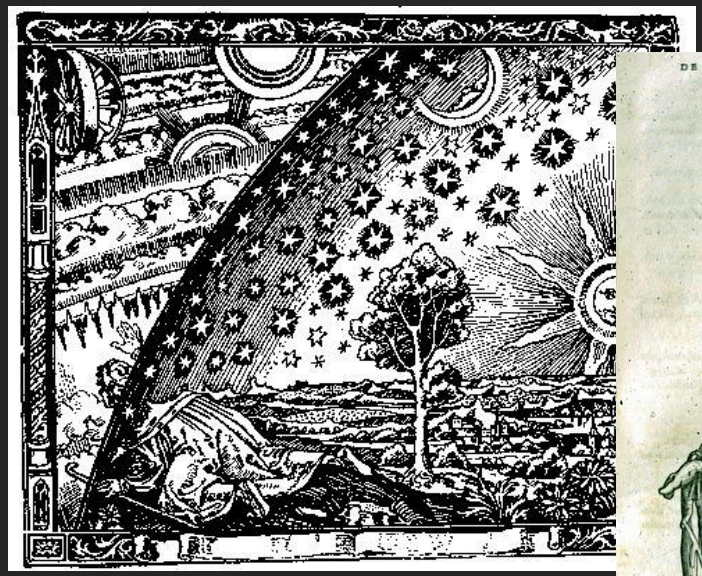
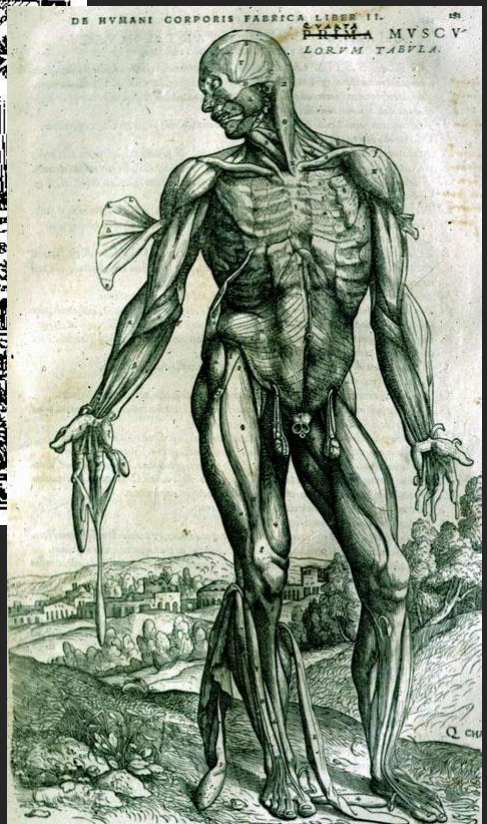
THE HUNTINGTON

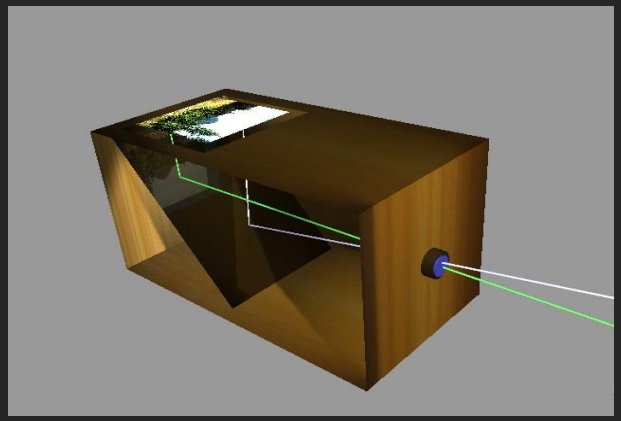
Library, Art Collections, and Botanical Gardens

History of Science School Program

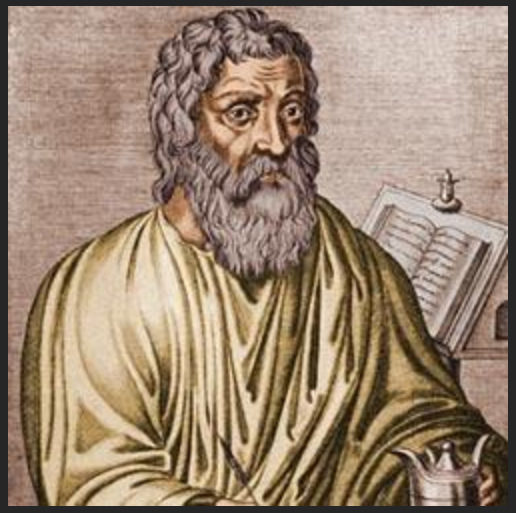
Week 4

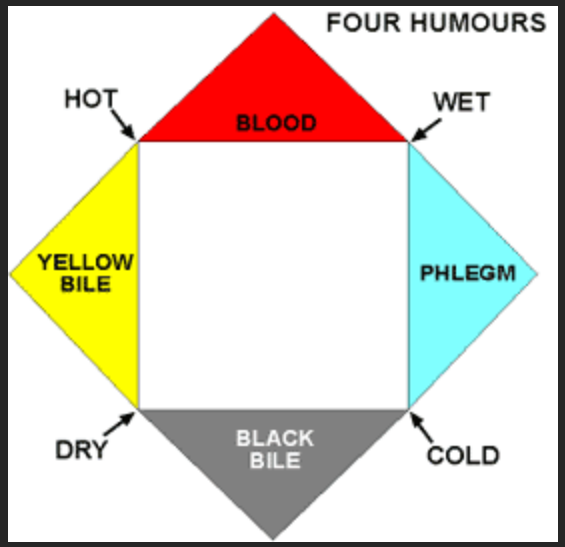




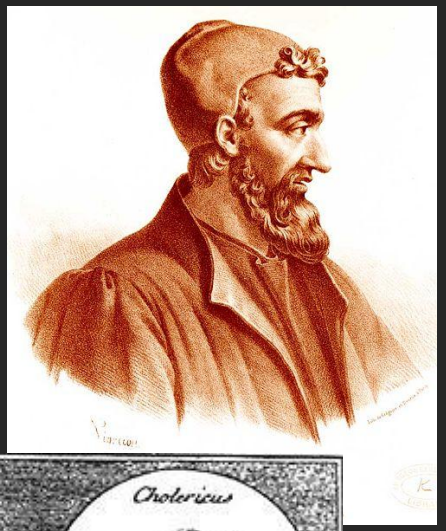


Hippocrates





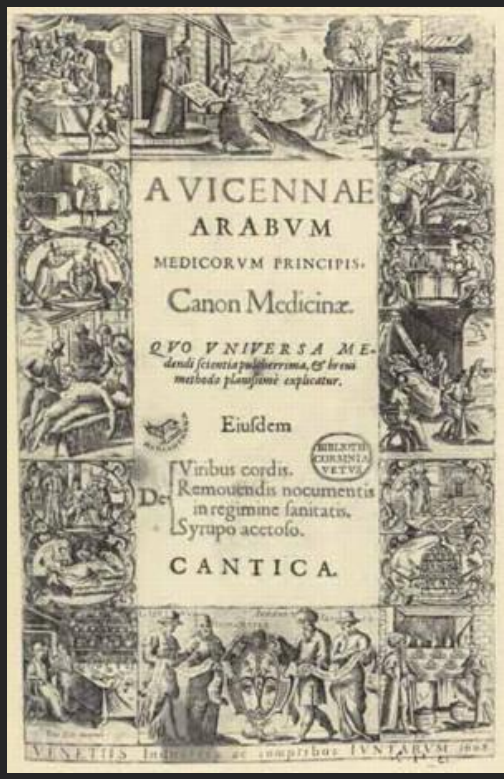
GALEN: 2ND CENTURY



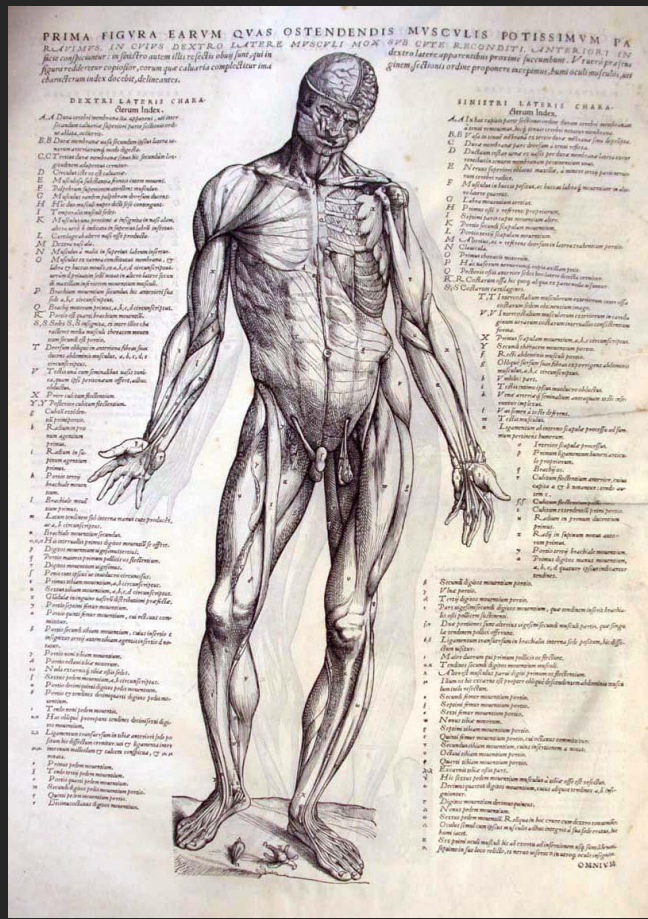
Circa 400 BC, Greek physician. Known as the 'father of medicine', he developed the belief that four fluids (or humors) of the body (blood, phlegm, yellow & black bile) are the primary seats of disease.

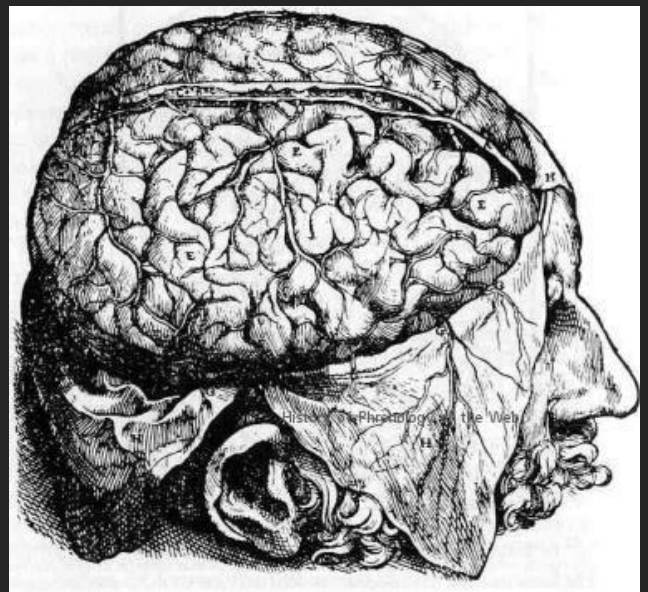
The four temperaments (Clockwise from top right; choleric; melancholic; sanguine; phlegmatic).

- **Ibn Sīnā** (Latinized: **Avicenna**) (c. 980 – 1037) Persian polymath, physician and philosopher
- Ibn Sīnā wrote almost 450 treatises on a wide range of subjects, of which around 240 have survived. In particular, 150 of his surviving treatises concentrate on philosophy and 40 of them concentrate on medicine.
- His most famous works are *The Book of Healing*, a vast philosophical and scientific encyclopedia, and *The Canon of Medicine*, which was a standard medical text at many medieval universities. The *Canon of Medicine* was used as a text-book in the universities of Montpellier and Louvain as late as 1650.

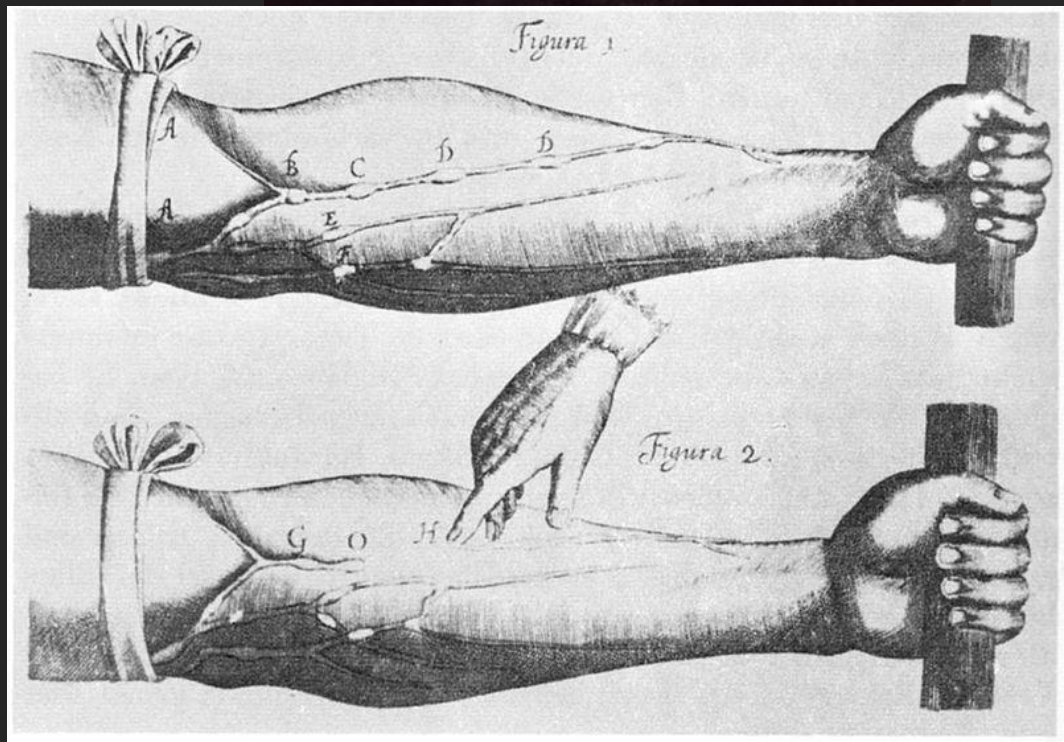


- Andreas Vesalius (1514 - 1564), Flemish anatomist and doctor, author of one of the most influential books on human anatomy, *De humani corporis fabrica* (*On the Workings of the Human Body*). Vesalius is often referred to as the founder of modern human anatomy.





- **William Harvey** (1588 – 1656) English physician
- For the first time described correctly and in exact detail the systemic circulation and properties of blood being pumped around the body by the heart.

