

**charles
darwin**

1809 - 1882

@ 72

Erasmus Darwin
1731 - 1802



ORGANIC LIFE beneath the shoreless waves
Was born and nurs'd in Ocean's pearly caves;
First forms minute, unseen by spheric glass,
Move on the mud, or pierce the watery mass;
These, as successive generations bloom,
New powers acquire, and larger limbs assume;
Whence countless groups of vegetation spring,
And breathing realms of fin, and feet, and wing.

Robert Waring Darwin
1766 - 1848



- ▶ Physician, FRS
1788
- ▶ Financially astute
 - Investment and money-broking
- ▶ Whig - critical of aristocracy

Charles Robert Darwin
1809 - 1882



- ▶ Born February 12th 1809
- ▶ Second son of Robert Darwin and Susannah Wedgwood.
- ▶ Marianne
- ▶ Charlotte Sarah
- ▶ Susan Elizabeth
- ▶ Erasmus Alvey
- ▶ **Charles Robert**
- ▶ Emily Catherine

Darwin @ 7 years

Darwin on Dr Butler's School



"Nothing could have been worse for the development of my mind than Dr Butler's school, as it was strictly classical, nothing else being taught except a little ancient geography and history. The school as a means of education to me was simply a blank. During my whole life I have been singularly incapable of mastering any language."

Robert Waring Darwin

1766 – 1848



"You care for nothing but shooting, dogs, and rat-catching, and you will be a disgrace to yourself and all your family."

Edinburgh University

Oct 1825 – Apr 1827



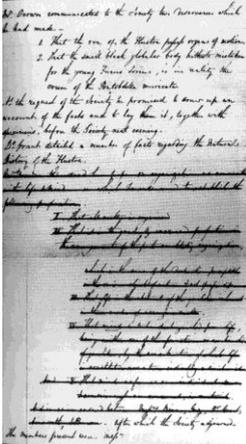
Robert Edmond Grant

1793 – 1874



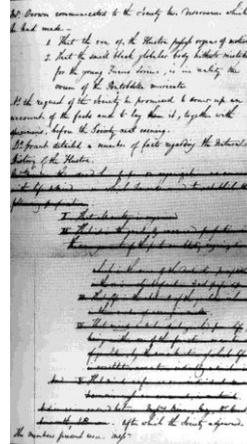
- ▶ Lamarckian Zoologist & physician

"He one day, when we were walking together burst forth in high admiration of Lamarck and his views on evolution. I listened in silent astonishment, and as far as I can judge, without any effect on my mind."



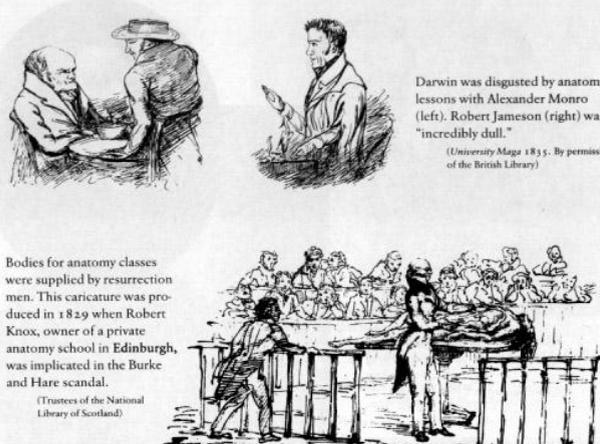
Plinian Society

- Nov '26; Darwin elected
- Apr '27; Darwin reads paper on *Flustra*.
 - "That the ova of *Flustra* possess organs of locomotion
 - That the small black globular body hitherto mistaken for the young of *Fucus loreus* is in reality the ovum of *Pontobdella muricata*"



William Browne's Paper

- "On organization as connected with Life and Mind"
- "That mind as far as one individual sense, & consciousness are concerned, is material"
- MATERIALISM !!!!**



Darwin was disgusted by anatomy lessons with Alexander Monro (left). Robert Jameson (right) was "incredibly dull."

(University Maga 1835. By permission of the British Library)

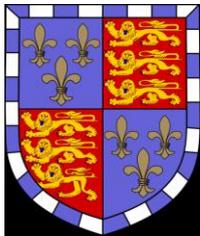
Bodies for anatomy classes were supplied by resurrection men. This caricature was produced in 1829 when Robert Knox, owner of a private anatomy school in Edinburgh, was implicated in the Burke and Hare scandal.

(Trustees of the National Library of Scotland)

Robert Knox




Christ's College Cambridge



Oct 1827 – Jun 1830.



Life in Cambridge



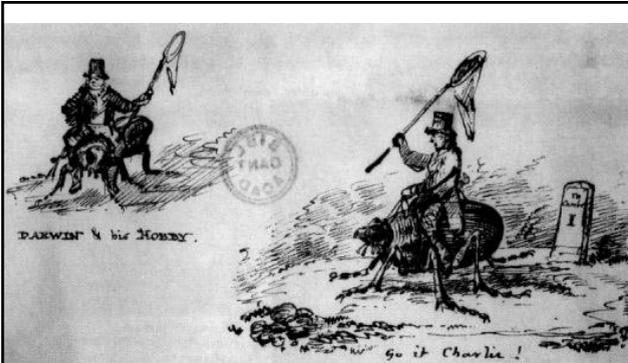
- ▶ Purpose of education?
- ▶ Self-contained enclave
- ▶ Gowns as badges or rank
- ▶ Proctors as enforcers of academic law
- ▶ Public hangings (200 crimes)

Robert Taylor & Richard Carlile May 1829



- ▶ Blasphemy as a capital crime
- ▶ An "infidel home missionary tour"
- ▶ Robert Taylor
 - 1784 – 1844
 - Ordained cleric turned free-thinker
 - "The Devil's Chaplain"
- ▶ Richard Carlile
 - 1790 – 1843
 - Social agitator & radical Republican
 - Universal suffrage

"The Rev. Robert Taylor, A.B., of Carey Street, Lincoln's Inn, and Mr. Richard Carlile, of Fleet-street, London, present their complements as infidel missionaries to ... invite discussion on the merits of the Christian religion, which they argumentatively challenge, in the confidence of their competence to prove, that such a person as Jesus Christ, alleged to have been of Nazareth, never existed; and that the Christian religion had no such origin as has been pretended; neither is it in any way beneficial to mankind; but that it is nothing more than an emanation from the ancient Pagan religion."



