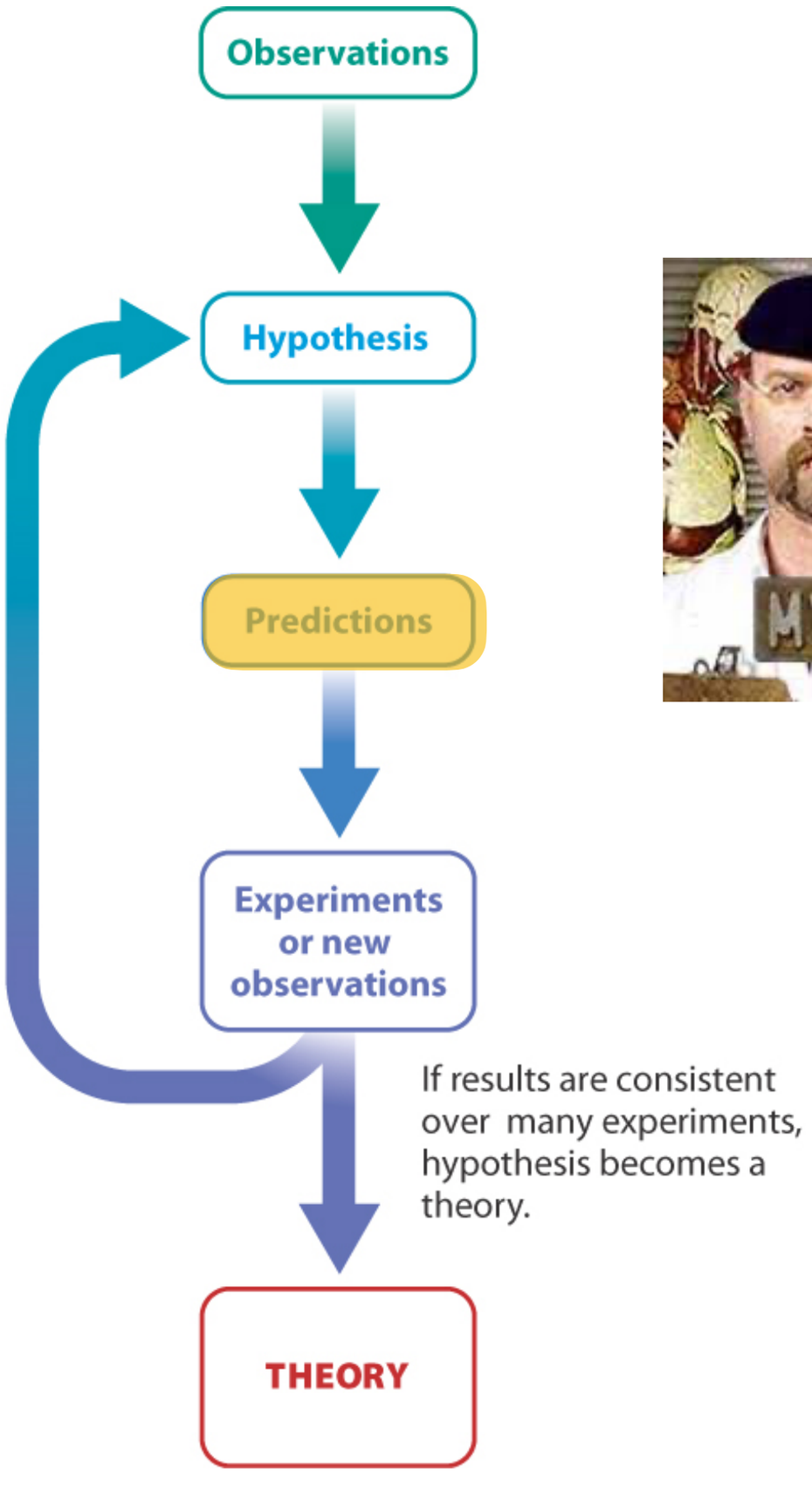
Scientific Method /approach



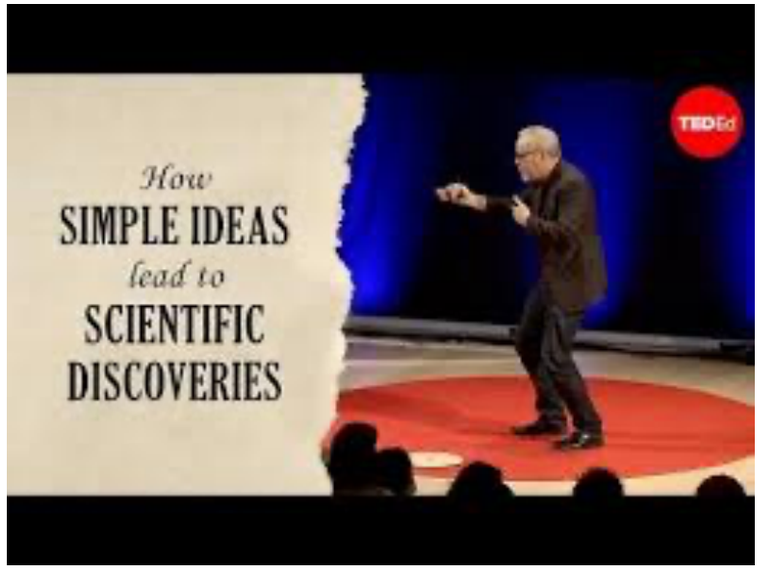


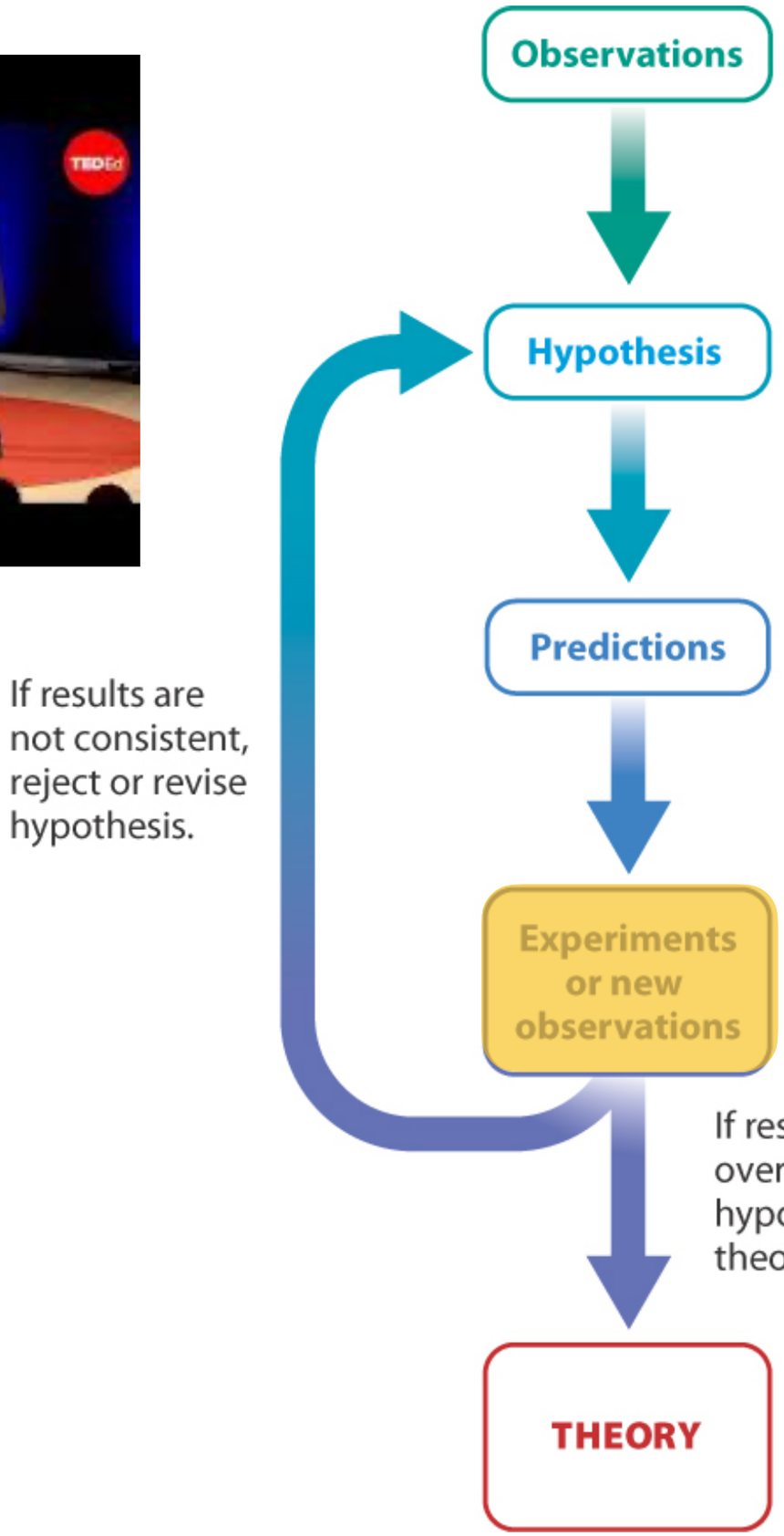
Scientific Method /approach



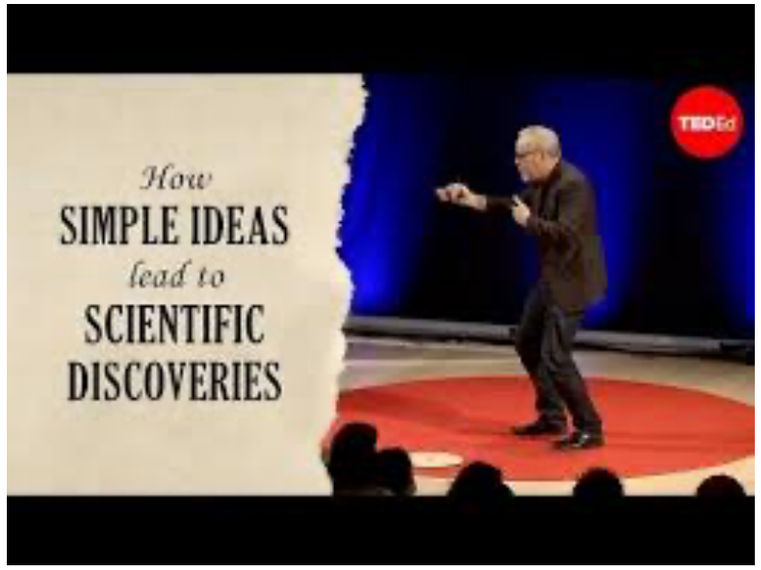


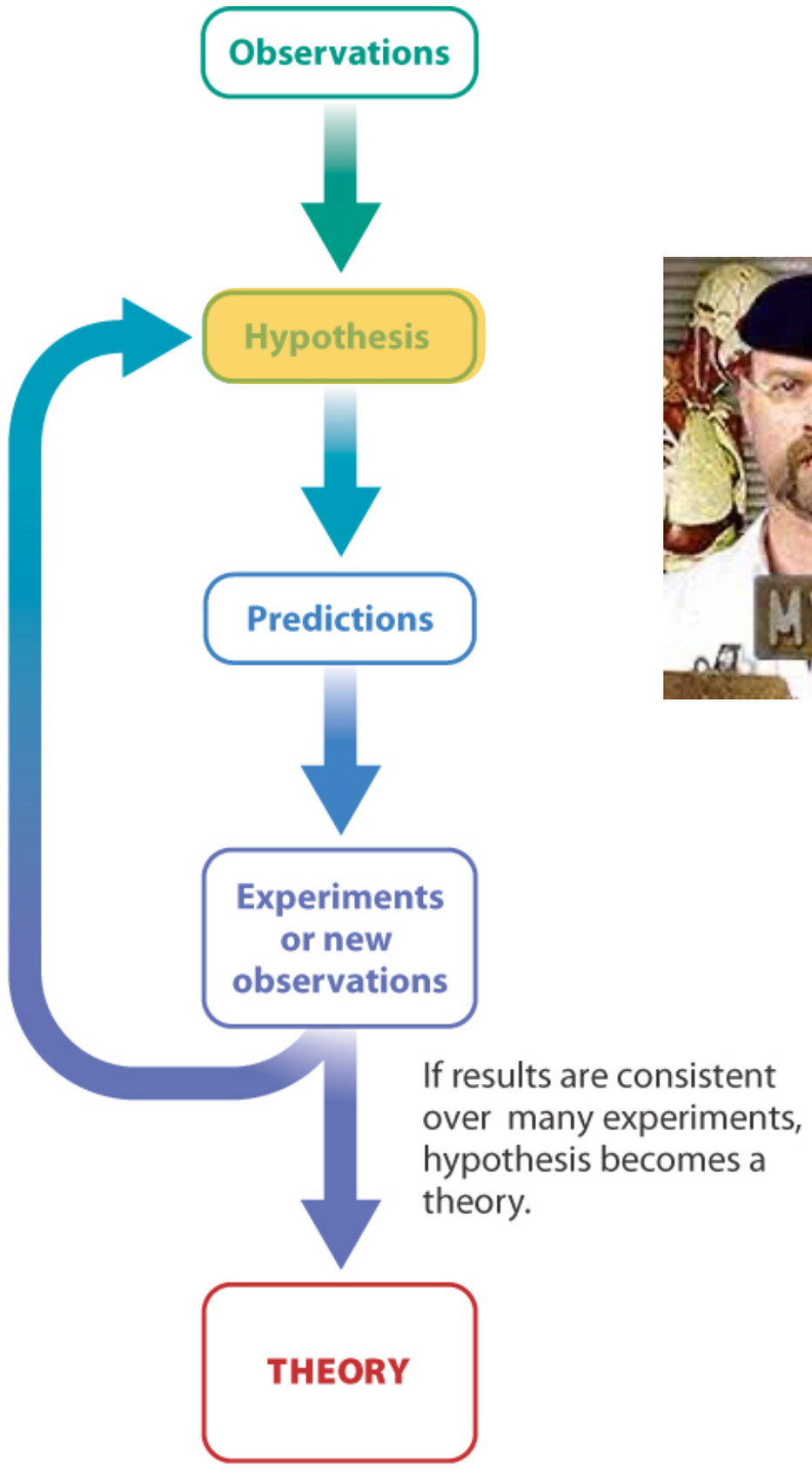
Scientific Method /approach



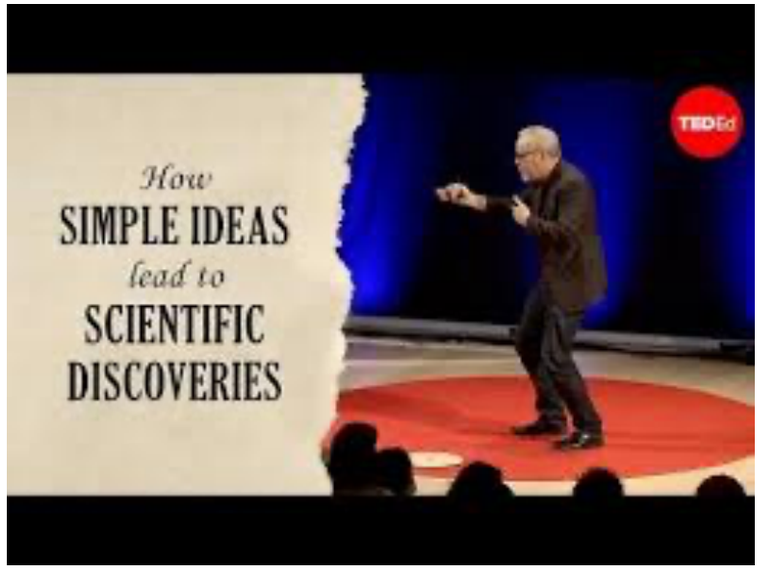


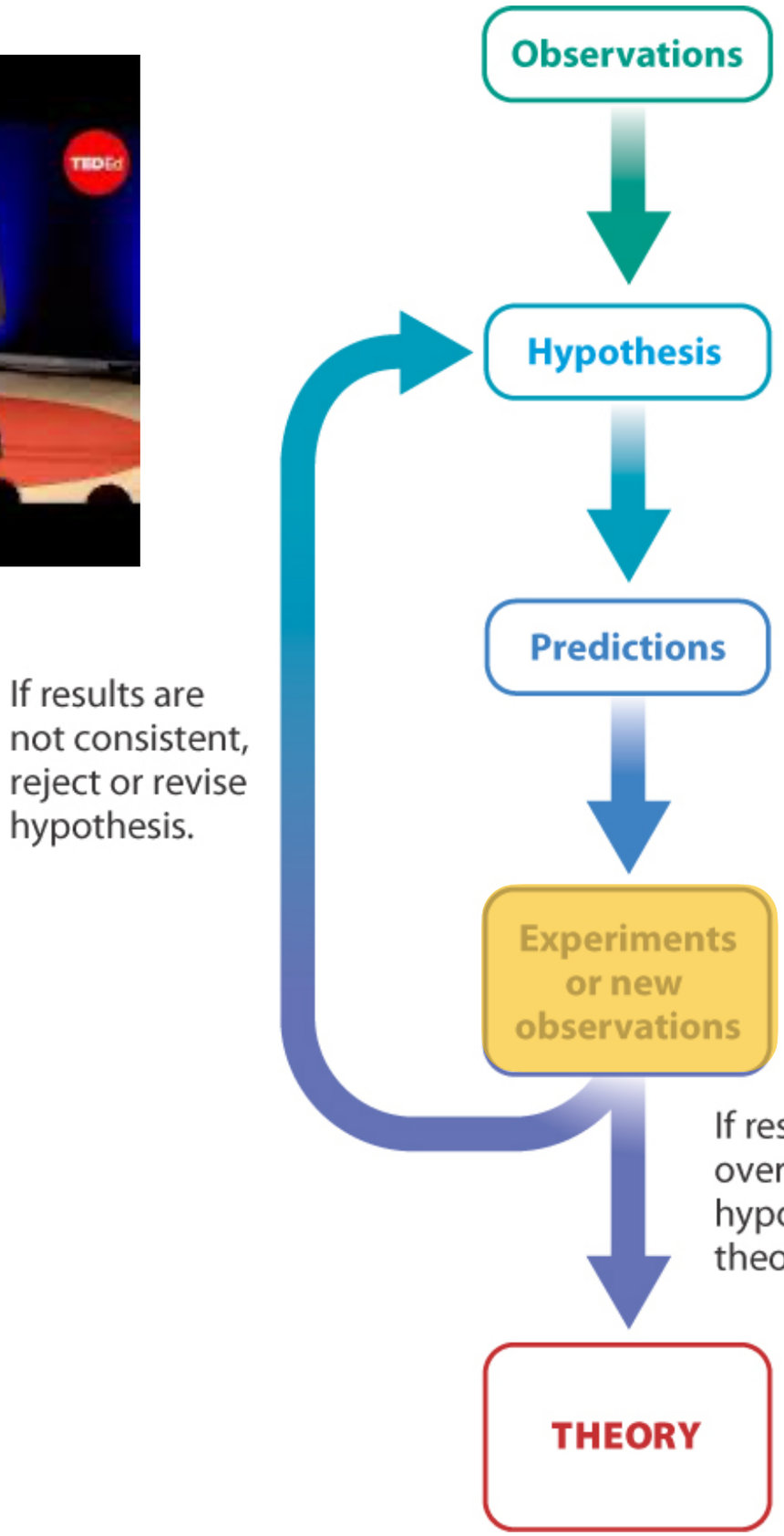
Scientific Method /approach



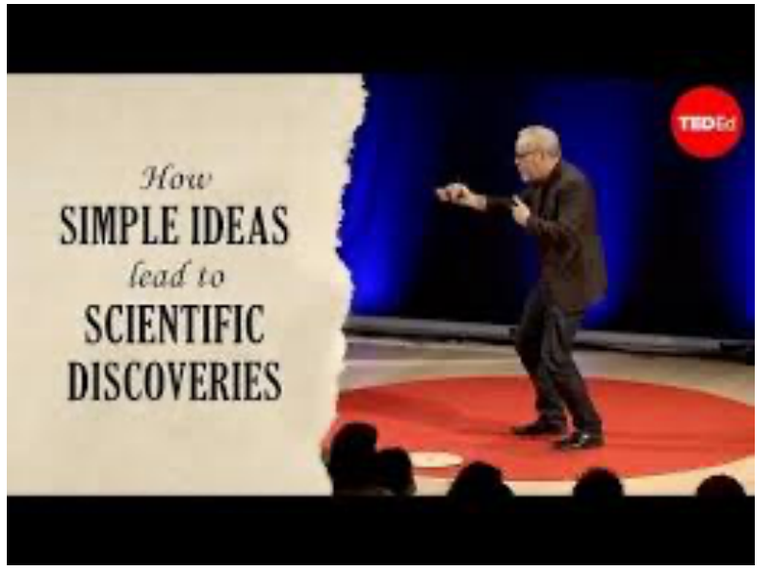


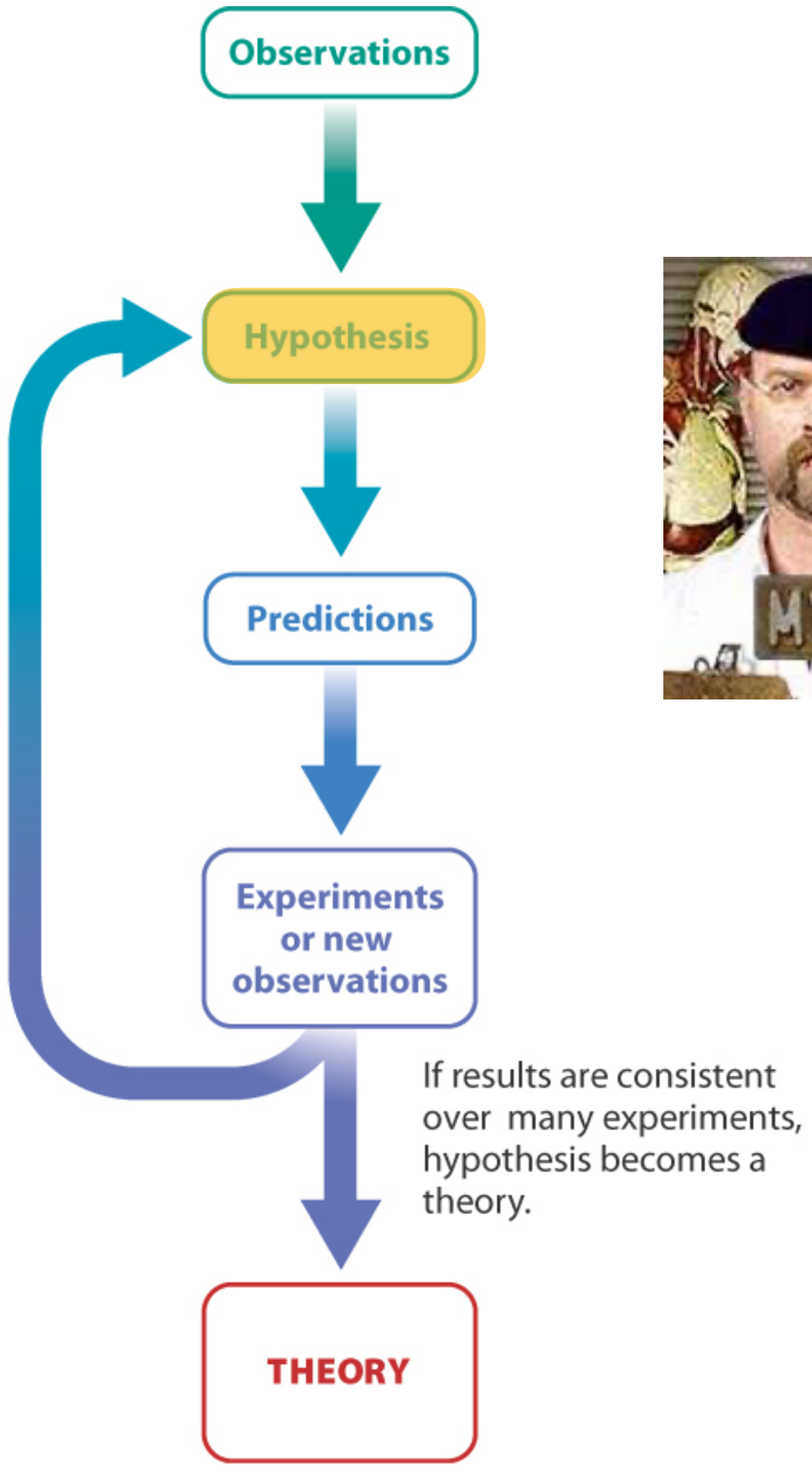
Scientific Method /approach



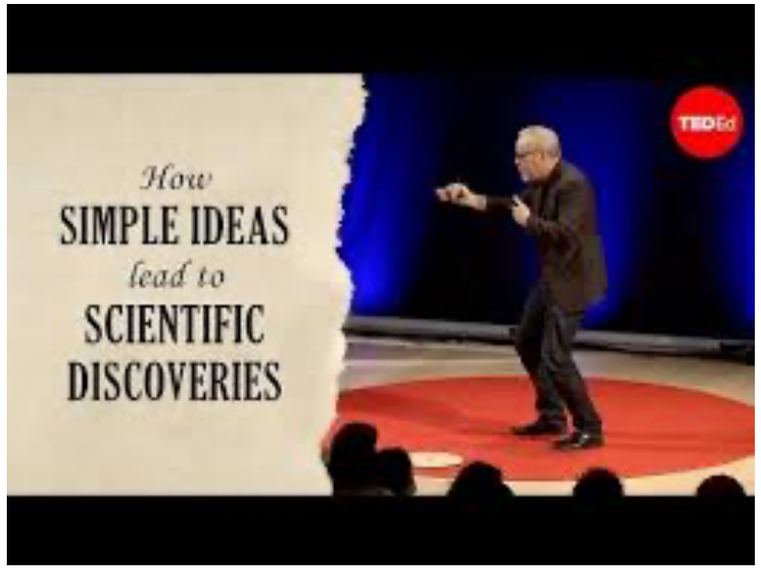


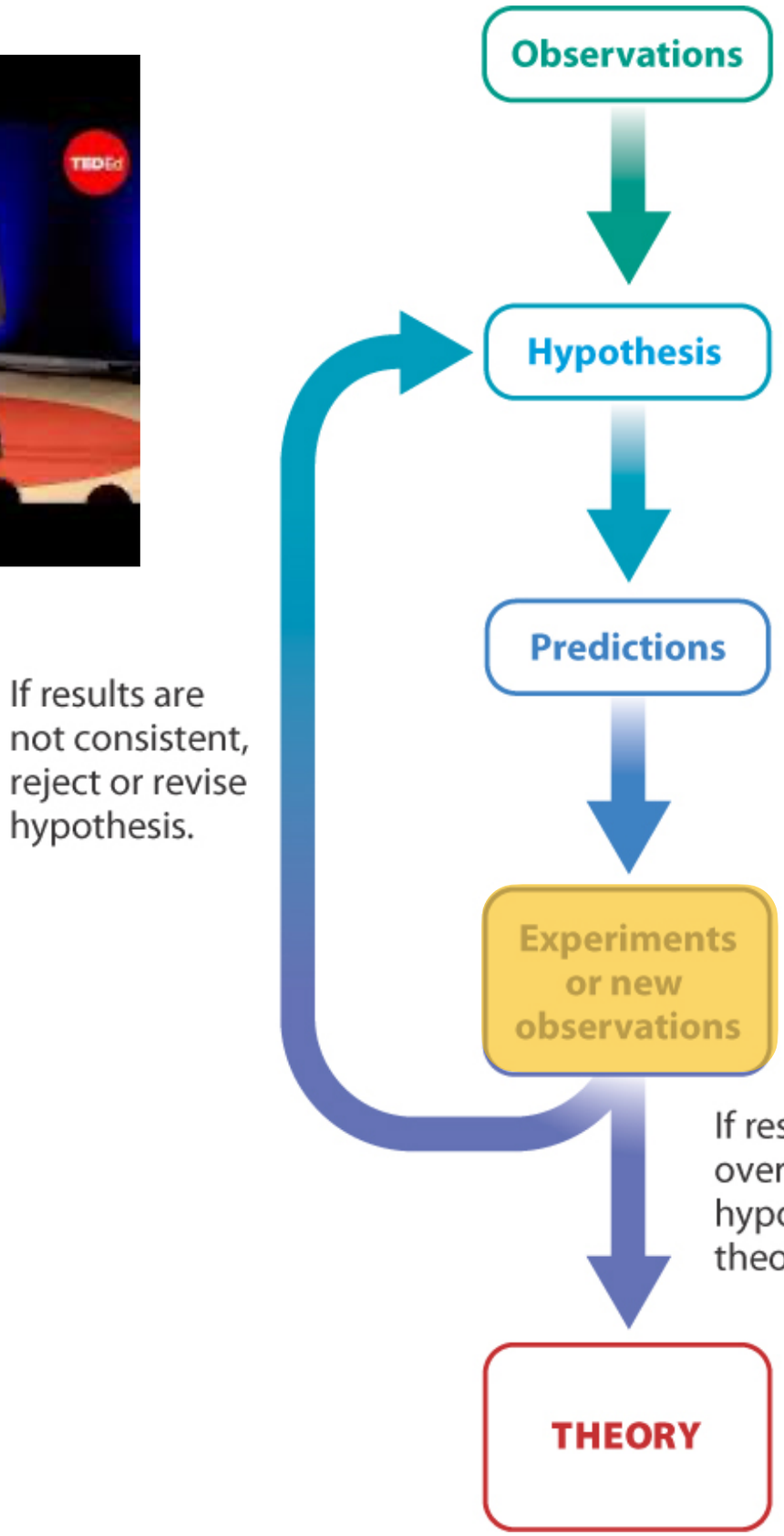
Scientific Method /approach



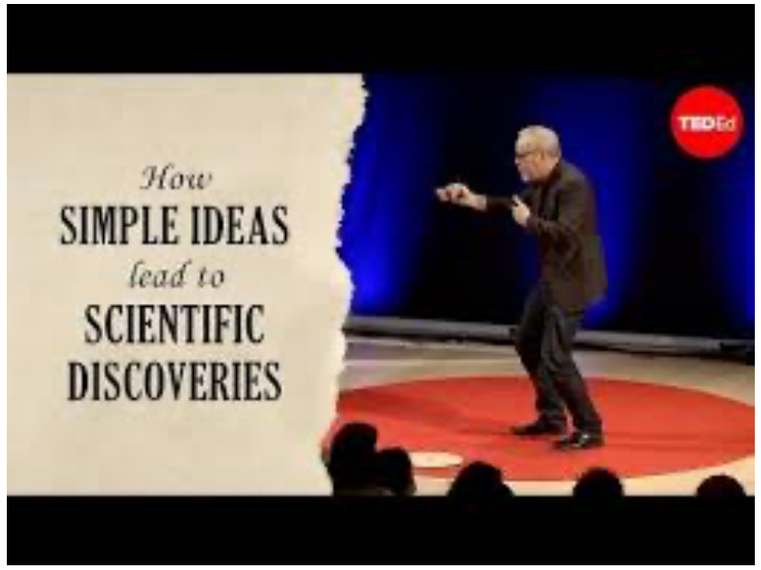


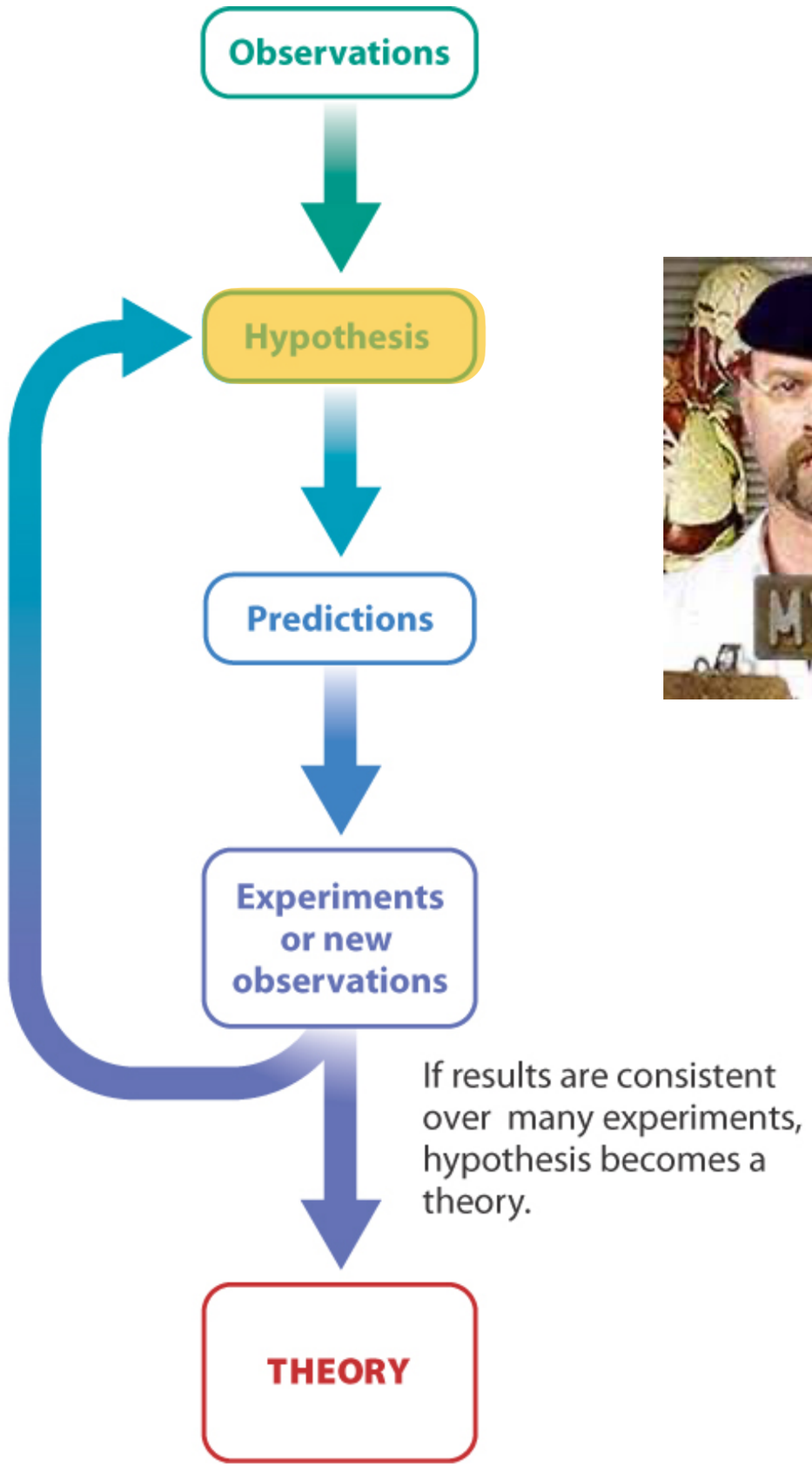
Scientific Method /approach



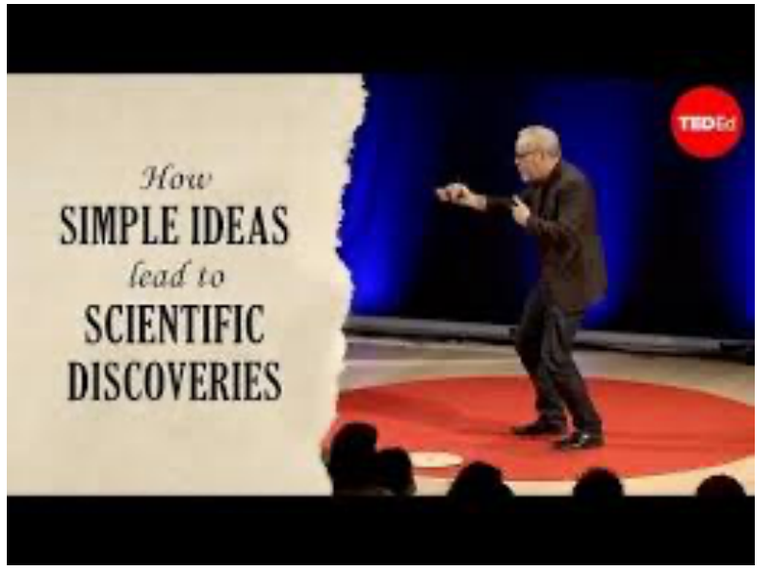


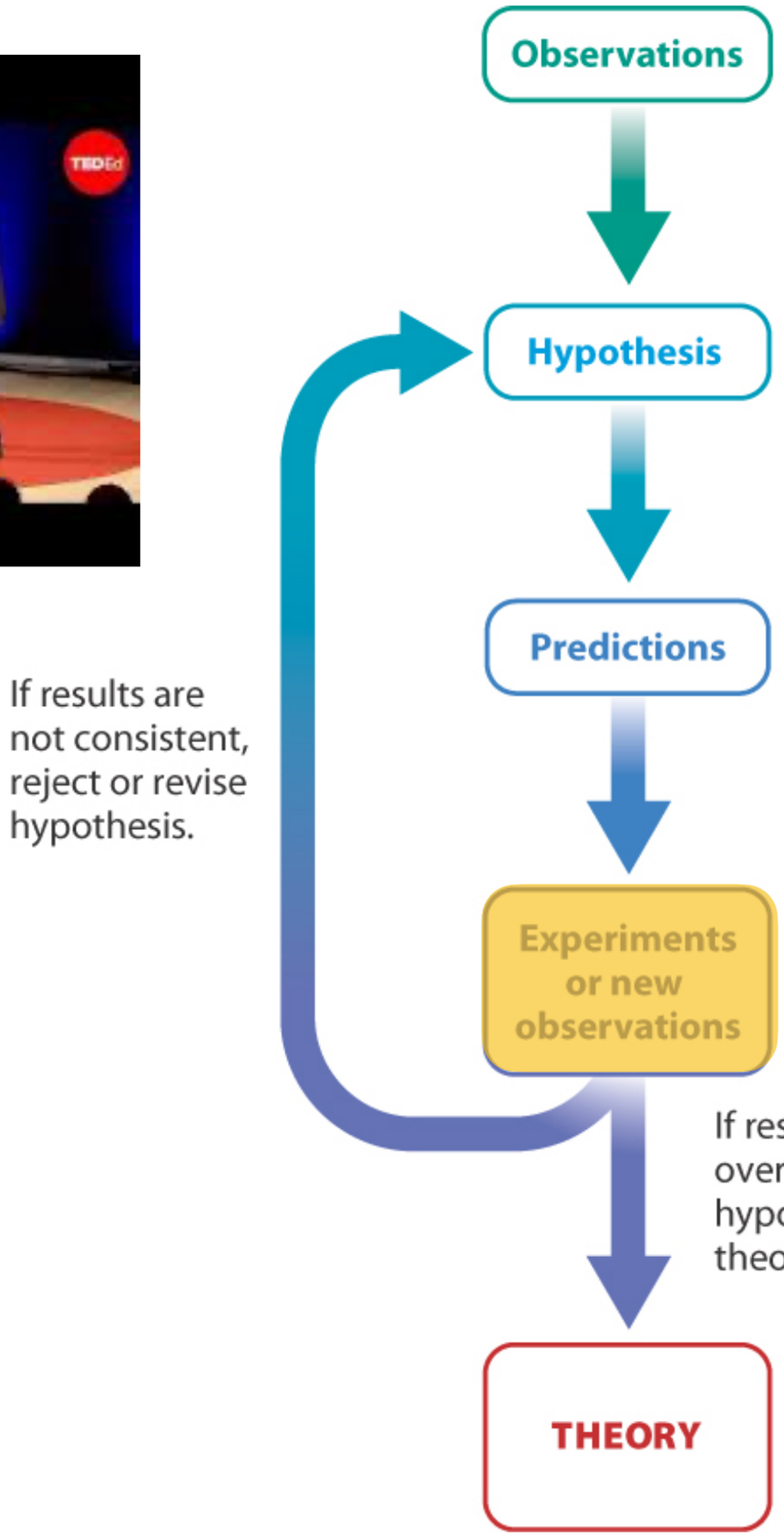
Scientific Method /approach



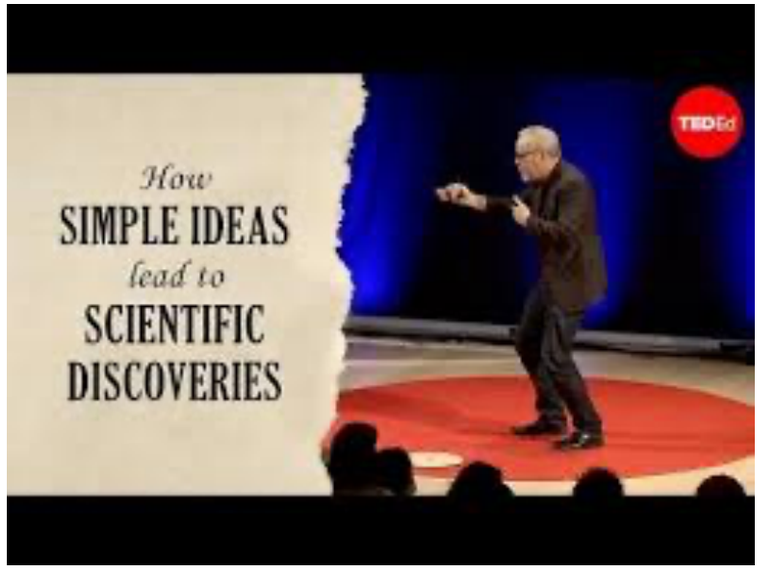


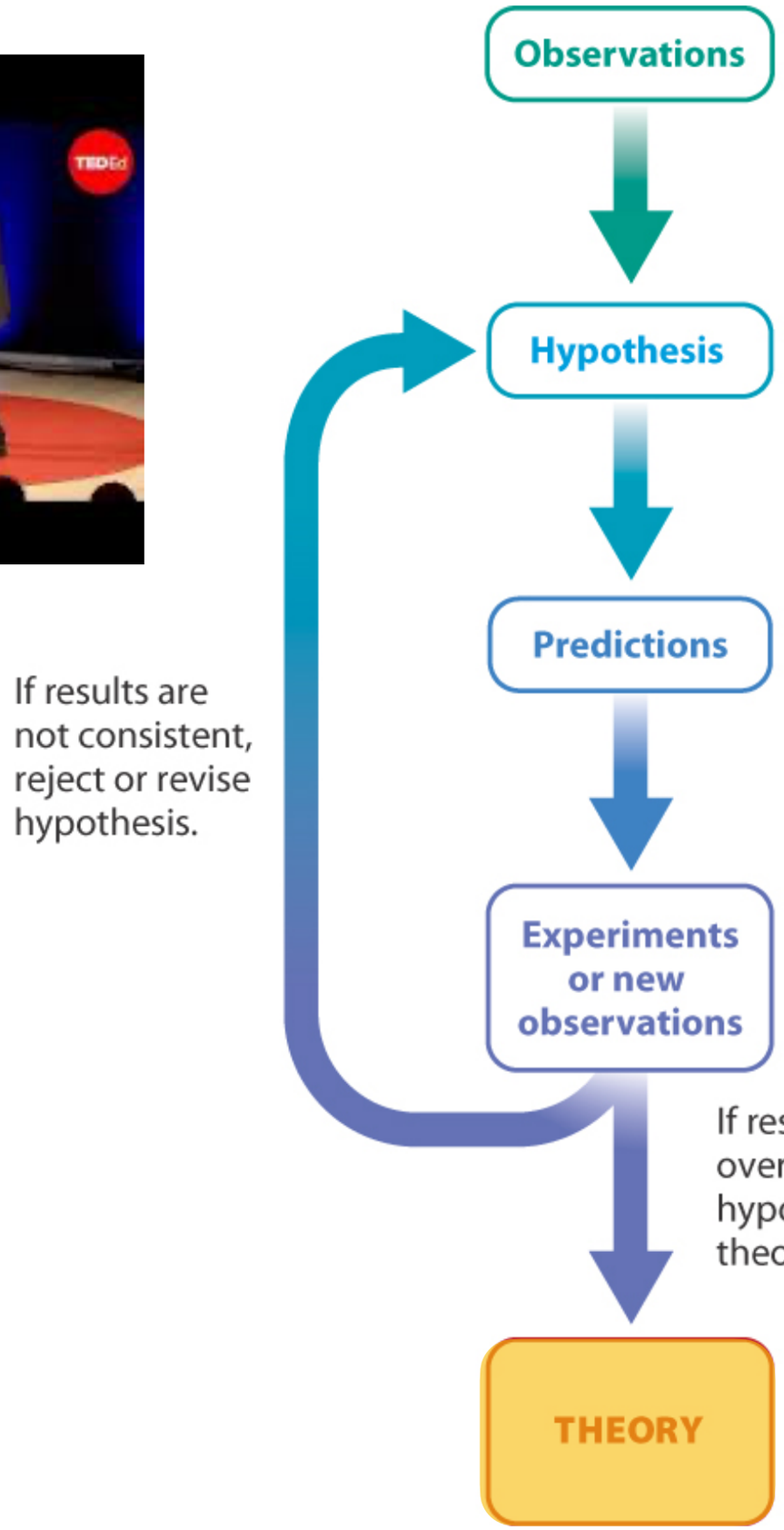
Scientific Method /approach

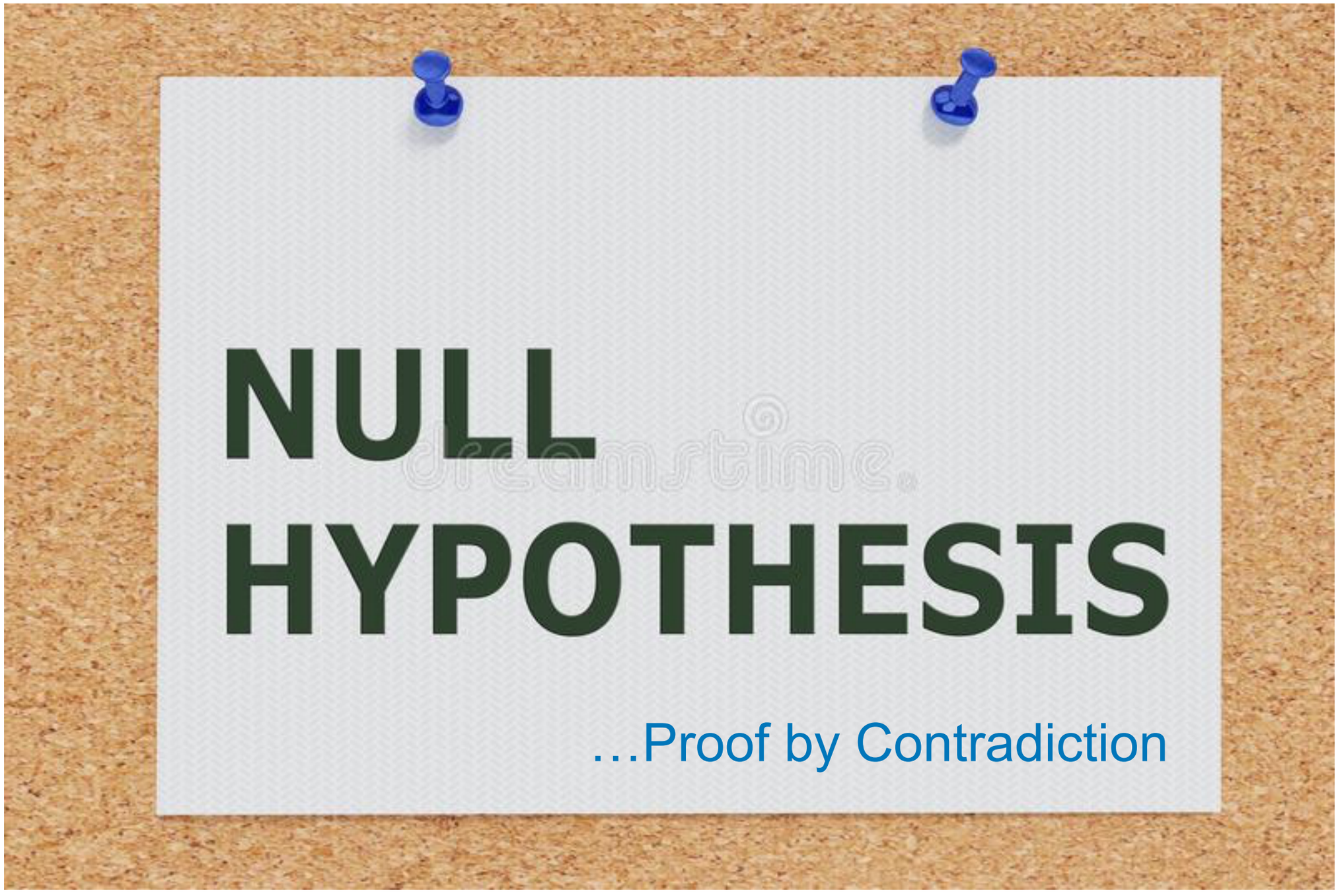




Scientific Method /approach






NULL
HYPOTHESIS
…Proof by Contradiction

One of the potential problems with any science, or any discipline that is based upon **"observations"**, is whether or not the observation(s) that can be made today actually APPLY to the situation or question(s) being addressed.

SPORTS Analogy: Barry Bonds vs. Hank Aaron vs. Babe Ruth.

Indeed, it can be critical that, when you are addressing a scientific question....you know what question is being asked, and that you are asking it in the right manner.....Nobel Prize in Chemistry 1989

It is also critical that the valid scientific questions are unencumbered by fluctuating social mores, and potential miss interpretation: as exemplified by Copernicus (1530's); Galileo (early 1600’s)....

Of course Societal Mores will/should always play a part ??

Career Leaders & Records for Home Runs

The **Barry Bonds perjury case** was a case of alleged perjury regarding use of anabolic steroids by former San Francisco Giants outfielder and all-time Major League Baseball career home run leader, Barry Bonds, and the related investigations surrounding these accusations. On April 13, 2011, Bonds was convicted of one felony count of obstruction of justice for giving an incomplete answer to a question in grand jury testimony. A mistrial was declared on the remaining three counts of perjury, and those charges were dropped.[1] The obstruction of justice conviction was upheld by an appellate panel in 2013, but a larger panel of the appellate court overturned the conviction in 2015.[2]