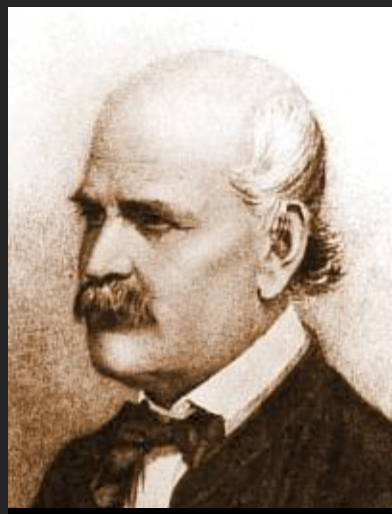


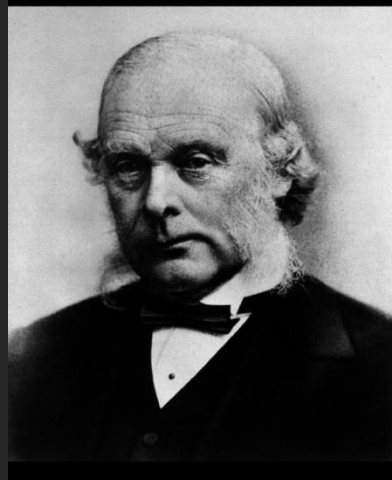
- Medicine was revolutionized in the 19th century and beyond by advances in chemistry and laboratory techniques and equipment,

- Development of new sciences of bacteriology and virology.

- Ignaz Semmelweis (1818-1865) in 1847 dramatically reduced the death rate of new mothers from childbed fever by requiring physicians to clean their hands before attending to women in childbirth. His discovery pre-dated the germ theory of disease.

- In 1865 British surgeon Joseph Lister proved the principles of antisepsis in the treatment of wounds.





In 1718, Lady Mary Wortley reported that the Turks had a habit of deliberately inoculating themselves with fluid taken from mild cases of smallpox, and that she had inoculated her own children.

Edward Jenner (1749 – 1823) English scientist is widely credited as the pioneer of smallpox vaccine, and is sometimes referred to as the 'Father of Immunology'. Jenner's discovery 'has saved more lives than the work of any other man'
The word vaccination was first used by Edward Jenner in 1796.

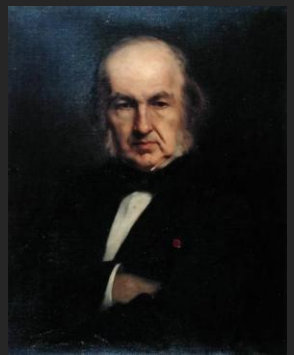
Inventor of vaccinations Edward Jenner vaccinates his son.

1869: British surgeon Joseph Lister (1827 - 1912), who discovered antiseptics in 1865.

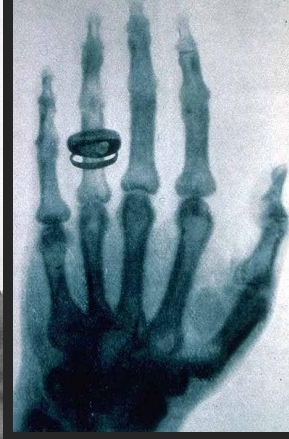
Louis Pasteur (1822 – 1895), French chemist and microbiologist, is best known for his remarkable breakthroughs in the causes and preventions of disease. His discoveries reduced mortality from puerperal fever, and he created the first vaccine for rabies. He is regarded as one of the main founders of microbiology, together Robert Koch.

Heinrich Herman Robert Koch (1843 – 1910), German physician, famous for isolating *Bacillus anthracis* (1877), the *Tuberculosis bacillus* (1882) and the *Vibrio cholera* (1883). He is considered one of the founders of microbiology.

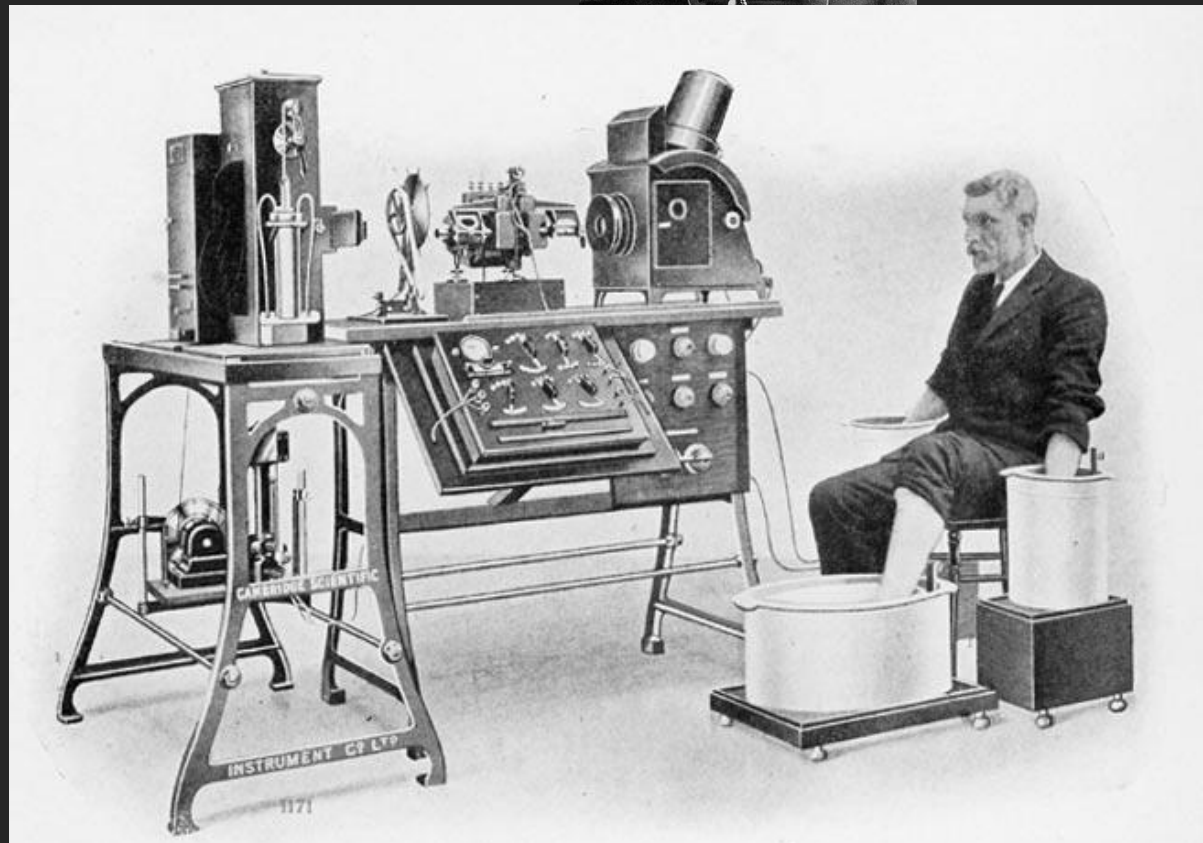
Claude Bernard (1813-1878), French physician, aimed at establishing scientific method in medicine; he published *An Introduction to the Study of Experimental Medicine* in 1865.



Wilhelm Conrad Röntgen (1845 – 1923) German physicist, who on 8 November 1895, produced and detected electromagnetic radiation in a wavelength range known as x-rays or Röntgen rays.



In the first years of the 20th century, Willem Einthoven (1860-1927), from Leiden, invented a one of the earliest instruments capable of detecting and recording the very small electrical currents produced by the human heart and provided the first practical Electrocardiogram (ECG).



PHOTOGRAPH OF A COMPLETE ELECTROCARDIOGRAPH, SHOWING THE MANNER IN WHICH THE ELECTRODES ARE ATTACHED TO THE PATIENT, IN THIS CASE THE HANDS AND ONE FOOT BEING IMMERSED IN JARS OF SALT SOLUTION

Pharmacology developed in the 19th century as a biomedical science that applied the principles of scientific experimentation to therapeutic contexts.

- The discovery of penicillin by Scottish scientist and Nobel laureate Alexander Fleming in 1928.

- The rise of Modern Biology and Genetics

- Scottish bacteriologist and Nobel laureate Sir Alexander Fleming (1881 - 1955) with Dr Robert Coghill. Fleming is most famous for his discovery of the antibiotic powers of penicillin in 1928. Fleming shared the 1945 Nobel Prize for Physiology or Medicine with the two chemists who had perfected a method of producing penicillin.

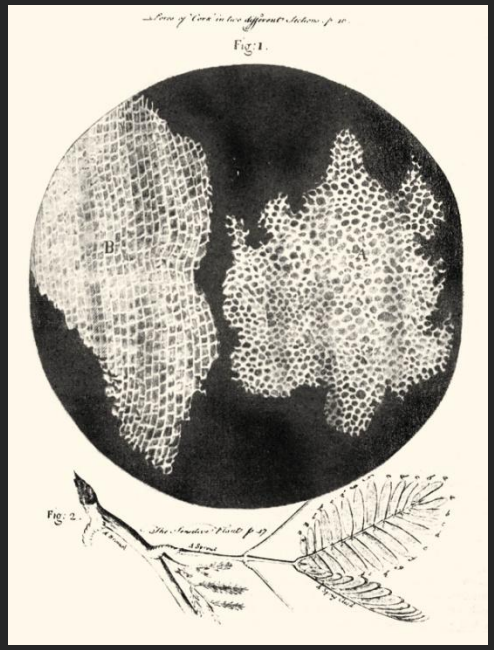
The New Biology

- 19th Century: Birth of modern biology
  - Life sciences still studied prior to 19th century, but often through natural history, anatomy and physiology
  - "Biologists" traditionally were in the field collecting and classifying species
    - New Biology shifted from the field to the lab
    - Interest in internal structure of life
      - Theory of the cell

New Biology Controversies

- Experimental physiology
  - Based in labs
  - Vivisection: operation on living animals
    - Moral question: greater good?
- Theoretical debate over nature of life
  - Vitalism
    - the origin and phenomena of life are due to or produced by a vital principle, as distinct from a purely chemical or physical force
    - Idea comes into question by 17th century
  - Materialism
    - The living body is nothing more than a complex physical structure driven by physical forces

The Study of Structure



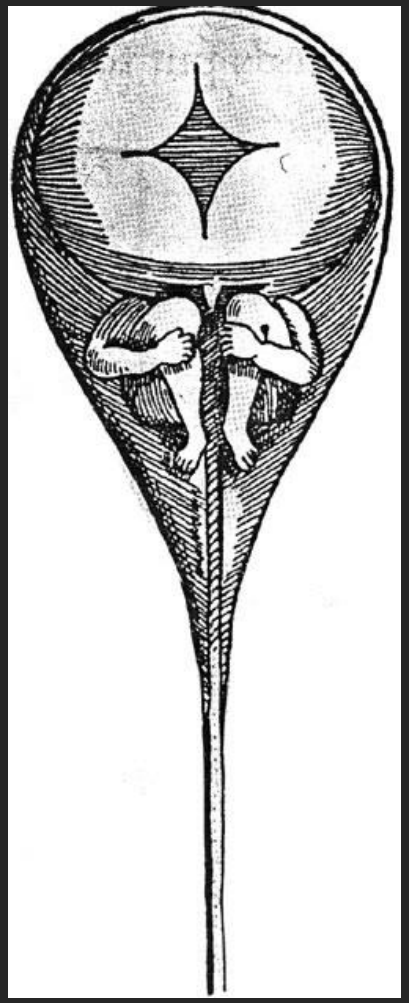
- Cells
  - Robert Hooke (1635-1703)
    - *Micrographia* (1665)
      - Plant cell
  - Until 19th century cell function unknown
    - New microscopes
- Cell Theory
  - Botanist, Jakob Mathia Schleiden (1804-1881) and zoologist Theodor Schwann (1810-1882)
  - Cells basic units of all living tissue
- Robert Remak (1815-1865) (embryologist)
  - Cell formed by a process of division initiated by the nucleus

Functions of the Living Body

- Physiology
  - Rise as a discipline in 18th century in medical faculties of universities
  - Justus von Liebig (1803-1873)
    - Established institute of Chemistry at Giessen
    - Lab-based experiment
      - "God has ordered all His creation by weight and measure"
    - Biological functions result from chemical and physical process going on in body
    - Use of physiological process like nutrition and respiration to explain body's sources of energy

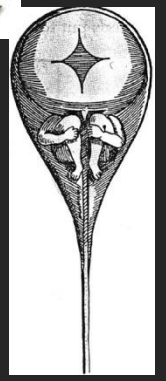
Preformation Versus Epigenesis

- Preformation
  - Late 17th century
  - Characters of the adult organism were predetermined from conception or even earlier
  - Structure of the organism existed in miniature
  - Russian doll theory
- Epigenesis
  - 18th century
  - Embryo grows from an undifferentiated piece of tissue by the sequential addition of parts



Preformation Versus Epigenesis

- Nicholas Hartsoeker (1656-1725)
  - Dutch mathematician and physicist
  - Invented screw-barrel simple microscope
  - 1674: Hartseoker assisted by Van Leeuwenhoek first to observe sperm
    - Did not claim to see tiny men inside the sperm,
      - Many thought miniature was in the female ovum



Preformation Versus Epigenesis

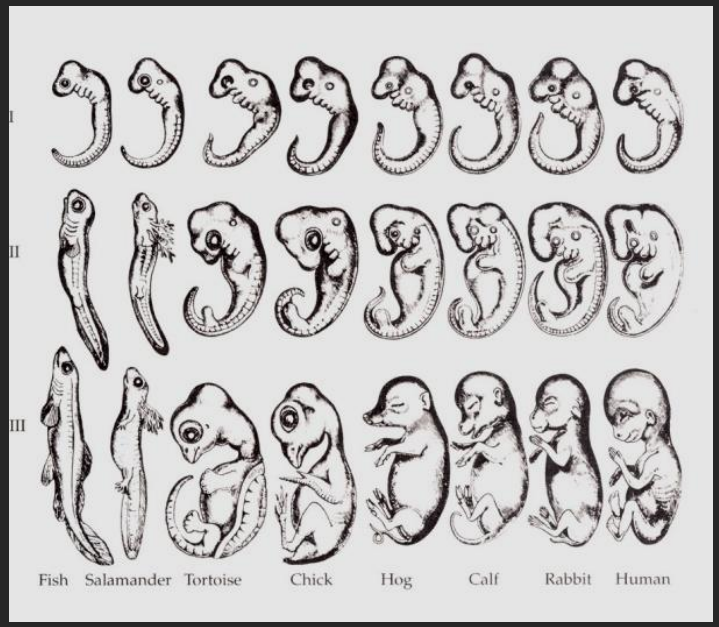
- Preformation Problems
  - If miniatures were stored within sperm, what was the function of the female ovum?
  - If the miniatures contain all of the hereditary information, how can we explain the transmission of characteristics from the mother's side?