"But no pursuit at Cambridge was followed with nearly so much eagerness or gave me so much pleasure as collecting beetles."

John Stevens Henslow

1796 – 1861



- ▶ Professor of Mineralogy (1822-'27) and Botany (1827-'61)
- ▶ Hosted Friday evening gatherings of some of the best minds in the university.
- ▶ Darwin was "the man who walks with Henslow"

Adam Sedgwick

1785 – 1873



- ▶ Woodwardian Professor of Geology
- ▶ A popular lecturer and academic liberal reformer.
- ▶ Would teach Darwin field geology upon graduation.

1831



Darwin @ 22

- ▶ Received BA (Classics), ranking tenth in *hoi polloi* (of 178)
- ▶ Future?
 - A parson?
 - A voyager?

Robert FitzRoy

1805 – 1865



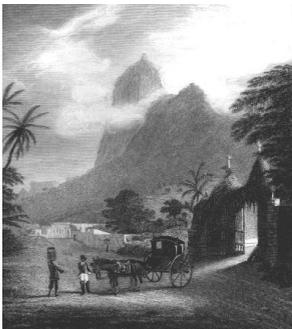
- ▶ Hydrographer & meteorologist
- ▶ Commanded *HMS Beagle* after suicide of Captain Stokes (1828 – '30)
- ▶ Nephew of Lord Castlereagh

Voyage of the Beagle

Jan 1832 – Oct 1836

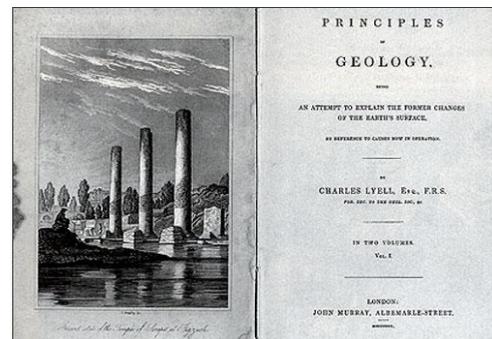


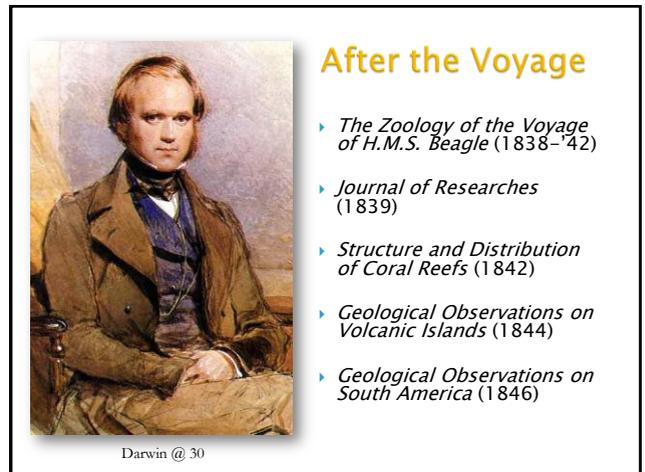
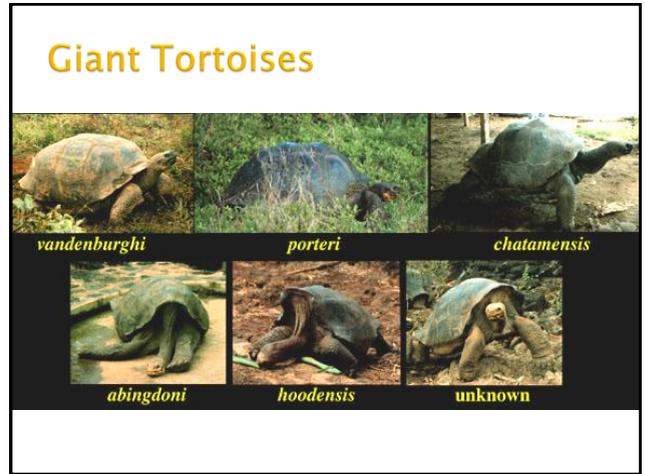
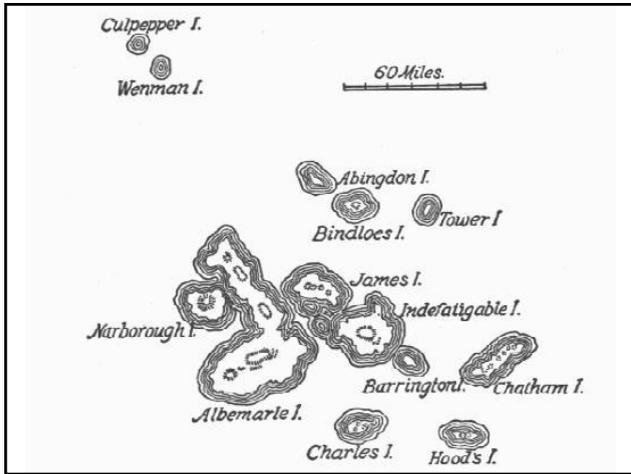
Slavery

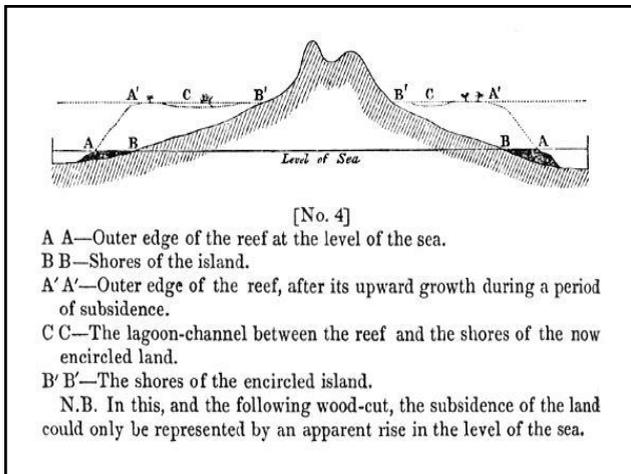


"Early in the voyage at Bahia, in Brazil, FitzRoy defended and praised slavery, which I abominated, and told me that he had just visited a great slave-owner, who had called up many of his slaves and asked them whether they were happy, and whether they wished to be free, and all answered "No." I then asked him, perhaps with a sneer, whether he thought that the answer of slaves in the presence of their master was worth anything? This made him excessively angry, and he said that as I doubted his word we could not live any longer together."