Rank	Player (yrs, age)	Home Runs	PA	Bats	HR Log
1.	Barry Bonds (22) *	762	12606	L	HR Log
2.	Henry Aaron+ (23)	755	13941	R	HR Log
3.	Babe Ruth+ (22)	714	10626	L	HR Log
4.	Alex Rodriguez (22)	696	12207	R	HR Log
5.	**Albert Pujols** (22, 42)	693	12921	R	HR Log
6.	Willie Mays+ (23)	660	12545	R	HR Log
7.	Ken Griffey Jr.+ (22)	630	11304	L	HR Log
8.	Jim Thome+ (22)	612	10313	L	HR Log
9.	Sammy Sosa (18)	609	9896	R	HR Log
10.	Frank Robinson+ (21)	586	11744	R	HR Log
11.	Mark McGwire (16)	583	7660	R	HR Log
12.	Harmon Killebrew+ (22)	573	9833	R	HR Log
13.	Rafael Palmeiro (20)	569	12046	L	HR Log
14.	Reggie Jackson+ (21)	563	11418	L	HR Log
15.	Manny Ramirez (19)	555	9774	R	HR Log
16.	Mike Schmidt+ (18)	548	10062	R	HR Log
17.	David Ortiz+ (20)	541	10091	L	HR Log
18.	Mickey Mantle+ (18)	536	9910	B	HR Log
19.	Jimmie Foxx+ (20)	534	9677	R	HR Log
20.	Willie McCovey+ (22)	521	9692	L	HR Log

8.	Jim Thome+ (22)	612	L	HR Log
9.	Sammy Sosa (18)	609	R	HR Log
10.	Frank Robinson+ (21)	586	R	HR Log
11.	Mark McGwire (16)	583	R	HR Log
12.	Harmon Killebrew+ (22)	573	R	HR Log
13.	Rafael Palmeiro (20)	569	L	HR Log
14.	Reggie Jackson+ (21)	563	L	HR Log
15.	Manny Ramirez (19)	555	R	HR Log
16.	Mike Schmidt+ (18)	548	R	HR Log
17.	David Ortiz+ (20)	541	L	HR Log
18.	Mickey Mantle+ (18)	536	B	HR Log
19.	Jimmie Foxx+ (20)	534	R	HR Log
20.	Willie McCovey+ (22)	521	L	HR Log

One of the potential problems with any science, or any discipline that is based upon **"observations"**, is whether or not the observation(s) that can be made today actually APPLY to the situation or question(s) being addressed.

SPORTS Analogy: Barry Bonds vs. Hank Aaron vs. Babe Ruth.

Indeed, it can be critical that, when you are addressing a Scientific question… you know what question is being asked, and that you are asking it in the right manner… Nobel Prize in Chemistry 1989

It is also critical that the valid scientific questions are unencumbered by fluctuating social mores, and potential miss interpretation: as exemplified by Copernicus (1530's); Galileo (early 1600's)....

Of course Societal Mores will/should always play a part ??

The Nobel Prize in Chemistry 1989

Photo from the Nobel Foundation archive.

Sidney Altman

Prize share: 1/2

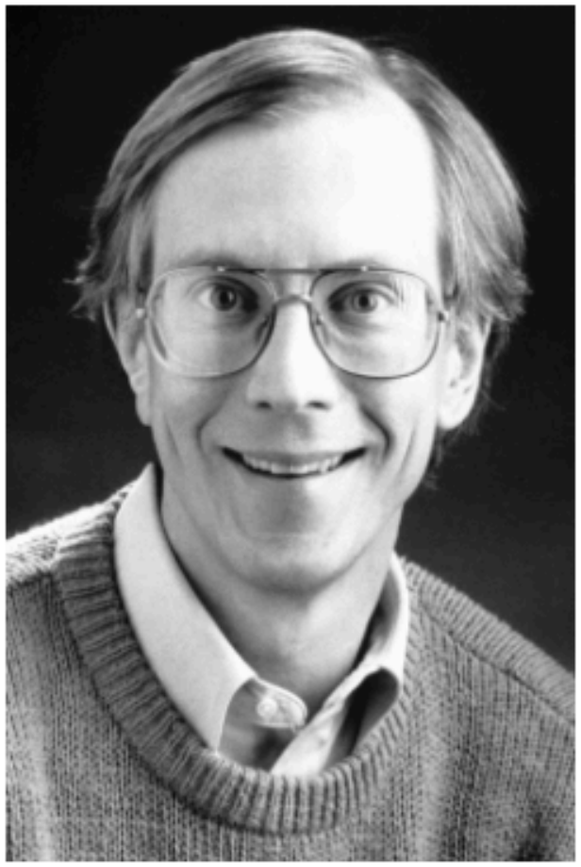


Photo from the Nobel Foundation archive.

Thomas R. Cech

Prize share: 1/2

The Nobel Prize in Chemistry 1989 was awarded jointly to Sidney Altman and Thomas R. Cech "for their discovery of catalytic properties of RNA."

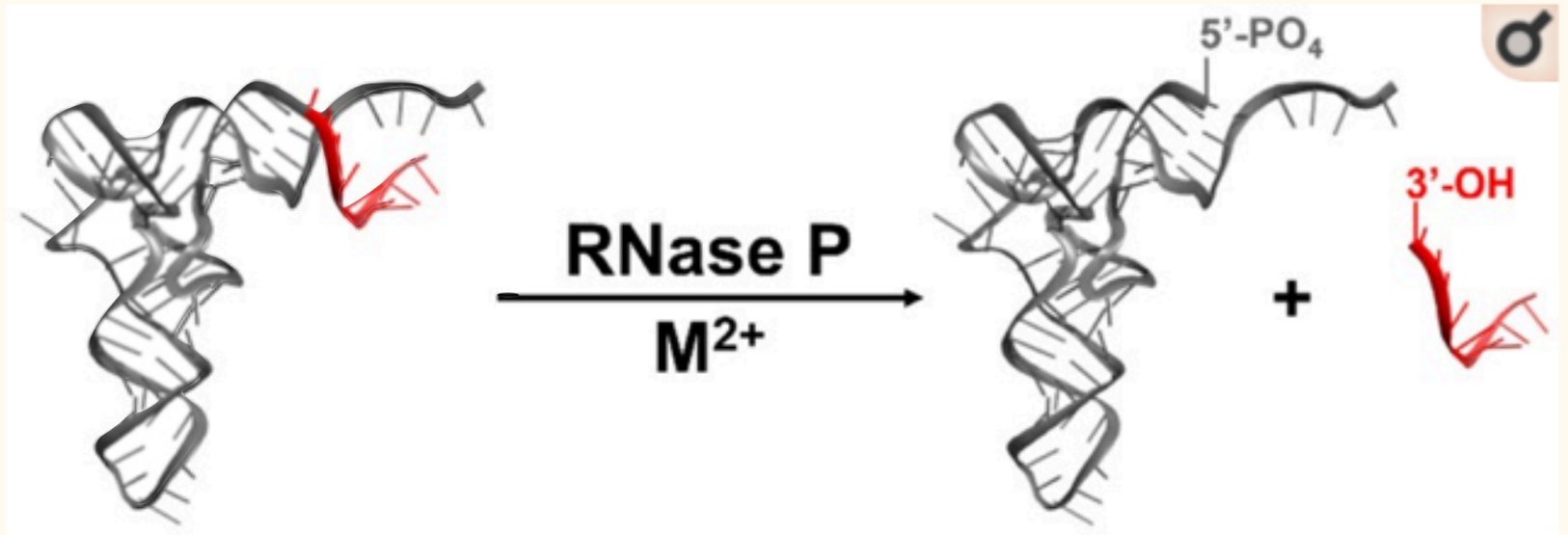
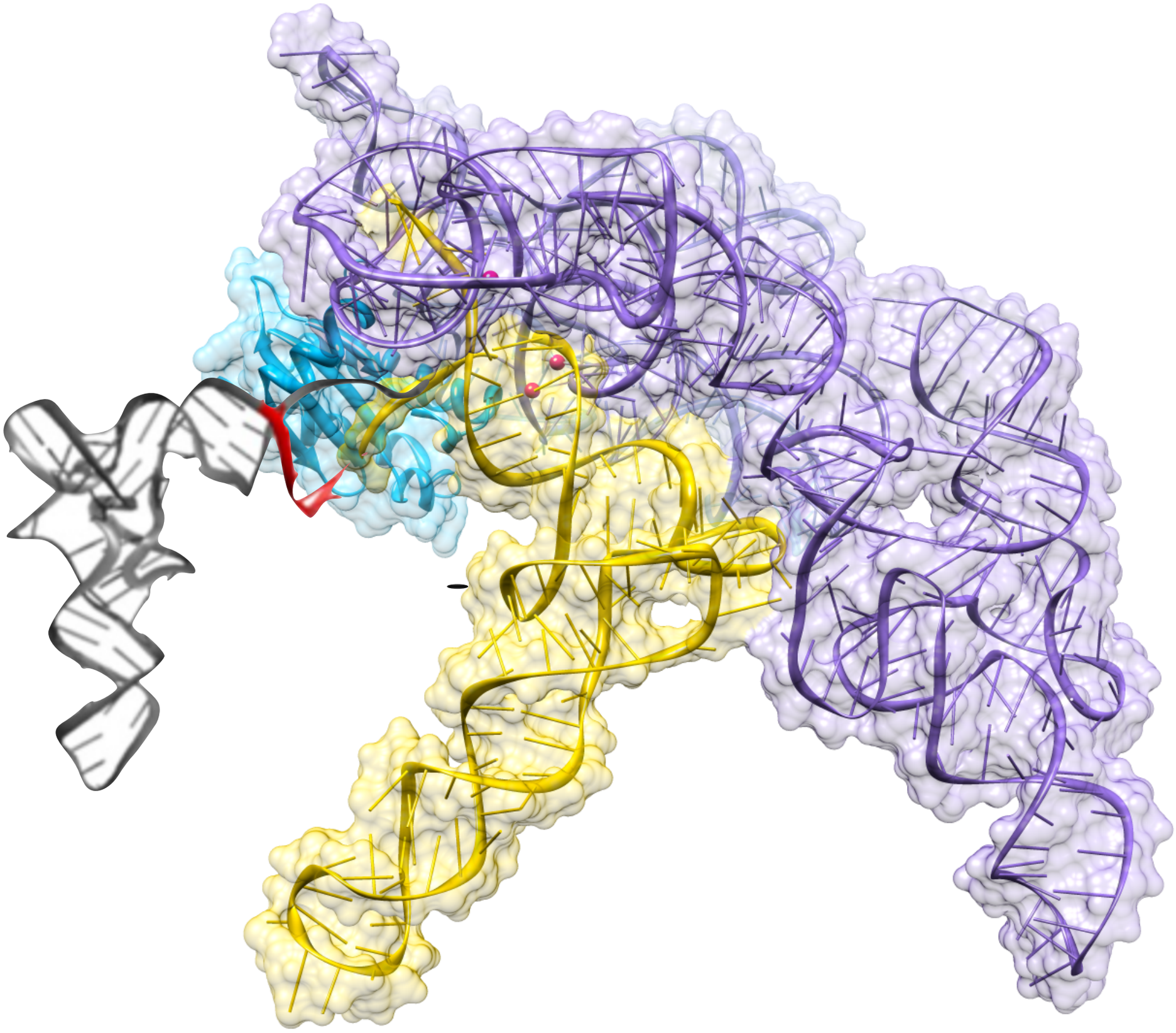
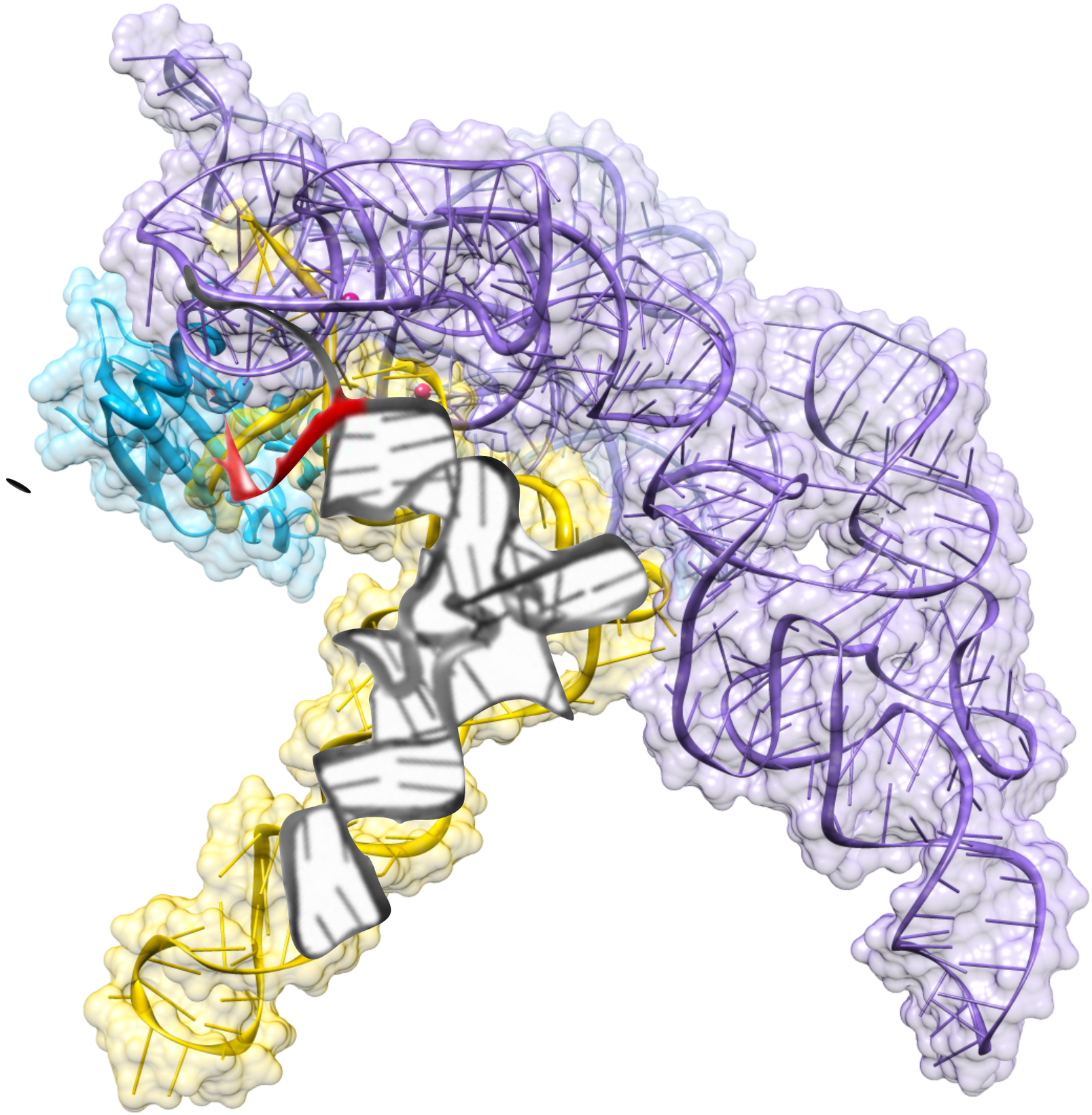