Preformation Versus Epigenesis

- Pierre Louis de Maupertuis (1698-1759), French philosopher and mathematician:
  - 1745: First attempt to trace characters through a series of generations on both male and female sides
    - Male semen nourishment for first steps of ovum's growth = male characteristics
    - Laws of nature can construct the embryo from a mixture of fluid semen provided by both parents
      - Theoretical problem: How can the mere laws of mechanics control the movement of matter so precisely that they can construct an embryo out of a disorganized fluid?
        - Matter has powers such as memory and volition

Preformation Versus Epegenisis

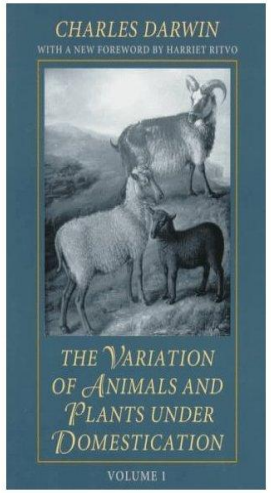
- The End of Preformation
  - Preformation theory largely dead by 19th century
  - Interest in gradual construction of a new organism
    - Pattern of development followed a hierarchy
      - Human embryo first an invertebrate, then a fish, reptile, lower mammal, human



Preformation Versus Epigenesis

- Ernst Haeckel (1834-1919)
  - German biologist, naturalist, philosopher, physician, professor and artist
    - discovered, described and named thousands of new species, mapped a genealogical tree relating all life forms, and coined many terms in biology
  - Haeckel developed the Recapitulation Theory
  - Recapitulation theory = development of the embryo recapitulates the evolutionary history of its species

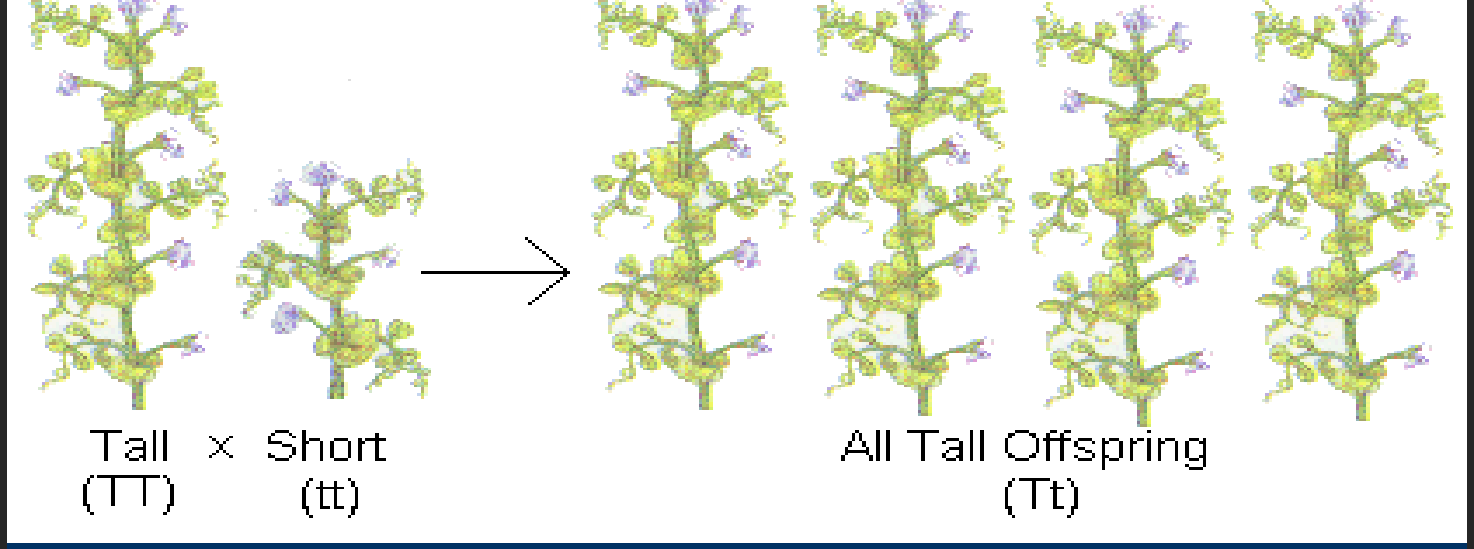
- Darwin and Genetics
  - 1868: "Pangenesis"
    - Heredity works through the transmission, to the offspring, of minute particles or "gemmules" budded off from the various parts of the parents' bodies
    - Character differences blended together
      - No genetic units transmitted unchanged from one generation to the next

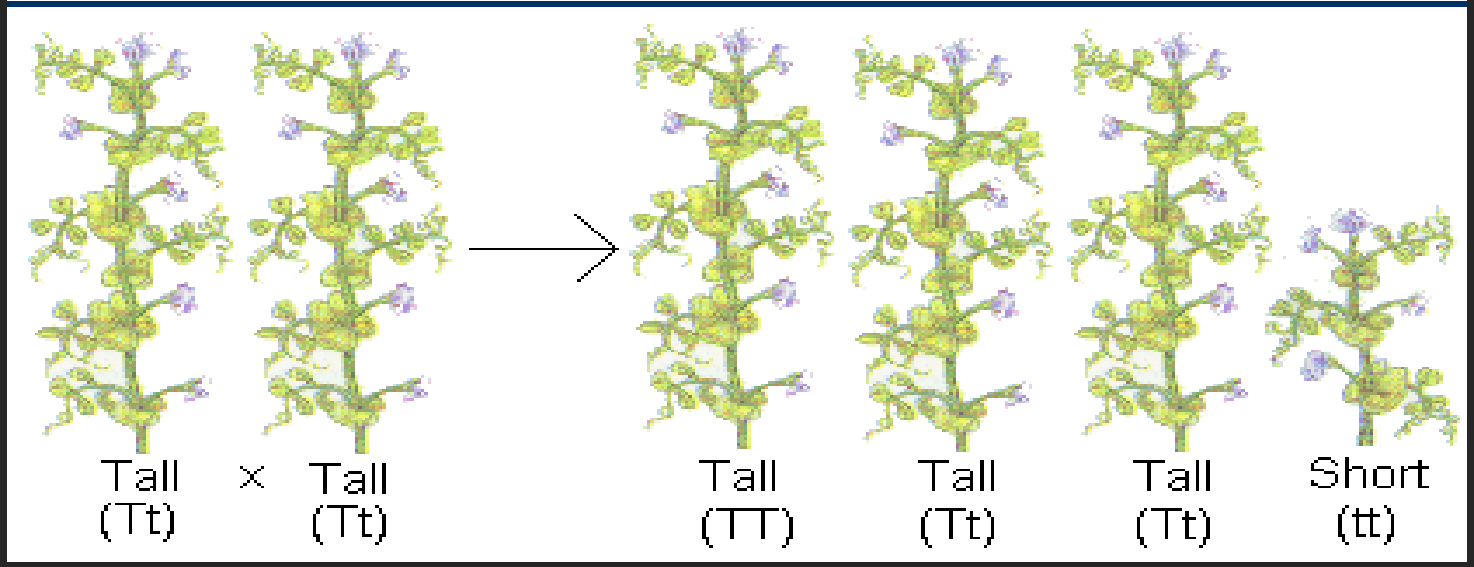


Mendel

- Gregor Johann Mendel (1822-1884)
  - Roman Catholic Priest and scientist, often called the father of genetics for his study of the inheritance of traits in pea plants
  - His discoveries remained unnoticed during own time
- Hybridized varieties of the garden pea
  - Traced distinctive characteristics through successive generations
    - Tall and short
      - 1st generation: Not blending, all tall
      - 2nd generation: 3:1 ration, 3 tall, 1 short
        - Heredity in terms of paired character determinant

Gregor Mendel





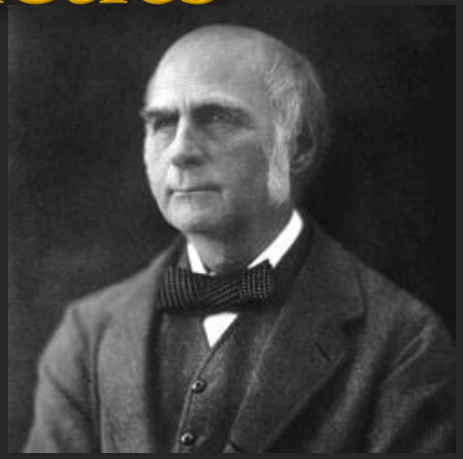
1st generation: Not blending, all tall

2nd generation: 3:1 ration, 3 tall, 1 short

- Heredity in terms of paired character determinant

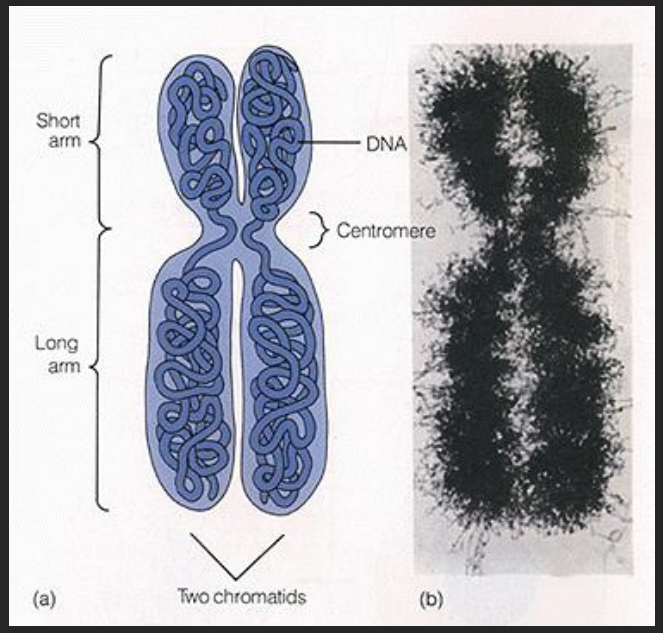
Prelude to Genetics

- Francis Galton (1822-1911)
  - Darwin's cousin
  - Human character is predetermined at birth by heredity
    - eugenics
- Oscar Hertwig (1849-1922)
  - German zoologists
  - recognized the role of the cell nucleus during inheritance
  - 1875: found that fertilization includes the penetration of a spermatozoon (sperm cell) into an egg cell.



Classical Genetics

- T.H. Morgan (1866-1945)
  - American biologist
  - genes are carried on chromosomes and are the mechanical basis of heredity



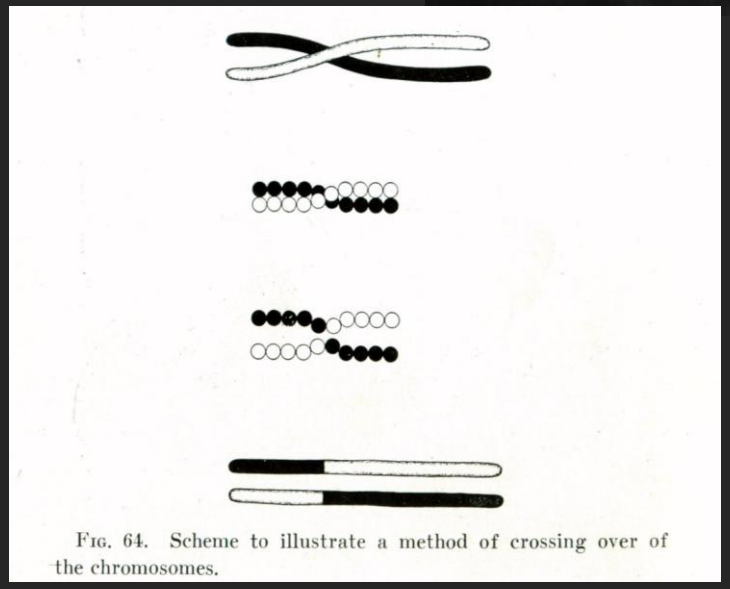
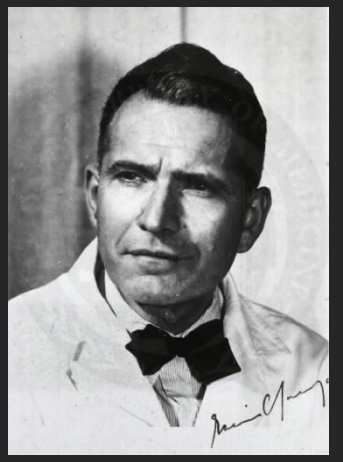


FIG. 64. Scheme to illustrate a method of crossing over of the chromosomes.

Molecular Biology

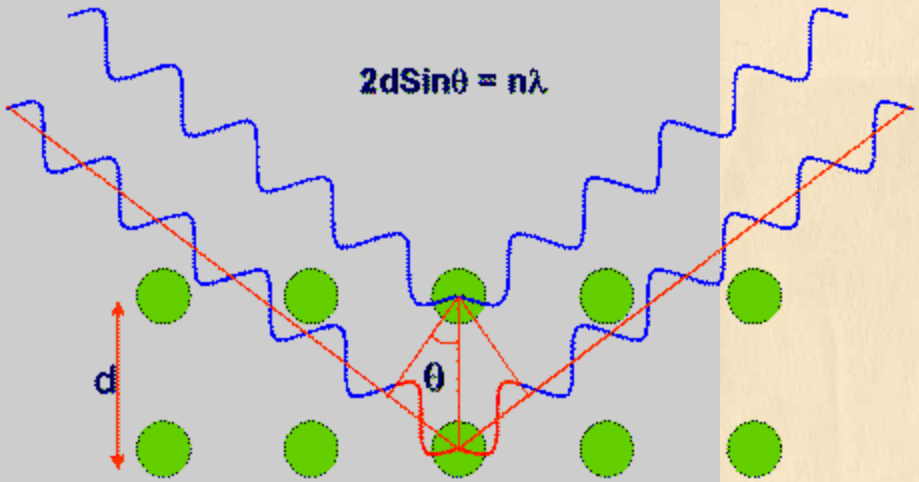
- 1930s: Viruses: 90% protein and 10% nucleic acid
  - First assumed genetic info in protein
  - 1940s: focus on nucleic acid
    - **Deoxyribonucleic acid (DNA)**and **Ribonucleic acid (RNA)**
      - DNA the genetic messenger
      - How could the structure of the DNA molecule both replicate itself and carry coded info that would trigger development in the organism?