Seeing "through Lyell's eyes"







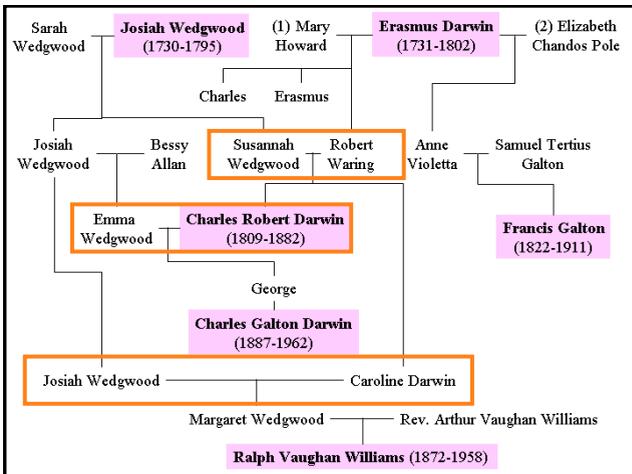
"Mental Rioting"

I think
 then between A & B. main
 top of which. C & B. The
 first position, B & D
 rather greater distance
 than former would be
 formed. - Henry Ulton

- ▶ Series of notebooks started in July '37 (*Zoonomia*)
- ▶ "Life sprawled through time, budding and branching like a tree – erupting in new species adapted to slowly changing environments."

Man and Mind

- ▶ "man, wonderful man ... with divine face, turned towards heaven ... he is not a deity, his end under present form will come ... he is no exception ... he possesses some of the same general instincts and feelings as animals"
- ▶ Thoughts are "as much a function of organ as bile of liver"
- ▶ "Love of the deity [is the] effect of organization, oh you materialist!"
- ▶ "Once grant that species may pass into each other and the whole fabric totters and falls"



Family Life

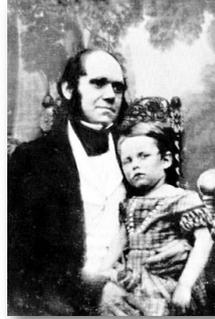


"Darwin (1861-1891) in 1848, Ch...
-ber of the famous..."

Married Emma
Wedgwood in 1839

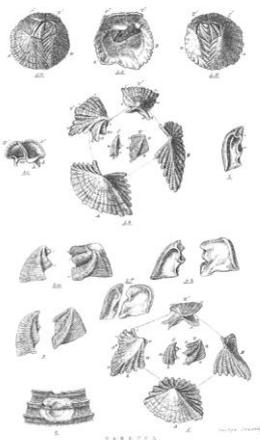
- William Erasmus (1839)
- Anne Elizabeth (1841)
- Mary Eleanor (1842)
- Henrietta Emma (1843)
- George Howard (1845)
- Elizabeth (1847)
- Francis (1848)
- Leonard (1850)
- Horace (1854)
- Charles Waring (1856)

William Erasmus Darwin



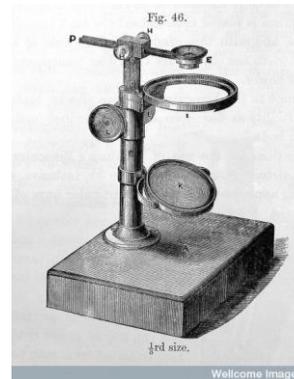
Darwin @ 33 (1842)

"A Biographical
Sketch of an Infant"
(1877) *Mind*



Barnacles

- ▶ *Monograph of the Cirripedia* (1851, 1854)
- ▶ *Monograph of the Lepadidae* (1851, 1854)



1/rd size.

Wellcome Images

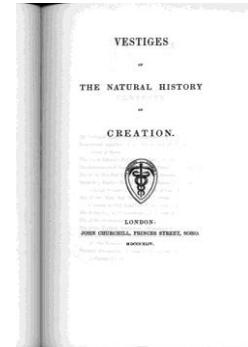
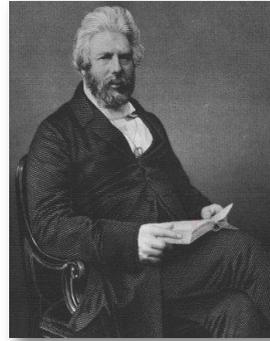
The Birth of A Theory



Darwin @ 40

- ▶ 1837: Notebooks
- ▶ 1842: *Pencil Sketch* (35 pp.)
- ▶ 1844: *Essay* (240 pp.)
 - Shares idea with Joseph Hooker
 - 1844 – 51: Work on barnacles
- ▶ 1856 – 58: *Natural Selection* (unfinished)

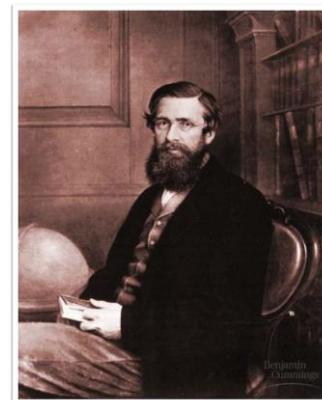
Robert Chambers



Charles Darwin



- ▶ 'his geology strikes me as bad, & his zoology far worse'
- ▶ 'strangely unphilosophical, but capitally written book'
- ▶ 'Mr Vestiges,' like Lamarck had 'in his absurd though clever work ... done the subject [of mutability of species] harm'
- ▶ 'I will not specify any genealogies – much too little known at present. Never use the word higher & lower – use more complicated'.



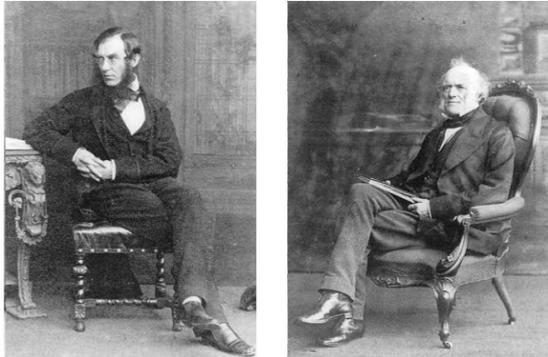
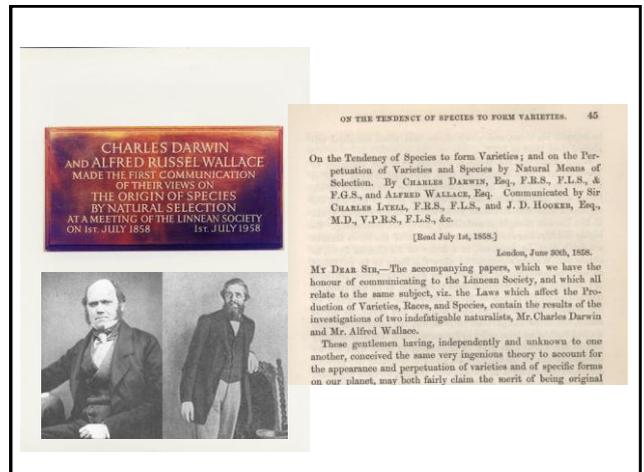