Figure 1

RNase P enzymes catalyze metal-dependent, endonucleolytic cleavage of pre-tRNA (adapted with permission from [7]).





Crystal structure of a bacterial **ribonuclease P holoenzyme** in complex with tRNA (**yellow**), showing metal ions involved in catalysis (pink spheres), PDB: 3Q1R

However, one of the potential problems with any science, or any discipline that is based upon **"observations"**, is whether or not the observation(s) that can be made today actually APPLY to the situation or question(s) being addressed.

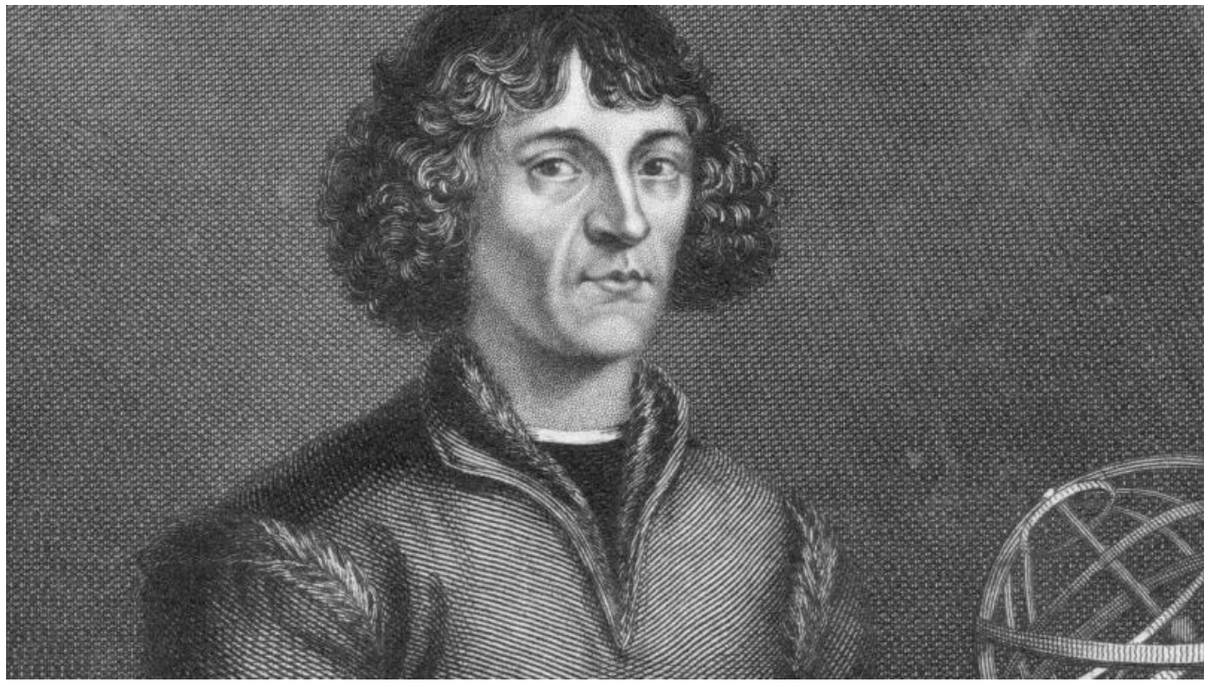
SPORTS Analogy: Barry Bonds vs. Hank Aaron vs. Babe Ruth.

Indeed, it can be critical that, when you are addressing a scientific question....you know what question is being asked, and that you are asking it in the right manner.....Nobel Prize in Chemistry 1989

It is also critical that the valid scientific questions are unencumbered by fluctuating social mores, and potential miss-interpretation:

as exemplified by Copernicus (1530's); Galileo (early 1600's)…

Of course Societal Mores will/should always play a part ??



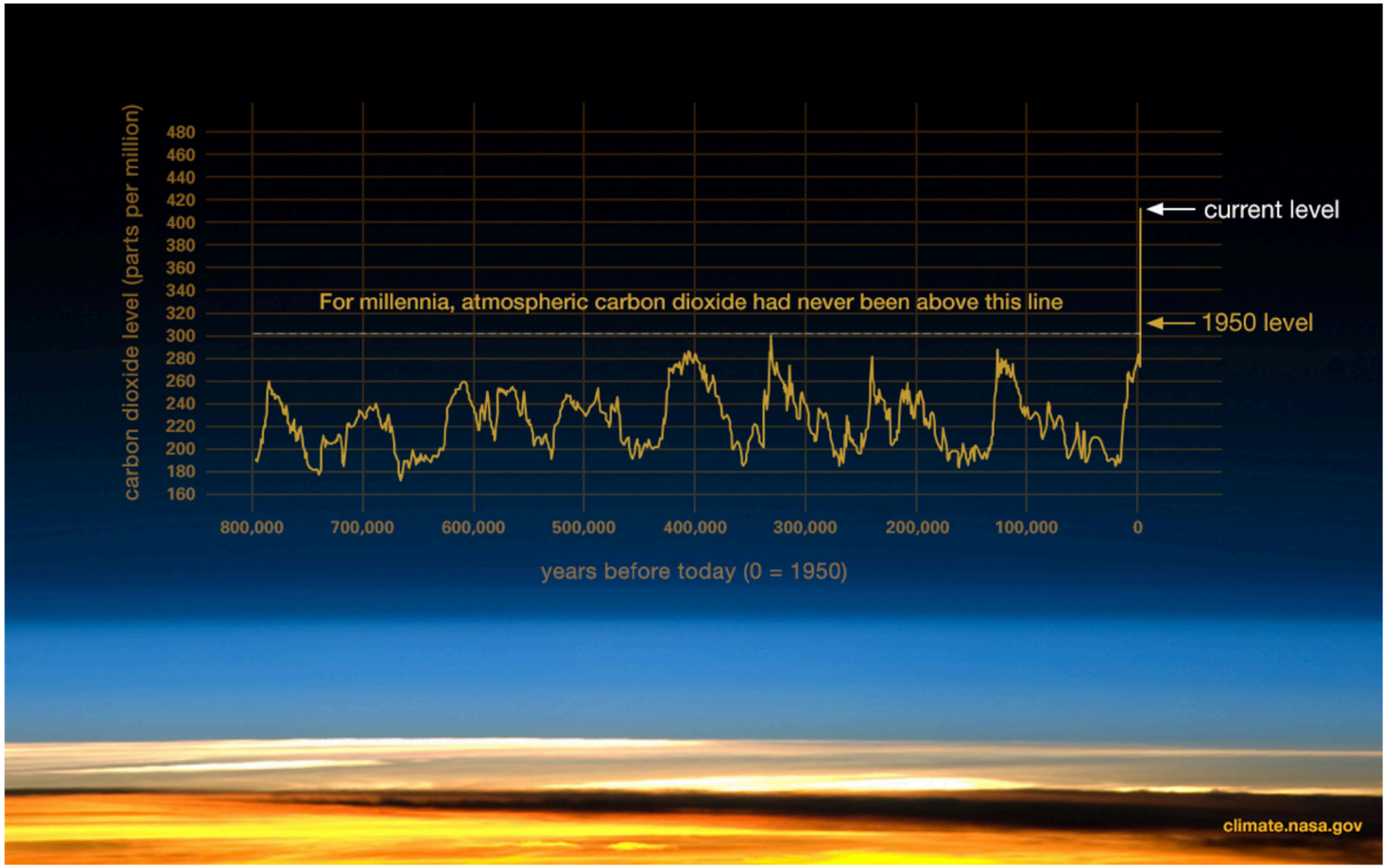
Copernicus (1543) A 'Perfect Heaven', but the Sun, not the earth, is at it's centre

Galileo is convicted of heresy, 1633

Scientific evidence for warming of the climate system is unequivocal.

- Intergovernmental Panel on Climate Change

Climate Change: How Do We Know?



This graph, based on the comparison of atmospheric samples contained in ice cores and more recent direct measurements, provides evidence that atmospheric CO_2 has increased since the Industrial Revolution. (Credit: Luthi, D., et al.. 2008; Etheridge, D.M., et al. 2010; Vostok ice core data/J.R. Petit et al.; NOAA Mauna Loa CO_2 record.) Find out more about ice cores (external

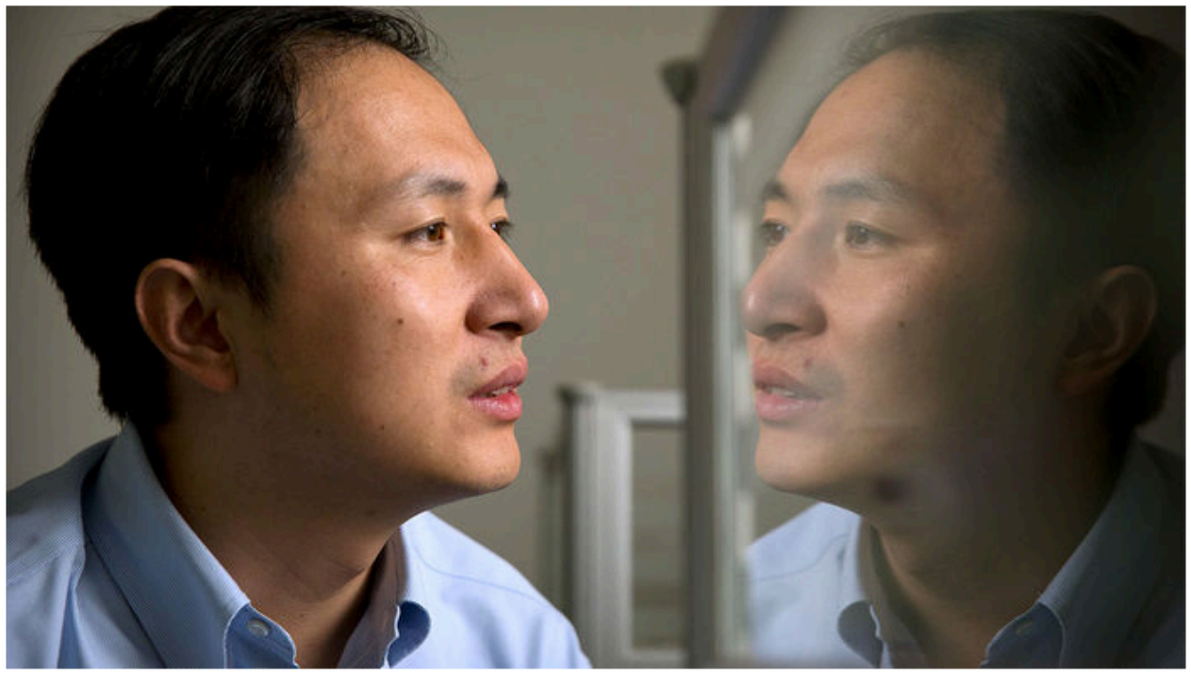
However, one of the potential problems with any science, or any discipline that is based upon **"observations"**, is whether or not the observation(s) that can be made today actually APPLY to the situation or question(s) being addressed.

SPORTS Analogy: Barry Bonds vs. Hank Aaron vs. Babe Ruth.

Indeed, it can be critical that, when you are addressing a scientific question....you know what question is being asked, and that you are asking it in the right manner.....Nobel Prize in Chemistry 1989

It is also critical that the valid scientific questions are unencumbered by fluctuating social mores, and potential miss interpretation: as exemplified by Copernicus (1530's); Galileo (early 1600's)…

Of course **Societal Mores** will/should always play a part ??



He Jiankui told The Associated Press that he carried out his experiment to protect the twin sisters from HIV infection later in life. MARK SCHIEFELBEIN/AP PHOTO

CRISPR bombshell: Chinese researcher claims to have created gene-edited twins

By Dennis Normile | Nov. 26, 2018 , 1:10 PM

HONG KONG, CHINA—On the eve of an international summit here on genome editing, a Chinese researcher has shocked many by claiming to have altered the genomes of twin baby girls born this month in a way that will pass the modification on to future generations. The alteration is intended to make the children's cells resistant to infection by HIV, says the scientist, He Jiankui of the Southern University of Science and Technology in Shenzhen, China.

The claim—yet to be reported in a scientific paper—initiated a firestorm of criticism today, with some scientists and bioethicists calling the work "premature," "ethically problematic," and even "monstrous." The Chinese Society for Cell Biology issued a statement calling the research "a serious violation of the Chinese government's laws and regulations and the consensus of the Chinese scientific community." And He's university **issued a statement** saying it has launched an investigation into the research, which it says may "seriously violate academic ethics and academic norms."

Aristotelian based logic

-together with

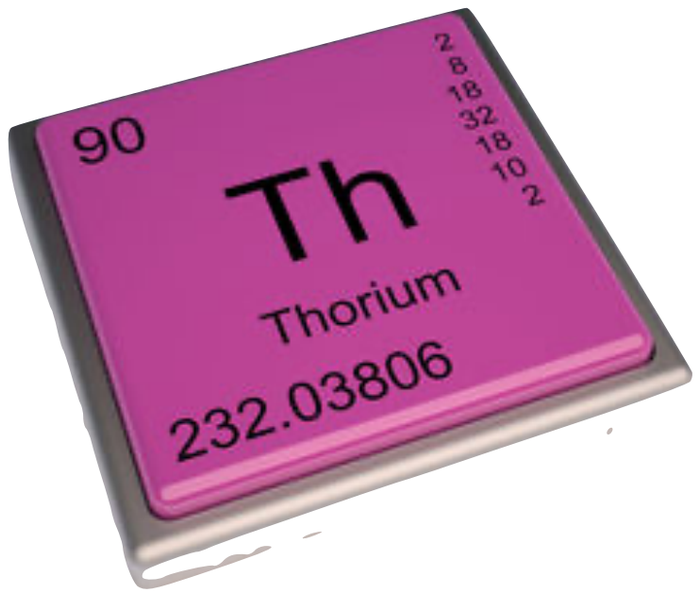
Scientific Method

are a POWERFUL combination...

So, having addressed various smaller questions using the **Scientific Methodology**....let's try to tackle some of the potentially more grandiose questions that might be thrown our way

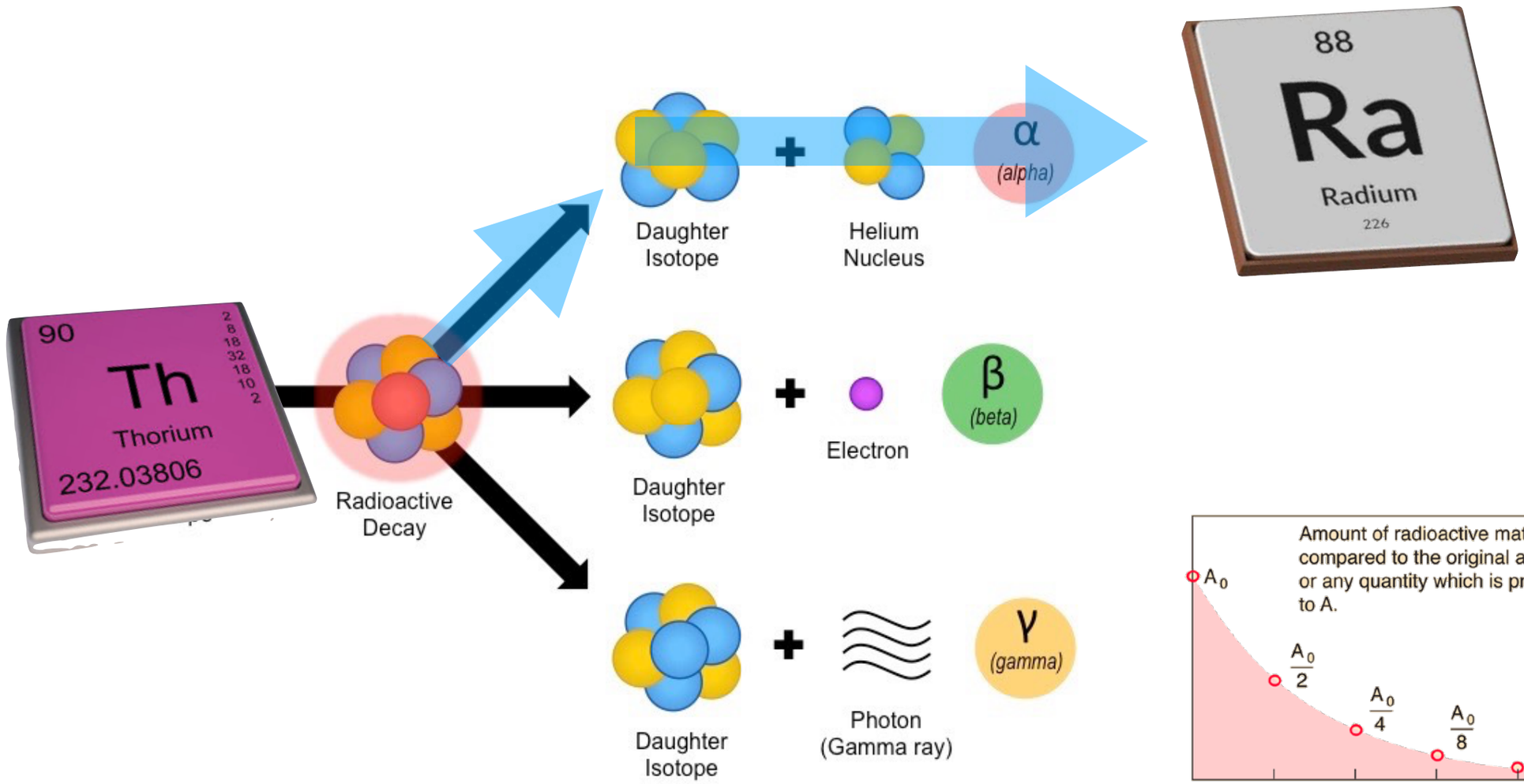
.....**How Big is the Universe? How old is the Universe?**
How Do We Know? Can we still apply "observational principles" in the current universe to address such lofty issues that -by definition- must have occurred before anyone was able to make any observations.
The answer is apparently, Yes.

The Luminosity of "old" star clusters changes, radioactive dating of old stars (the element Thorium decays with a half life of **14.05 Gyr**) as well as the presence of "white dwarfs".



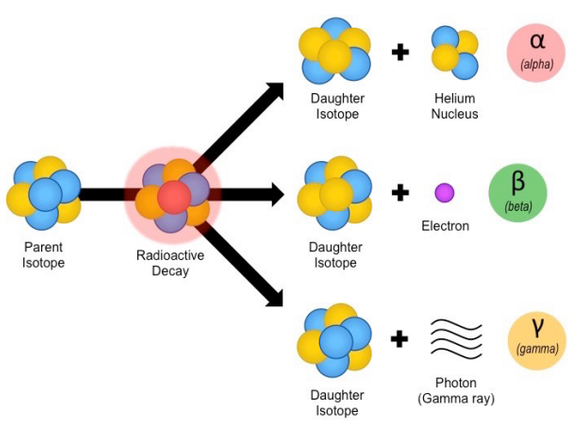
Radioisotopes undergo Radioactive decay.

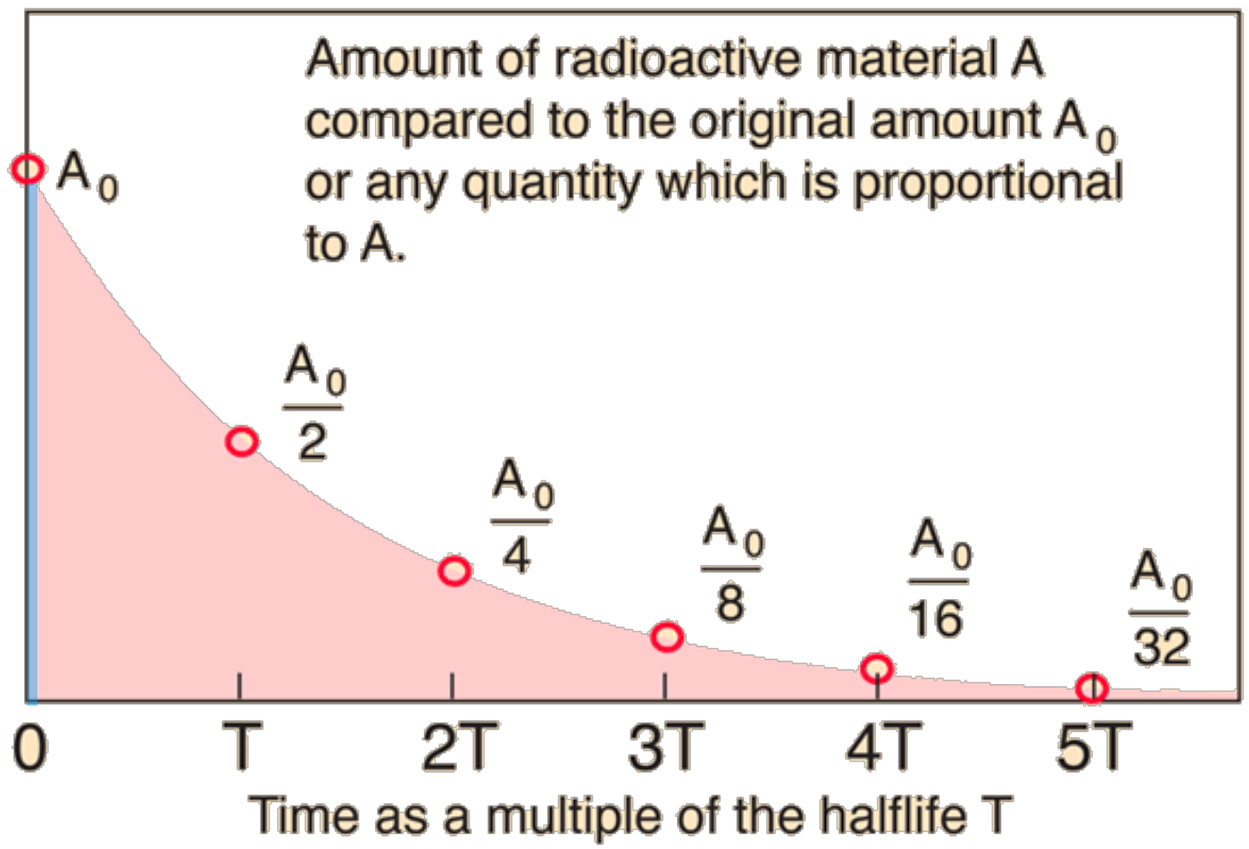
The radioactive “half-life” for a given radioisotope is the time for half the radioactive nuclei in any sample to undergo radioactive decay. After two half-lives, there will be one fourth the original sample, after three half-lives one eight the original sample, and so forth.



Radioisotopes undergo Radioactive decay.

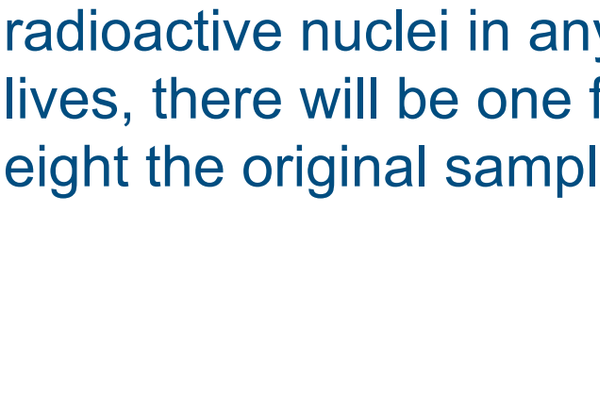
The radioactive "half-life" for a given radioisotope is the time for half the radioactive nuclei in any sample to undergo radioactive decay. After two half-lives, there will be one fourth the original sample, after three half-lives one eight the original sample, and so forth.

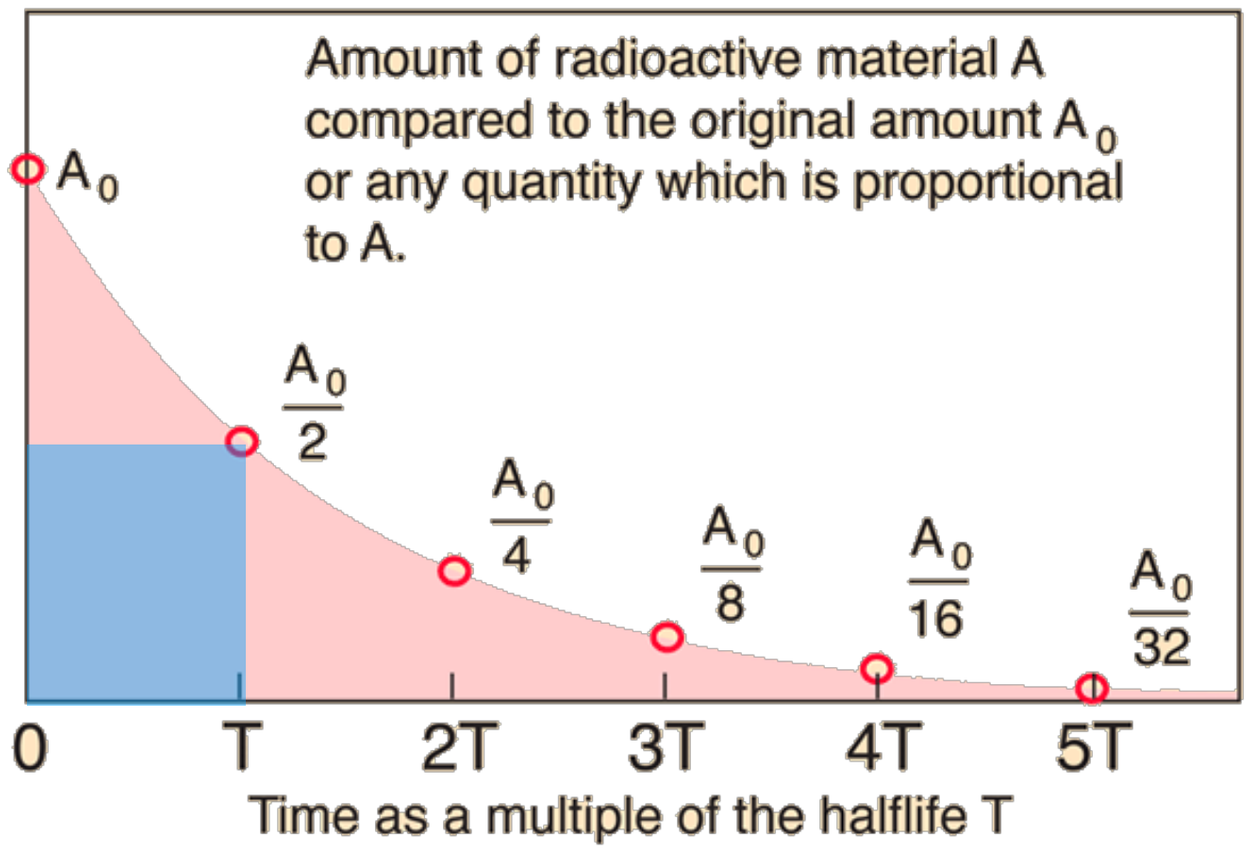


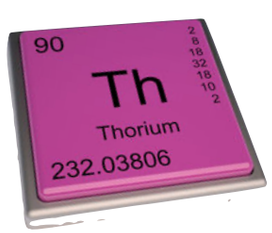


Radioisotopes undergo Radioactive decay.