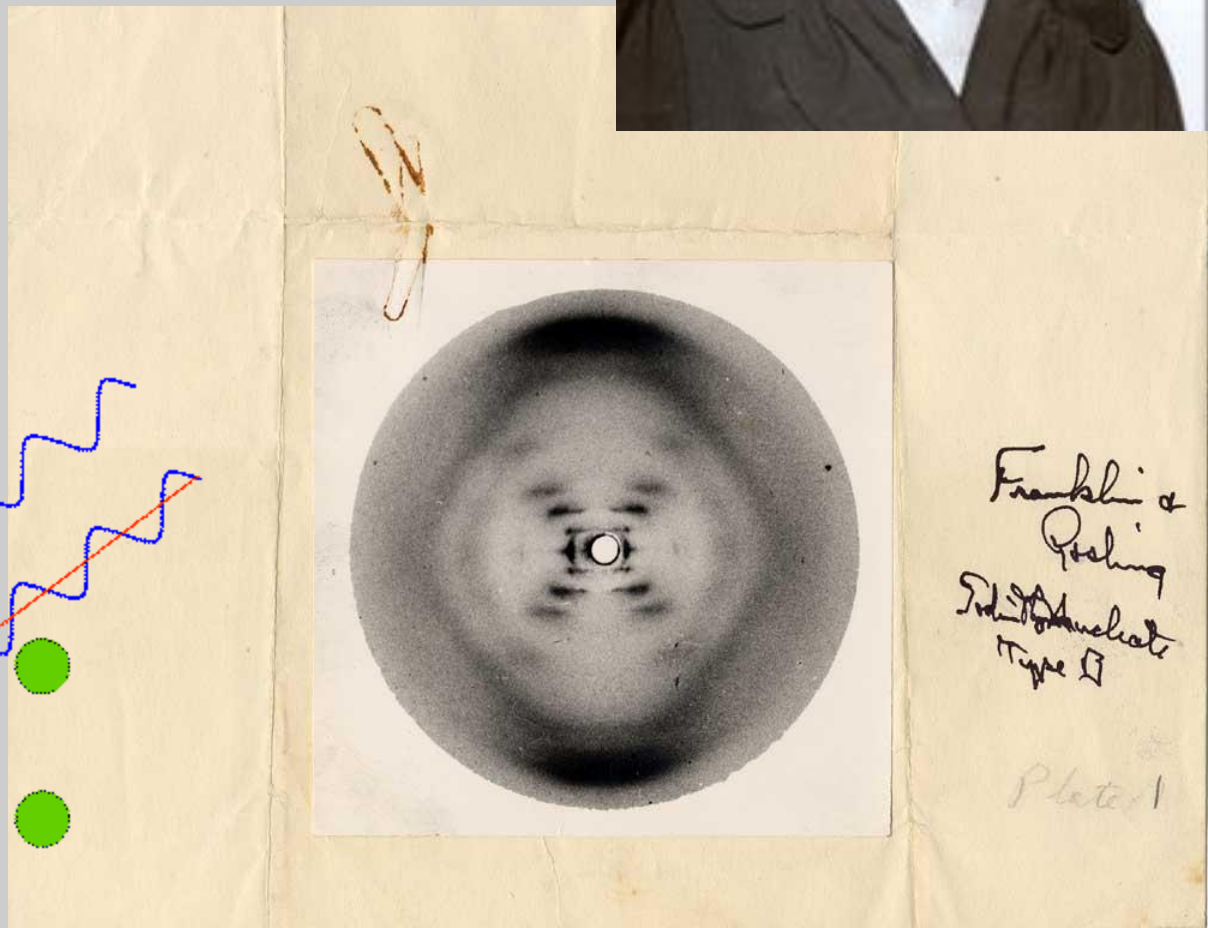
Molecular Biology



- Erwin Chargaff (1905-2002)
  - Austrian biochemist, who emigrated to the United States during the Nazi era
  - Chargaff discovered two rules that helped lead to the discovery of the double helix structure of DNA
  - The four bases found in DNA are adenine (abbreviated A), cytosine (C), guanine (G) and thymine (T).
    - In the DNA of any cell of all organisms the amount of guanine is equal to cytosine and the amount of adenine is equal to thymine. This pattern is found in both strands of the DNA

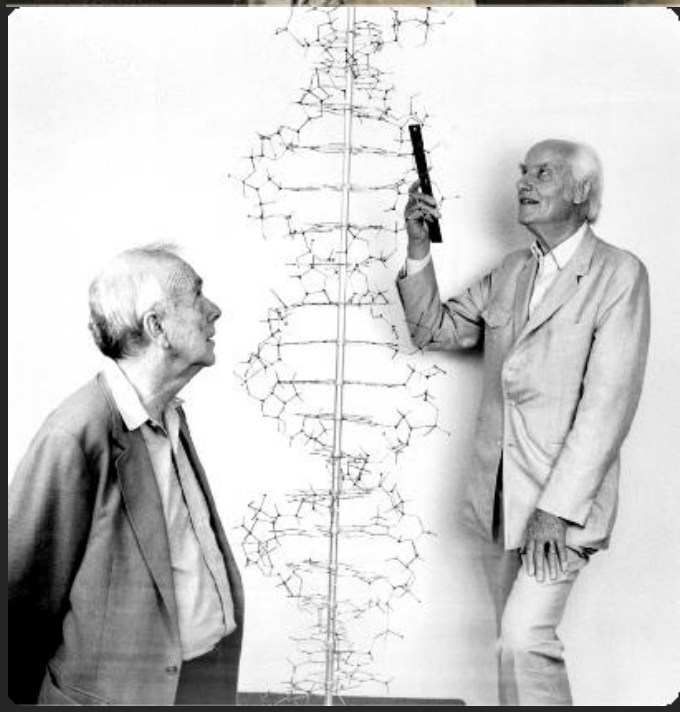
Rosalind Franklin (1920-1958)
X-ray studies of the molecule





Molecular Biology

- Double Helix
  - Maurice Wilkins (1916-2004) and Rosalind Franklin (1920-1958)
    - X-ray studies of the molecule
      - Spiral arrangement
  - James Watson (1928-) and Francis Crick (1916-2004)
    - 1953: the molecule was double helix with the information carried in the arrangement of the bases that make up the arms of the spiral



THE AGE OF THE EARTH

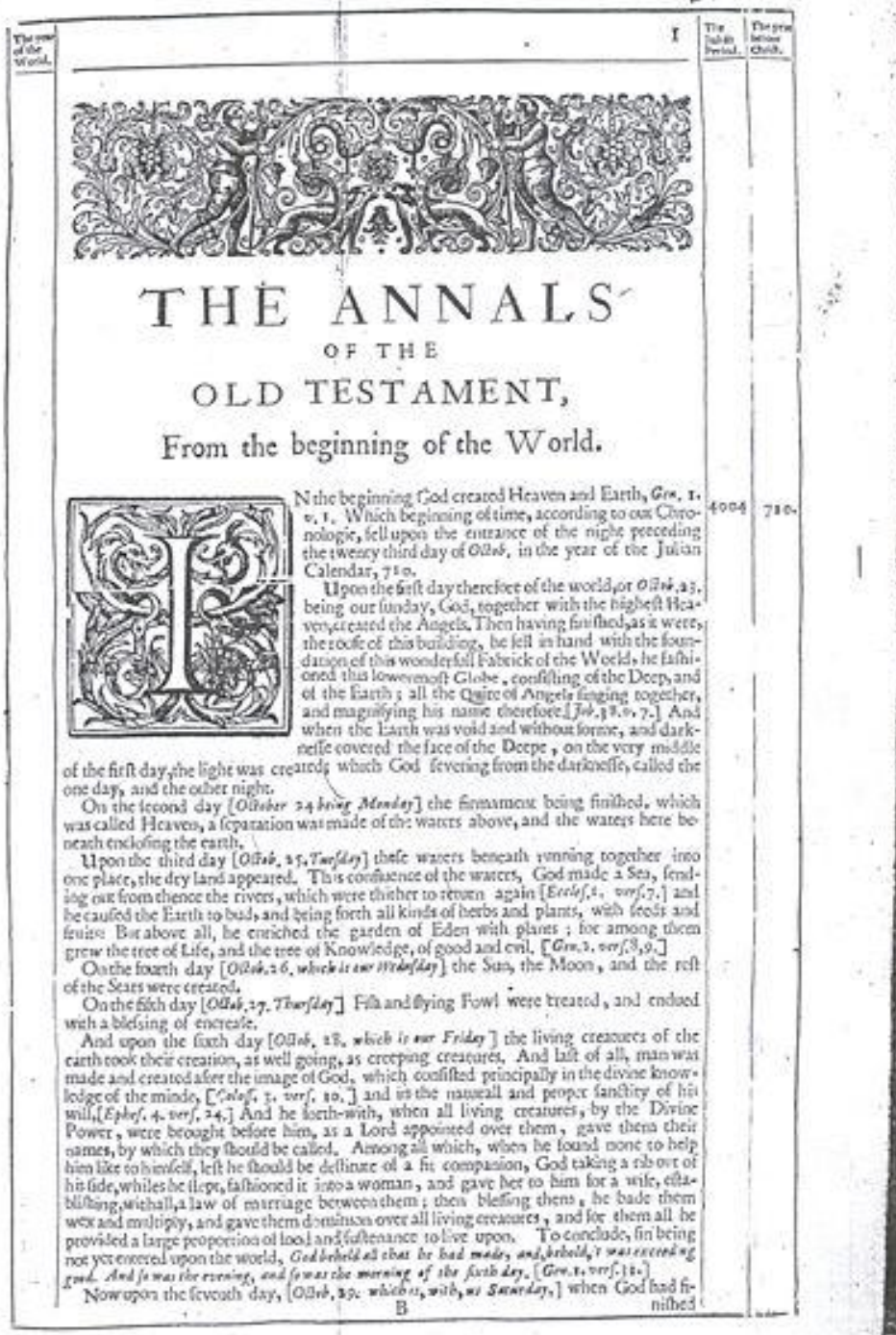
- One of the consequences of the 17th century Scientific Revolution was that by the middle decades of the 17th century the earth itself became an object of studying, and its origin a topic of the theoretical speculation.

- The 17th century was the period in which Protestant theologians and scholars established the “young earth” chronology based on a literal reading of Genesis.

Name KJ Version	Name NIV version	Date of Birth	Age upon 1st son	Age at Death	Years lived			
Adam	Adam	1	130	930	1-931	Genesis	5:3-5	(NIV)
Seth	Seth	131	105	912	131-1043	Genesis	5:6-8	(NIV)
Enos	Enosh	236	90	905	236-1141	Genesis	5:9-11	(NIV)
Cainan	Kenan	326	70	910	326-1236	Genesis	5:12-14	(NIV)
Mahalaleel	Mahalalel	396	65	895	396-1291	Genesis	5:15-17	(NIV)
Jared	Jared	461	162	962	461-1423	Genesis	5:18-20	(NIV)
Enoch	Enoch	623	65	365	623-988	Genesis	5:21-24	(NIV)
Methuselah	Methuselah	688	187	969	688-1657	Genesis	5:25-27	(NIV)
Lamech	Lamech	875	182	777	875-1652	Genesis	5:28-31	(NIV)
Noah	Noah	1057	500	950	1057-2007	Genesis	6:8-9:29	(NIV)
Shem	Shem	1559	100	600	1559-2159	Genesis	11:10	(NIV)
Arphaxad	Arphaxad	1659	35	438	1659-2097	Genesis	11:10-13	(NIV)
Salah	Shelah	1694	30	433	1694-2127	Genesis	11:12-15	(NIV)
Eber	Eber	1724	34	464	1724-2188	Genesis	11:14-17	(NIV)
Peleg	Peleg	1758	30	239	1758-1997	Genesis	11:16-19	(NIV)
Reu	Reu	1788	32	239	1788-2027	Genesis	11:18-21	(NIV)
Serug	Serug	1820	30	230	1820-2050	Genesis	11:20-23	(NIV)
Nahor	Nahor	1850	29	148	1850-1998	Genesis	11:22-25	(NIV)
Terah	Terah	1879	70	205	1879-2084	Genesis	11:24-32	(NIV)
Abram/Abraham	Abram/Abraham	2009	100	175	2009-2184	Genesis	12:1-25:10	(NIV

- Mid 17th century:

  James Ussher, archbishop of Armagh: The first day of creation began at nightfall preceding Sunday October 23, 4004 BC.



THE ANNALS
OF THE
OLD TESTAMENT,
From the beginning of the World.

IN the beginning God created Heaven and Earth, *Gen.* 1. v. 1. Which beginning of time, according to our Chronologie, fell upon the entrance of the night preceding the twenty third day of *Octob.* in the year of the Julian Calendar, 710. 4004 710

Upon the first day therefore of the world, or *Octob.* 23. being our sunday, God, together with the highest Heavens, created the Angels. Then having finished, as it were, the roofe of this building, he fell in hand with the foundation of this wonderfull Fabrick of the World. he fashioned this lowermost Globe, consisting of the Deep, and of the Earth; all the Quire of Angels singing together, and magnifying his name therefore. [*Job.* 38. v. 7.] And when the Earth was void and without forme, and darkenesse covered the face of the Deepe, on the very middle of the first day, the light was created; which God severing from the darkenesse, called the one day, and the other night.

On the second day [*October* 24 *being Monday*] the firmament being finished, which was called Heaven, a separation was made of the waters above, and the waters here beneath enclosing the earth.

Upon the third day [*Octob.* 25. *Tuesday*] these waters beneath running together into one place, the dry land appeared. This confluence of the waters, God made a Sea, sending out from thence the rivers, which were thither to returne again [*Eccles.* 1. *vers.* 7.] and he caused the Earth to bud, and bring forth all kinds of herbs and plants, with seeds and fruits. But above all, he enriched the garden of Eden with plants; for among them grew the tree of Life, and the tree of Knowledge, of good and evil. [*Gen.* 2. *vers.* 8, 9.]

On the fourth day [*Octob.* 26. *which is our Wednesday*] the Sun, the Moon, and the rest of the Stars were created.

On the fifth day [*Octob.* 27. *Thursday*] Fish and flying Fowl were created, and endued with a blessing of encrease.

And upon the sixth day [*Octob.* 28. *which is our Friday*] the living creatures of the earth took their creation, as well going, as creeping creatures. And last of all, man was made and created after the image of God, which consisted principally in the divine knowledge of the minde, [*Colos.* 3. *vers.* 10.] and in the naturall and proper sanctity of his will, [*Ephes.* 4. *vers.* 24.] And he forth-with, when all living creatures, by the Divine Power, were brought before him, as a Lord appointed over them, gave them their names, by which they should be called. Among all which, when he found none to help him like to himself, lest he should be destitute of a fit companion, God taking a rib out of his side, whiles he slept, fashioned it into a woman, and gave her to him for a wife, establishing withall, a law of marriage between them; then blessing them, he bade them wex and multiply, and gave them dominion over all living creatures, and for them all he provided a large proportion of food and sustenance to live upon. To conclude, sin being not yet entered upon the world, *God beheld all that he had made, and, behold, it was exceeding good. And so was the evening, and so was the morning of the sixth day.* [*Gen.* 1. *vers.* 31.]

