Lecture 2

Darwin's big idea and how it changed biology

1. Evolution - the central unifying concept of biology

2. Development of Darwin's idea

3. Evolution facts and fiction

Relevant reading in Coyne – Chapter 2

1

The theory of evolution

- Living things change gradually from one form into another over time
- Challenges view of special creation (= direct creation of all things in effectively their present form)

2

Theory of evolution involved two controversial ideas

- ***Concept of a changing universe***

  replaced view of a static world

- ***A phenomenon with no purpose***

  replaced view that the causes of all phenomena had to have a purpose

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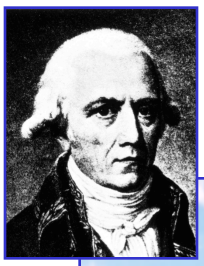

Jean-Baptiste de Lamarck
(1744 -1829)

- First to use the term evolution
- Linear rather than branching view of evolution
- First to provide a causal mechanism –
  The inheritance of acquired characters

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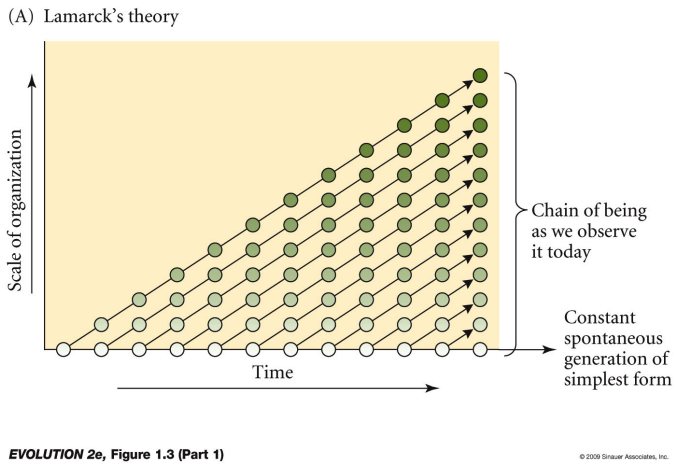
Lamarck's incorrect view of evolution



Simplest forms evolve directly to complex forms – thus no evolutionary tree

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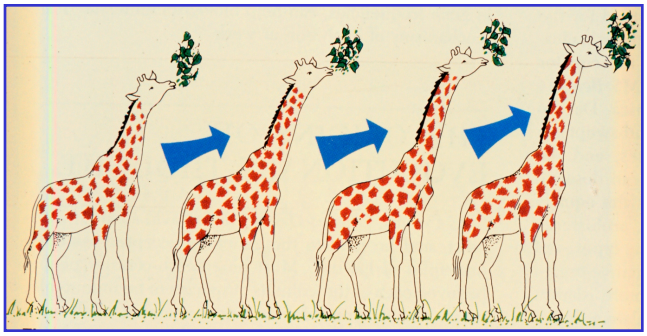
Lamarck's mechanism is wrong !



- The giraffe's neck: Lamarck's example for the inheritance of acquired characters
- Progressive increase in neck during the life time of an individual is passed on to offspring

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Why was Lamarck wrong?

1. Thought evolution of different forms was **linear**
2. Proposed the **mechanism** for evolution was inheritance of acquired characters

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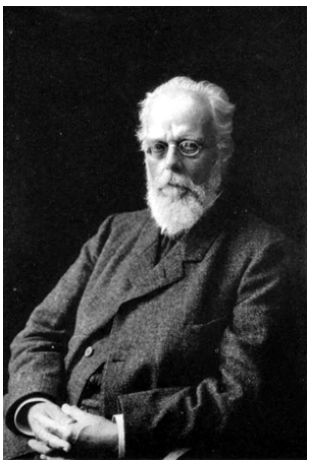
Why was Lamarck wrong?