The radioactive "half-life" for a given radioisotope is the time for half the radioactive nuclei in any sample to undergo radioactive decay. After two half-lives, there will be one fourth the original sample, after three half-lives one eight the original sample, and so forth.







= 14,050,000,000 yrs

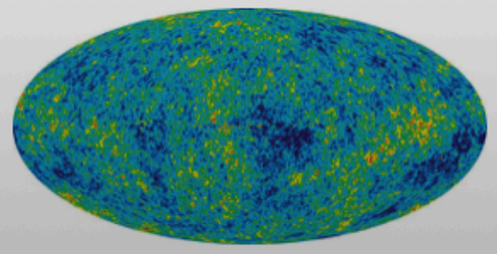
Age of the Universe

There are at least 3 ways that the age of the Universe can be estimated.

- The age of the chemical elements… **~ 14.5 Gyrs**
- The age of the oldest star clusters. **~ 14.6 Gyrs +/- 1.7 Gyrs**
- The age of the oldest white dwarf stars. **~ 12.7 Gyrs +/- 0.7 Gyrs**

The New York Times

Gauging Age of Universe Becomes More Precise



WMAP cosmic microwave fluctuations over the full sky using five years of data. The colors represent tiny temperature fluctuations of the remnant glow from the infant universe: red regions are warmer and blue are cooler.
WMAP Science Team

By Kenneth Chang

March 9, 2008

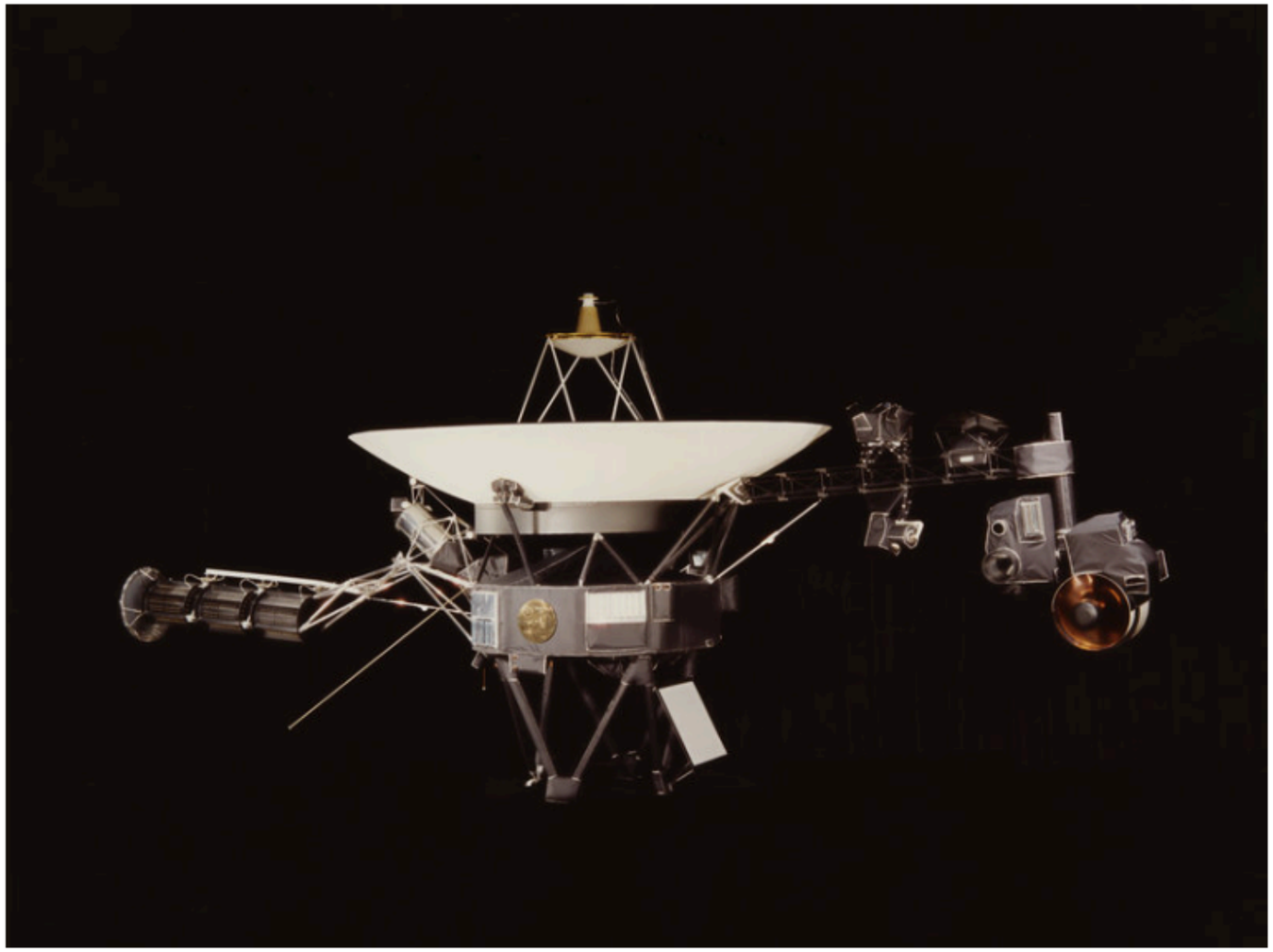
The universe is 13.73 billion years old, give or take 120 million years, astronomers said last week.

AMERICA

Voyager Has Left The Solar System (This Time For Real!)

September 12, 2013 · 2:53 PM ET

SCOTT NEUMAN



A NASA image of one of the Voyager space probes, launched in 1977 to study the outer solar system and eventually interstellar space.

NASA/Getty Images

Stop us if you've heard this one: A spacecraft flies out of the solar system ...

Yes, the planetary probe Voyager 1, launched in the era of Jimmy Carter and bell-bottoms, has finally left the room, so to speak, years after completing its primary mission: a "grand tour" of the gas giants Jupiter and Saturn (twin Voyager 2 also visited Uranus and Neptune).

Can we now apply such observationally based Scientific methodology to questions, concerning our own earth, and may be even apply such methodologies to questions about Life itself, and or where do we (did we) come from?

Well, geologists and paleantologists would claim the answer to these questions would again be a resounding YES!

Earth's geological history can be divided into **era**s and **period**s. The boundaries between these rather large units of time are based on differences between their fossil **biotas**.

-**Review:** biotic changes and Geological changes

543 500 440 409 354 290 245 206 144 65 1.8

Millions of years ago (mya)

REWIND | STOP | PLAY | << | >>

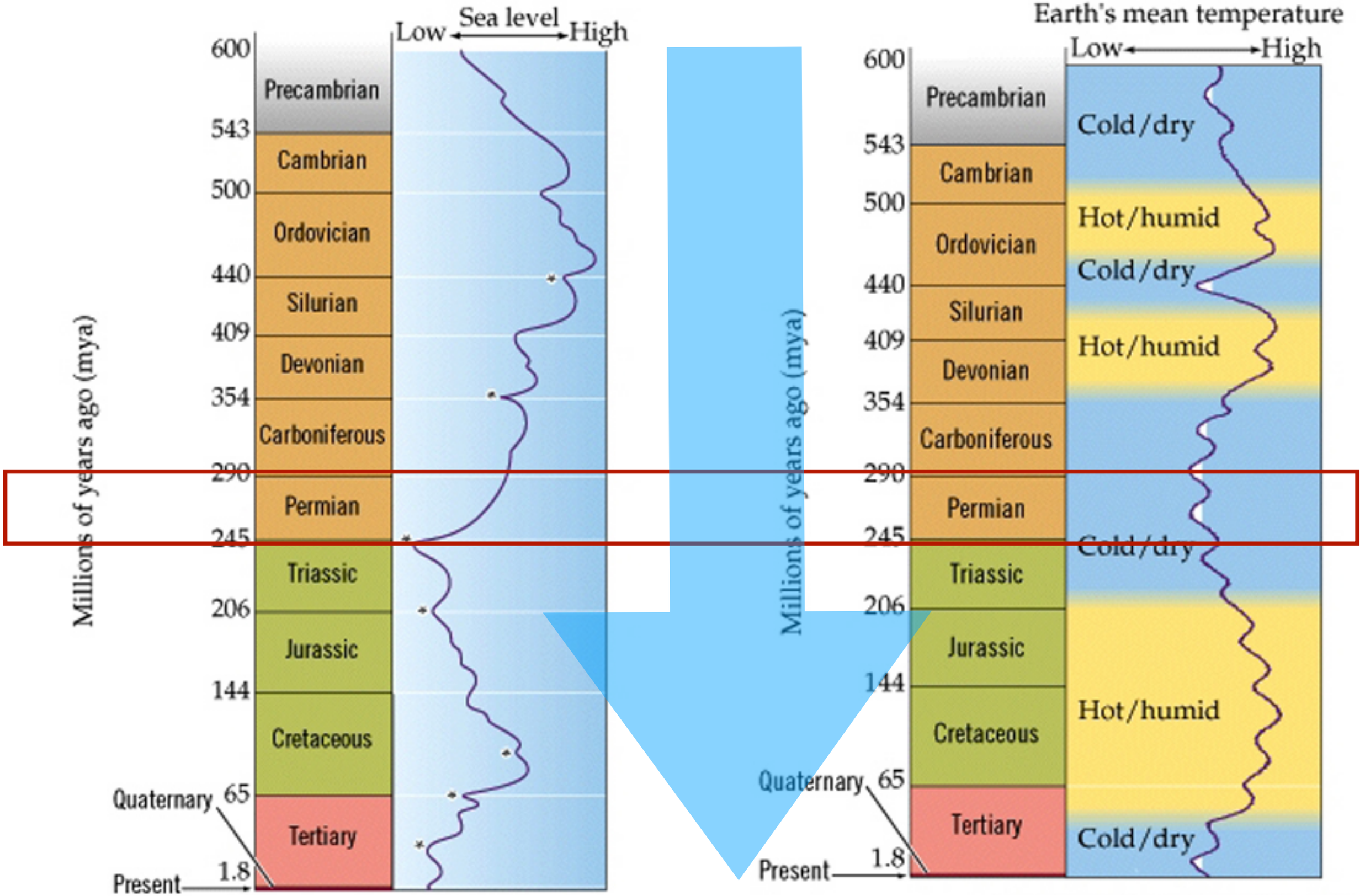
TABLE 21.2

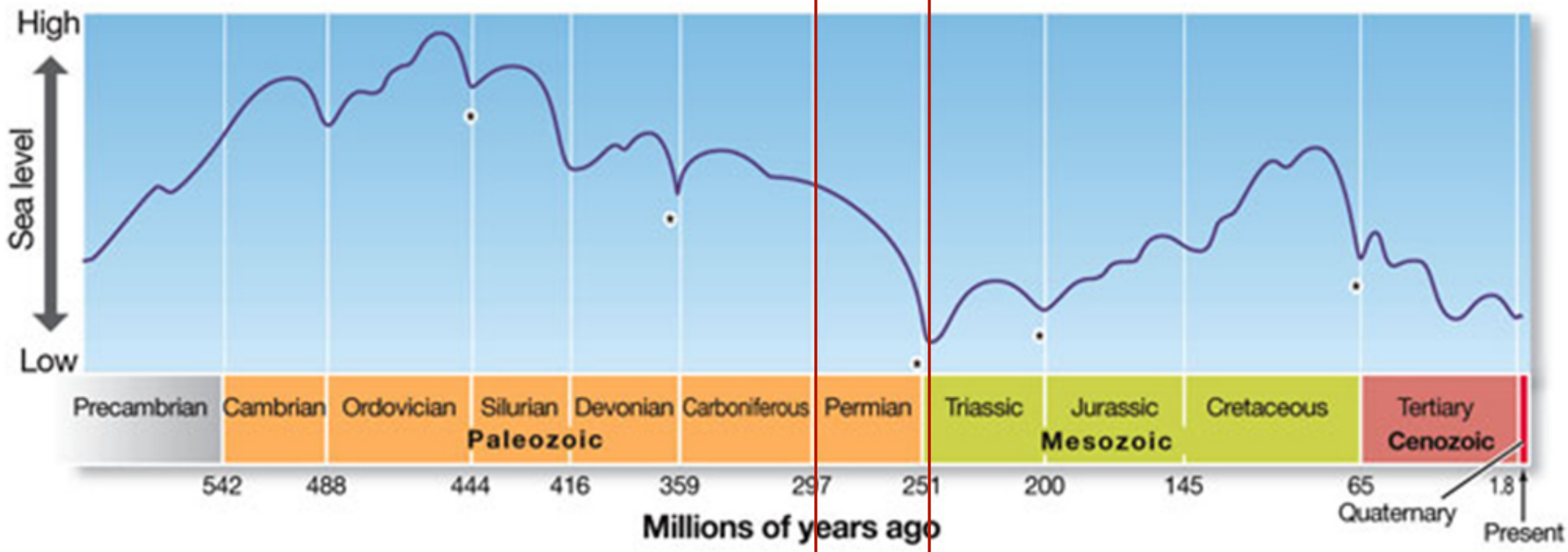
Earth's Geological History *(Part 1)*

RELATIVE TIME SPAN	ERA	PERIOD	ONSET	MAJOR PHYSICAL CHANGES ON EARTH
Precambrian	Cenozoic	Quaternary	1.8 mya	Cold/dry climate; repeated glaciations
		Tertiary	65 mya	Continents near current positions; climate cools
	Mesozoic	Cretaceous	145 mya	Northern continents attached; Gondwana begins to drift apart; meteorite strikes Yucatán Peninsula
		Jurassic	200 mya	Two large continents form: Laurasia (north) and Gondwana (south); climate warm
		Triassic	251 mya	Pangaea begins to slowly drift apart; hot/humid climate
	Paleozoic	Permian	297 mya	Continents aggregate into Pangaea; large glaciers form; dry climates form in interior of Pangaea
		Carboniferous	359 mya	Climate cools; marked latitudinal climate gradients
		Devonian	416 mya	Continents collide at end of period; meteorite probably strikes Earth
		Silurian	444 mya	Sea levels rise; two large continents form; hot/humid climate
		Ordovician	488 mya	Massive glaciation, sea level drops 50 meters
		Cambrian	542 mya	O_2 levels approach current levels
	Precambrian		600 mya	O_2 level at >5% of current level
			1.5 bya	O_2 level at >1% of current level
			3.8 bya	O_2 first appears in atmosphere
			4.5 bya	

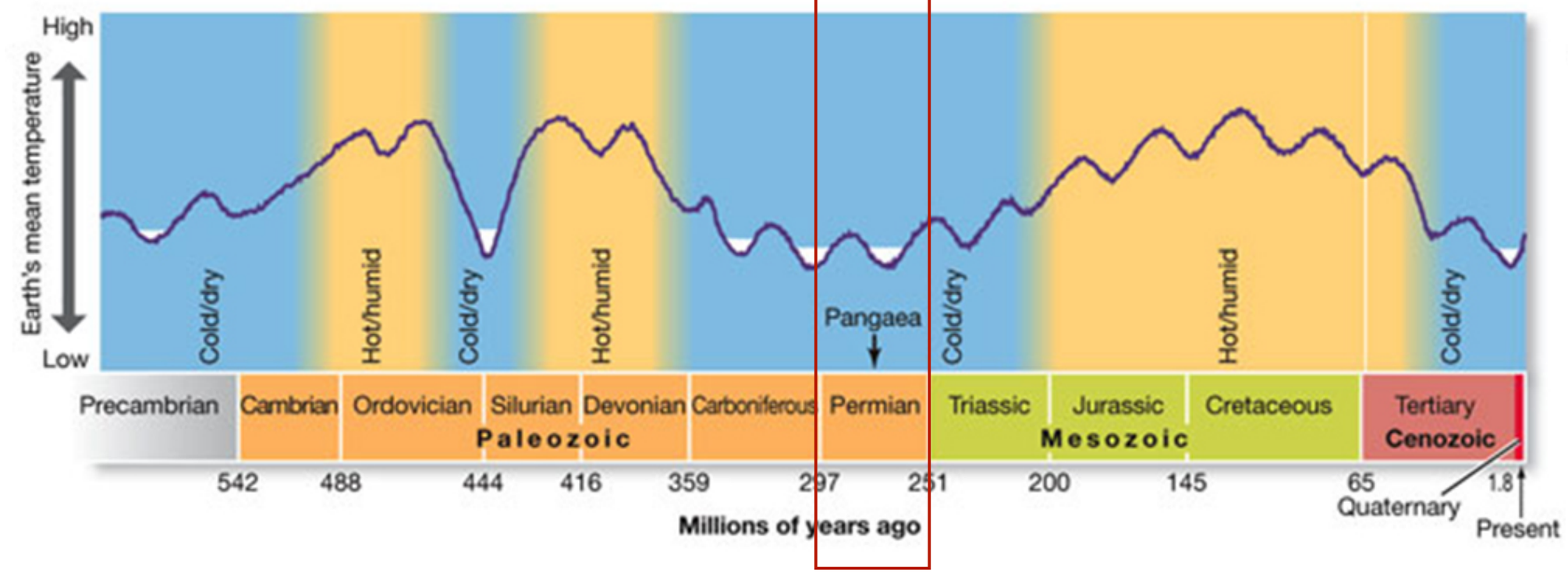
[a]mya, million years ago; bya, billion years ago.

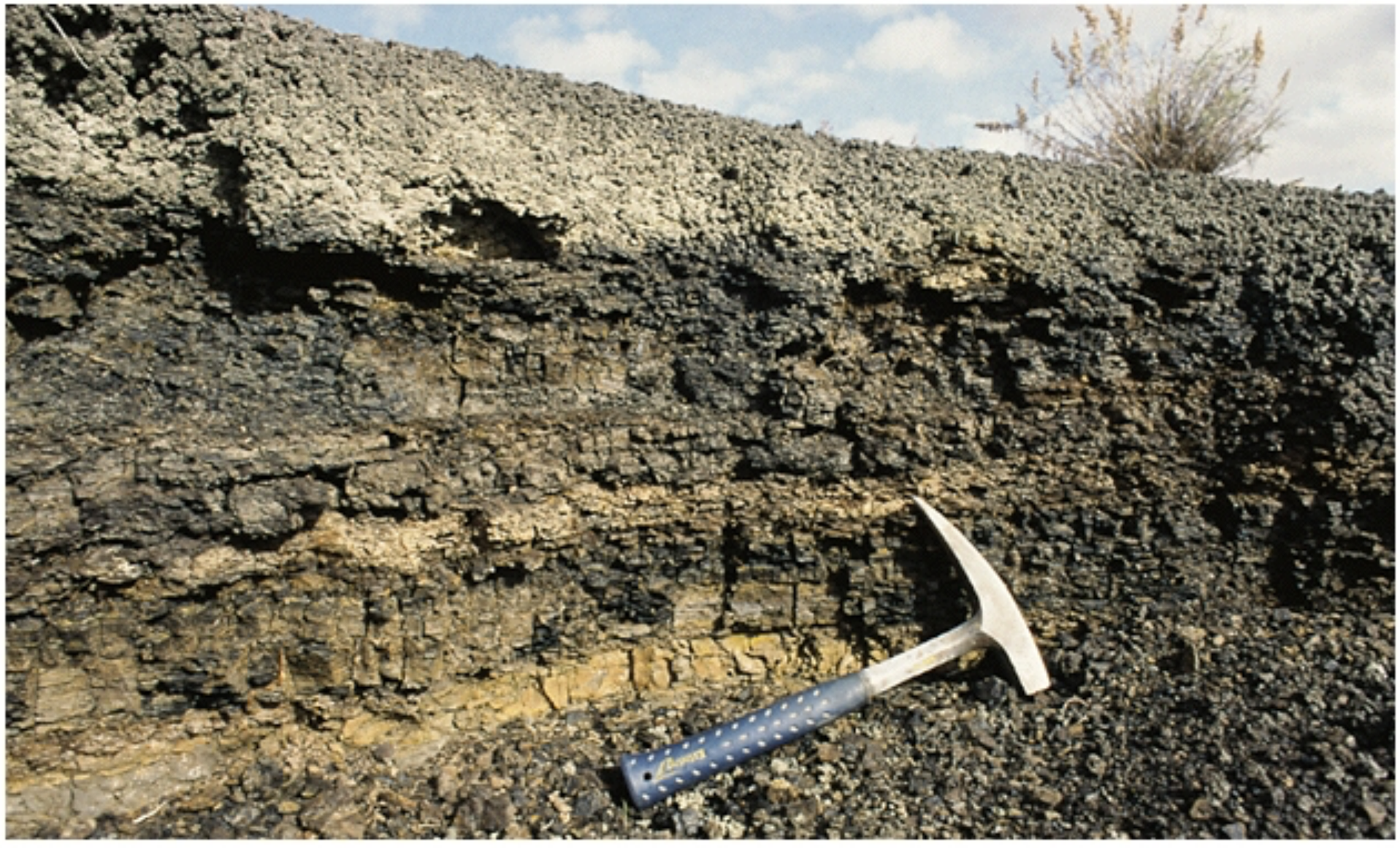
***LIFE 8e*, Table 21.2 (Part 1)**


Sea level
Low
High
Millions of years ago (mya)
600
543
500
440
409
354
290
245
206
144
65
1.8
Present
Quaternary
Precambrian
Cambrian
Ordovician
Silurian
Devonian
Carboniferous
Permian
Triassic
Jurassic
Cretaceous
Tertiary
Earth's mean temperature
Low
High
Cold/dry
Hot/humid
Cold/dry
Hot/humid
Cold/dry
Hot/humid
Cold/dry



Humans arrive on the scene





1 H 1.0079																	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.179
11 Na 22.990	12 Mg 24.305											13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.06	17 Cl 35.453	18 Ar 39.948
19 K 39.098	20 Ca 40.08	21 Sc 44.956	22 Ti 47.88	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.847	27 Co 58.933	28 Ni 58.69	29 Cu 63.546	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.922	34 Se 78.96	35 Br 79.909	36 Kr 83.80
37 Rb 85.4778	38 Sr 87.62	39 Y 88.906	40 Zr 91.22	41 Nb 92.906	42 Mo 95.94	43 Tc (99)	44 Ru 101.07	45 Rh 102.906	46 Pd 106.4	47 Ag 107.870	48 Cd 112.41	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.904	54 Xe 131.30
55 Cs 132.905	56 Ba 137.34	71 Lu 174.97	72 Hf 178.49	73 Ta 180.948	74 W 183.85	75 Re 186.207	76 Os 190.2	77 Ir 192.2	78 Pt 195.08	79 Au 196.967	80 Hg 200.59	81 Tl 204.37	82 Pb 207.19	83 Bi 208.980	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226.025	103 Lr (260)	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (269)	109 Mt (268)	110 (269)	111 (272)	112 (277)	113	114 (285)	115 (289)	116	117	118 (293)

Chemical symbol

Atomic number

Atomic mass (average of all isotopes)

Lanthanide series	57 La 138.906	58 Ce 140.12	59 Pr 140.9077	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.924	66 Dy 162.50	67 Ho 164.930	68 Er 167.26	69 Tm 168.934	70 Yb 173.04
Actinide series	89 Ac 227.028	90 Th 232.038	91 Pa 231.0359	92 U 238.02	93 Np 237.0482	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)

^{32}P 14.3 days, **^{3}H** 12.3 years, **^{192}Ir 73.83 days** **^{14}C** 5,700 years and **^{40}K** 1.3 billion years

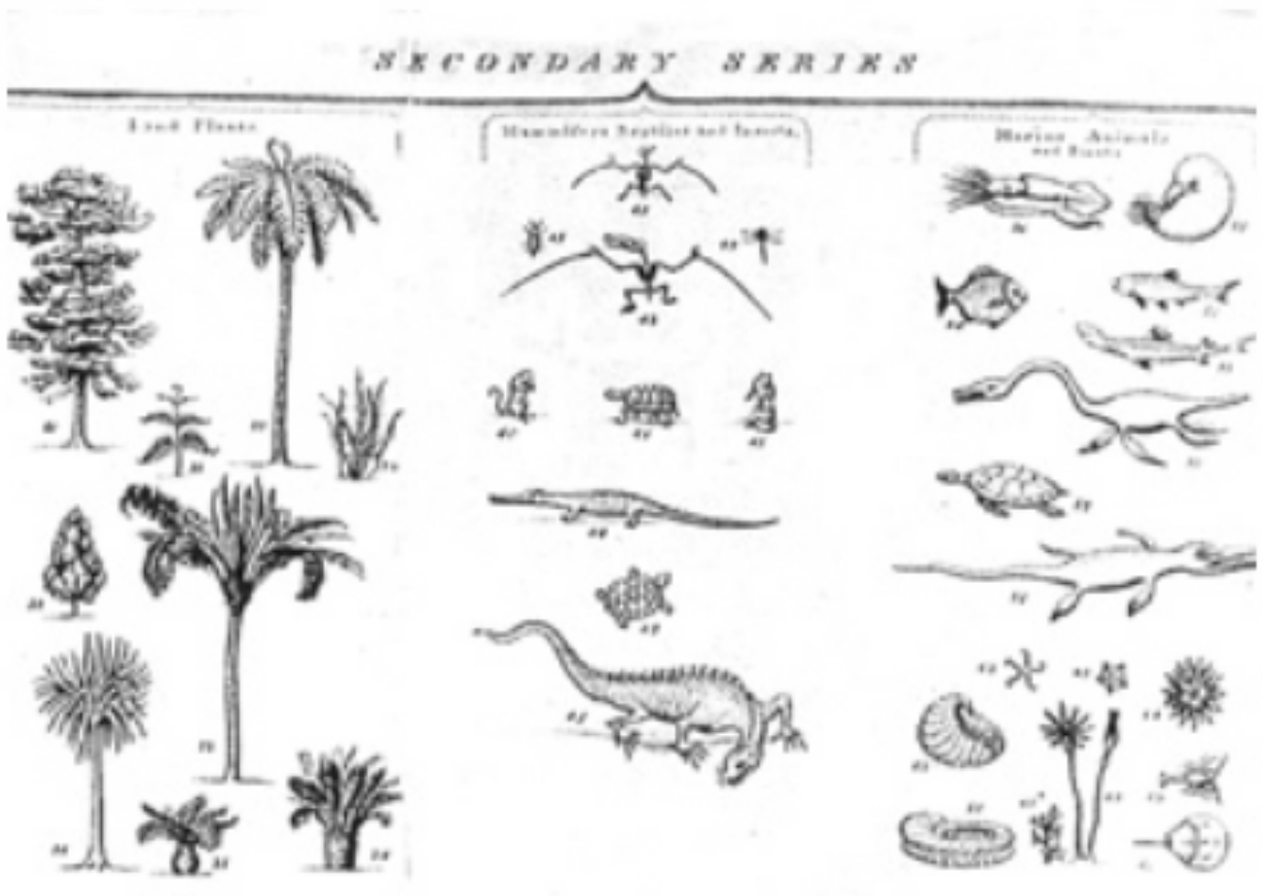
TABLE 21.2

Earth's Geological History *(Part 1)*

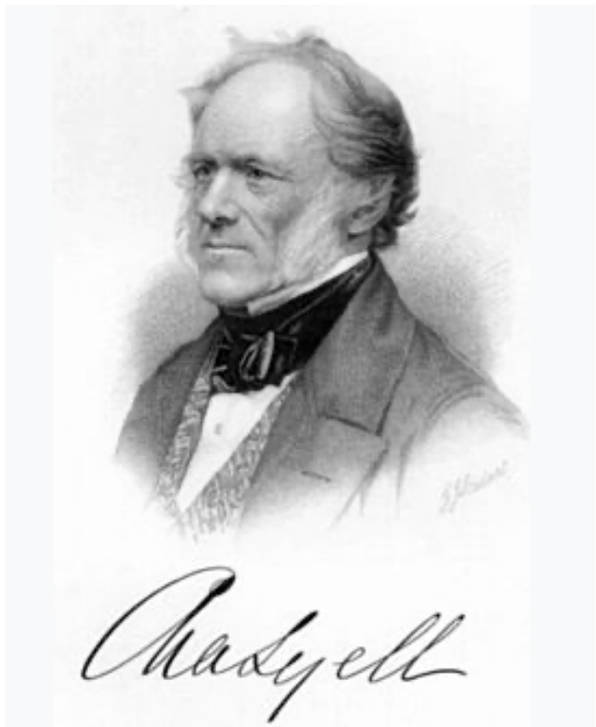
RELATIVE TIME SPAN	ERA	PERIOD	ONSET	MAJOR PHYSICAL CHANGES ON EARTH
Phanerozoic	Cenozoic	Quaternary	1.8 mya	Cold/dry climate; repeated glaciations
		Tertiary	65 mya	Continents near current positions; climate cools
	Mesozoic	Cretaceous	145 mya	Northern continents attached; Gondwana begins to drift apart; meteorite strikes Yucatán Peninsula
		Jurassic	200 mya	Two large continents form: Laurasia (north) and Gondwana (south); climate warm
		Triassic	251 mya	Pangaea begins to slowly drift apart; hot/humid climate
	Paleozoic	Permian	297 mya	Continents aggregate into Pangaea; large glaciers form; dry climates form in interior of Pangaea
		Carboniferous	359 mya	Climate cools; marked latitudinal climate gradients
		Devonian	416 mya	Continents collide at end of period; meteorite probably strikes Earth
		Silurian	444 mya	Sea levels rise; two large continents form; hot/humid climate
		Ordovician	488 mya	Massive glaciation, sea level drops 50 meters
		Cambrian	542 mya	O_2 levels approach current levels
Precambrian			600 mya	O_2 level at >5% of current level
			1.5 bya	O_2 level at >1% of current level
			3.8 bya	O_2 first appears in atmosphere
			4.5 bya	

[a]mya, million years ago; bya, billion years ago.