Figure 5-2 Joseph Hooker and Charles Lyell, friends and colleagues of both Charles Darwin and Alfred Wallace. (From Burkhardt, 1991, 90, 122)

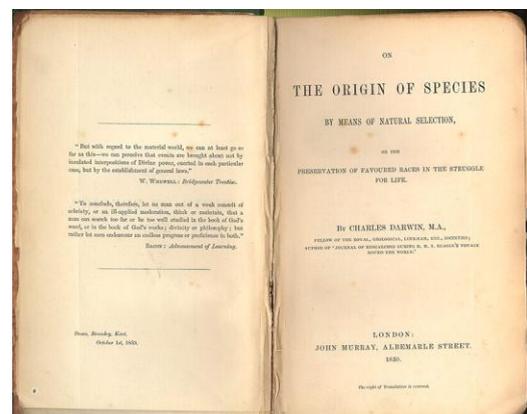


Wallace to Hooker, Oct 6th 1858

"I beg leave to acknowledge the receipt of your letter of July last, sent me by Mr. Darwin, & informing me of the steps you had taken with reference to a paper I had communicated to that gentleman. Allow me in the first place sincerely to thank yourself & Sir Charles Lyell for your kind offices on this occasion, & to assure you of the gratification afforded me both by the course you have pursued & the favourable opinions of my essay which you have so kindly expressed. I cannot but consider myself a favoured party in this matter, because it has hitherto been too much the practice in cases of this sort to impute *all the merit to the first discoverer of a new fact or a new theory, & little or none to any other party who may, quite independently, have arrived at the same result a few years or a few hours later.*

I also look upon it as a most fortunate circumstance that I had a short time ago commenced a correspondence with Mr. Darwin on the subject of "Varieties," since it has led to the earlier publication of a portion of his researches & has secured to him a claim of priority which an independent publication either by myself or some other party might have injuriously affected, — for it is evident that the time has now arrived when these & similar views will be promulgated & *must be fairly discussed.*

It would have caused me such pain & regret had Mr. Darwin's excess of generosity led him to make public my paper unaccompanied by his own much earlier & I doubt not much more complete views on the same subject, & I *must again thank you for the course you have adopted, which while strictly just to both parties, is so favourable to myself.*"



This View of Life



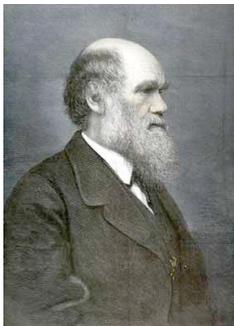
"There is grandeur in this view of life, with its several powers, having originally been breathed into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being, evolved."

Origin

On the various contrivances by which British and foreign orchids are fertilised by insects (1862)



1872



Darwin @ 62

*Descent of Man and
Selection in Relation to
Sex*

*Expression of Emotion in
Man and Animals*

Burial at Westminster



"Happy is the man who finds wisdom, and the man who gains understanding; For her proceeds are better than the profits of silver, and her gain than fine gold;

She is more precious than rubies, and all things you may desire cannot compare with her;

Her ways are ways of pleasantness, and all her paths are peace

She is the tree of life to those who take hold of her, and happy are those who retain her."

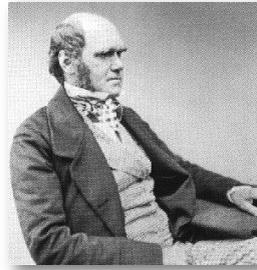
Proverbs 3: 13 - 17 & 18

Annie Darwin

1841 - 1851



April 1856



"What a book a devil's chaplain could write on the clumsy, wasteful, blundering, low and horridly cruel works of nature"

Natural Selection

Nature "cares not for mere external appearances; she may be said to scrutinize with a severe eye, every nerve, vessel & muscle; every habit, instinct, shade of constitution, - the whole machinery of the organization. There will be here no caprice, no favoring: the good will be preserve [sic] & the bad rigidly destroyed."

"By nature, I mean the laws ordained by God to govern the Universe."

"A celebrated author and divine"



Charles Kingsley
(1819-1875)

"A celebrated author and divine has written to me that 'he has gradually learnt to see that it is just as noble a conception of the Deity to believe that **He created a few original forms capable of self-development into other and needful forms**, as to believe that He required a fresh act of creation to supply the voids caused by the action of His laws.'"

Charles Darwin

"With respect to the theological view of the question: This is always painful to me. I am bewildered. I had no intention to write atheistically, but I own that I cannot see as plainly as others do, and as I should wish to do, evidence of design and beneficence on all sides of us. There seems to me too much misery in the world. I cannot persuade myself that a beneficent and omnipotent God would have designedly created the *Ichneumonidae* with the express intention of their feeding within the living bodies of caterpillars or that a cat should play with mice... On the other hand, I cannot *anyhow be contented to view this wonderful universe, and especially the nature of man, and to conclude that everything is the result of brute force. I am inclined to look at everything as resulting from designed laws, with the details, whether good or bad, left to the working out of what we may call chance.*"

Letter to Asa Grey (1860)

Darwin, 1873

"I may say that the impossibility of conceiving that this grand and wondrous universe, with our conscious selves, arose through chance, seems to me the chief argument for the existence of God; but whether this is an argument of real value, I have never been able to decide. I am aware that if we admit a first cause, the mind still craves to know whence it came from and how it arose. Nor can I overlook the difficulty from the immense amount of suffering through the world. I am, also, induced to defer to a certain extent to the judgment of many able men who have fully believed in God; but here again I see how poor an argument this is. *The safest conclusion seems to me to be that the whole subject is beyond the scope of man's intellect; but man can do his duty.*"

Charles Darwin

"The old argument of design in nature, as given by Paley, which formerly seemed to me to me so conclusive, fails, now that the law of natural selection has been discovered. We can no longer argue that, for instance, the beautiful hinge of a bivalve shell must have been made by an intelligent being, like the hinge of a door by a man. There seems to be no more design in the variability of organic beings and in the action of natural selection, than in the course which the wind blows. *Everything in nature is the result of fixed laws.*"