Now upon the seventh day, [*Octob.* 29. *which is, with us, Saturday.*] when God had finished

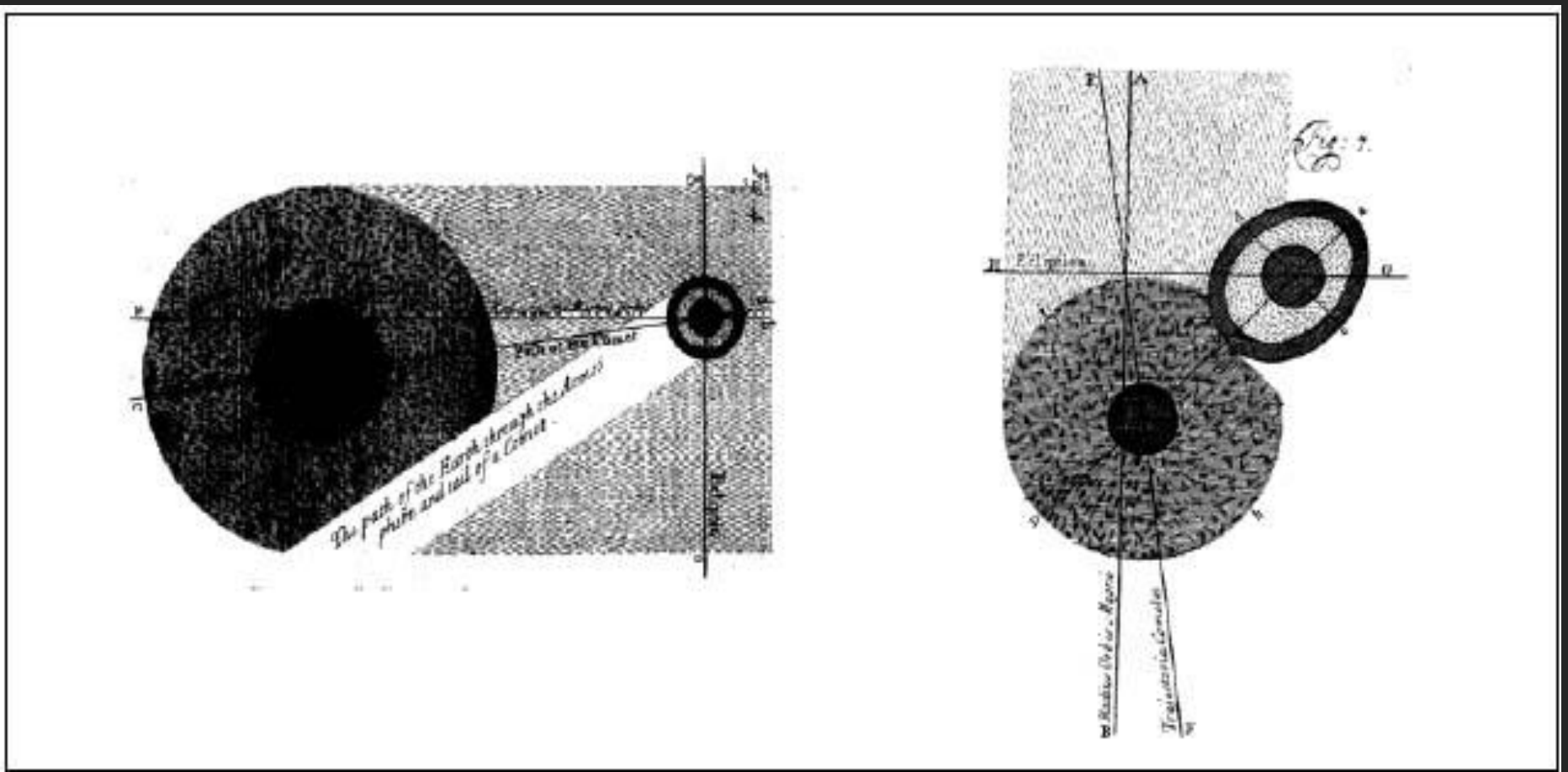
- Some of the early theories of the earth arouse out of efforts to situate the origin of the earth within new cosmologies proposed by Descartes and Newton.

- Thomas Burnet's ***Sacred Theory of the Earth*** (1691) followed Descartes' cosmology

- William Whiston's ***New Theory of the Earth*** (1696) followed Newton's theory and explained the flood as a due to water deposited from a near-approach of a comet

- What was new about these theories was their willingness to explain events of deep spiritual significance, such as Noah's flood, as a consequence of purely physical events.

William Whiston's theory about the flood



- From geological studies, and findings from mining activities it became widely accepted that fossils were the remains of once-living creatures petrified within the rocks.

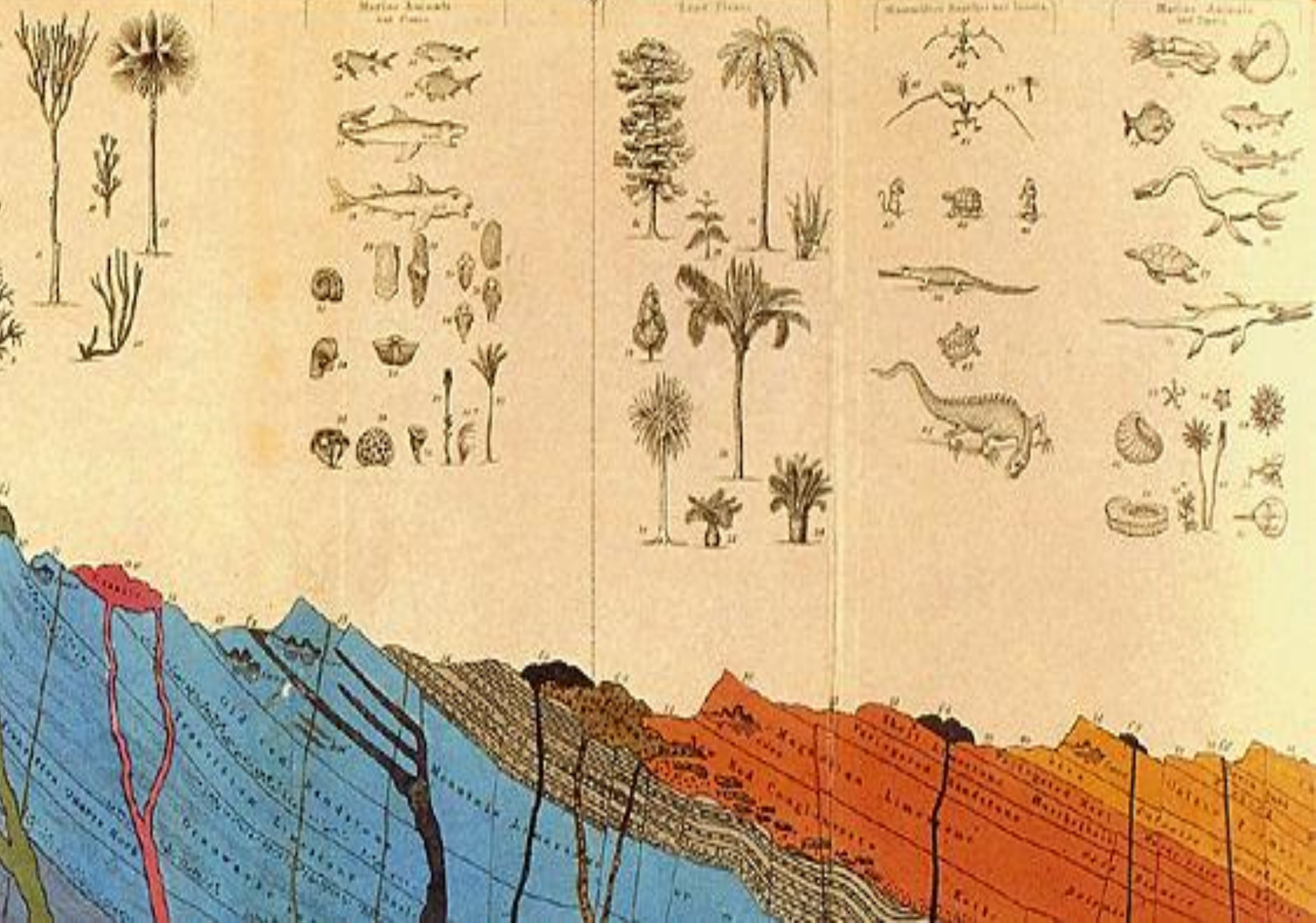
- British scientist Robert Hooke, and the anatomist Nicholas Steno noted that the appearance of fossils within layers or strata of rock that gave every appearance of being deposited under water, even though they were now exposed on dry land.

- Georges Louis Leclerc, comte de Buffon: *Natural History* (1749): A Mechanistic and anti-biblical interpretation of the terrestrial phenomena:
- Planets were all derived from globules of molten material struck off from the sun by glancing blow by a comet.
- It took about 70,000 years for the earth to cool down. Not a long age for the earth but better than bishop Ussher's estimation!
- Buffon's cosmological theory gave his history an obvious direction defined by the cooling of the earth.
- Discovery of the fossils of elephants in Siberia shows that tropical creatures had once flourished in places that now are very cold.

- Mining academies were set up to train people in skills needed to locate and extract minerals, and here the practical implications of a detailed knowledge of the earth's crust first became apparent.
- Out of this practical study of minerals came a methodology for identifying the sequence in which the successive rocks had been deposited in the course of the earth's history.
- The identification of a rock's position in the sequence of deposits implied identifying the period in the earth's history when it was laid down.

TRANSITION SERIES

SECONDARY SERIES



- Since it was recognized that similar rocks could be formed at different periods in the earth's history, the best way of identifying the sequence was through the fossils embedded in the strata.
- The fossils of each period were characteristic, whatever the type of rock they were embedded in.
- The fossil- based stratigraphy was pioneered by the English canal-builder William Smith, and in France by the paleontologist Georges Cuvier and geologist Alexandre Brongiart.


MESOZOIC ERA
JURASSIC PERIOD
CRETACEOUS PERIOD
TRIASSIC PERIOD
CAMBRIAN PERIOD
ORDOVICIAN PERIOD
PALEOZOIC ERA
PERMIAN PERIOD
PENNSYLVANIAN PERIOD
MISSISSIPPIAN PERIOD
DEVONIAN PERIOD
PRECAMBRIAN
CENOZOIC ERA
Holocene Epoch
Pleistocene Epoch
Pliocene Epoch
Miocene Epoch
TERTIARY PERIOD
QUATERNARY PERIOD
1 BILLION YEARS AGO
2 BILLION YEARS AGO

- **Catastrophism :**
- **Terrestrial changes happened because of catastrophic events like volcanoes, earthquakes, etc (Cuvier)**

- **Uniformitarianism:**
- **Terrestrial changes happened gradually during a long period of time (Hutton and Lyell)**

- Hutton's unifomrmitarian idea gained more evidence because he showed that the process responsible for forming the rocks have all occurred at the same rate as we observe today.

- Darwin's theory also was pro-uniformitarianism, because the evolution needed a long time for steady changes in the species

Darwin ....

1831 - 26 April Darwin received his BA degree.

1831 - Darwin received an invitation to serve as unpaid naturalist on the survey ship H.M.S. *Beagle*, which was to travel around the world. At this point Darwin had no formal training in science.

1831 December 27 - The H.M.S. *Beagle* sailed from Devonport, England

1832 September 23 - Darwin made his first important fossil find, notably various extinct mammals.

1835 September - Darwin studied geology and the fauna, and flora of Galapagos Islands. Here he made detailed observations, eventually noting of the now-famous 'Darwin's finches' as well as the Galapagos tortoises.

1835 December - Darwin wrote his first known draft of his paper on theory of formation of coral reefs.

1836 October 2 - The H.M.S. *Beagle* finally returned to England and docked at Falmouth, England.

1837 July - Darwin 'Opened first notebook on Transmutation of Species.'

1837 October - Darwin began work leading to *Zoology of the Voyage of H.M.S. Beagle, edited and superintended by Charles Darwin*, published 1840-1843, 5 volumes.

1838 September 28 - Darwin started to read Malthus, and later claimed to have formulated his theory of evolution by natural selection.

1842 (May) & 1844 (July) - Darwin wrote preliminary essays, similar in content and structure to *Origin of Species,* a Pencil Sketch (1842) and a later a longer Outline (1844) in ink.

1844 - Robert Chambers published his *Vestiges of the Natural History of Creation* anonymously. The response was vigorous but mixed.

1846 October 1 - Darwin finished the third and final volume of *The Geology of the Voyage of the Beagle*. It was a popular success.

1856 May 14 - Darwin began to write large work on species, *Natural Selection*, a massive study on evolution, which he never finished. The *Origin* was later called an 'Abstract'.

1858 June 18 - Darwin received the now-famous letter from Alfred Russell Wallace, who had formulated a theory of evolution through natural selection. Wallace's key concepts seemed to reflect the very chapter titles of the draft version of Darwin's as yet unpublished *Origin*.

1858 July 1 - A solution is found. Papers by Darwin and Wallace, announcing theory of Evolution through natural selection, were read at Linnaean Society, London. The effect was underwhelming.

1858 August 20 - joint paper with Wallace is published.

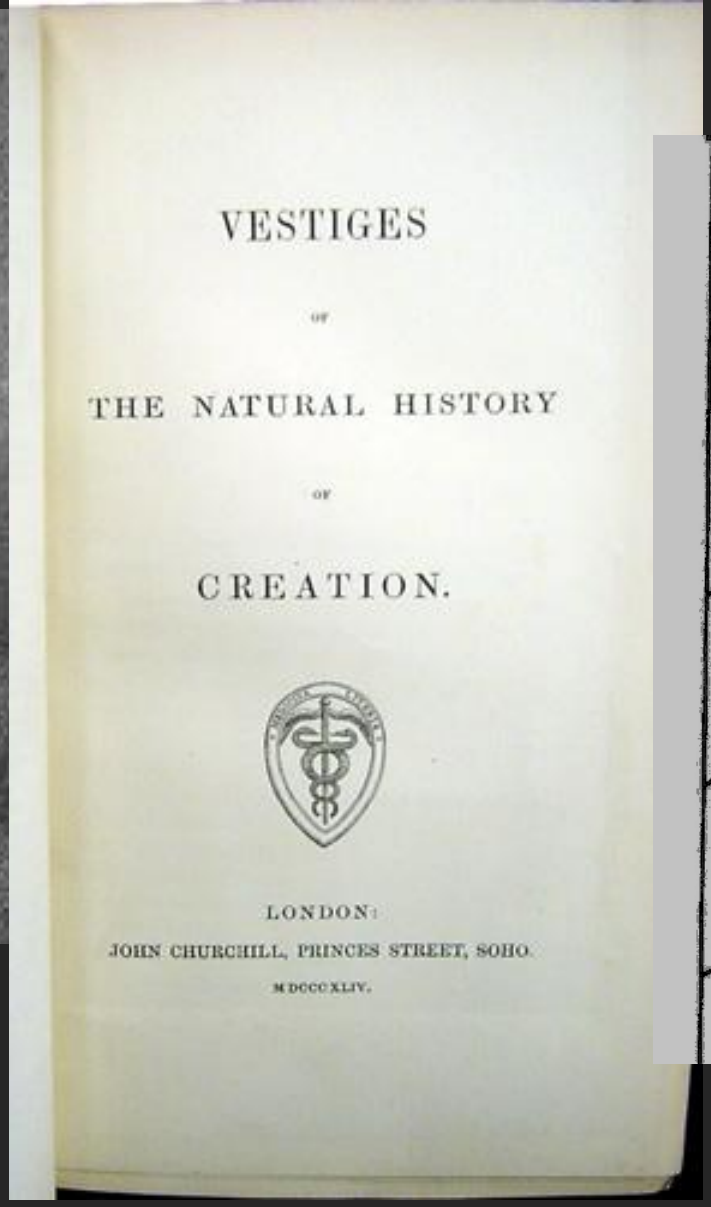
1859 March 19 - Darwin finished writing the last chapter of *Origin*.