***LIFE 8e*, Table 21.2 (Part 1)**



Various kinds of fossils were discovered at different depths of ”sedimentary” rocks



-original drawings by Charlese Lyell *circa* 1752

TABLE 21.2

Earth's Geological History *(Part 2)*

RELATIVE TIME SPAN	ERA	PERIOD	ONSET	MAJOR EVENTS IN THE HISTORY OF LIFE
	Cenozoic	Quaternary	1.8 mya	Humans evolve; many large mammals become extinct
		Tertiary	65 mya	Diversification of birds, mammals, flowering plants, and insects
	Mesozoic	Cretaceous	145 mya	Dinosaurs continue to diversify; flowering plants and mammals diversify; mass extinction at end of period (≈76% of species disappear)
		Jurassic	200 mya	Diverse dinosaurs; radiation of ray-finned fishes
		Triassic	251 mya	Early dinosaurs; first mammals; marine invertebrates diversify; first flowering plants; mass extinction at end of period (≈65% of species disappear)
	Paleozoic	Permian	297 mya	Reptiles diversify; amphibians decline; mass extinction at end of period (≈96% of species disappear)
		Carboniferous	359 mya	Extensive "fern" forests; first reptiles; insects diversify
		Devonian	416 mya	Fishes diversify; first insects and amphibians; mass extinction at end of period (≈75% of species disappear)
		Silurian	444 mya	Jawless fishes diversify; first ray-finned fishes; plants and animals colonize land
		Ordovician	488 mya	Mass extinction at end of period (≈75% of species disappear)
		Cambrian	542 mya	Most animal phyla present; diverse photosynthetic protists
Precambrian			600 mya	Ediacaran fauna
			1.5 bya	Eukaryotes evolve; several animal phyla appear
			3.8 bya	Origin of life; prokaryotes flourish
			4.5 bya	

[a]mya, million years ago; bya, billion years ago.

***LIFE 8e*, Table 21.2 (Part 2)**

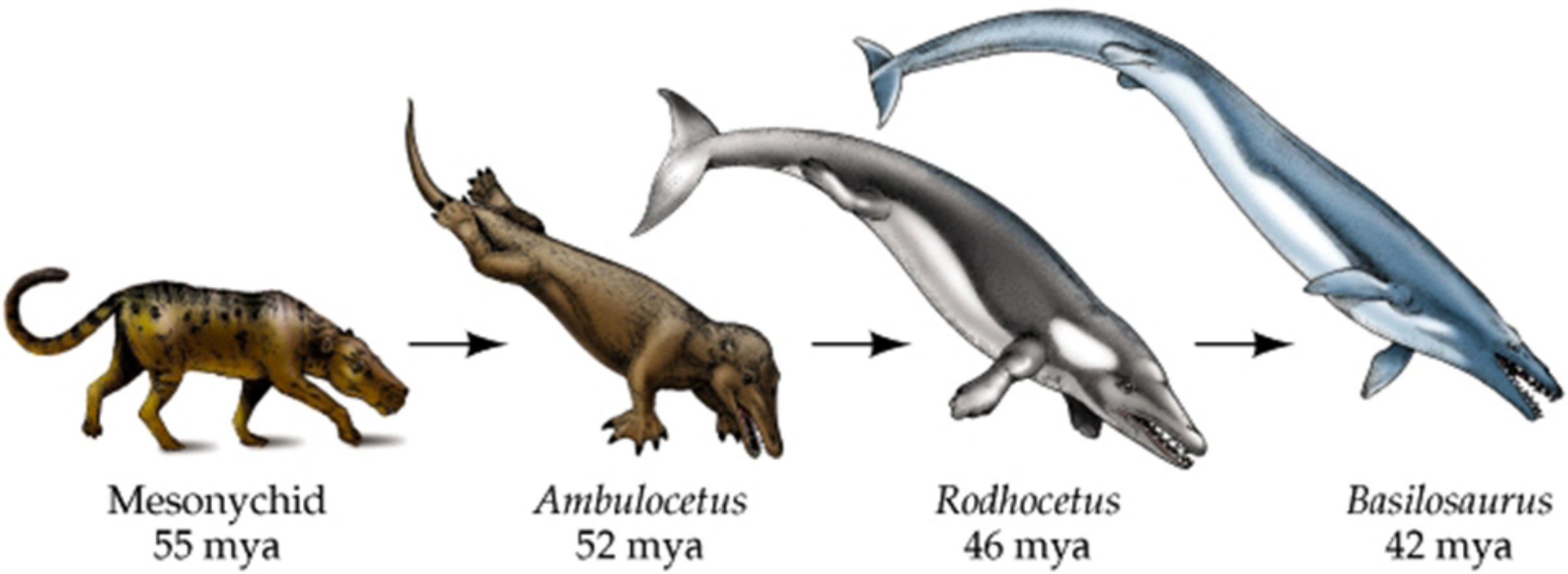
TABLE 21.2

Earth's Geological History *(Part 2)*

RELATIVE TIME SPAN	ERA	PERIOD	ONSET	MAJOR EVENTS IN THE HISTORY OF LIFE
Phanerozoic	Cenozoic	Quaternary	1.8 mya	Humans evolve; many large mammals become extinct
		Tertiary	65 mya	Diversification of birds, mammals, flowering plants, and insects
	Mesozoic	Cretaceous	145 mya	Dinosaurs continue to diversify; flowering plants and mammals diversify; mass extinction at end of period (≈76% of species disappear)
		Jurassic	200 mya	Diverse dinosaurs; radiation of ray-finned fishes
		Triassic	251 mya	Early dinosaurs; first mammals; marine invertebrates diversify; first flowering plants; mass extinction at end of period (≈65% of species disappear)
	Paleozoic	Permian	297 mya	Reptiles diversify; amphibians decline; mass extinction at end of period (≈96% of species disappear)
		Carboniferous	359 mya	Extensive "fern" forests; first reptiles; insects diversify
		Devonian	416 mya	Fishes diversify; first insects and amphibians; mass extinction at end of period (≈75% of species disappear)
		Silurian	444 mya	Jawless fishes diversify; first ray-finned fishes; plants and animals colonize land
		Ordovician	488 mya	Mass extinction at end of period (≈75% of species disappear)
		Cambrian	542 mya	Most animal phyla present; diverse photosynthetic protists
Precambrian			600 mya	Ediacaran fauna
			1.5 bya	Eukaryotes evolve; several animal phyla appear
			3.8 bya	Origin of life; prokaryotes flourish
			4.5 bya	

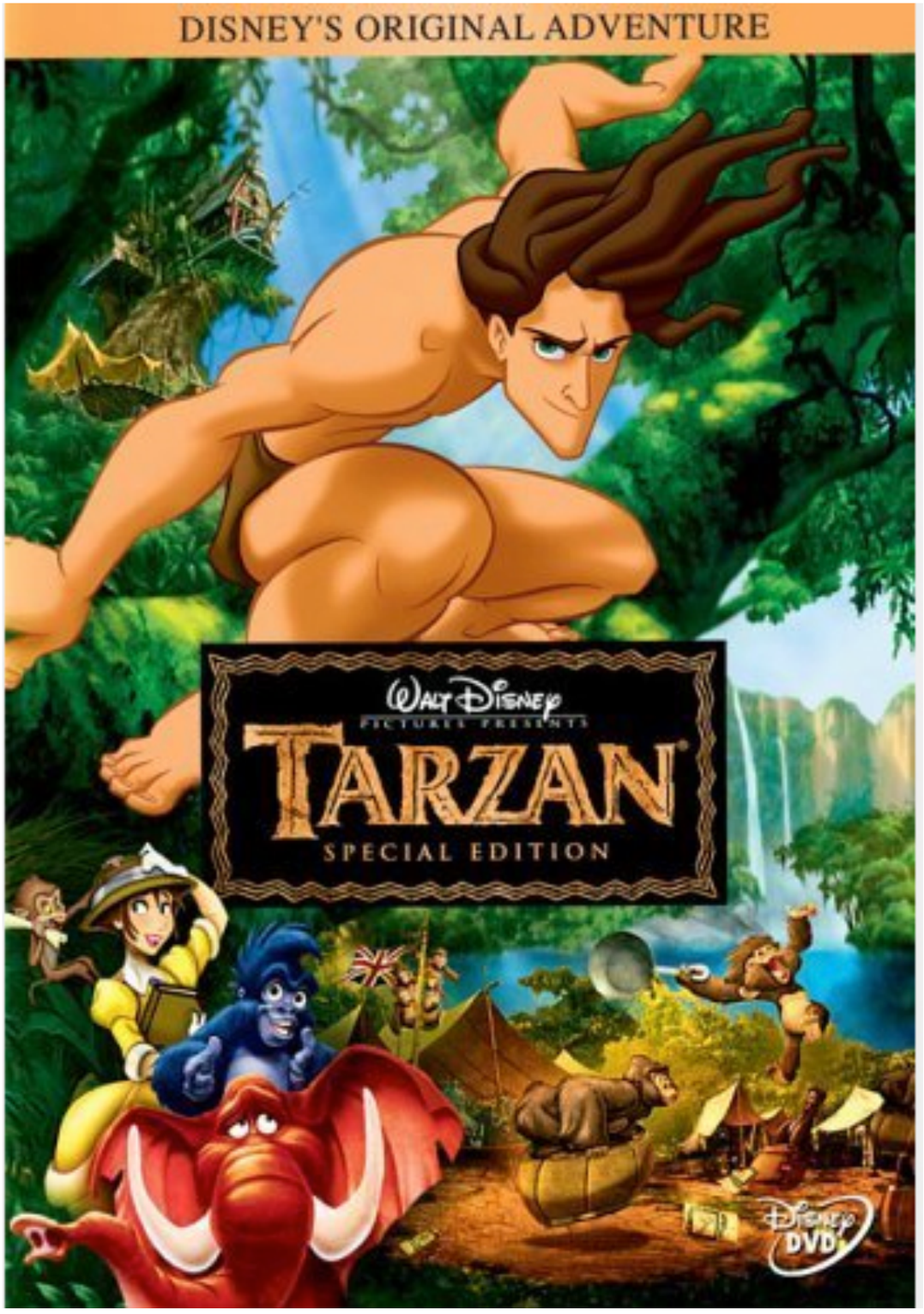
[a]mya, million years ago; bya, billion years ago.

***LIFE 8e*, Table 21.2 (Part 2)**



Fossil Records… Evolution of Whales?

Evolution of Whales?


DISNEY'S ORIGINAL ADVENTURE
Walt Disney
PICTURES PRESENTS
TARZAN
SPECIAL EDITION
Disney DVD

1999

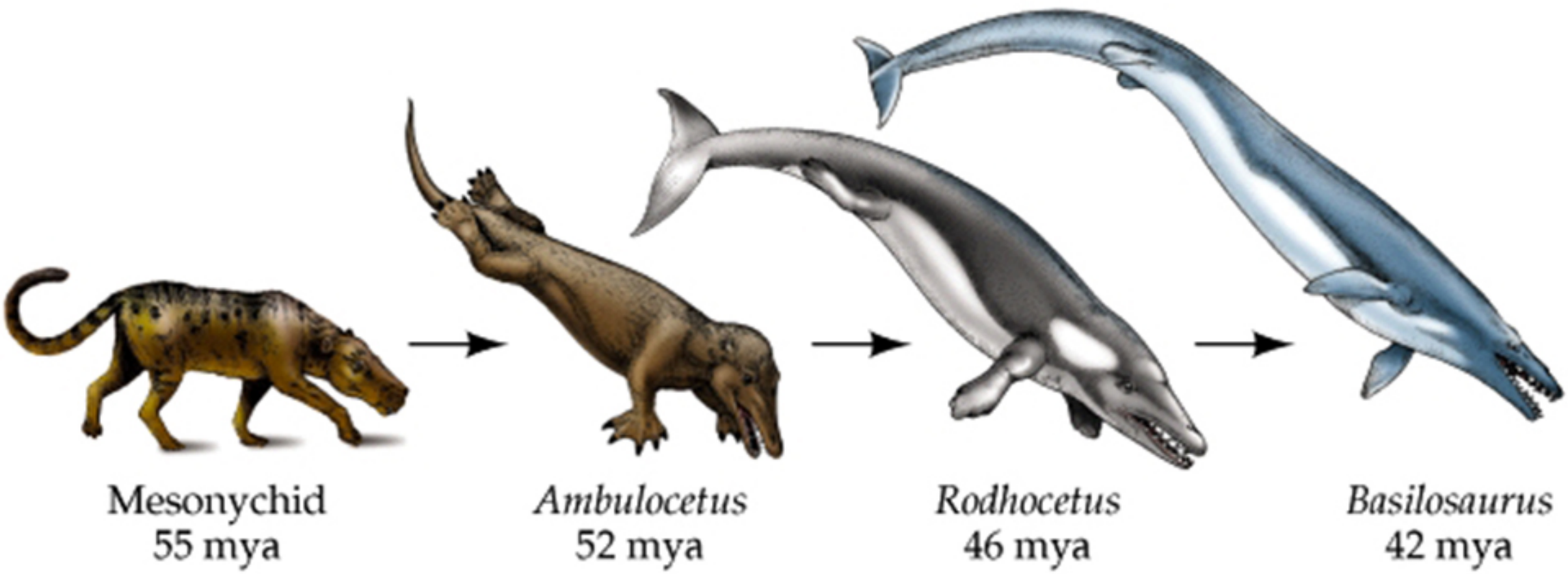
New species of ancient four-legged whale discovered in Egypt

Aug 26, 2021

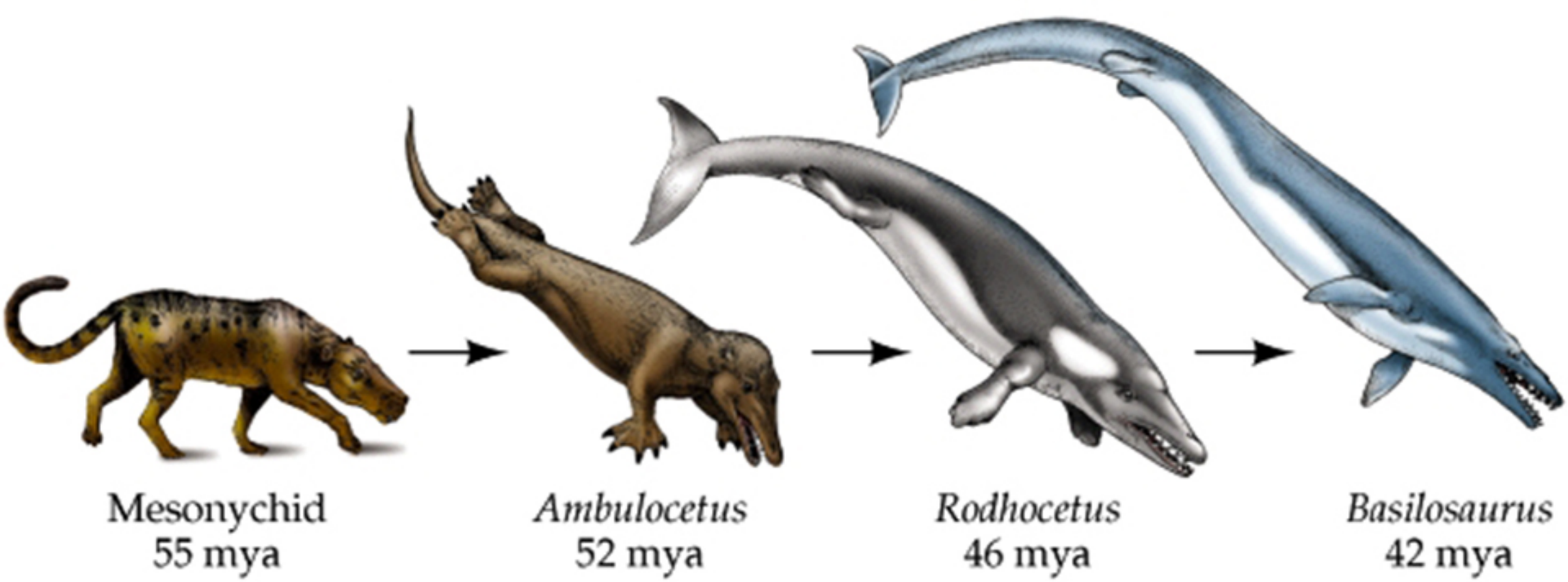
The partial skeleton was found in Egypt's Western Desert

Scientists in Egypt have identified a new species of four-legged whale that lived around 43 million years ago.

The fossil of the amphibious Phiomicetus anubis was originally discovered in Egypt's Western Desert.



Fossil Records… Evolution of Whales?



Fossil Records… Evolution of Whales?

https://www.youtube.com/watch?v=pKYdDJxK42o

Phiomicetus anubis

ANIMALS

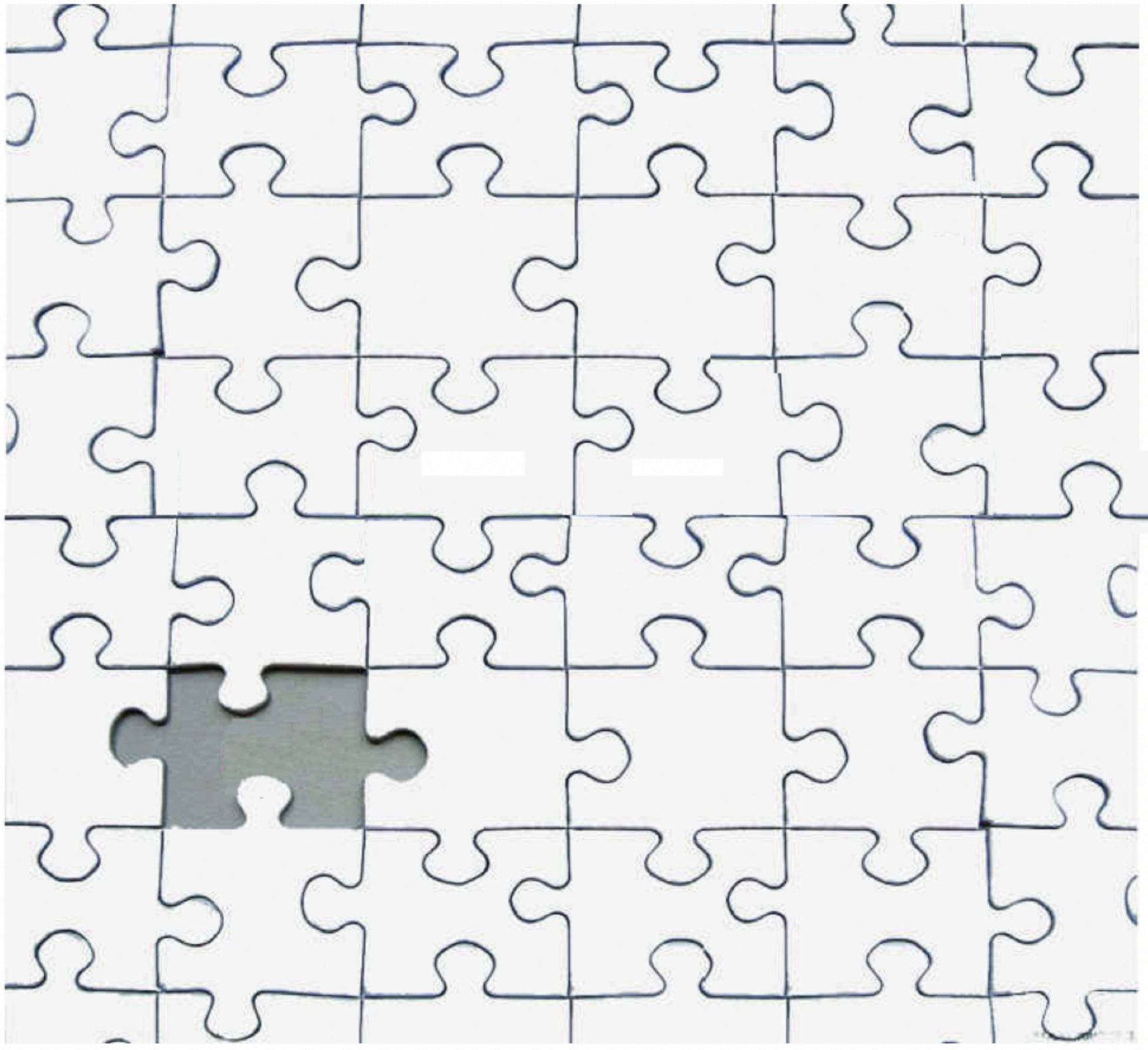
Climate change led to dinosaurs' demise. Now, drought reveals more of their tracks

August 25, 2022 · 5:00 AM ET

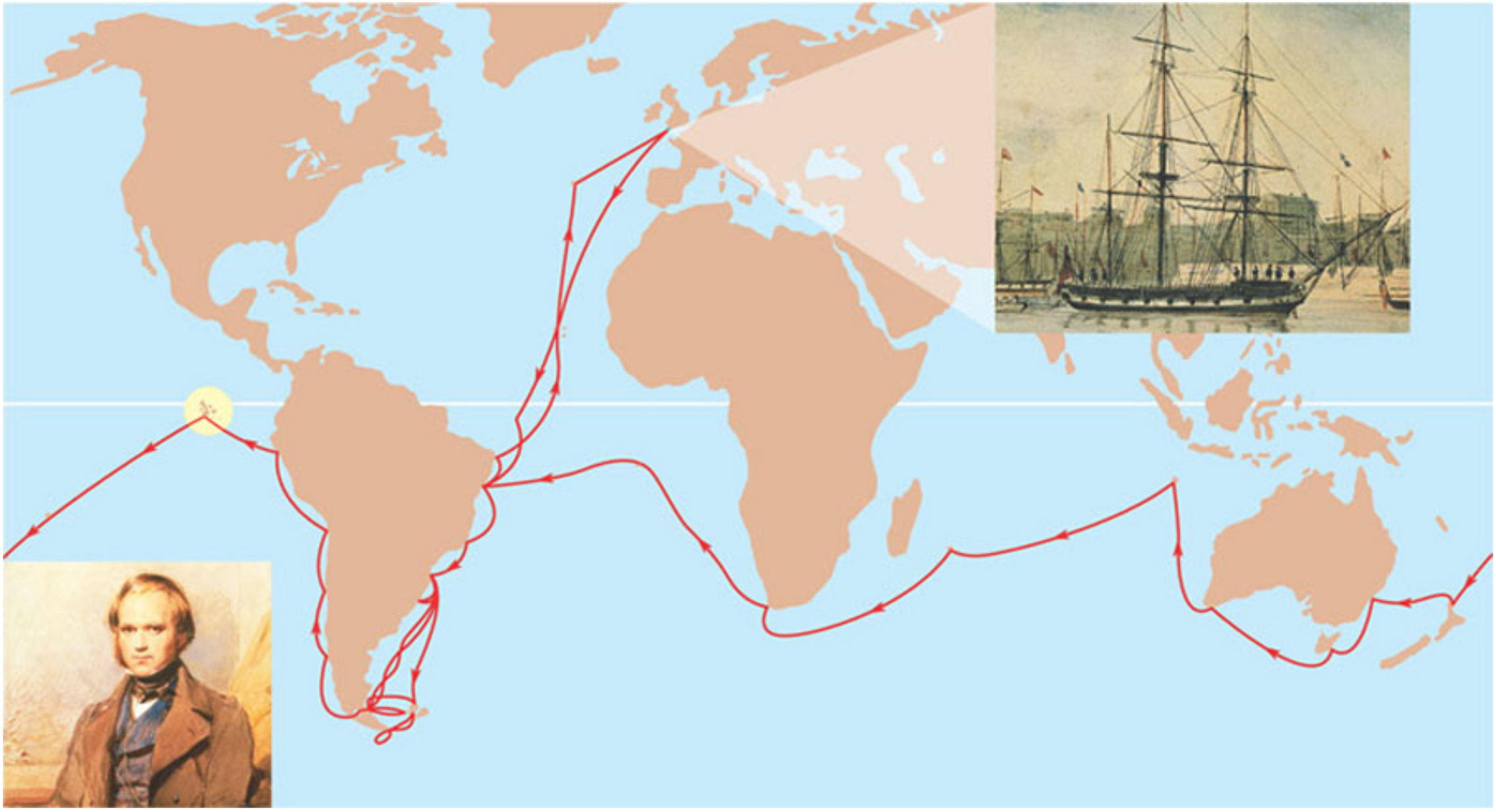
WYNNE DAVIS

Dinosaur Valley State Park is home to many dinosaur tracks, but when drought conditions caused Paluxy River to dry up, it revealed tracks that are usually not visible.

Texas Parks and Wildlife Department




GALLAPAGOS ISLANDS.
Discovered and Described
by Capt. Cowley in
1684.
ord Culpeper's
Island
Lord Wenman's
Island
Nories Rocks
East Bay
South Bay
Bay
Bindloss Isl.
Dassigney's Isl.



1859

ON THE ORIGIN OF SPECIES.

INTRODUCTION.

When on board H.M.S. 'Beagle,' as naturalist, I was much struck with certain facts in the distribution of the inhabitants of South America, and in the geological relations of the present to the past inhabitants of that continent. These facts seemed to me to throw some light on the origin of species—that mystery of mysteries, as it has been called by one of our greatest philosophers. On my return home, it occurred to me, in 1837, that something might perhaps be made out on this question by patiently accumulating and reflecting on all sorts of facts which could possibly have any bearing on it. After five years' work I allowed myself to speculate on the subject, and drew up some short notes; these I enlarged in 1844 into a sketch of the conclusions, which then seemed to me probable: from that period to the present day I have steadily pursued the same object. I hope that I may be excused for entering on these personal details, as I give them to show that I have not been hasty in coming to a decision.

My work is now nearly finished; but as it will take me two or three more years to complete it, and as my health is far from strong, I have been urged to publish this Abstract. I have more especially been induced to do this, as Mr. Wallace, who is now studying the natural history of the Malay archipelago, has arrived at almost exactly the same general conclusions that I have on the origin of species. Last year he sent to me a memoir on this subject, with a request that I would forward it to Sir Charles Lyell, who sent it to the Linnean Society, and it is published in the third volume of the Journal of that Society. Sir C. Lyell and Dr. Hooker, who both knew of my work—the latter having read my sketch of 1844—honoured me by thinking it advisable to publish, with Mr. Wallace's excellent memoir, some brief extracts from my manuscripts.

This Abstract, which I now publish, must necessarily be imperfect. I cannot here give references and authorities for my several statements; and I must trust to the reader reposing some confidence in my accuracy. No doubt errors will have crept in, though I hope I have always been cautious in trusting to good authorities alone. I can here give only the general conclusions at which I have

In considering the Origin of Species, it is quite conceivable that a naturalist, reflecting on the mutual affinities of organic beings, on their embryological relations, their geographical distribution, geological succession, and other such facts, might come to the conclusion **that each species had not been independently created, but had descended, like varieties, from other species.**

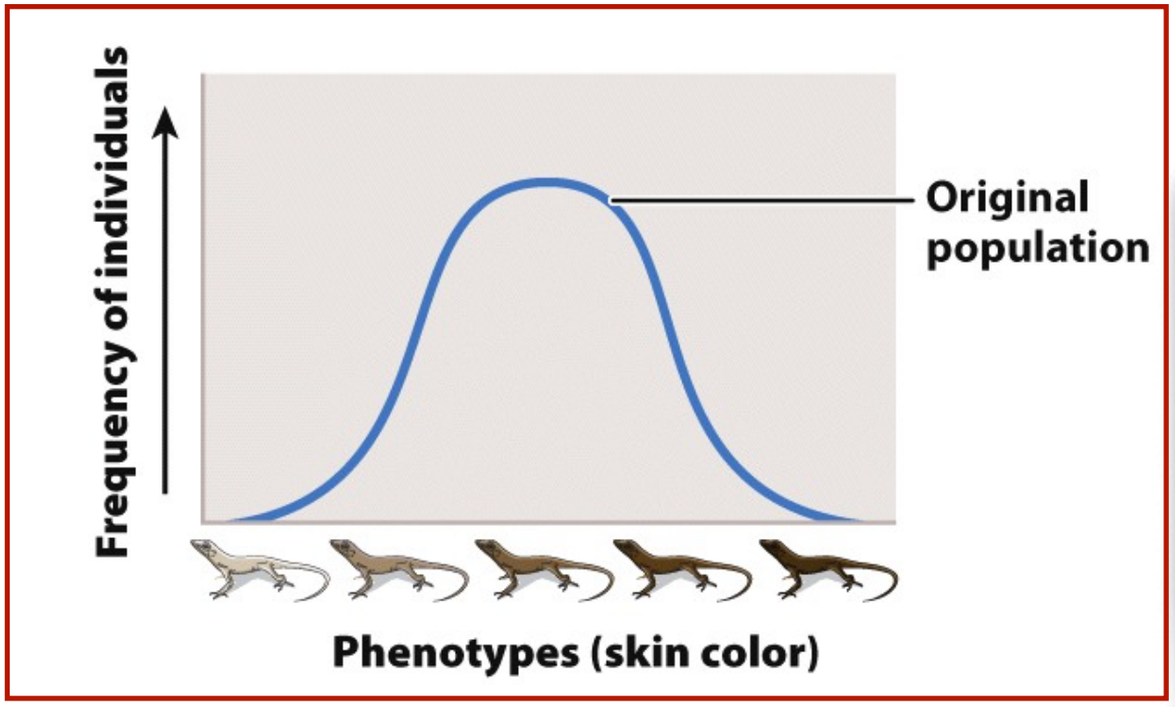
Nevertheless, such a conclusion, even if well founded, would be **unsatisfactory**, until it could be shown how the innumerable species inhabiting this world **have been modified, so as to acquire that perfection of structure** and coadaptation which most justly excites our admiration.

and that these had been produced perfect as we now see them; but this assumption seems to me to be no explanation, for it leaves the case of the coadaptations of organic beings to each other and to their physical conditions of life, untouched and unexplained.