Autobiography

Letter to John Fordyce, 1879

"It seems to me absurd to doubt that a man may be an ardent Theist & an evolutionist ... What my own views may be is a question of no consequence to any one except myself.— But as you ask, I may state that my judgment often fluctuates. Moreover whether a man deserves to be called a theist depends on the definition of the term: which is much too large a subject for a note. *In my most extreme fluctuations I have never been an atheist in the sense of denying the existence of a God.— I think that generally (& more and more so as I grow older) but not always, that an agnostic would be the most correct description of my state of mind.*"

The Lady Hope Story

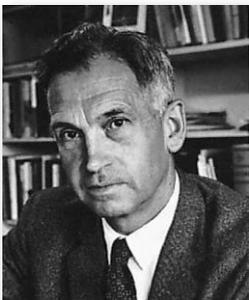


“I was a young man with unformed ideas. I threw out queries, suggestions, wondering all the time over everything, and to my astonishment, the ideas took like wildfire. People made a religion of them.”

Darwin's Dangerous Idea



Ernst Mayr



Darwin “caused a greater upheaval in man’s thinking than any other scientific advance since the rebirth of science in the Renaissance.” (1972, p. 987).

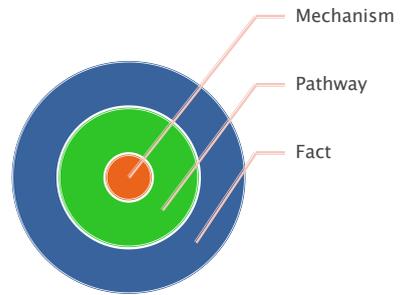
Evolution is ...

- ▶ the process of unrolling or opening out (OED, More, 1647)
- ▶ the process of developing from a rudimentary to a mature or complete state. (OED, 1670)
- ▶ the origination of species of animals and plants, as conceived by those who attribute it to a process of development from earlier forms, and not to a process of special creation. (OED, Lyell, 1832)

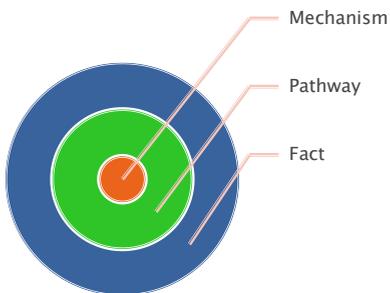
Cosmogony
Cosmogogenesis
Abiogenesis

EVOLUTION IS NOT ...

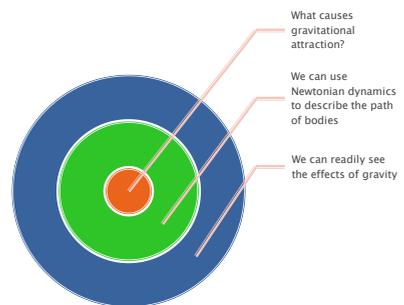
Evolution as



Gravity as



Gravity as



Change over time observable in fossil record

EVOLUTION AS A FACT

Multiplication of Species *via* splitting or budding
Common descent

EVOLUTION AS A PATHWAY

darwinian natural selection
other mechanisms

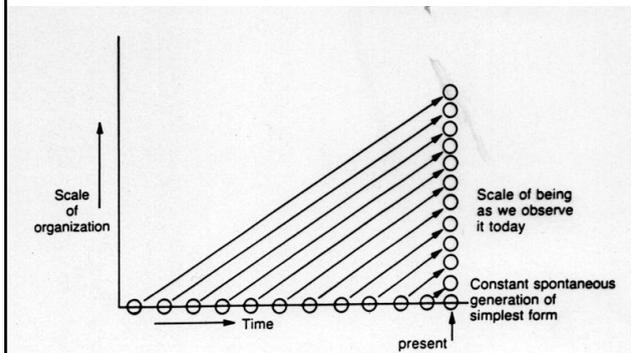
EVOLUTION AS A MECHANISM



Jean Baptiste
Pierre Antoine
de Monet, le
chevalier de
Lamarck

1744 - 1829

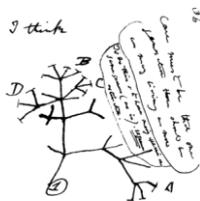
Zoological Philosophy – 1809



Lamarckian Evolution's Mechanism

- ▶ Primary: Pure internal drive
- ▶ Secondary: Branching due to **inheritance of acquired characteristics** (adaptation to changing conditions)
 - Change in environment brings
 - Change in "needs" (*besoins*), brings
 - Change in behavior, brings
 - Change in organ usage and development, brings
 - Change in form over time – **EVOLUTION!**

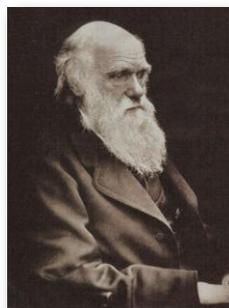
Darwinian Evolution as ...



I think
D & E
then when A & B. are
not + when C + B. the
first production, B + D
rather greater extinction
then form would be
formed. - Henry Miller

- ▶ **Fact**
- ▶ **Pathway**
 - Establishment of genealogical relationship ("tree thinking")
 - Common descent
 - Multiplication of species *via* splitting or budding
- ▶ **Mechanism**
 - Natural selection and other mechanisms

Explaining Diversity, Design and Death



- ▶ **Diversity** could be explained using a natural mechanism which was also sufficient to explain good (and bad) design.
- ▶ Thus, **design** was apparent and did not require a designer.
- ▶ "Evil" is a meaningless concept when considering the natural world. **Death** and extinction are part of the natural process. Moral evil (i.e. human evil) has natural roots.