1859 November 24 - Darwin's *Origin of Species* is published by Murray of London (1,250 copies, all sold first day).

Source: Dr. Robert A. Hatch, http://www.clas.ufl.edu/users/rhatch/pages/02-TeachingResources/readingwriting/darwin/05-DARWIN-CHRON.htm

- A literal reading of the Genesis creation story first became widely accepted in the 17th century.
- If the earth was only a few thousand years old, any gradual process of development of living systems became unthinkable. The only explanation for the origin of plants, animals, and human beings was that their first a ancestors were created directly by God.

- J. B. Lamarck, French naturalist, made important contribution to invertebrate taxonomy: around 1800 he argued that the higher animals evolved from in the course of time by a progressive trend that made each generation slightly more complex than its parents.
- Ladder model of evolution, no branching
- The concept of “Inheritance of acquired characteristics”


VESTIGES

OF

THE NATURAL HISTORY

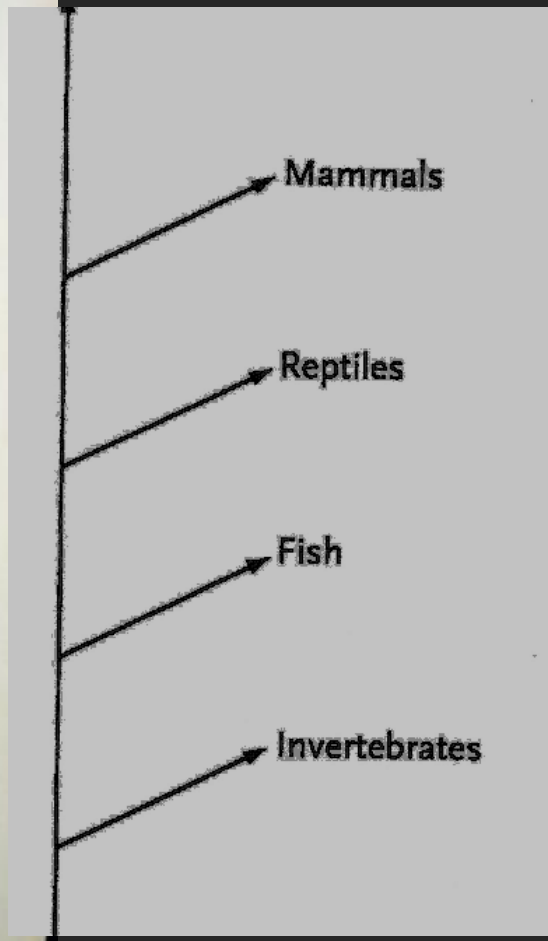
OF

CREATION.

LONDON:

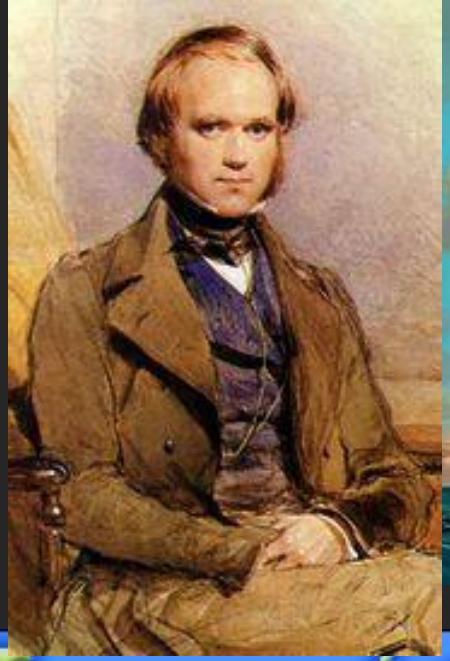
JOHN CHURCHILL, PRINCES STREET, SOHO.

MDCCCXLIV.



Chambers' ***Vestiges of the Natural History***- 1844. This book popularized the concept of Evolution.

Charles Darwin

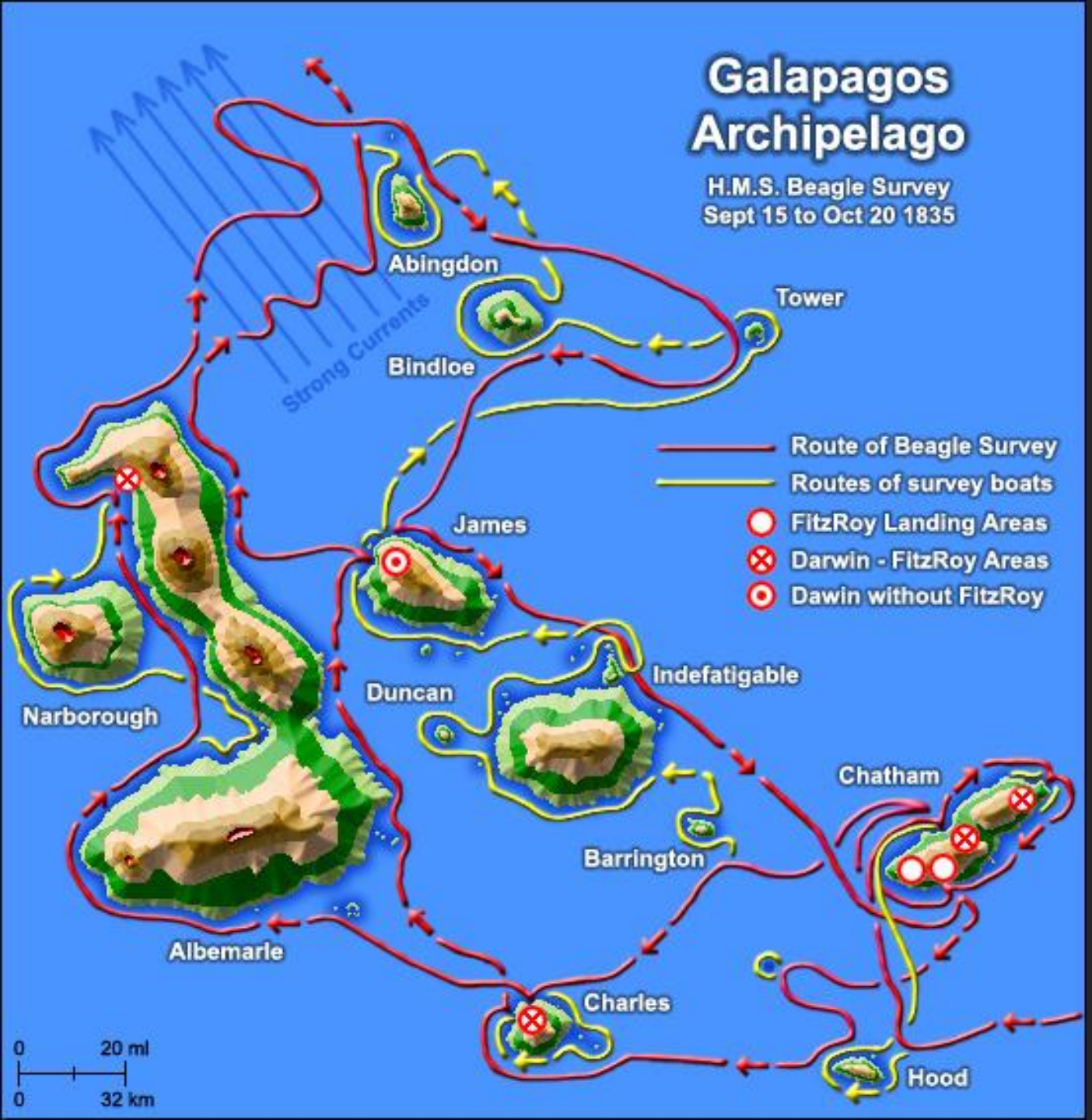



Salvador
Abrolhos
Shoals
Rio de
Janeiro
0
400 mi
0
640 km

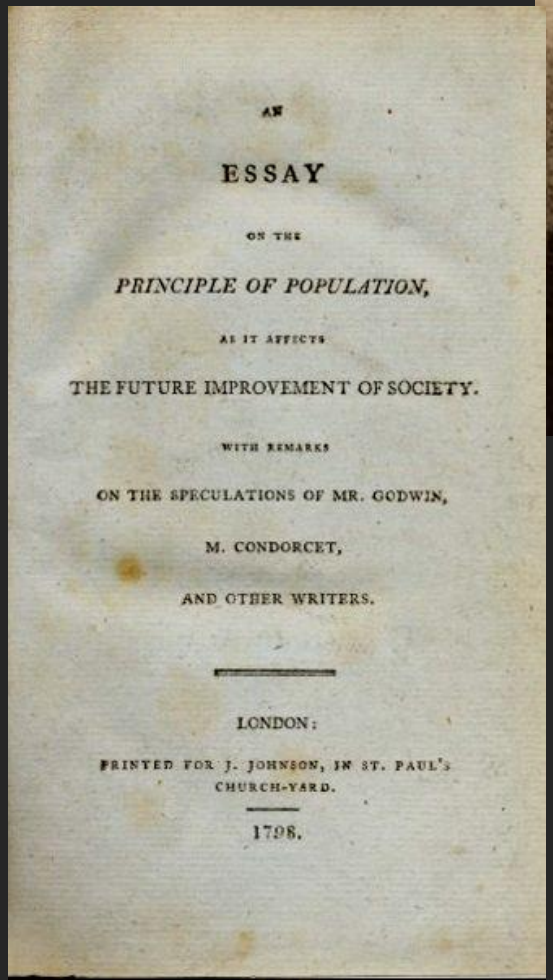

All Saints Bay
Conjectured route
of Darwin's trek.
Salvador
0
25 mi
0
40 km


Rio
Macae
0
25 mi
0
40 km
Cape
Frio
Rio de Janeiro
Lagoa Marica


Rio de
Janeiro
0
400 mi
0
640 km
Buenos
Aires
Maldonado
Montevideo
Bahia
Bianca


Galapagos Archipelago
H.M.S. Beagle Survey
Sept 15 to Oct 20 1835
Abingdon
Tower
Bindloe
Strong Currents
Route of Beagle Survey
Routes of survey boats
FitzRoy Landing Areas
Darwin - FitzRoy Areas
Dawin without FitzRoy
James
Indefatigable
Duncan
Narborough
Chatham
Barrington
Albemarle
Charles
Hood
0
20 mi
0
32 km

Malthus:
The reproductive capacity
Of any population always
Exceeds the food supply:
Struggle for Existence



AN

ESSAY

ON THE

PRINCIPLE OF POPULATION,

AS IT AFFECTS

THE FUTURE IMPROVEMENT OF SOCIETY.

WITH REMARKS

ON THE SPECULATIONS OF MR. GODWIN,

M. CONDORCET,

AND OTHER WRITERS.

LONDON:

PRINTED FOR J. JOHNSON, IN ST. PAUL'S CHURCH-YARD.

1798.

- "In October 1838, that is, fifteen months after I had begun my systematic inquiry, I happened to read for amusement Malthus on *Population*, and being well prepared to appreciate the struggle for existence which everywhere goes on from long- continued observation of the habits of animals and plants, it at once struck me that under these circumstances favorable variations would tend to be preserved, and unfavorable ones to be destroyed. The results of this would be the formation of a new species. Here, then I had at last got a theory by which to work". Charles Darwin, from his autobiography. (1876)

Natural selection

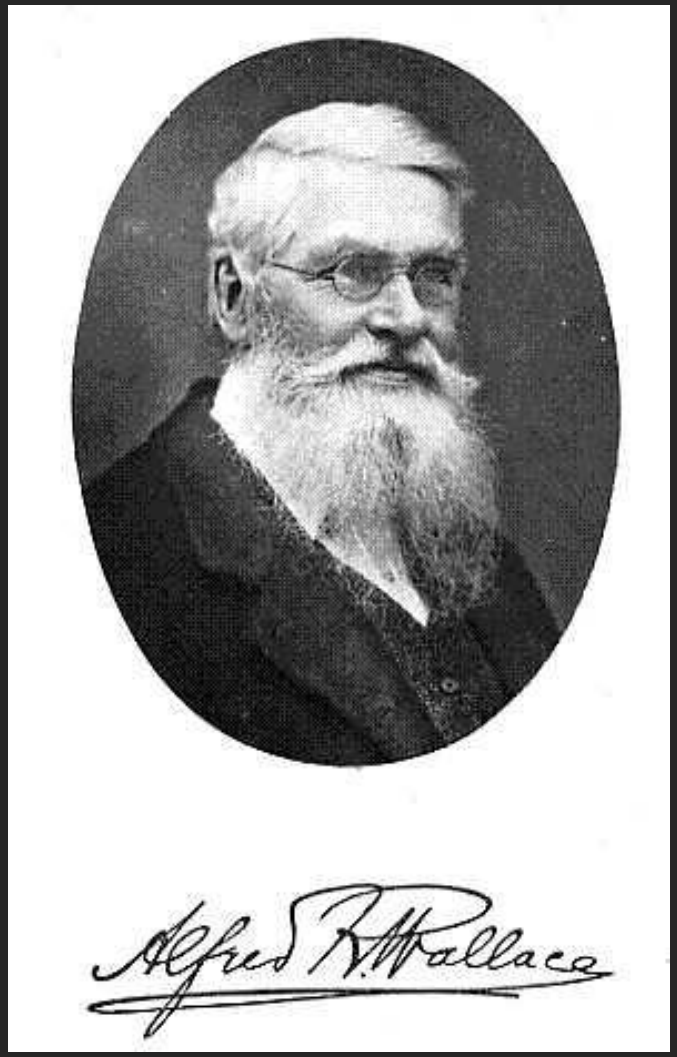
- Darwin:

  “In plants man presents mixtures, varies conditions, and destroy, the unfavourable kind – could he do this last effectively and keep on the same exact conditions for many generations he would make species, which would be infertile with other species”

Natural Selection

- Darwin:

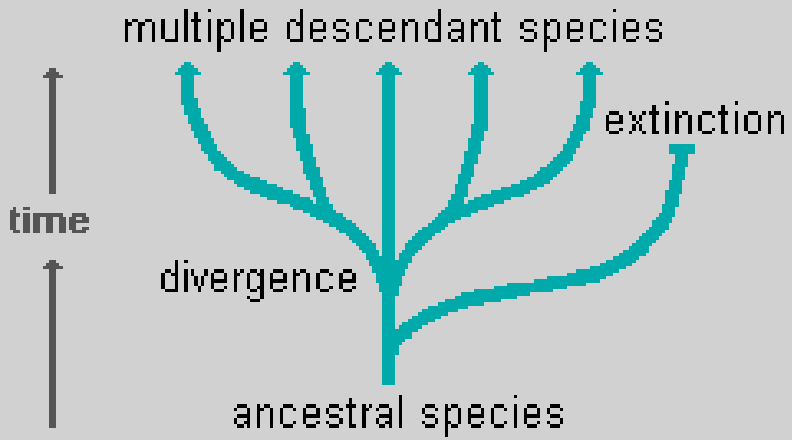
  "A severe winter, or scarcity of food, by destroying the weak and the unhealthy, has all the good effects of the most skilful selections"

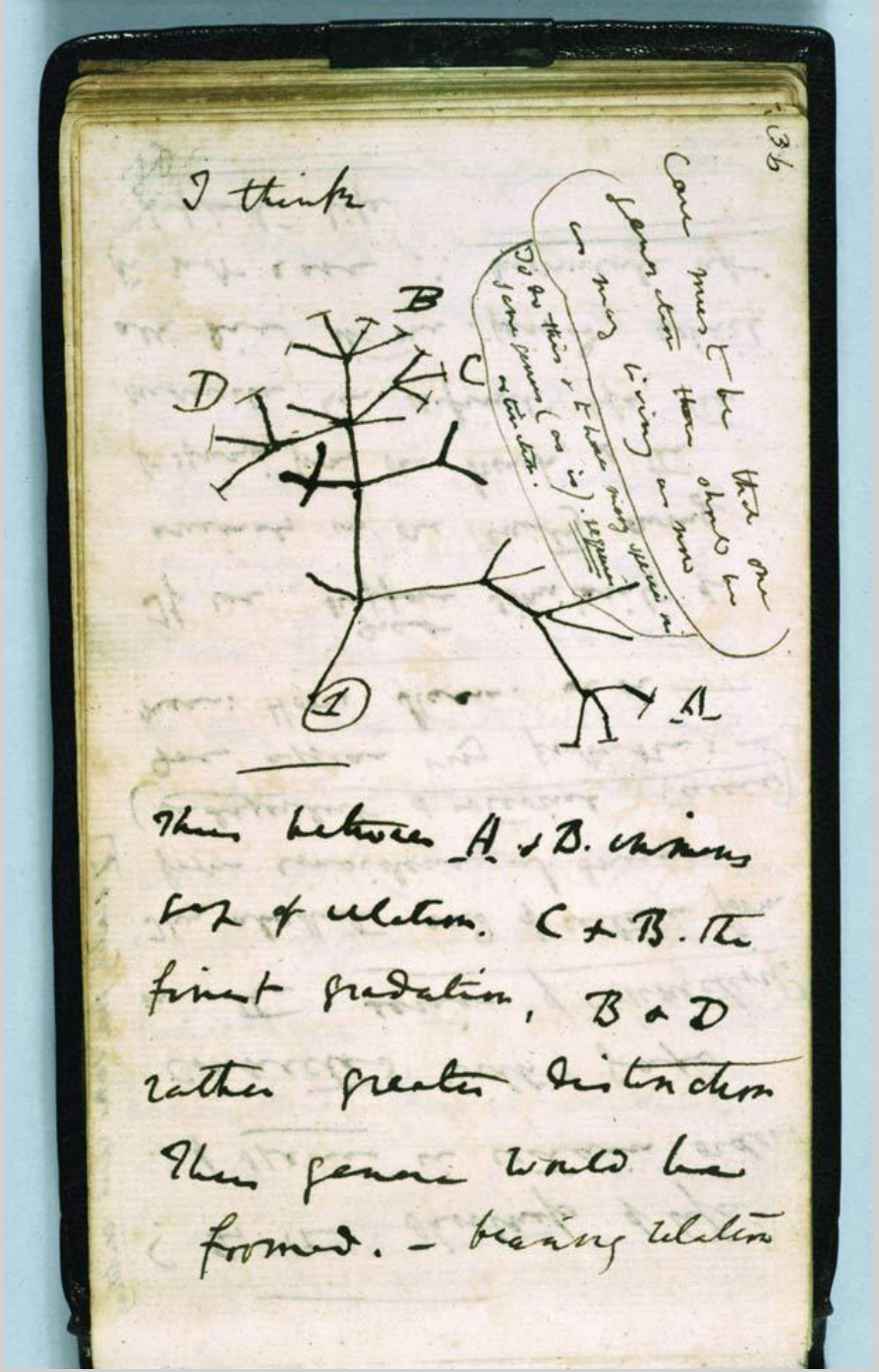


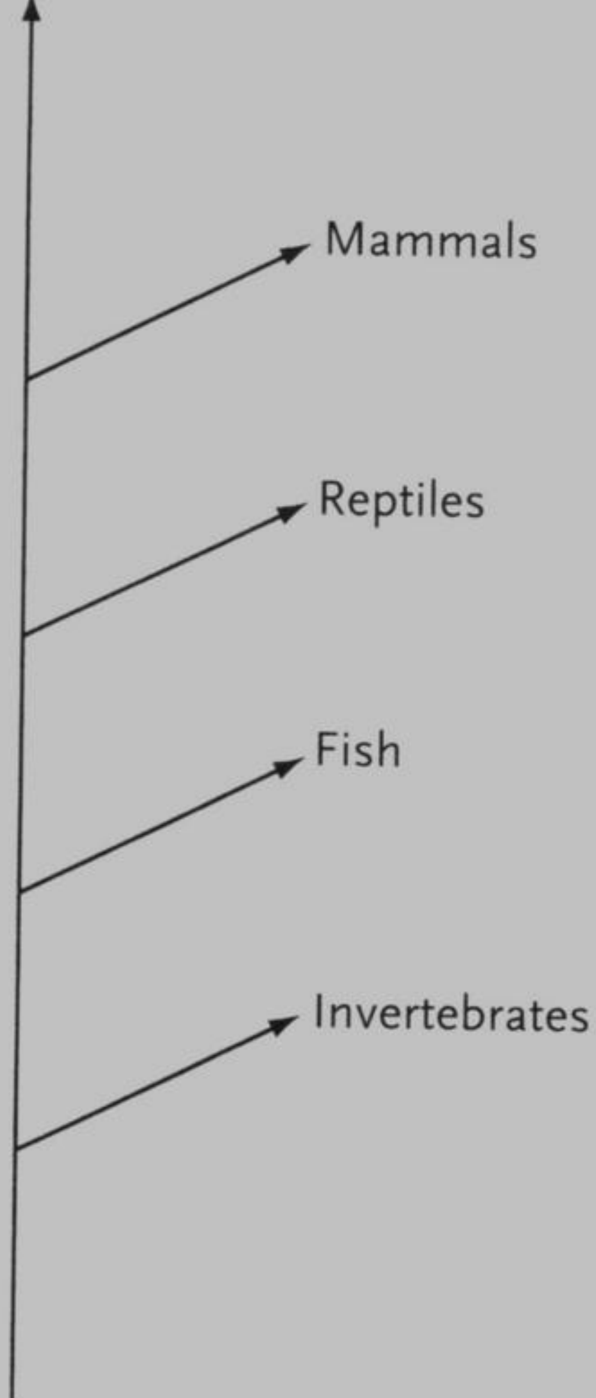
Alfred Russel Wallace (8 January 1823 – 7 November 1913) British naturalist, explorer, geographer, anthropologist and biologist.

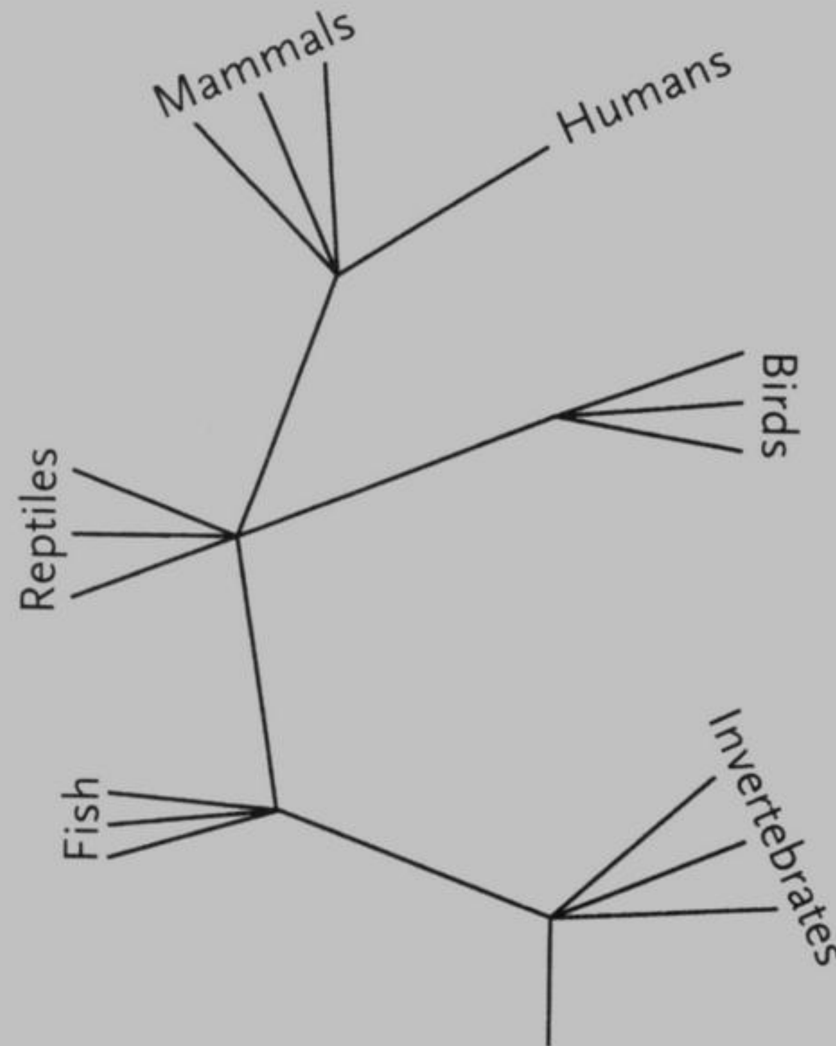
He is best known for independently proposing a theory of natural selection which prompted Charles Darwin to publish his own theory.

Darwin came to understand that any population consists of individuals that are all slightly different from one another. Those individuals having a variation that gives them an advantage in staying alive long enough to successfully reproduce are the ones that pass on their traits more frequently to the next generation. Subsequently, their traits become more common and the population evolves. Darwin called this "descent with modification."






Mammals
Reptiles
Fish
Invertebrates


Mammals
Humans
Birds
Reptiles
Fish
Invertebrates

"But with regard to the material world, we can at least go so far as this—we can perceive that events are brought about not by insulated interpositions of Divine power, exerted in each particular case, but by the establishment of general laws."

W. Whewell: *Bridgewater Treatise.*

"To conclude, therefore, let no man out of a weak conceit of sobriety, or an ill-applied moderation, think or maintain, that a man can search too far or be too well studied in the book of God's word, or in the book of God's works; divinity or philosophy; but rather let men endeavour an endless progress or proficience in both."

Bacon: *Advancement of Learning.*

Down, Bromley, Kent,
October 1st, 1859.

ON

THE ORIGIN OF SPECIES

BY MEANS OF NATURAL SELECTION,

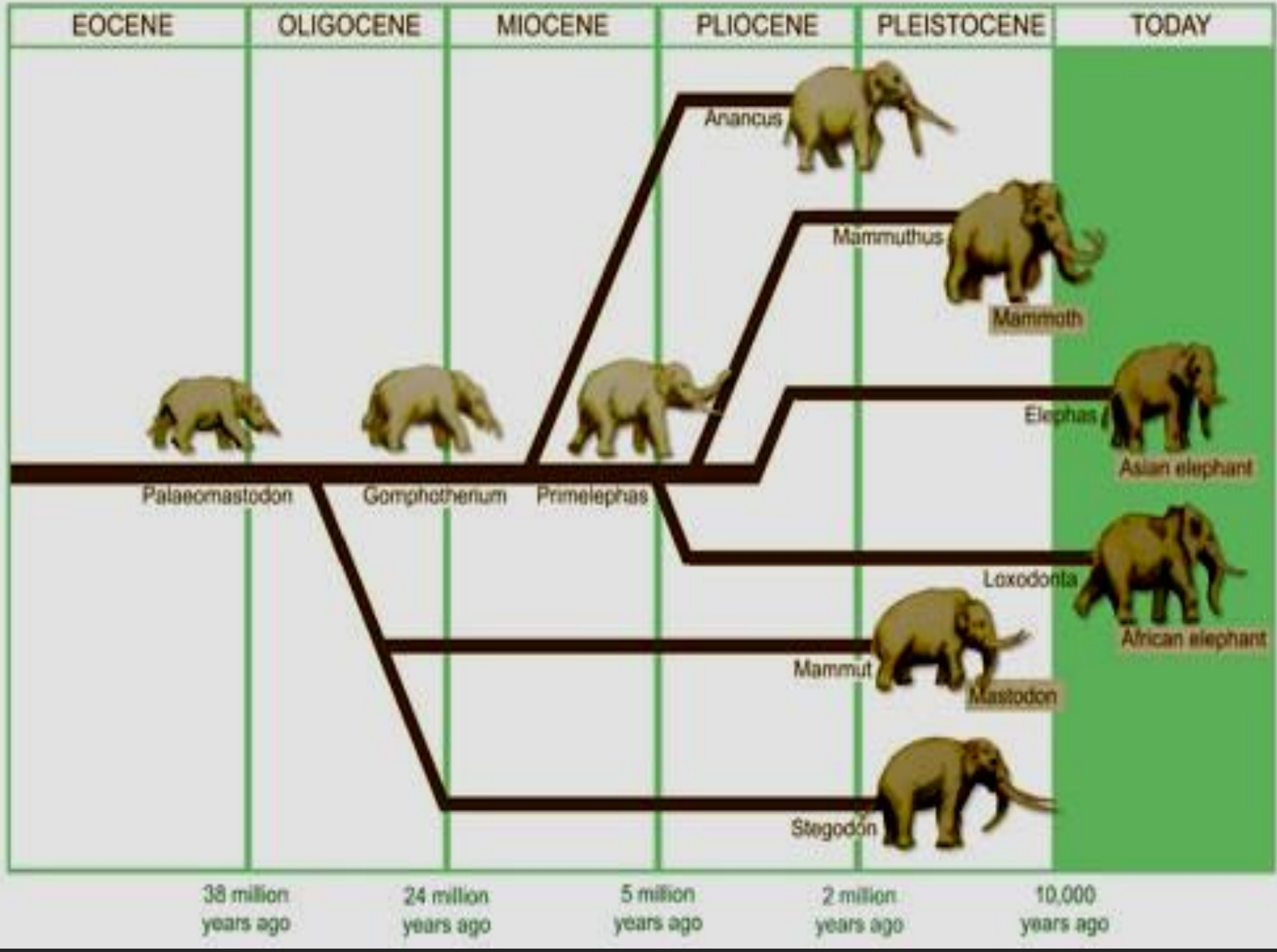
OR THE

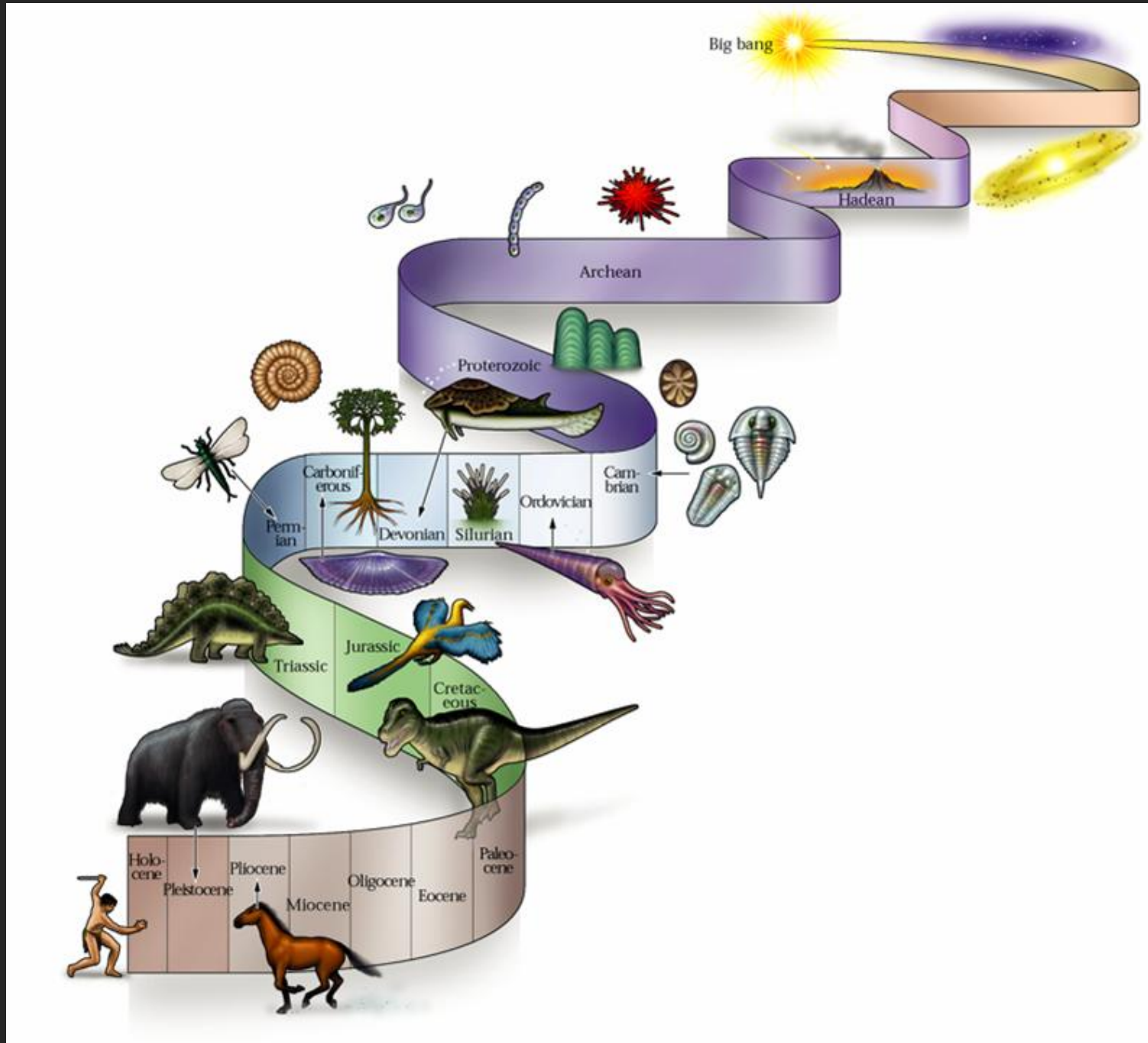
PRESERVATION OF FAVOURED RACES IN THE STRUGGLE FOR LIFE.

By CHARLES DARWIN, M.A.,

FELLOW OF THE ROYAL, GEOLOGICAL, LINNÆAN, ETC., SOCIETIES;
AUTHOR OF 'JOURNAL OF RESEARCHES DURING H. M. S. BEAGLE'S VOYAGE ROUND THE WORLD.'

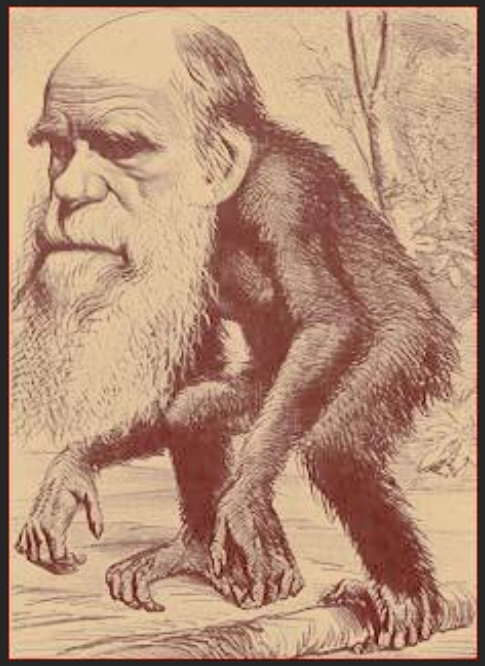
LONDON:
JOHN MURRAY, ALBEMARLE STREET.
1859.

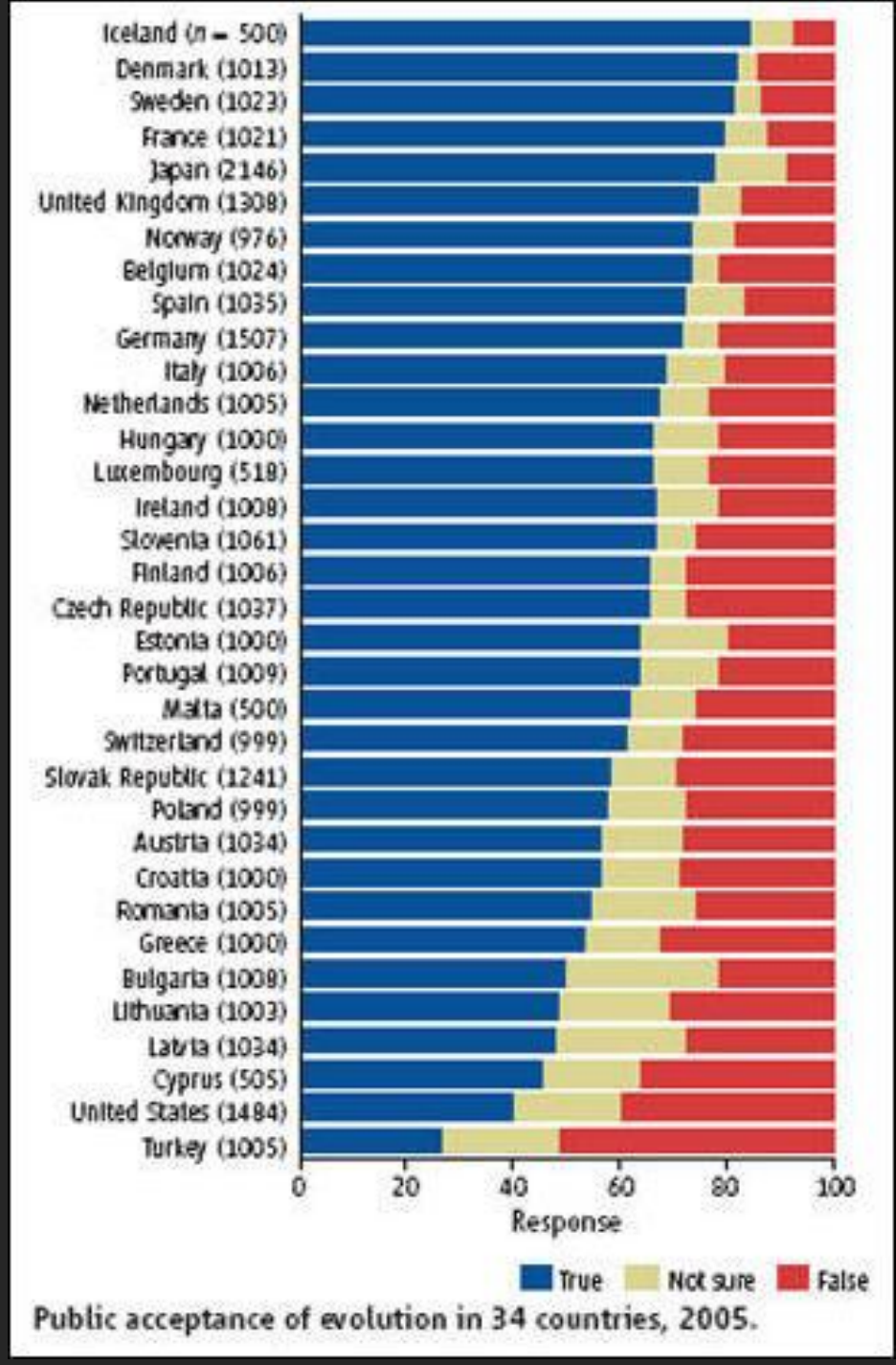

EOCENE
OLIGOCENE
MIOCENE
PLIOCENE
PLEISTOCENE
TODAY
Anancus
Mammuthus
Mammoth
Elephas
Asian elephant
Palaeomastodon
Gomphotherium
Primelephas
Loxodonta
African elephant
Mammut
Mastodon
Stegodon
38 million years ago
24 million years ago
5 million years ago
2 million years ago
10,000 years ago


Big bang
Hadean
Archean
Proterozoic
Carbonif-
erous
Cam-
brian
Ordovician
Perm-
ian
Devonian
Silurian
Jurassic
Triassic
Cretac-
eous
Holo-
cene
Pleistocene
Pliocene
Miocene
Oligocene
Eocene
Paleo-
cene

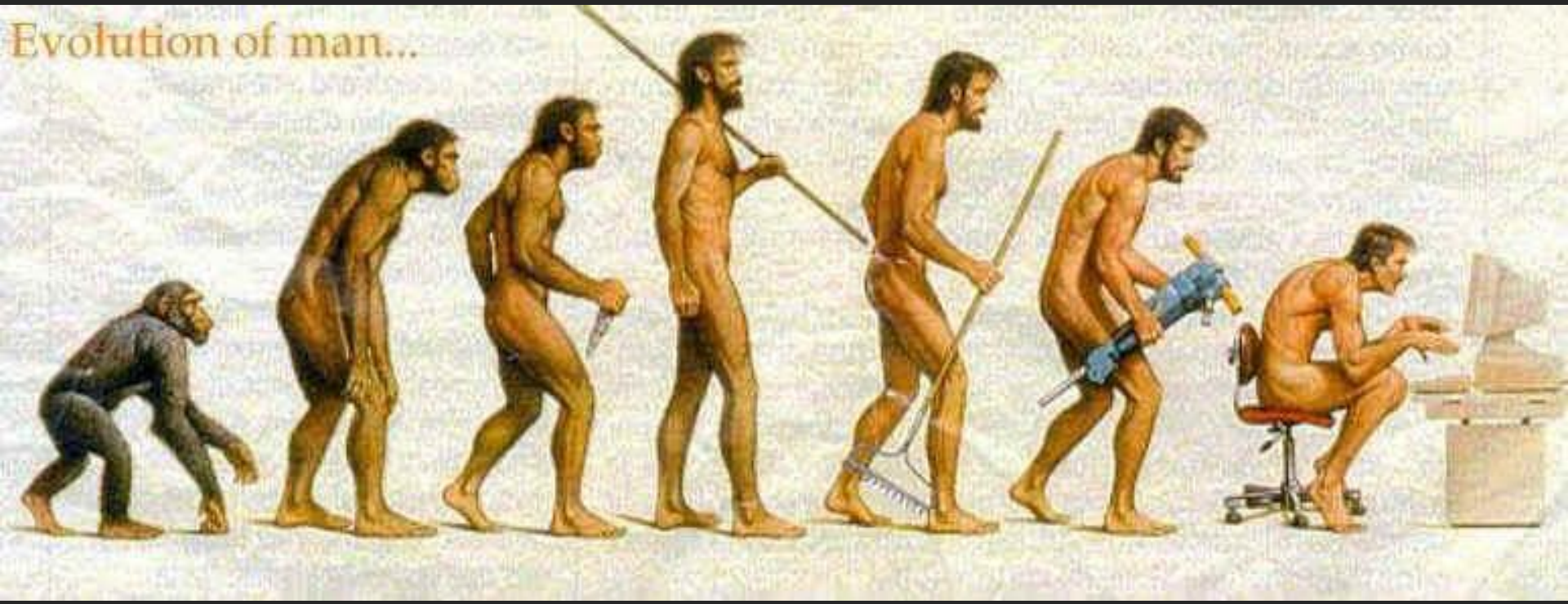
- 1) Species have great fertility. They make more offspring than can grow to adulthood.
- 2) Populations remain roughly the same size, with modest fluctuations.
- 3) Food resources are limited, but are relatively constant most of the time.
- From these three observations it may be inferred that in such an environment there will be a struggle for survival among individuals.
- 4) In sexually reproducing species, generally no two individuals are identical. Variation is rampant.
- 5) Much of this variation is heritable.

- 1. Variation: There is Variation in Every Population.
  2. Competition: Organisms Compete for limited resources.
  3. Offspring: Organisms produce more Offspring than can survive.
  4. Genetics: Organisms pass Genetic traits on to their offspring.
  5. Natural Selection: Those organisms with the Most Beneficial Traits are more likely to Survive and Reproduce.





Public acceptance of evolution in 34 countries, 2005.


Evolution of man...