It is, therefore, of the highest importance to gain a clear insight into the means of modification and coadaptation. At the commencement of my observations it seemed to me probable that a careful study of domesticated animals and of cultivated plants would offer the best chance of making out this obscure problem. Nor have I been disappointed; in this and in all other perplexing cases I have invariably found that our knowledge, imperfect though it be, of variation under domestication, afforded the best and safest clue. I may venture to express my conviction of the high value of such studies, although they have been very commonly neglected by naturalists.

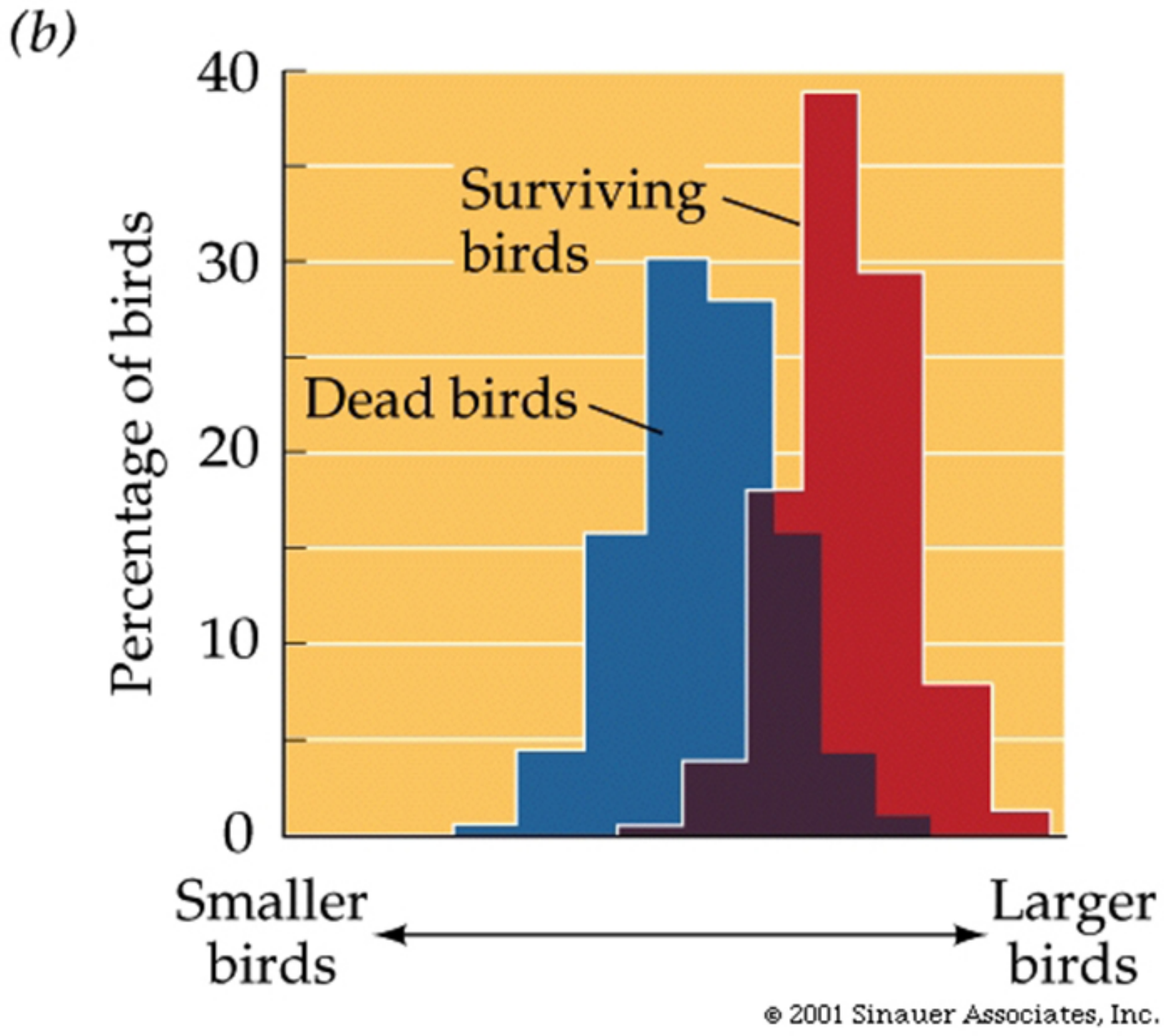
From these considerations, I shall devote the first chapter of this Abstract to Variation under Domestication. We shall thus see that a large amount of hereditary modification is at least possible, and, what is equally or more important, we shall see how great is the power of man in accumulating by his Selection successive slight variations. I will then pass on to the variability of species in a state of nature; but I shall, unfortunately, be compelled to treat this subject far too briefly, as it can be treated properly only by giving long catalogues of facts. We shall, however, be enabled to discuss what circumstances are most favourable to variation. In the next chapter the Struggle for Existence amongst all organic beings throughout the world, which inevitably follows from their high geometrical powers of increase, will be treated of. This is the doctrine of Malthus, applied to the whole animal and vegetable kingdoms. As many more individuals of each species are born than can possibly survive; and as, consequently, there is a frequently recurring struggle for existence, it follows that any being, if it vary however slightly in any manner profitable to itself, under the complex and sometimes varying conditions of life, will have a better chance of surviving, and thus be NATURALLY SELECTED. From the strong principle of inheritance, any selected variety will tend to propagate its new and modified form.

Bell Curve



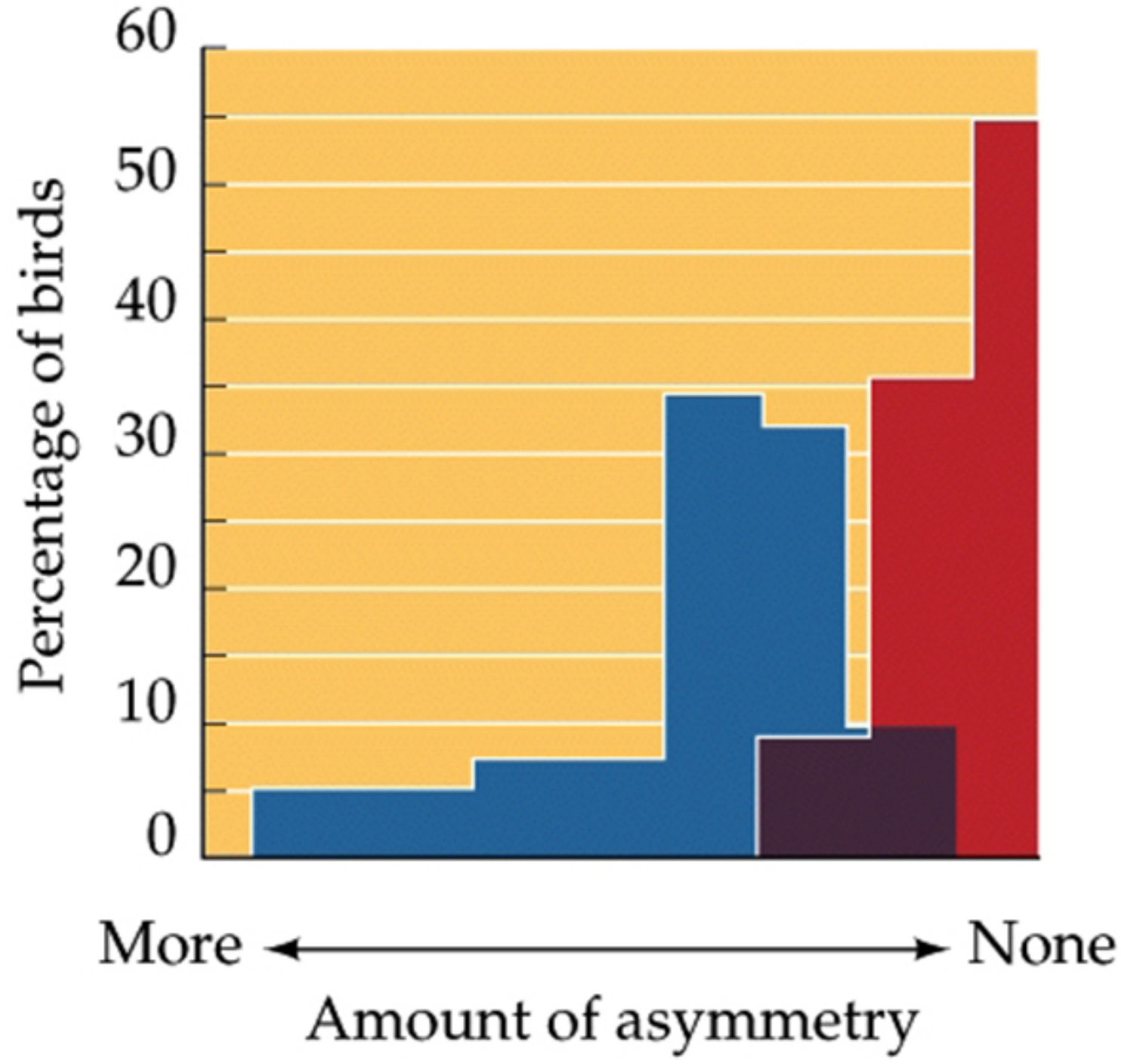
How does selection affect this distribution of phenotypes in three environments in which the background colors differ? In each case, lizards that are camouflaged against the background survive and reproduce whereas those that do not are eliminated by predators.

Cliff swallows in Nebraska 1991- 6



Cliff swallows in Nebraska

(c)


60
50
40
30
20
10
0
Percentage of birds
More
None
Amount of asymmetry

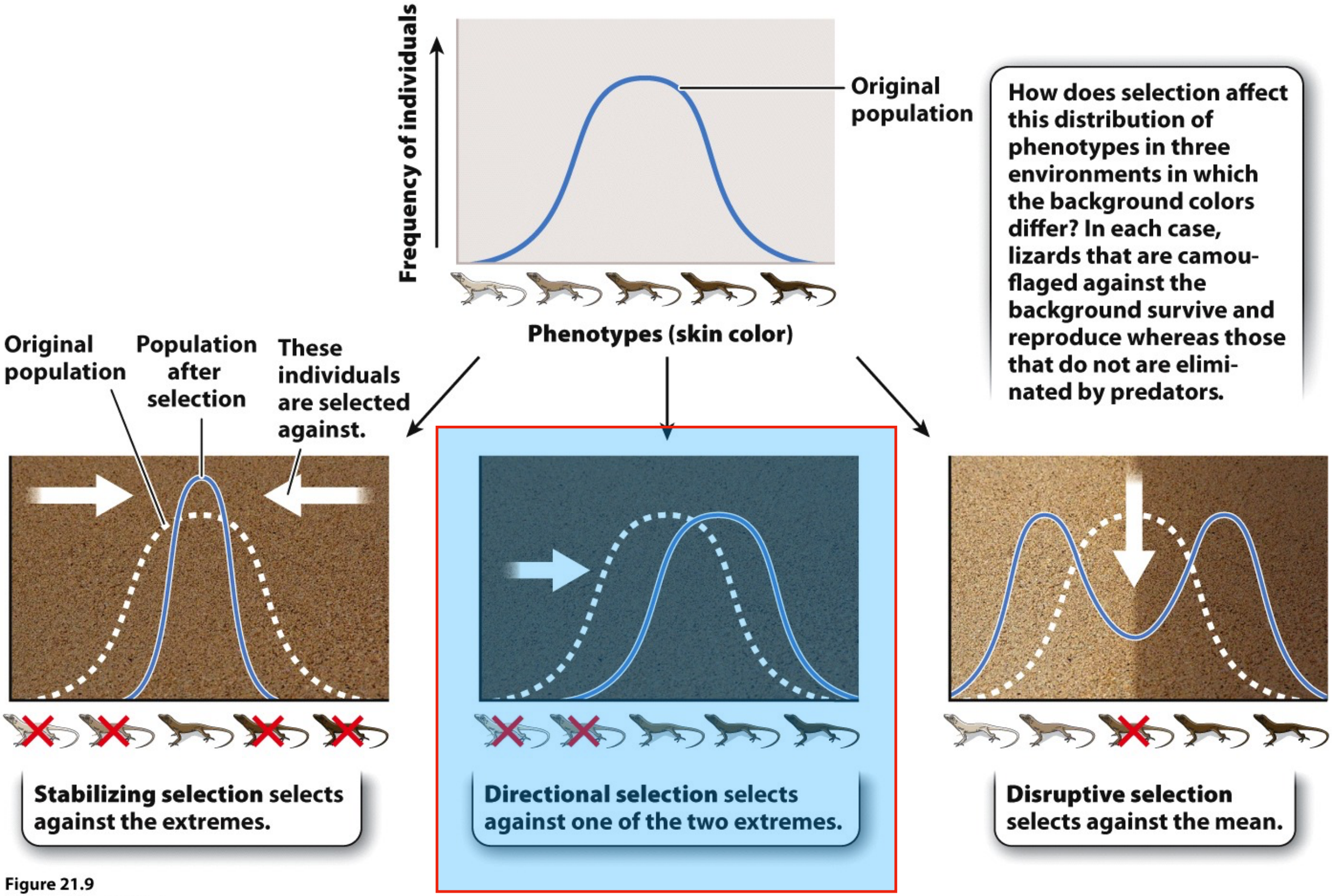


Figure 21.9
Biology: How Life Works

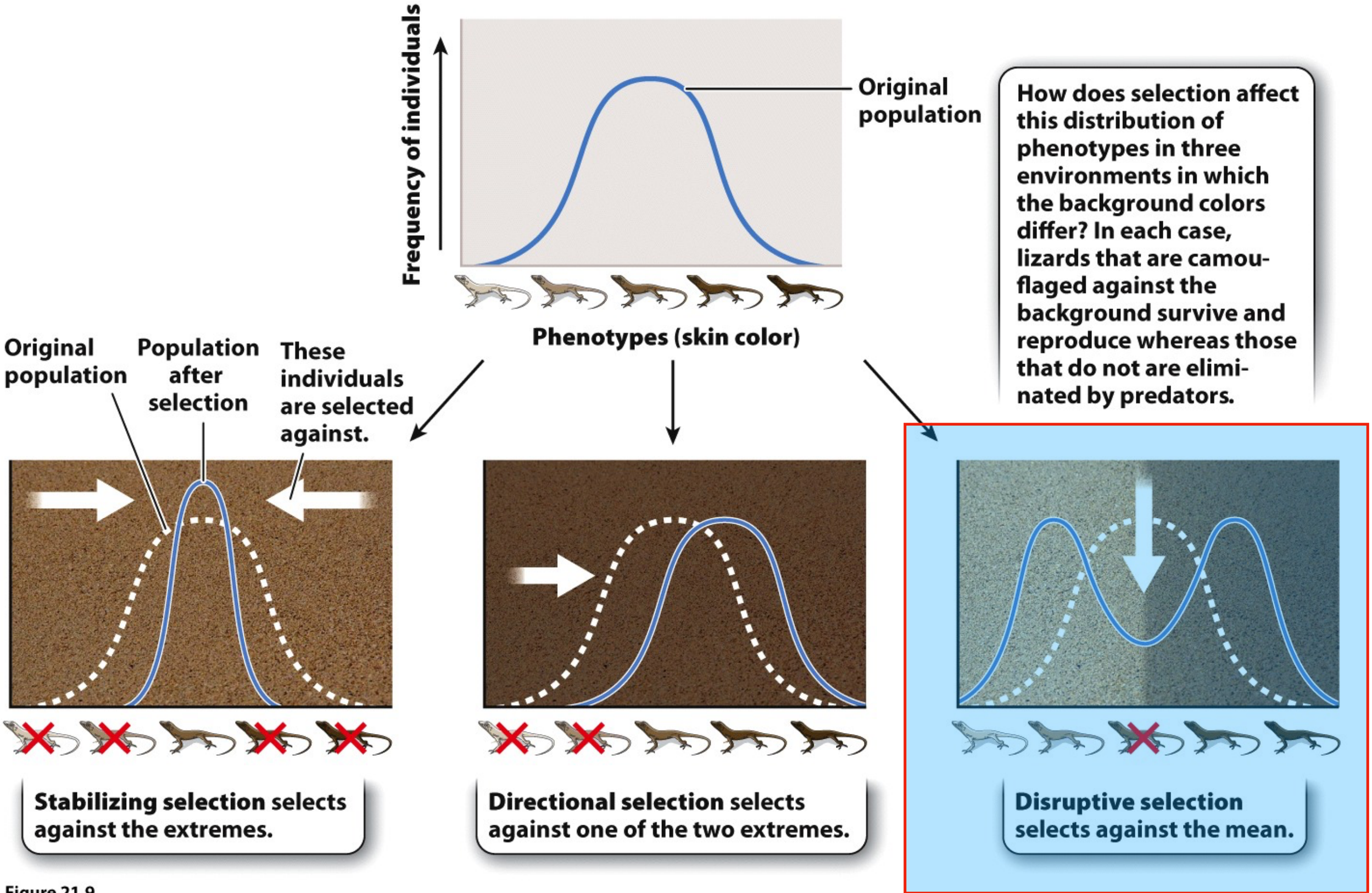
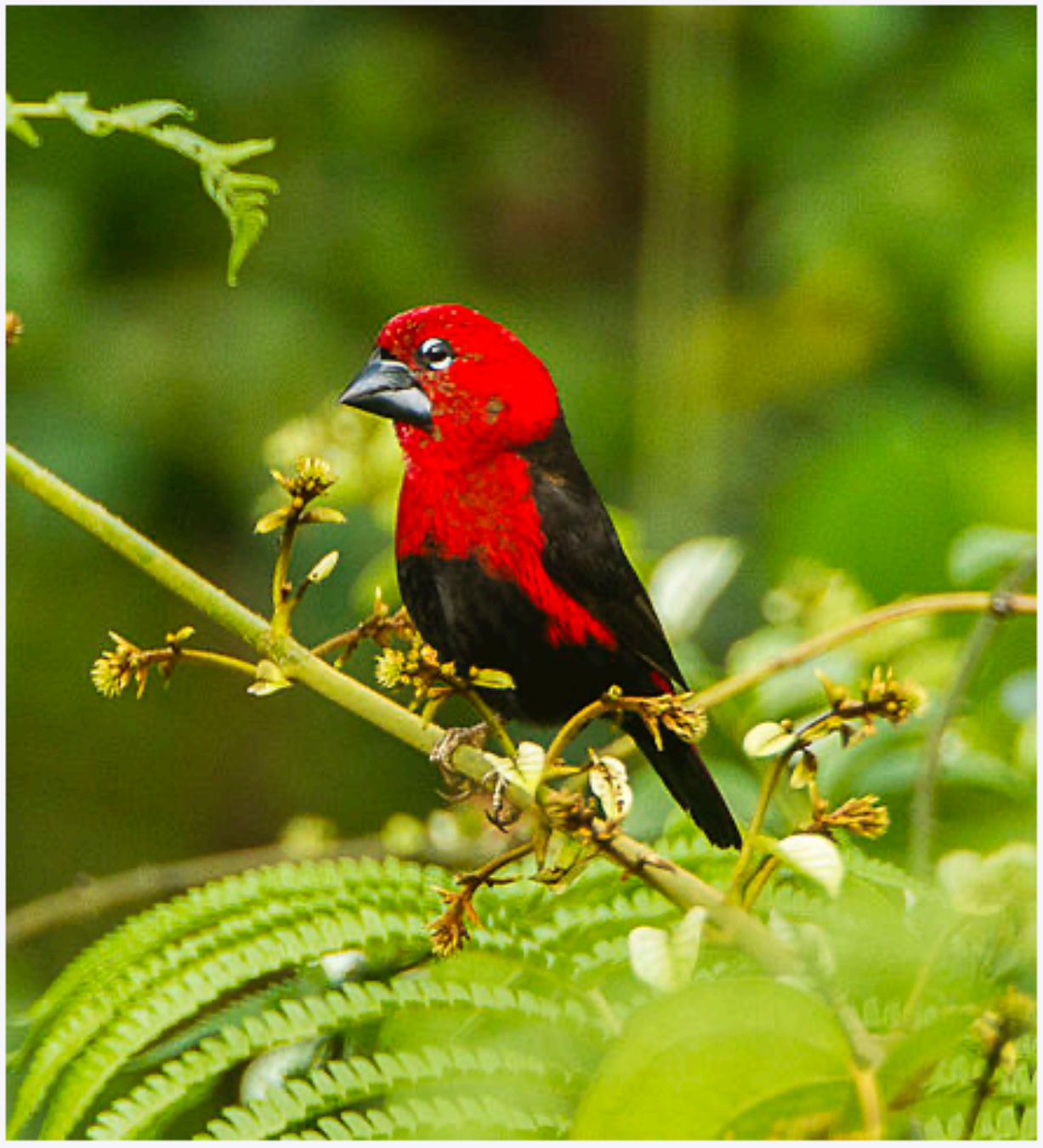
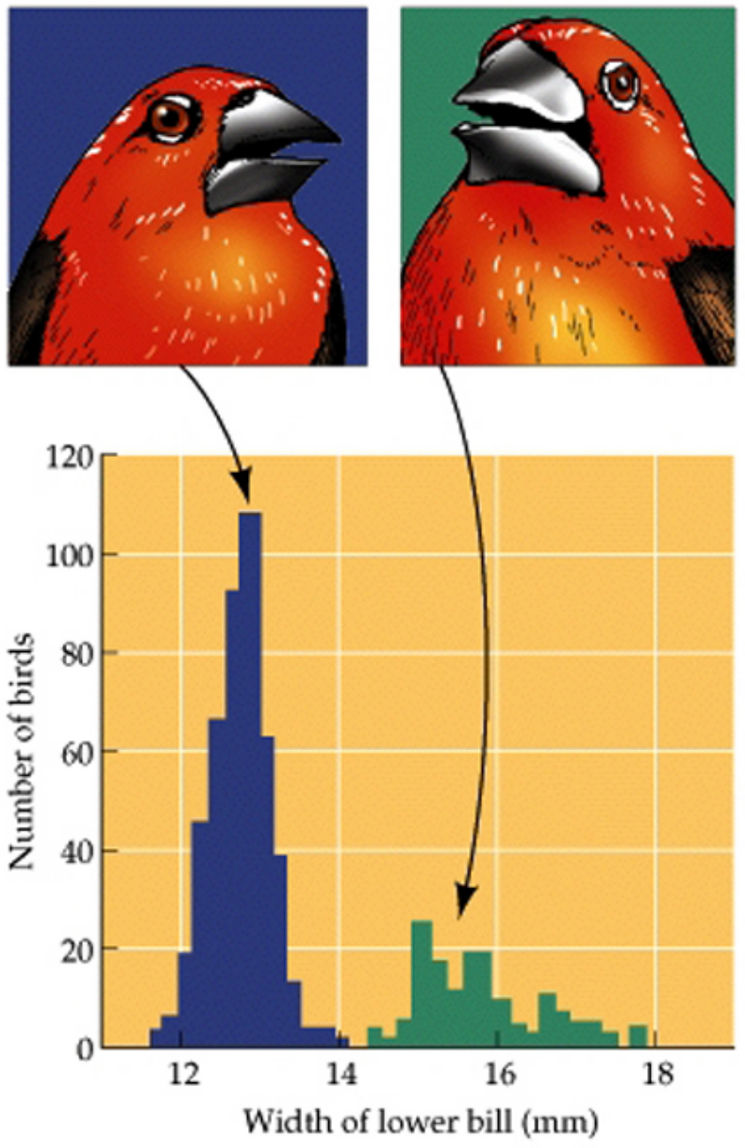
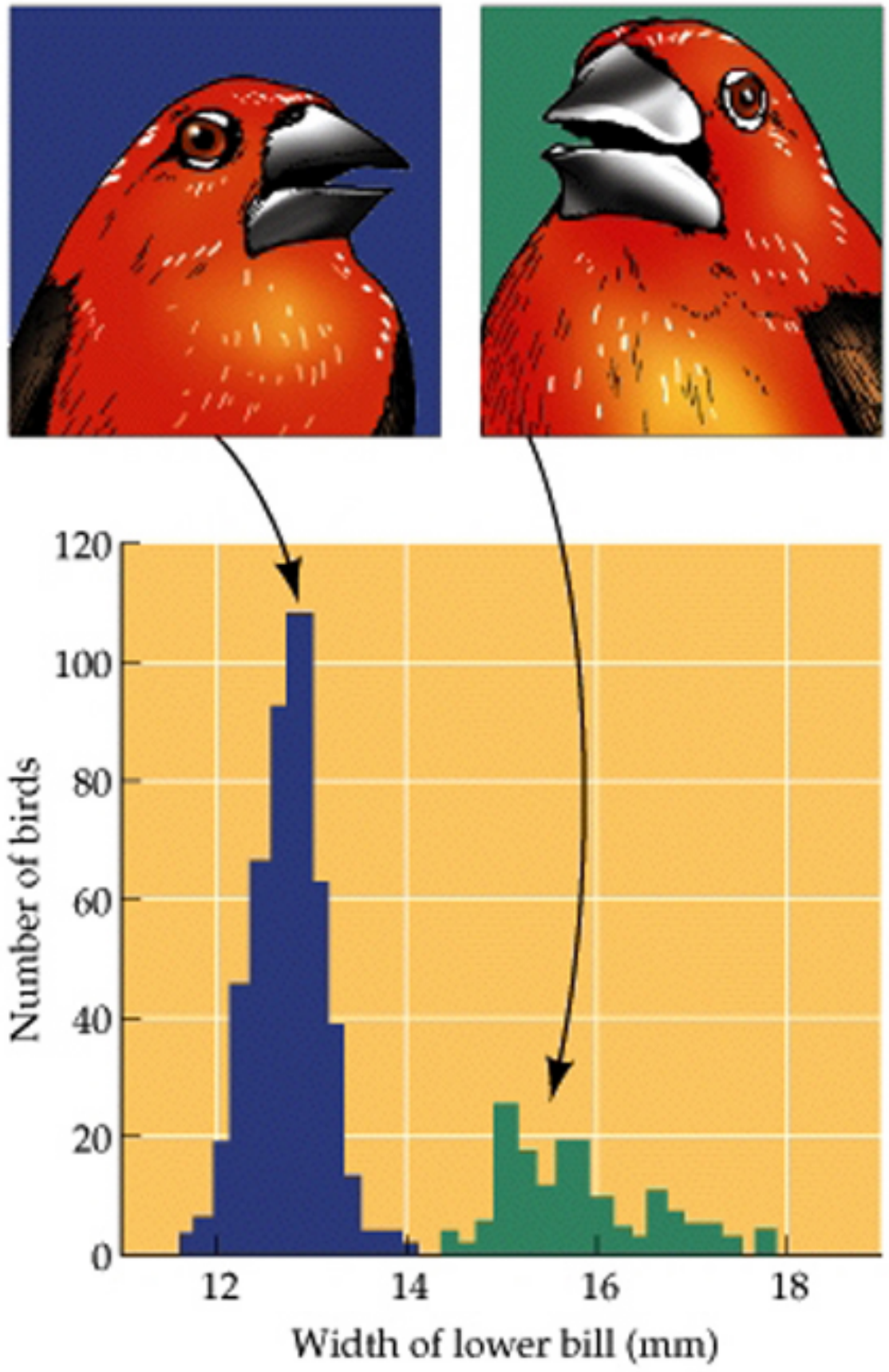