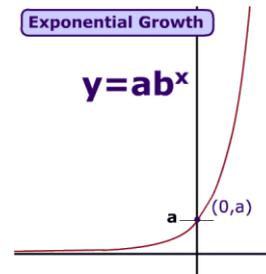
The Logic of Natural Selection

Five facts
Three inferences

Fact #1

- ▶ Potential exponential increase of populations (“superfecundity”)

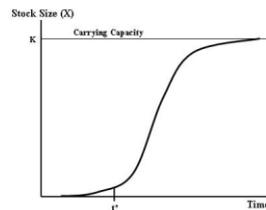
▶ *Source:* Thomas Malthus, William Paley, observation



Fact #2

- ▶ Observed steady-state stability of most populations

▶ *Source:* observation



Fact #3

- ▶ Limitation of resources

▶ *Source:* observation



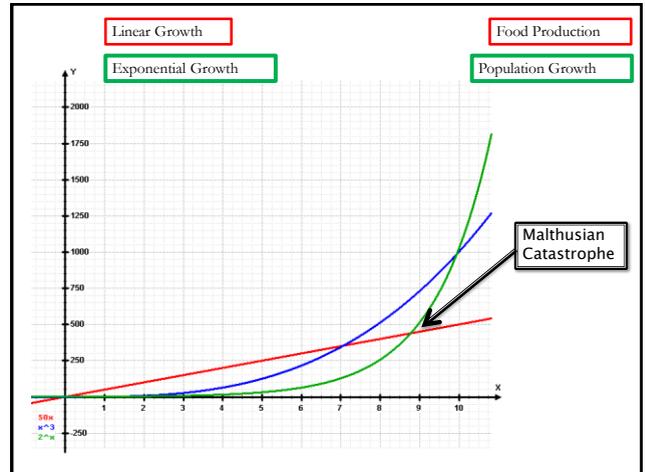
Thomas Robert Malthus

1766 - 1834



"The power of population is so superior to the power of the earth to produce subsistence for man, that premature death must in some shape or other visit the human race. The vices of mankind are active and able ministers of depopulation. They are the precursors in the great army of destruction; and often finish the dreadful work themselves. But should they fail in this war of extermination, sickly seasons, epidemics, pestilence, and plague, advance in terrific array, and sweep off their thousands and tens of thousands. Should success be still incomplete, gigantic inevitable famine stalks in the rear, and with one mighty blow levels the population with the food of the world."

Essay on the Principle of Population, 1798



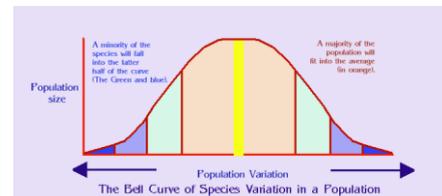
Inference #1



- ▶ Struggle for existence among individuals
- ▶ *Author of inference:* Malthus

Fact #4

- ▶ Variation between individuals
- ▶ *Source:* animal breeders & observation

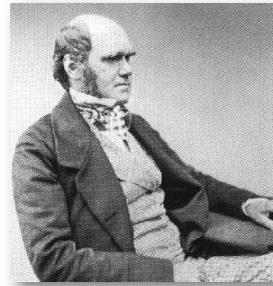


Fact #5

- ▶ Heritability of much of this variation
- ▶ *Source*: animal breeders



Inference #2



- ▶ **Some** of this variation is advantageous in **certain** environments therefore differential survival, i.e. **natural selection**, will occur.
- ▶ Inference held by Darwin & Wallace.
- ▶ (Also held by others)

William Wells (1818)

- ▶ *Two essays: On Upon Single Vision with Two Eyes; The Other on Dew...and An Account of a Female of the White Race...Part of Whose Skin Resembles That of a Negro...By the Late W.C. Wells...with a Memoir of His Life, Written by Himself.*
- ▶ Darwin wrote "In this paper he [Wells] distinctly recognizes the principle of natural selection, and this is the first recognition which has been indicated..." (4th edition, 1866)

Patrick Matthew (1831)



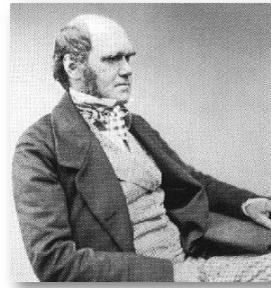
- ▶ Appendix to *Naval Timber and Arboriculture*
- ▶ Claims priority in 1860 letter to *Gardeners Chronicle*
- ▶ Darwin acknowledges this.

Edward Blyth (1835)



- ▶ "An Attempt to Classify the 'Varieties' of Animals, with Observations on the Marked Seasonal and Other Changes Which Naturally Take Place in Various British Species, and Which Do Not Constitute Varieties" *Magazine of Natural History*
- ▶ Natural selection working to **preserve type and essence**, i.e. selection as a negative force.

Inference #3



- ▶ Over many generations, **provided selection pressure is maintained**, evolution will occur
- ▶ Inference unique to Darwin & Wallace

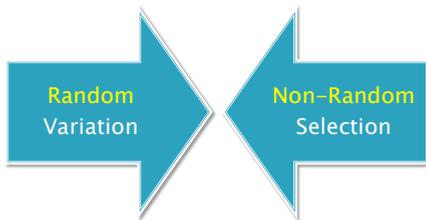
A Different Formulation

- ▶ **If** there are variations in an entity, **and**
- ▶ **If** these are inherited, **and**
- ▶ **If** one variant is more suited to some task than the others, **and**
- ▶ **If** that task directly affects survival and therefore reproduction of the entities,
- ▶ **Then** selection will result in evolutionary change in the population of entities.

Implications

- ▶ **Evolution by natural selection need not occur.**
- ▶ Natural selection acts on **individuals** but its consequence occur in **populations**. It does not, however, work for "the good of the species."
- ▶ Fitness is a **relative** concept depending on the environment and the population.
- ▶ No need to be able to predict long-term course of evolution. Evolution is analogous to a poker tournament.
- ▶ Natural selection is not forward looking and does not lead to perfection or necessarily progress. Adaptations need not be "perfect" in any sense.

Darwinian Evolution is a non-random process



Paley's Supernatural Watchmaker

A: X is intricate and well suited to a task T

W₁: X is a product of intelligent design

W₂: X is a product of random physical forces

Paley claims that the likelihood of **W₁** given **A** exceeds that of **W₂**, i.e. $P(A|W_1) \gg P(A|W_2)$

Darwin's Natural Mechanism

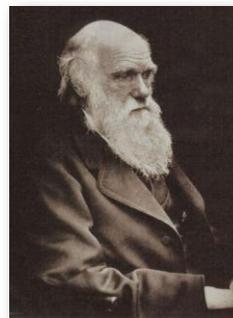
A: X may or may not be intricate or well-suited to a task T.

W₁: X is a product of intelligent design

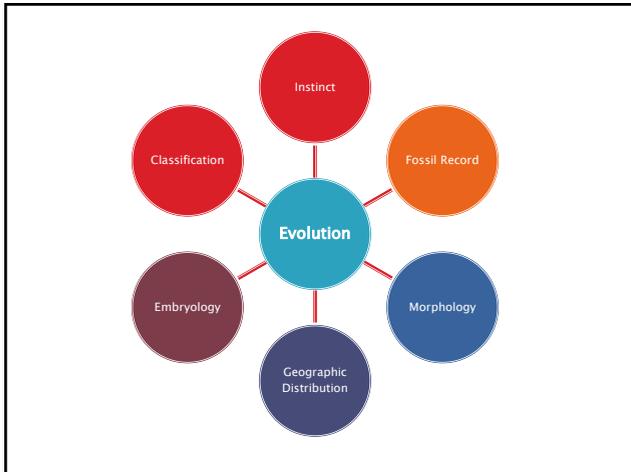
W₂: X is a product of a non-random natural mechanism

Darwin claims that the likelihood of **W₂** given **A** exceeds that of **W₁**, i.e. $P(A|W_2) \gg P(A|W_1)$

Darwin's Uniqueness

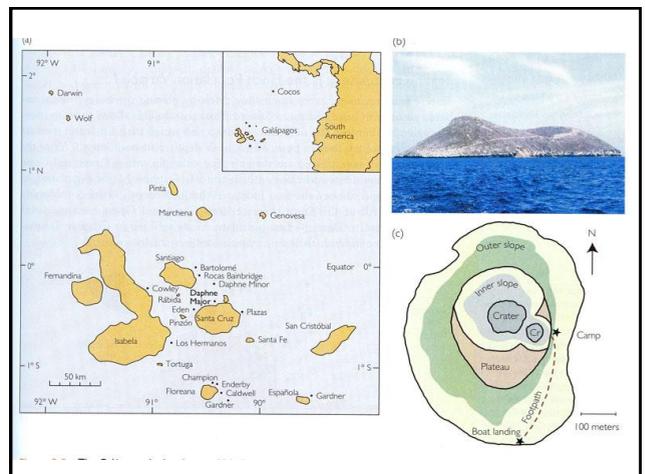
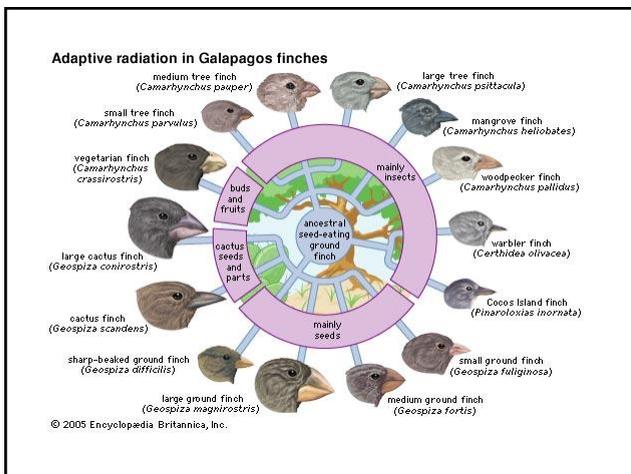


- ▶ Not in originating natural selection
- ▶ But in seeing what natural selection was potentially capable of doing
- ▶ But where was the evidence for natural selection?

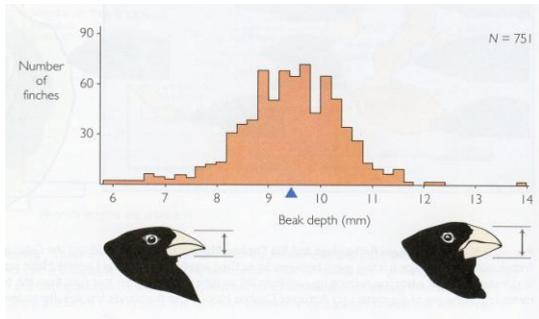


Analysis of Selection Events

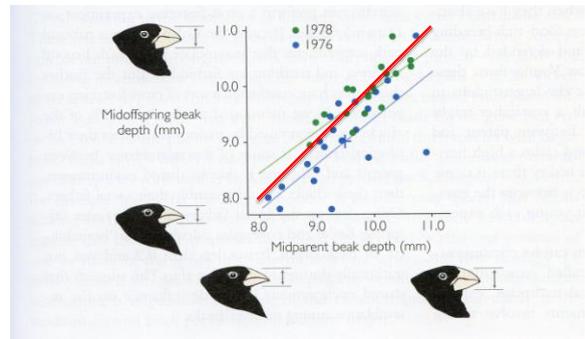
1. Is the **population** variable?
2. Is some of the variation among **individuals** within the **population** heritable?
3. Do **individuals** vary in their success as surviving or reproducing?
4. Are survival and reproduction **non-random**?
5. Did the **population** change over time?



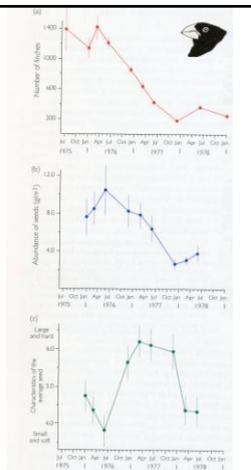
Is the population variable?



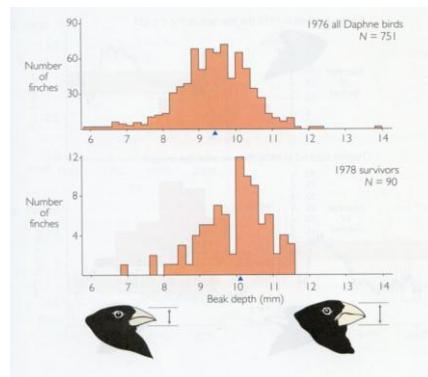
Is some of the variation heritable?



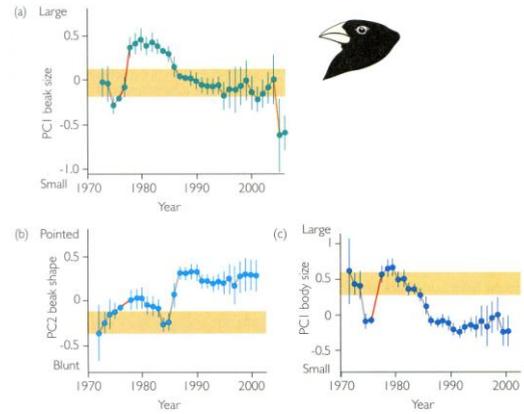
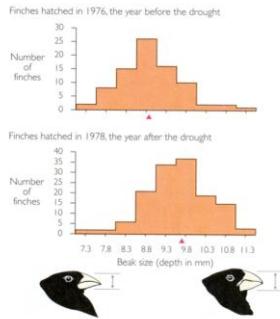
Do individuals vary in their success at surviving or reproducing?



Are Survival and Reproduction Non-Random?

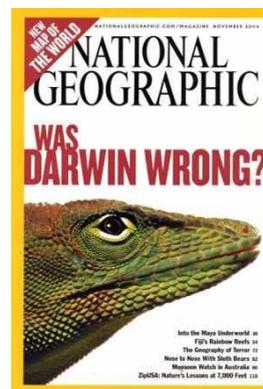
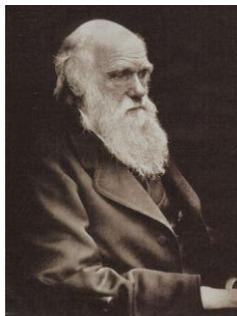


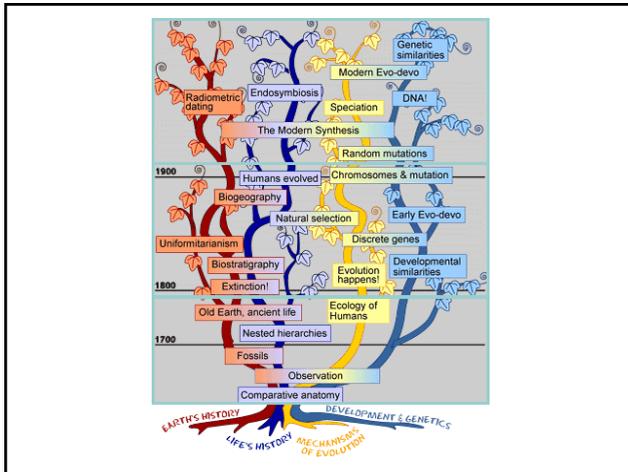
Did the Population evolve?



Darwin on Natural Selection

“I am convinced that [it] has been the main, **but not exclusive** means of modification.”





Four Stages

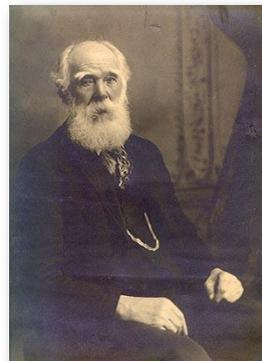
- ▶ Pre-Darwinian evolutionary thought
- ▶ Advent of “Darwinism” in 1859.
- ▶ Non-Darwinian Evolution (1859 – 1930’s)
 - Mendelism
 - Neo-Lamarckism / Orthogenesis
- ▶ Modern Synthesis (1930’s – today)
 - Mendelism + Darwinism + **Other mechanisms**

Darwinism is extinct.

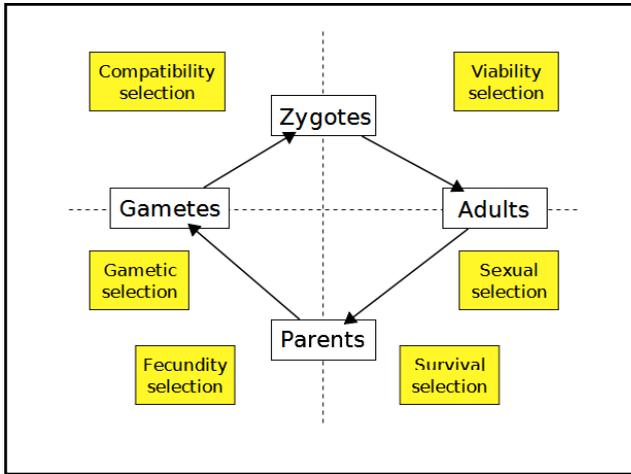
Darwinists do not exist.

Evolution ≠ Natural Selection

Contemporary Evolutionary Biology



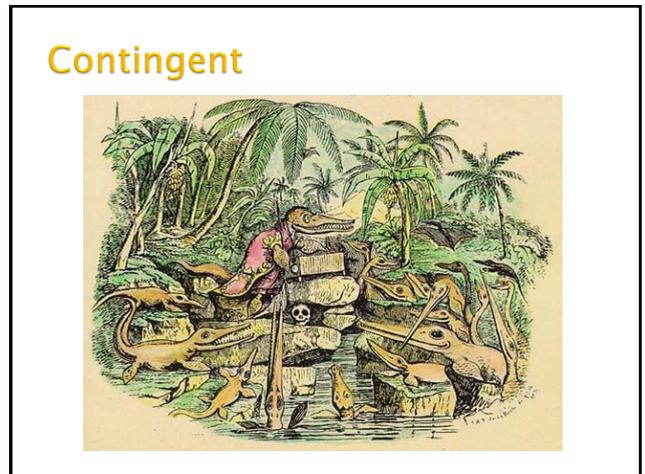
We have a professional, natural-selection-based discipline and an entirely convincing, naturalistic explanation of the design-like appearance of the natural world.



Macroevolutionary Hierarchy

Type	Resolution	Mechanism	Causality	Direction	Process	Label
Macro ₂	Highest Taxa (Family, Order, etc.)	External (Abiotic?)	Stochastic (Non-deterministic, Non-random)	↑ Environmental Constraints	Faunal Replacement, Mass Extinction, Punctuated	Non-Darwinian
Macro ₁	Mic-Taxa (Genus, Species, etc.)	Taxon Sorting	Broadly Contingent (Deterministic & Non-deterministic Processes)	↑ Species (Group) Selection	Differential Species/Genus Survival	Semi-Darwinian
Micro ₂	Population	Natural Selection	Deterministic	↑ Organism Selection	Individual Organismal Survival	Darwinian
Micro ₁	Individual	Genetic Drift and Mutation	Stochastic (Non-deterministic, Non-random)	↑ Gene Selection	DNA Recombination	Ultra-Darwinian
Cellular	Cytoplasmic	Selection on Replication Rates	Contingent	↑ Selection of Cytoplasmic Elements	Genomic Conflict	Genomic
Molecular	Molecular	Biochemistry	Deterministic	↑ Molecular Configuration	Chemical Bonds	Chemical
Atomic	Atoms	Physics	Stochastic	↑ Quantum Uncertainty	Quantum Mechanics	Physicalist

Tree-like



The Death of Design, Teleology & Supernaturalism within Biology