August Weismann
1834-1914

August Weisman Germplasm Theory

1)Inheritance only by germ cells (gametes); somatic cells (soma) do not function as agents of heredity

1)Thus genetic information cannot pass from soma to gametes and onto next generation

1)Modern interpretation stated in molecular terms genetic information flows in one direction only from DNA to protein but **never** in reverse

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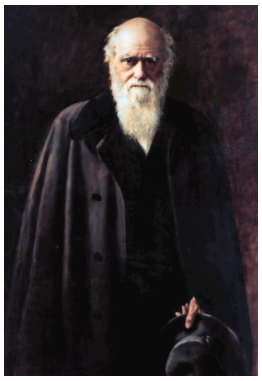
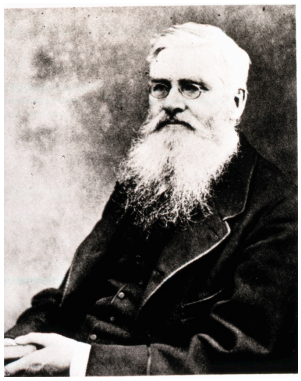
Discovery of the correct mechanism



Darwin



Wallace

Charles Darwin & Alfred Russel Wallace co-discover the chief mechanism of evolution

Natural selection

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Development of Darwin's ideas on evolution - exploration

- Darwin influenced by the botanist John S. Henslow at Cambridge
- Voyage on H.M.S. Beagle around the world (1831-1836) as ship's naturalist
- Made numerous observations and collections of plants, animals & fossils
- Returned to England and spent the rest of his life in seclusion at Down House developing his ideas, conducting experiments and writing books (25 in all)

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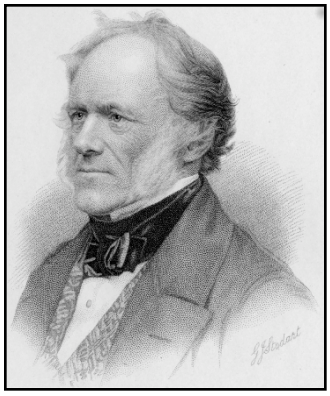
Development of Darwin's ideas on evolution – gradualism

- Darwin reads Lyell's book "*Principles of Geology*" (1830)
- Lyell argued that present day geological processes can explain the history of the earth – **gradualism**
- The notion of a **dynamic** rather than a static world emerged in Darwin's thinking



Charles Lyell
(1797-1875)

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Development of Darwin's ideas on evolution – species change

Patterns of variation

Species vary over space and time

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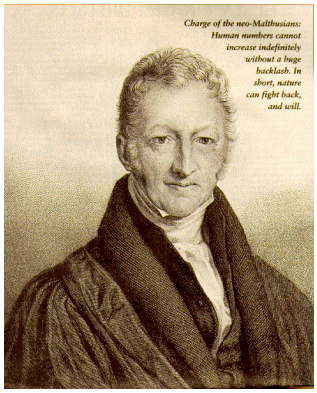
Development of Darwin's ideas on evolution - selection

Darwin reads Malthus' (1798) *Essay on the Principle of Population* (Sept 1838)

"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 favourable variations would tend to be preserved and unfavourable ones would be destroyed."

Charles Darwin (1838)



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Down House – Darwin's family home (Kent, England)

Darwin lived at Down house from 1842-1882 and conducted all his research and writing there

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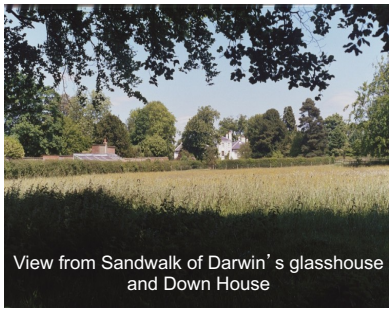
The Sandwalk – Darwin's thinking walk


View from Sandwalk of Darwin's glasshouse and Down House

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Events leading up to the publication of "The Origin of Species"

- After return from Beagle 20 years taken up with accumulation of evidence for the theory of evolution
- 1844: wrote but did not publish an essay on natural selection
- 1856: began work on natural selection book

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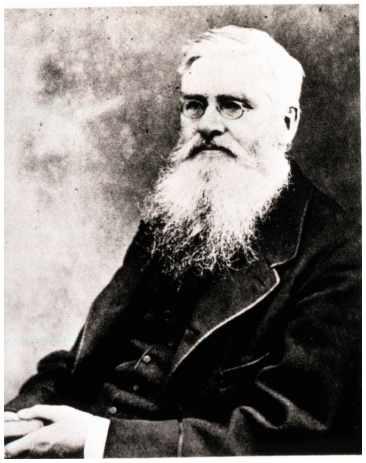
Alfred Russel Wallace

- 1823-1913
- travelled in SE Asia and South America
- self-taught naturalist



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Alfred Russel Wallace

- 1858: sick with malaria in SE Asia
- influenced by Malthus' essay
- all organisms struggle to survive and only those best suited to their environment survive
- a species must make so many changes over time that it may become a different species
- writes manuscript and sends it to Darwin

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Events leading up to the publication of "The Origin of Species"

- June 1858**:** received "*On the tendency of varieties to depart indefinitely from the original type*" by A.R. Wallace
- July 1858: Linnean Society presentation in London of Darwin–Wallace paper
- 1859: publication of "*The origin of species by means of natural selection or the preservation of favoured races in the struggle for life*"

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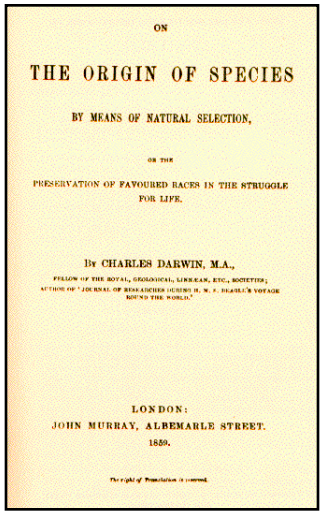
Arguably the most important scientific book ever written


ON

THE ORIGIN OF SPECIES

BY MEANS OF NATURAL SELECTION,

OR THE

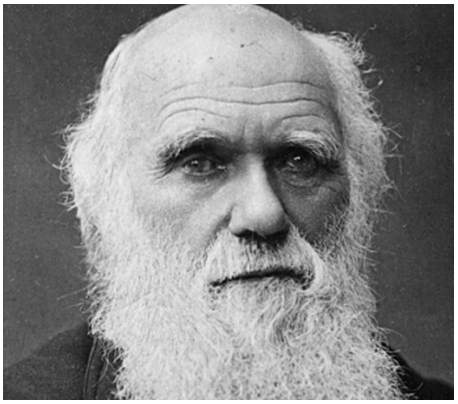
PRESERVATION OF FAVOURED RACES IN THE STRUGGLE FOR LIFE.

By CHARLES DARWIN, M.A.,

FELLOW OF THE ROYAL, GEOLOGICAL, LINNEAN, ETC., SOCIETIES;

AUTHOR OF "JOURNAL OF RESEARCHES DURING H. M. S. BEAGLE'S VOYAGE ROUND THE WORLD."

LONDON:
JOHN MURRAY, ALBEMARLE STREET.
1859.



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The Origin of Species

Two key components

- All organisms have descended with modification from common ancestors
- The major agent of modification is natural selection operating on variation among individuals

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Requirements for Darwin's theory to work

- **Variation –** variation among individuals in a population
- **Heredity –** progeny resemble their parents more than unrelated individuals
- **Selection –** some forms better at surviving and breeding than others in a given environment

All are accepted and known to be true !

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Theory of evolution involved two controversial ideas

- ***Concept of a changing universe***

  replaced view of a static world

- ***A phenomenon with no purpose***

  replaced view that the causes of all phenomena had to have a purpose

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Creationist Doctrine

- Literal reading of *Book of Genesis*
- Creation of all living organisms by divine order in 6 days
- All types of organisms individually created and designed by a purposeful creator

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"*Today, the theory of evolution is an accepted fact for everyone but a fundamentalist minority, whose objections are based not on reasoning but on doctrinaire adherence to religious principles*"

James D. Watson (1965)
Molecular Biologist & Nobel Laureate

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"Scientific" creationism is not science because:

- It is not supported by any empirical observations
- It does not infer its principles from observation, as does all science
- Its assumptions lead to no testable or falsifiable hypotheses

Some last words

"Science emphasizes evidence and logical deduction. It deals not with facts engraved on stone tablets, but with hypotheses that may be refuted by tomorrow's experiments and concepts formulated by fallible human minds. The best scientific education encourages skepticism, questioning, independent thought, and the use of reason"

Douglas J. Futuyma (1995)
Science on Trial

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Next Lecture - 3

What Darwin saw on the Beagle

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