Figure 21.9
Biology: How Life Works

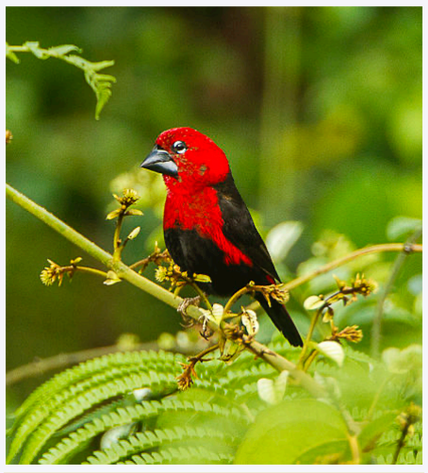
Black-bellied seedcracker



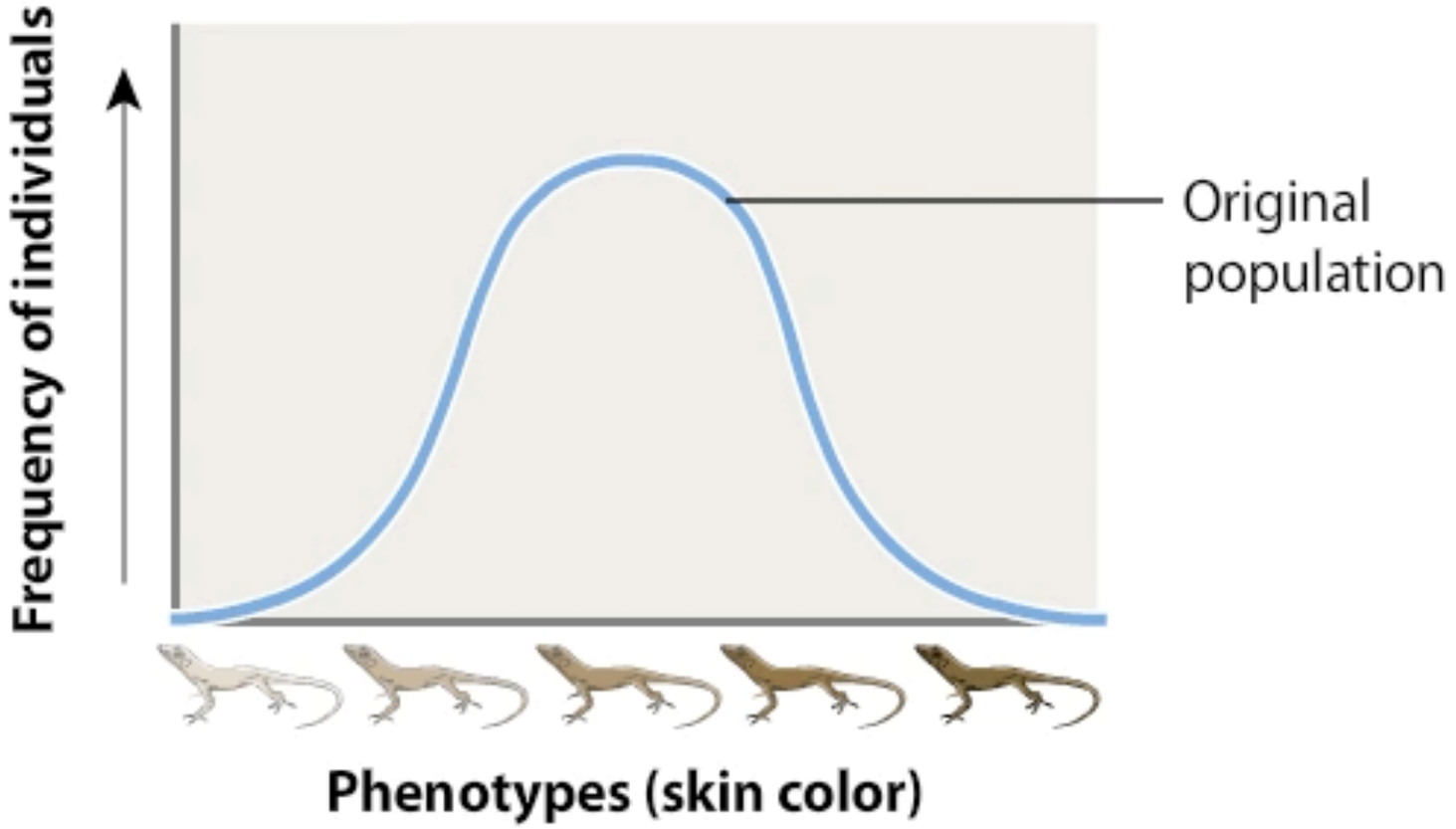




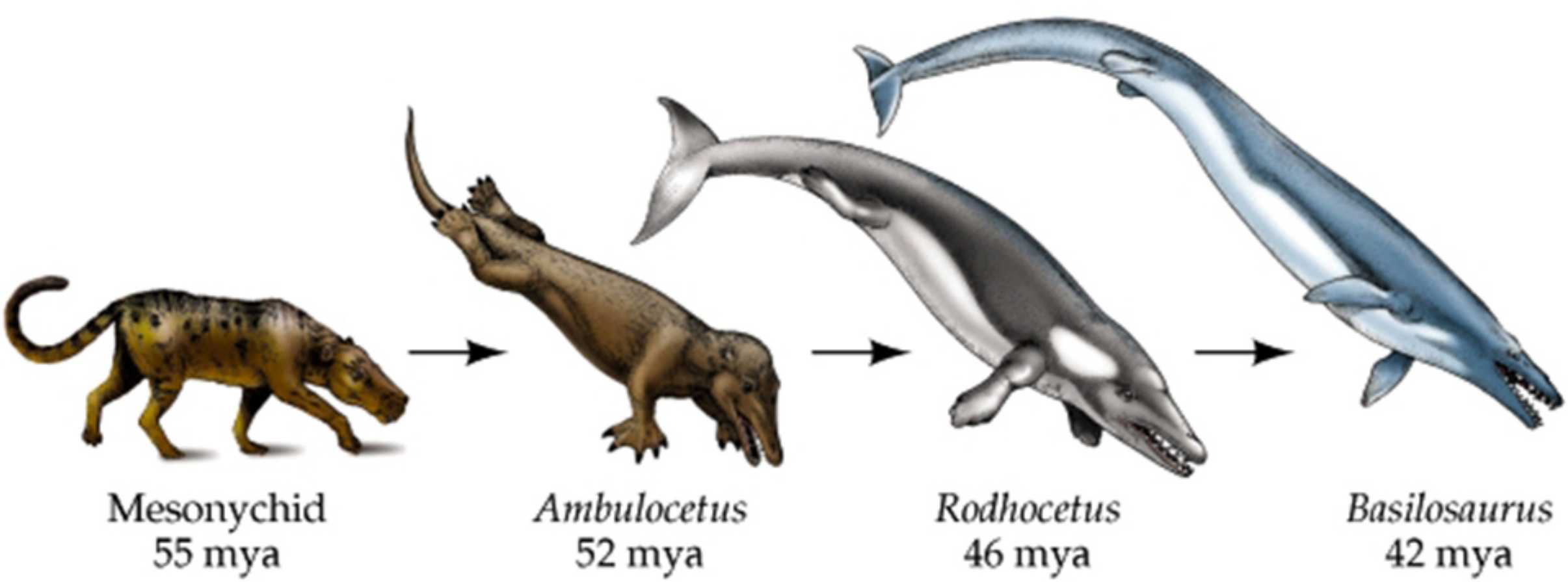
Black-bellied seedcracker



Three Types of Selection



Many traits we see in nature are distributed according to a bell-shaped curve. In our example, the color of the lizards varies from light to dark, with most individuals somewhere in the middle.



Fossil Records… Evolution of Whales?

https://www.youtube.com/watch?v=pKYdDJxK42o

Phiomicetus anubis

Fossil Records… Lucy?

Fossil Records…

Fossil Records… Panda’s thumb

UPDATED: AUG 22, 2018 · ORIGINAL: DEC 18, 2012

Piltdown Man Hoax, 100 Years Ago

On its 100th anniversary, mystery still lingers over one of history's most spectacular scientific hoaxes.

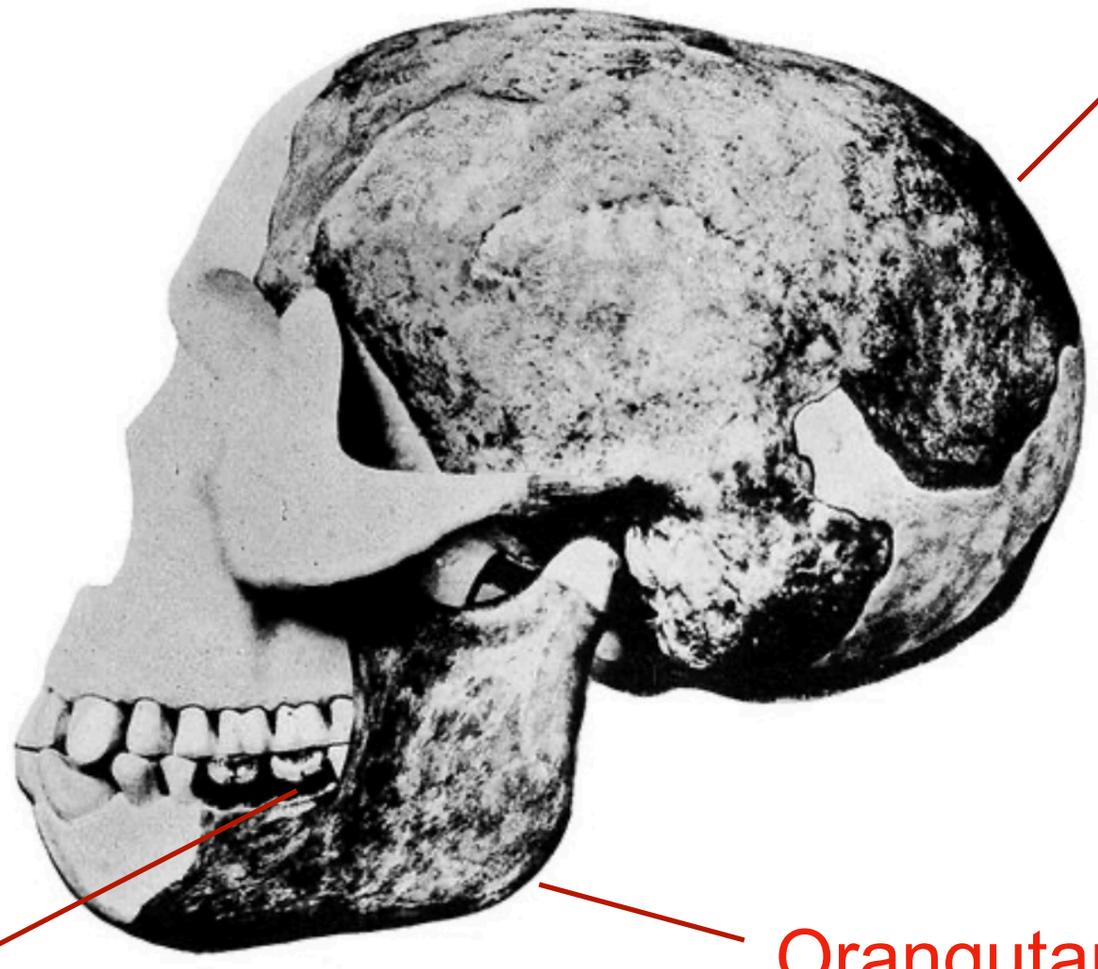
SARAH PRUITT

By the time of Dawson and Woodward's historic announcement, the search for a missing link to prove Darwin's still-controversial theory had grown intense. Significant evidence of early humans in the British Isles had not yet been found, and the success of the Sussex dig was a major headline-grabber. Woodward, who was the curator of the British Museum's paleontology department, dubbed the discovery Eoanthropus dawsoni, or "Dawson's Dawn-man," but he was more commonly known as the Piltdown Man.

1912

Falsified Fossil Records…

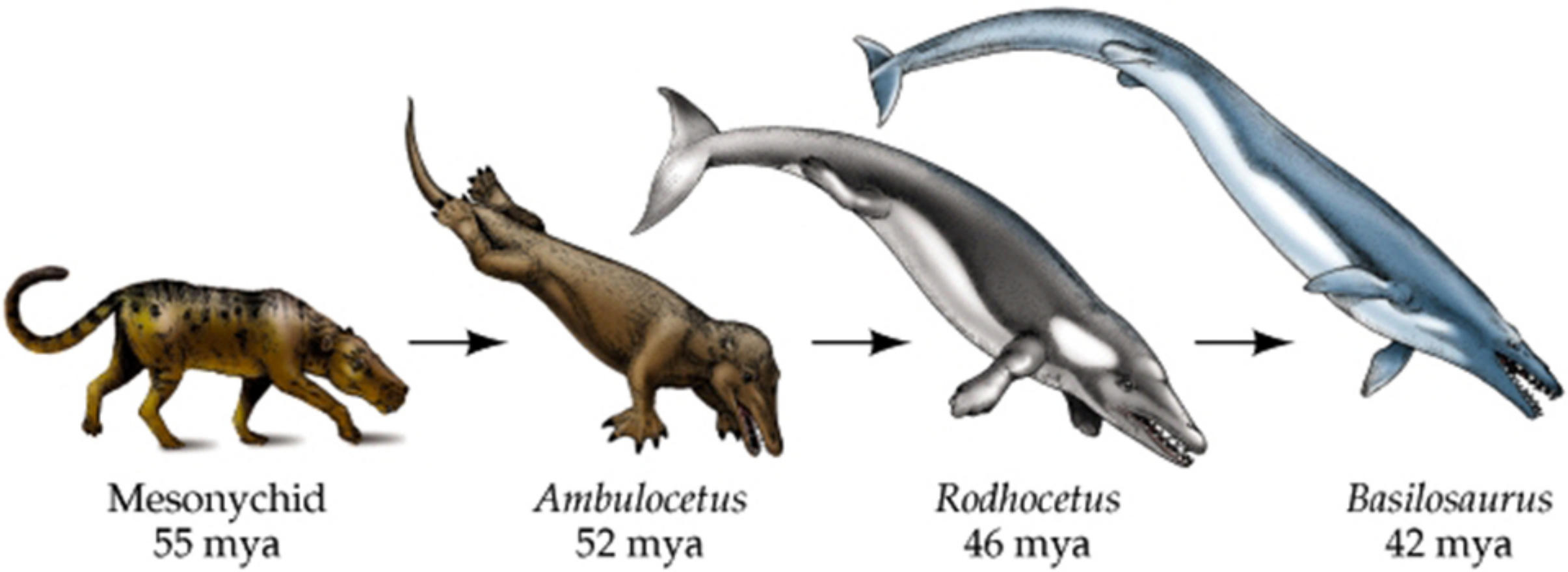
Human Cranium
(~600 yrs old)



Tooth of
a chimpanzee

Orangutan Jaw

Falsified Fossil Records…



Fossil Records… Evolution of Whales?

Phiomicetus anubis

Natural Selection: ”the gradual process by which heritable biological traits become either more or less common in a population as a function of the effect of inherited traits on the differential reproductive success of organisms interacting with their environment"

Genetic/Evolutionary Vocabulary

- **population:** all individuals of the same species occupying the same area.

- **gene:** A unit of heritable information -usually associated (at the molecular level) with a specific region located on the chromosome.

- **allele:** one of two or more slightly different forms, or "variants" of a given gene.

- **allelic frequency:** the number of times a particular allelic variant that shows up -usually refers to a population

- **genotype:** a selection of the genes that make up an individual.

- **phenotype:** the consequence(s) of all the allelic interactions that give rise to a visibly determinable "type".

Genetic/Evolutionary Vocabulary

- **population:** all individuals of the same species occupying the same area.

- **gene:** A unit of heritable information -usually associated (at the molecular level) with a specific region located on the chromosome.

- **allele:** one of two or more slightly different forms, or "variants" of a given gene.

- **allelic frequency:** the number of times a particular allelic variant shows up usually refers to a population

- **genotype:** a selection of the genes that make up an individual.

- **phenotype:** the consequence(s) of all the allelic interactions that give rise to a visibly determinable "type".

Consider a newly introduced **allele** within a population. The presence of this **allele** will have an **allelic frequency** that can change over time.

At some stage, perhaps, the frequency of a particular **allele** would become either “fixed” in a population or “lost” from a population for one reason or another.

This can happen rapidly or need not happen at all -especially in large populations .

To understand what **populations** are and how they can change…

We need to understand that populations are "populations of individuals" NOT a group of identical **"clones"**. ..

Populations are a group of individuals that exhibit an assorted array of similar **phenotypic traits** (the operative word being **"similar"**), and that each individual has a slightly different organismal **"signature"** that contributes to the collective "**gene pool**”

From and understanding of a few of these fundamental concepts we can then build a greater understanding of more complex evolutionary terms, such as-

Genetic drift: a random change in **allelic frequency** over time

-appreciate this as being a key mechanism of evolutionary change.

Of it's nature **genetic drift** might be **strongest** in **small populations** (?)

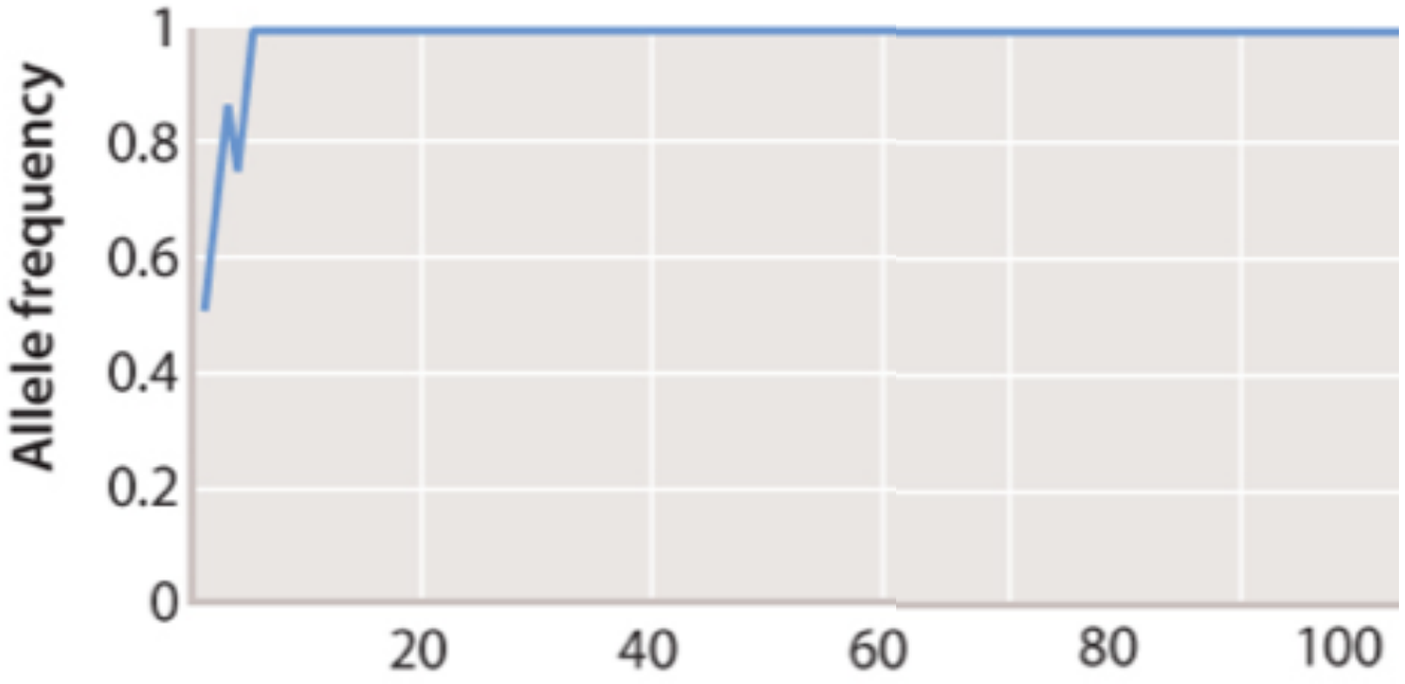
Why would that be (?) -the fewer individuals in the population, the more likely it is that random fluctuations will completely disrupt the **allelic frequency.**

In the short term (i.e over a few generations), one might expect **allelic frequencies** to increase and decrease in a random, unpredictable way, as a result of **genetic drift .**

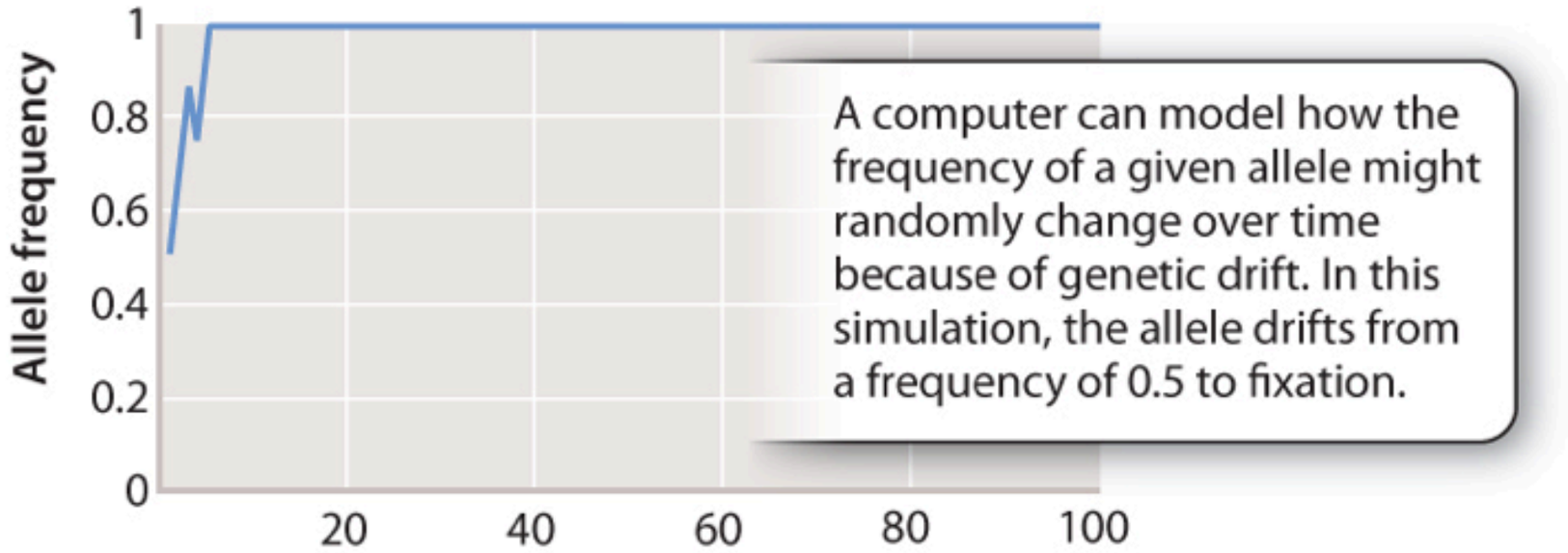
Consider a newly introduced **allele** within a population. The presence of this **allele** will have an **allelic frequency** that can change over time.

At some stage, perhaps, the frequency of a particular **allele** would become either “fixed” in a population or “lost” from a population for one reason or another.

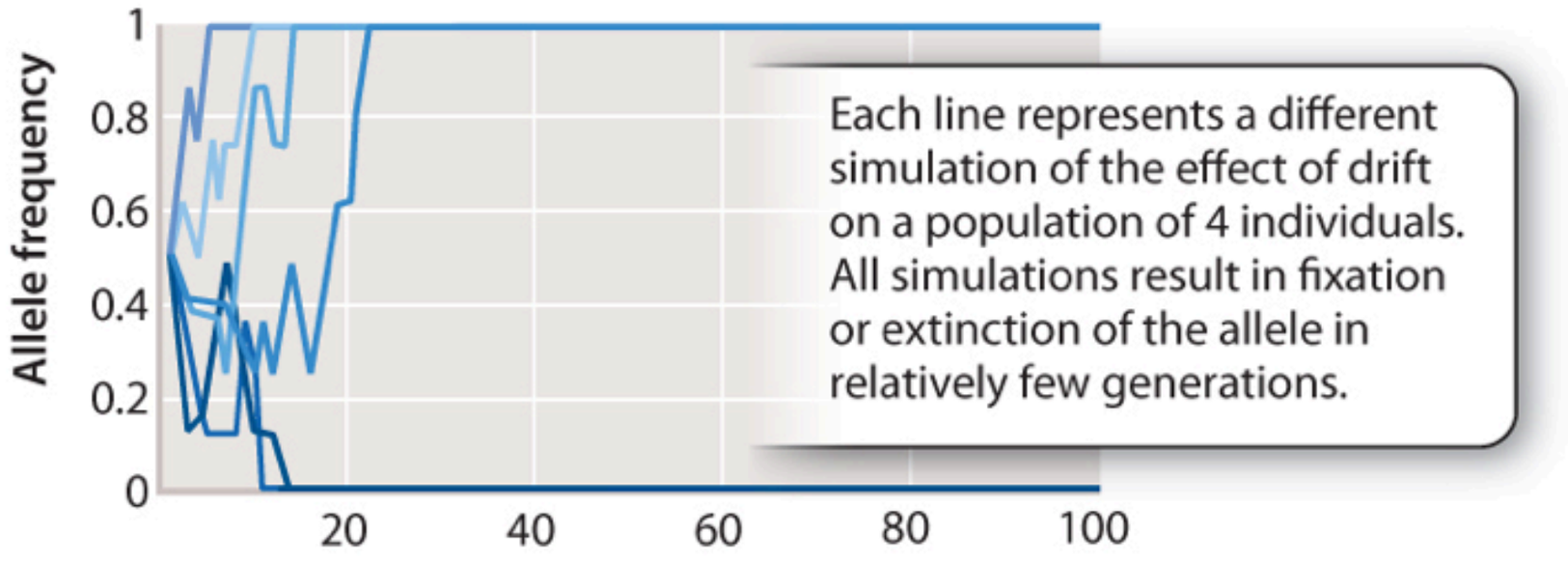
This can happen rapidly or need not happen at all -especially in large populations .



a. Population size = 4



b. Population size = 4

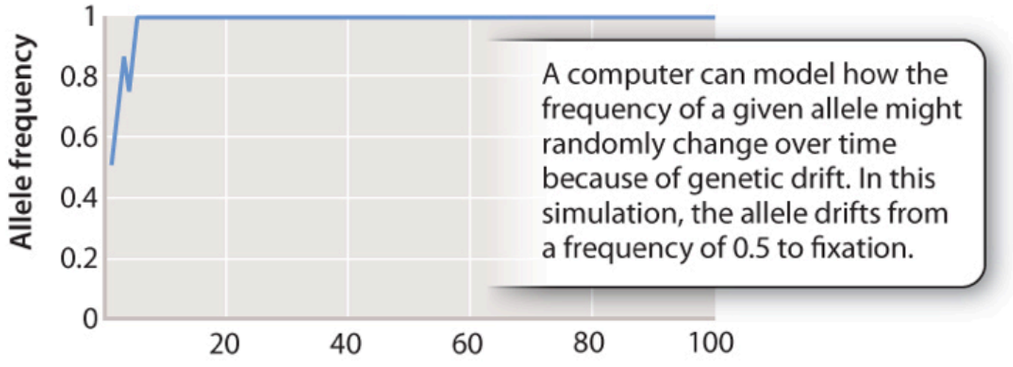


Consider a newly introduced **allele** within a population. The presence of this **allele** will have an **allelic frequency** that can change over time.

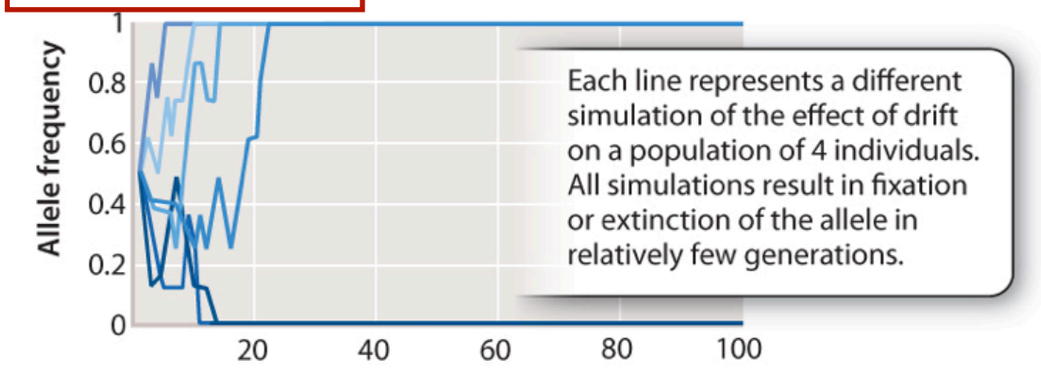
At some stage, perhaps, the frequency of a particular **allele** would become either “fixed” in a population or “lost” from a population for one reason or another.

This can happen rapidly or need not happen at all -especially in large populations .

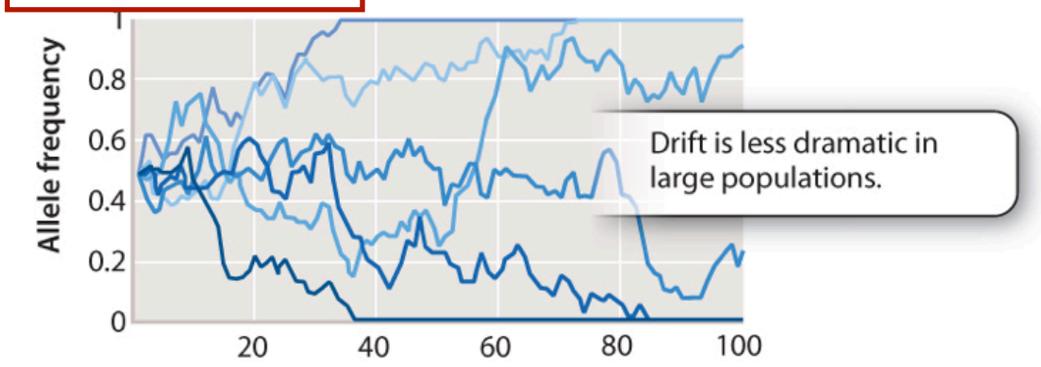
a. Population size = 4



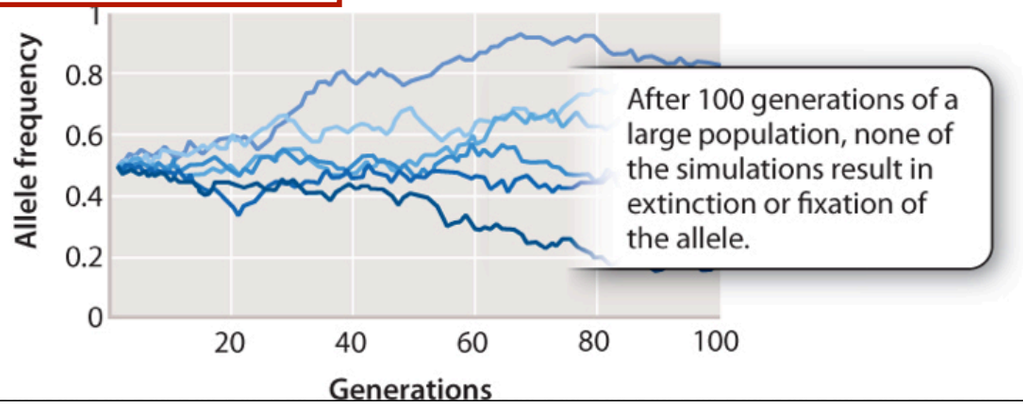
b. Population size = 4



c. Population size = 40



d. Population size = 400



Genetic Drift

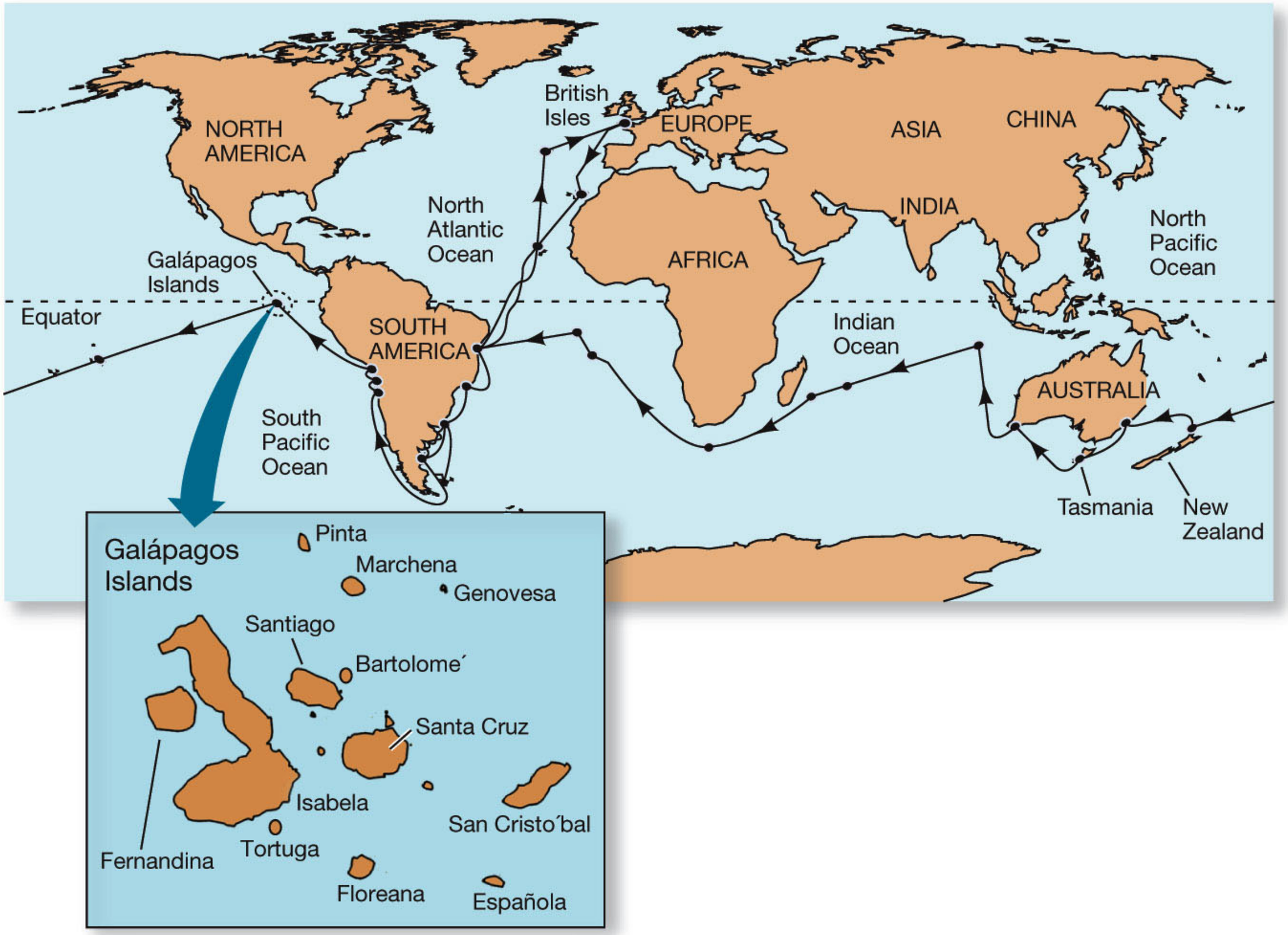
Allele frequencies are subject to genetic drift, caused by sampling error from generation to generation.

Genetic drift: a random change in **allelic frequency** over time and appreciate this as being a key mechanism of evolutionary change.

As a result, we have suggested, the effects of **genetic drift** might be strongest in small populations (?)

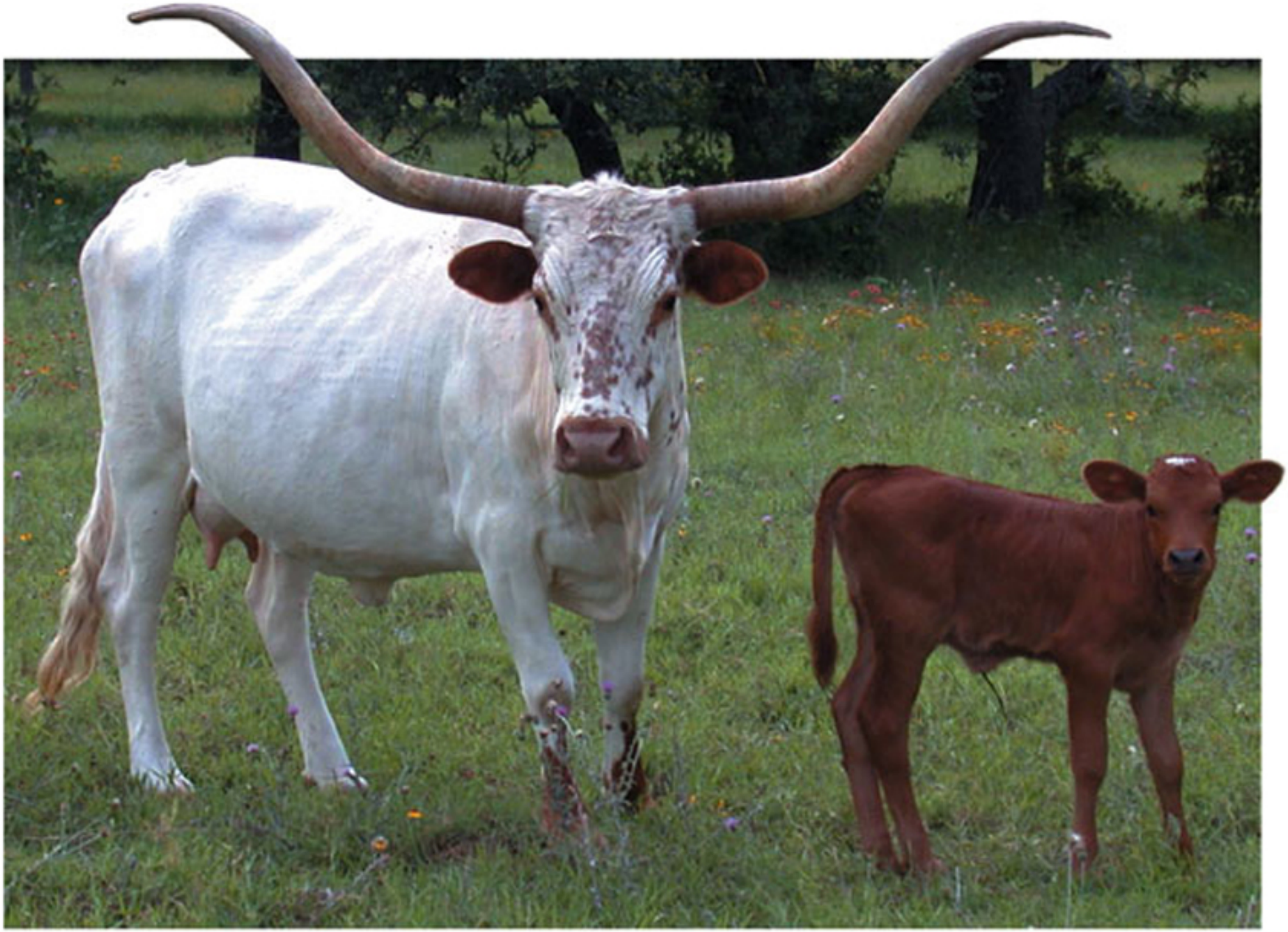
In the short term (i.e over a few generations), one might expect **allelic frequencies** to increase and decrease in a random, unpredictable way, as a result of **genetic drift…**


GALLAPAGOS ISLANDS.
Discovered and Described
by Capt. Cowley in
1684.
ord Culpeper's
Island
Lord Wenman's
Island
Nories Rocks
East Bay
South Bay
Bay
Bindloss Isl.
Dassigney's Isl.


NORTH AMERICA
British Isles
EUROPE
ASIA
CHINA
INDIA
North Atlantic Ocean
North Pacific Ocean
AFRICA
Galápagos Islands
Equator
SOUTH AMERICA
Indian Ocean
AUSTRALIA
South Pacific Ocean
Tasmania
New Zealand
Galápagos Islands
Pinta
Marchena
Genovesa
Santiago
Bartolome´
Santa Cruz
Isabela
San Cristo´bal
Fernandina
Tortuga
Floreana
Española

Genetic drift: a random change in **allelic frequency** over time and appreciate this as being a key mechanism of evolutionary change.

Natural Selection: ”the gradual process by which heritable biological traits become either more or less common in a **population** as a function of the effect of inherited traits on the differential reproductive success of organisms interacting with their environment"



***LIFE* 9e, Figure 21.14**

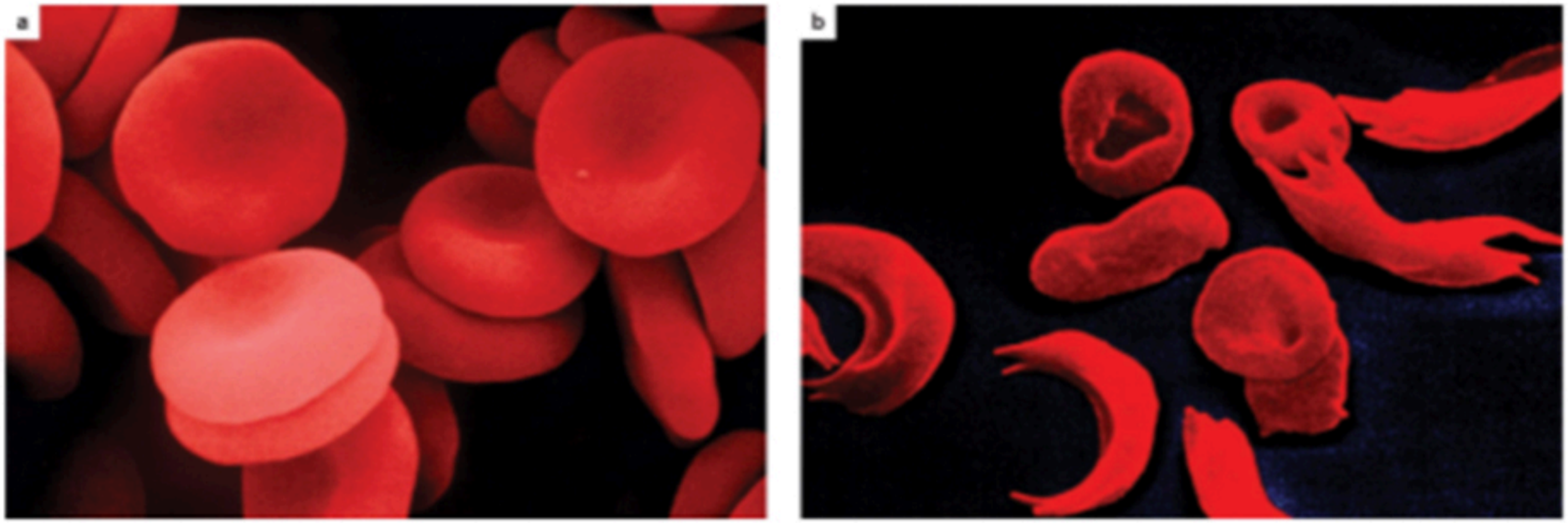
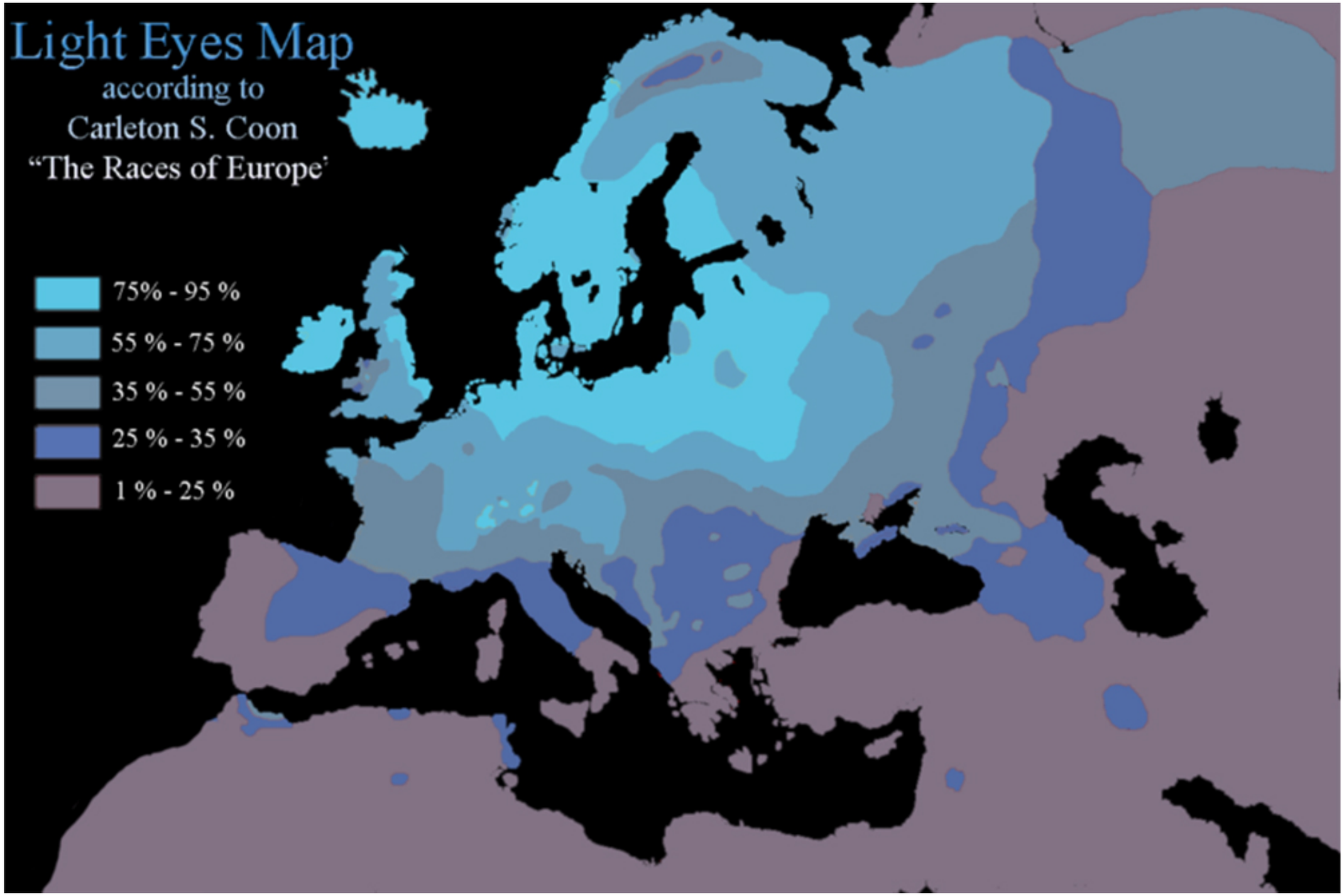
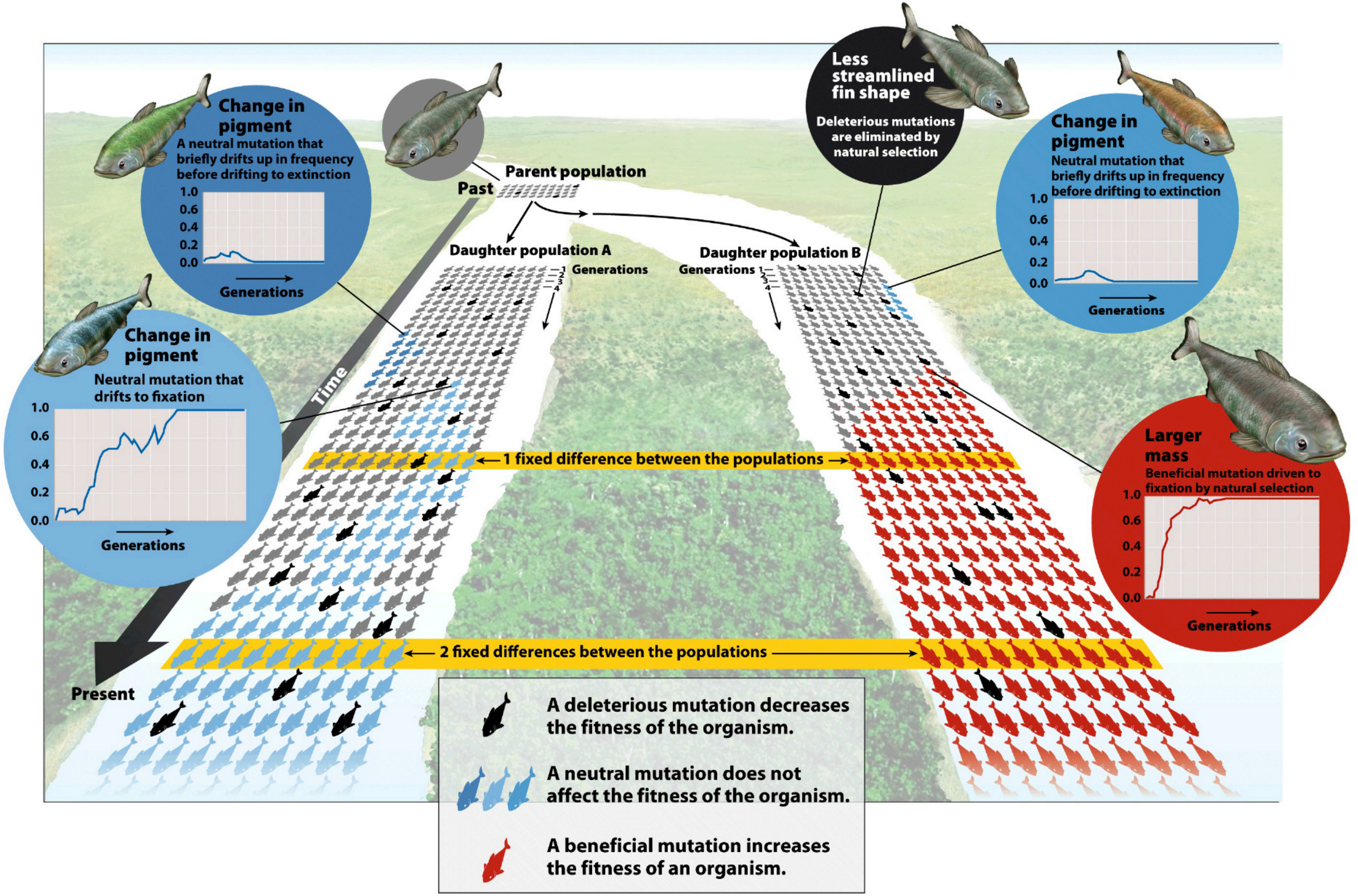


Figure 21.8: The effect of a single base-pair mutation. (a) Normal red blood cells look different from (b) sickled ones, whose shape has been distorted by hemoglobin molecules with the sickle variant.



Eye Colour is heavily influenced by geography and natural selection…


Change in pigment
A neutral mutation that briefly drifts up in frequency before drifting to extinction
1.0
0.6
0.4
0.2
0.0
Generations
Parent population
Past
Less streamlined fin shape
Deleterious mutations are eliminated by natural selection
Change in pigment
Neutral mutation that briefly drifts up in frequency before drifting to extinction
Daughter population A
Generations
1
2
3
4
Daughter population B
Generations
Time
Change in pigment
Neutral mutation that drifts to fixation
Larger mass
Beneficial mutation driven to fixation by natural selection
1 fixed difference between the populations
2 fixed differences between the populations
Present
A deleterious mutation decreases the fitness of the organism.
A neutral mutation does not affect the fitness of the organism.
A beneficial mutation increases the fitness of an organism.

Genetic drift: a random change in **allelic frequency** over time and appreciate this as being a key mechanism of evolutionary change.

Natural Selection: ”the gradual process by which heritable biological traits become either more or less common in a **population** as a function of the effect of inherited traits on the differential reproductive success of organisms interacting with their environment"

Gene flow is the intermingling of separate traits among similar populations. This increase occurs because individuals from other populations will bring in **alleles** that would otherwise be absent or rare (may be even lost) from the population that is being observed. In other words they would add **variety** to the **gene pool**.

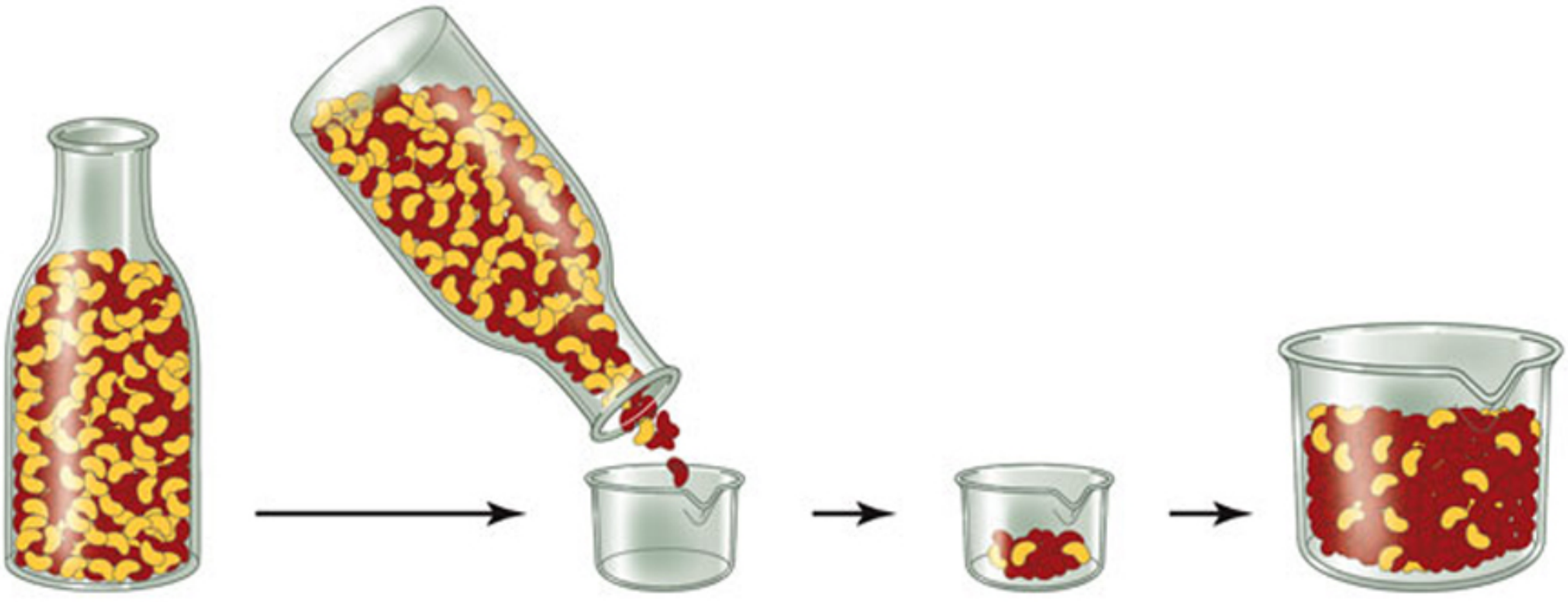
Toba catastrophe theory

From Wikipedia, the free encyclopedia

The **Toba supereruption** was a supervolcanic eruption that occurred about 75,000 years ago at the site of present-day Lake Toba in Sumatra, Indonesia. It is one of the Earth's largest known eruptions. The **Toba catastrophe theory** holds that this event caused a global volcanic winter for several years and possibly a 1,000-year-long cooling episode.

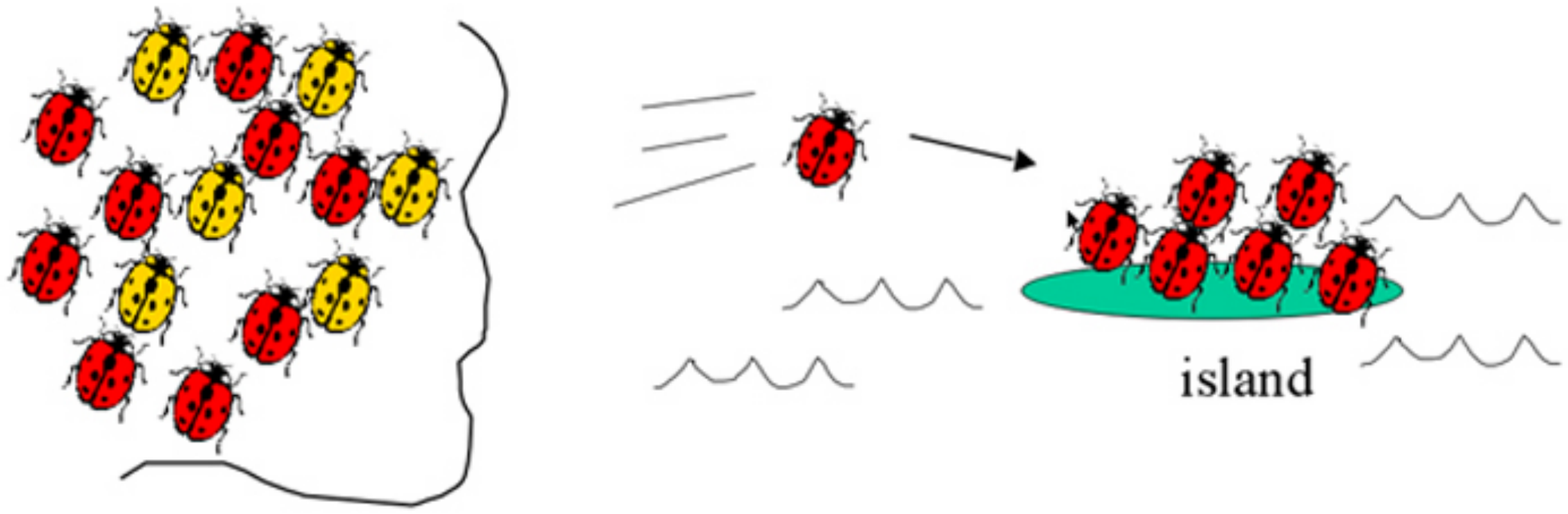
Bottlenecks

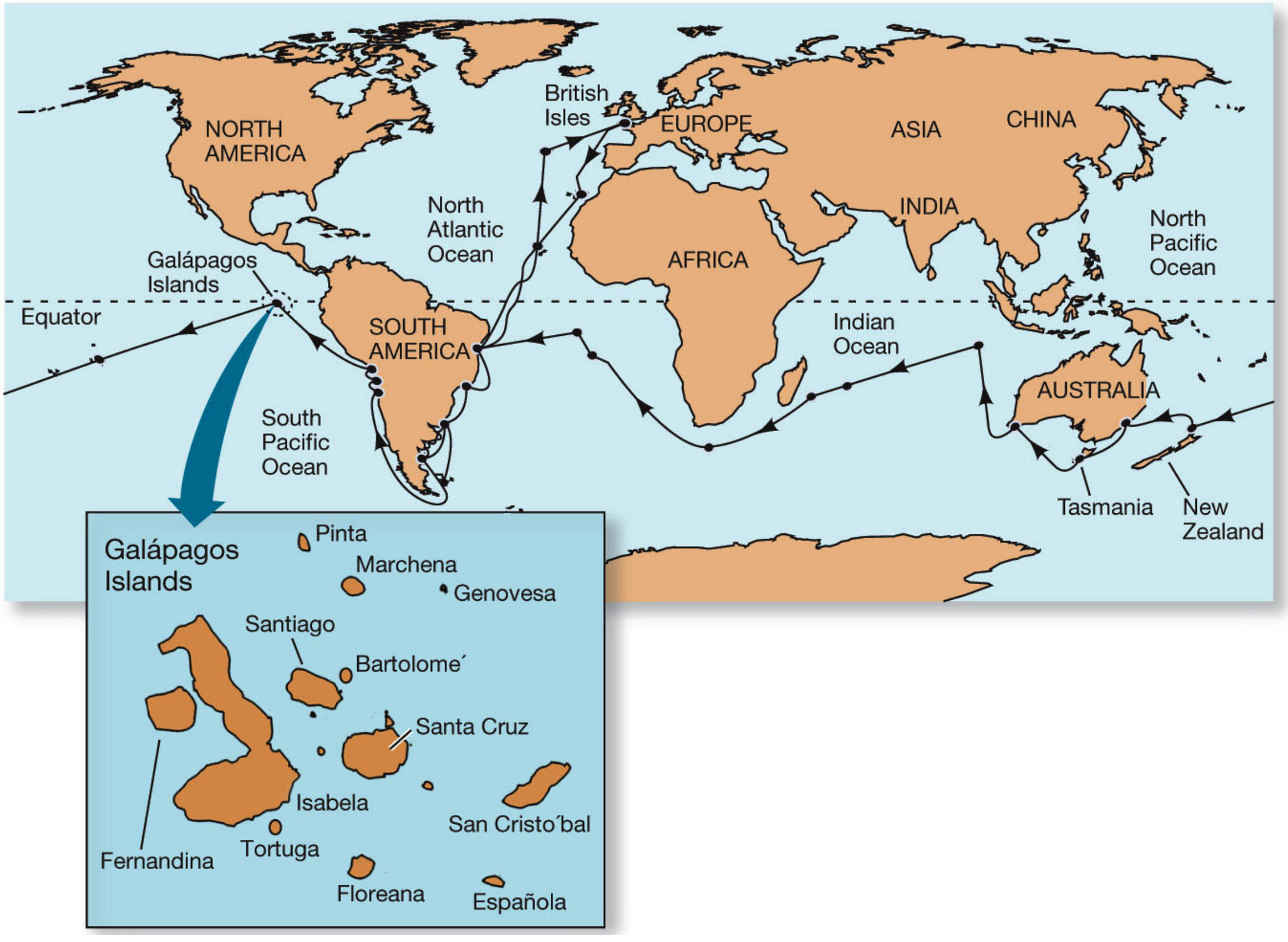
In 1993, science journalist Ann Gibbons posited that a population bottleneck occurred in human evolution about 70,000 years ago, and she suggested that this was caused by the eruption. Geologist Michael R. Rampino of New York University and volcanologist Stephen Self of the University of Hawaii at Manoa support her suggestion. In 1998, the bottleneck theory was further developed by anthropologist Stanley H. Ambrose of the University of Illinois at Urbana–Champaign. Both the link and global winter theories are highly controversial.[1] The Toba event is the most closely studied supereruption.[2][3]



The case of **Huntington's disease** in South Africa

The Afrikaner population of South Africa is mainly descended from one shipload of immigrants which landed in **1652.** The early colonists included individuals with a number of rare genes. The ship of 1652 contained a Dutch man carrying the gene for Huntington's disease, an autosomal dominant disease which does not appear until the sufferer is over 40 years old and leads to certain death within five to 10 years. Most cases of the disease in the modern Afrikaner population can be traced back to that individual.




NORTH AMERICA
British Isles
EUROPE
ASIA
CHINA
INDIA
North Atlantic Ocean
North Pacific Ocean
AFRICA
Galápagos Islands
Equator
SOUTH AMERICA
Indian Ocean
AUSTRALIA
South Pacific Ocean
Tasmania
New Zealand
Galápagos Islands
Pinta
Marchena
Genovesa
Santiago
Bartolome´
Santa Cruz
Isabela
San Cristo´bal
Fernandina
Tortuga
Floreana
Española

Question: Are there any constraints to evolutionary change(s)?

Answer: