


History of Biology: Before Darwin

BIO1130 Organismal Biology
Jon G. Houseman



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Organismal Biology – Main themes.

- Major events in the history of Biology
- Earth's changing biodiversity




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Major events in the history of Biology



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History of Biology: Before Darwin

Major events in the history of biology:

- Identify and understand the major events and findings in Biology.
- Be able to place the main findings of biology in a historical context.
- Explain how biology differs from the other sciences
- Understand how biology is done – scientific method in natural sciences.

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Defining biology (Treviranus 1802)

The subject matter of our investigations will be the various forms and manifestations of life, the conditions and laws controlling their existence, and the causes by which this is effected. The science, which occupies itself with these subjects, we shall designate by the name biology, or science of life.

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Types of Biology

- Molecular biology and biochemistry
- Genetics
- Cell biology
- Physiology
- Developmental biology
- Morphology
- Evolution and systemic biology
- Ecology
- Behavioural biology
- Nutrition
- Disease mechanisms
- Pharmacology
- Genomics
- Proteomics

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History of Biology: Before Darwin

Major events in the history of biology:

- **Predarwinian and the natural sciences**
(400 BCE – late 1800's)
 - 400 BCE – 450CE: Greek and Roman ages
 - 450 – 16th century: _____
 - 16th-18th century: _____
- **Darwin and evolutionary thought**
(late 1800's – mid 1900's)
- **Modern theory of evolution and more**
(mid 1900's – present)

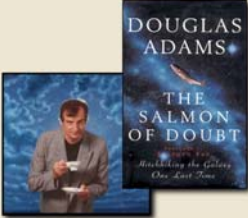
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Important stages in the history of Biology
16th-18th century: The scientific revolution and the start of modern sciences

Douglas Adams 1952-2001

Four ages of sand


- First - Telescope 1608
- Second - _____
- Third - Computer chip 1961
- Fourth - Fiber optics 1980s



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Major events in the history of Biology
Predarwinian

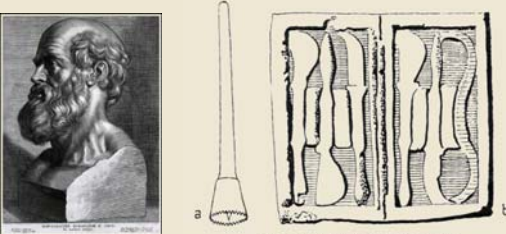


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Important stages in the history of Biology
400 BCE – 450: Greek and Roman ages




Hippocrates
 (460-370 BCE)

FIG. 15. Types of instruments used by Greek surgeons
 (a) Simple trephine with centre pin. (b) Case of scalpels.
 (c) Seventeenth-century instrument of ancient type. (d) Relief in the Asclepeion, Aegina.

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Important stages in the history of Biology
400 BCE – 450: Greek and Roman ages




Aristotle
 (384-322 BCE)

FIG. 18. The *Scala Naturae* or 'Ladder of Life' according to the descriptions of Aristotle.

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Some initial definitions about naming

- Classification
- Taxonomy
- Hierarchical
- Systematics

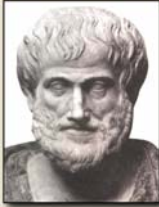


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History of Biology: Before Darwin



Types of taxonomies

- Artificial
- Mechanical
- Natural (Evolutionary)
- Cladistic (Phylogenetic)



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Important stages in the history of Biology
400 BCE – 450: Greek and Roman ages

Theophrastus (371-287 BCE)

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Important stages in the history of Biology
400 BCE – 450: Greek and Roman ages

- *Scala naturae* - the great chain of being
- Essentialism

FIG. 18. The *Scala Naturae* or 'Ladder of Life' according to the descriptions of Aristotle.

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History of Biology: Before Darwin

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Important stages in the history of Biology
450-16th century: Medieval ages

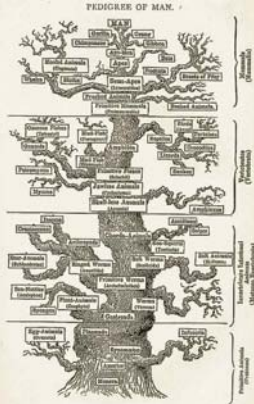
- **Scala naturae - the great chain of being**
- **Essentialism**



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Special creation

- **Pattern**
 - Species don't change
 - Each species created on Oct 23, 4004 BCE
 - Species are not old
- **Process**
 - A designer of some sort




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Important stages in the history of Biology
450-16th century: Medieval ages

- **Europe**
 - 400-700 Early middle ages (Dark Ages)
 - 1000-1300 High middle Ages
 - 1300-1400 Late middle Ages



Black plague (1347-1351)



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Important stages in the history of Biology
450-16th century: Medieval ages

- **Byzantium and Islamic world**
 - Al-Jahiz (781-869)

Animals engage in a struggle for existence; for resources, to avoid being eaten and to breed. Environmental factors influence organisms to develop new characteristics to ensure survival, thus transforming into new species. Animals that survive to breed can pass on their successful characteristics to offspring.





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Important stages in the history of Biology
450-16th century: Medieval ages

- **Byzantium and Islamic world**
 - al-Jahiz (781-869)
 - al-Dinawari (826-896)
 - Avicenna (980-1037)
 - Alhazen (965-1040)
 - Ibn al-Baitar (1197-1248)



Avicenna

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Important stages in the history of Biology
450-16th century: Medieval ages

- **Byzantium and Islamic world**
 - Alhazen (965-1040)

Scientific Method

1. Observation
2. Statement of problem
3. Formulation of hypothesis
4. Testing of hypothesis using experimentation
5. Analysis of experimental results
6. Interpretation of data and formulation of conclusions
7. Publication of findings



Alhazen


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Important stages in the history of Biology
450-16th century: Medieval ages

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Important stages in the history of Biology
16th-18th century: The scientific revolution and the start of modern sciences

- Copernicus (1473-1543) earth not the center of the universe.
- Kepler (1571-1630) – planetary motion
- Newton (1643-1727) – laws of motion, gravity and thermal conduction
- Galileo (1561-1626) – further proof of earth revolving around the sun
- Boyle (1627-1691) – behaviour of gases
- Pascal (1623-1662) –
- Descartes (1596-1650) – geometry
- **Van Leeuwenhoek (1673) – first microscope,**
- **Alfonso Vesalius (1542) - Anatomy**
- **Harvey (1650's) –**
- **Linnaeus (1735) – Systema naturae.**

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Important stages in the history of Biology
16th-18th century: The scientific revolution



Van Leeuwenhoek
(1632-1723)

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Important stages in the history of Biology
16th-18th century: The scientific revolution



Andrea Vesalius
(1514-1564)

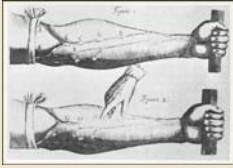

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Important stages in the history of Biology
16th-18th century: The scientific revolution




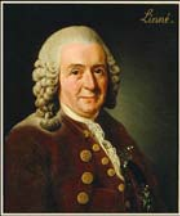
Harvey
(1578-1657)

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Important stages in the history of Biology
16th-18th century: The scientific revolution



Linnaeus
(1707-1778)

First published 1735


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Types of taxonomies

- Artificial
- Mechanical
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- Cladistic (Phylogenetic)



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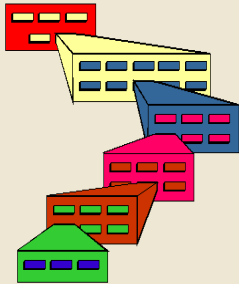
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The "scientific revolution" 16th – 18th century
Linnaeus – Taxonomic hierarchy



He divided hting sup into many
system(quadropeds,etc..)

The "scientific revolution" 16th – 18th century
Linnaeus – Taxonomic hierarchy



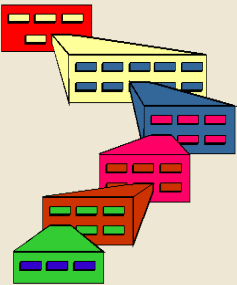
Kingdom:
Phylum:
Class:
Order:
Family:
Genus:
Species:

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2 have been added since linneausd

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The "scientific revolution" 16th – 18th century
Linnaeus – Taxonomic hierarchy



Kingdom: Animalia
Phylum: Chordata
Class: Mammalia
Order: Rodentia
Family: Castoridae
Genus: *Castor*
Species: *canadensis*




Figure 18.8

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Animalia: Ingestive heterotroph multicellular organism (have to ingest food and dissolve internally)

Chordata: have a single cord from which muscles originate

Mammalia: feed babies through milk glands


Rodentia: teeth never stop growing (due to ingesting wood)

Castoridae: special gland in tail that stops water from wetting downy fur and staying warm

Castor: beaver

Castor Canadensis

The "scientific revolution" 16th – 18th century
Linnaeus – Binomen



Apis pubescens, thorace subgriseo, abdominae fusco, pedibus utrinque margine ciliatis

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So when somebody tries to identify something they are giving a description

Prior to Linnaeus

The "scientific revolution" 16th – 18th century
Linnaeus – Binomen



The fuzzy bee with the greyish thorax, hairless hind legs that are bordered with hairs on both sides

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What the latin really means, therefore its name is really a long description

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The "scientific revolution" 16th – 18th century
Linnaeus – Binomen



Apis mellifera
(Honey bee)

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The binomen of Linnaeus Apis(bee) Mell(honey)lfera(small)

Small Honey bee

Changing thoughts on what living things are
Two different forms of thought

- **Physicalists** – with the exception of humans all living things are machines (Descartes, 17th century)
Organisms are really just mechanical levers & pulleys etc... we know how they function but all that happens is that nothing special about being a living being
- **Vitalists** – physical and chemical laws apply but living things have a vital force (essence)
This shows that there is a vital force/essence to make things be alive, so basically aristotle is still right/similar ideals

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Major division between the two sciences

Physical science	Natural science
<ul style="list-style-type: none">• Inanimate objects• Physical and chemical laws• Universal	<ul style="list-style-type: none">• Animate objects (living world)• More than physical and chemical laws (Genetics)• Not Universal

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Physical science

- Inanimate objects
- Physical and chemical laws
- Universal
- Based on empirical observations
- Experimentation preferred method

Natural science

- Animate objects
- More than physical and chemical laws (Genetics)
- Not Universal
- Based on historical narratives
- Induction most used method

based on an equation where new things can be predicted with equations

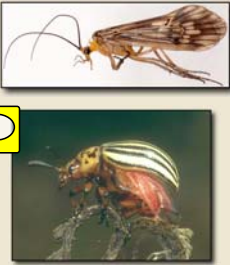
based on a story (observation) to much variance to be able to predict

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Induction vs. Deduction

- **Deduction** (from the general to the specific): All insects have wings and this animal is an insect. This animal has wings.
- **Induction**: (from the specific to the general) This animal is an insect and it has wings therefore all insects have wings. (many multiple observations!)



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Anatomy of a scientific explanation (theory)

- **Two parts**
 - **Pattern** all animals breed in similar ways and produce similar looking animals
 - **Mechanism or process** on October 4004, they were all created
- **Questions to be asked**
 - What?
 - How (proximate cause)? or Why (ultimate causes)?

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Proximate causes (Physical science-like biology)

- Phenotype – morphology and behaviour
- Mechanical (predictable)
- Here and now
- Genes in action
- Experiments

Ultimate causes (Natural science-like biology)

- Genotype - Genes and history
- Variable (probabilistic)
- Evolutionary past
- Changes in genetic programs
- Historical narratives

Proximate vs Ultimate causes
Mechanical vs Variable
Biology was a worse science b/c we could not describe heritability

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Physical science

- Inanimate objects
- Physical and chemical laws
- Universal
- Based on empirical observations
- Experimentation preferred method
- Single theory
- Single falsification enough to abandon a theory

Natural science

- Animate objects
- More than physical and chemical laws (Genetics)
- Not Universal
- Based on historical narratives
- Induction most used method
- Multiple theories
- Single falsification not necessary to abandon a theory

DEDUCTION= MOST USED METHOD


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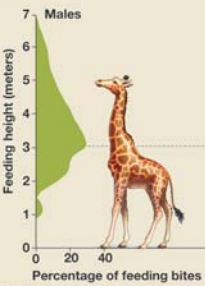
Multiple theories

- Food competition
- Sexual competition

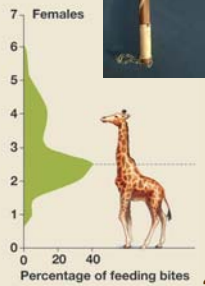
Video



Males



Females



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This demonstrates our acceptance of multiple theories
Giraffes long neck= eat leaves etc.. from top of trees

But giraffes were mainly eating from shoulder height, so the grad student came up with an alternative model: Head was used as a weapon (males will kill each other in sexual competition), the long neck was used in combination with the head & stubby horns as a form of mace and chain (long neck was used to make a whiplash to be able to do more damage to the other male), however also during drought it would be also ad-vantageous to have a long neck to reach to the top to eat the last bits of food therefore there are multiple accepted theories about the same, whereas in the physical sciences this would not be allowed
~~Darwin basically allowed the narrative to become a reliable proof, through his amazing logical arguments and huge amounts of proof.~~

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Changing thoughts on what living things are

- **Physicalists** – with the exception of humans all living things are machines (Descartes, 17th century)
- **Vitalists** – physical and chemical laws apply but living things have a vital force (essence)

↓

- **Organicists (1930)** – vital force replaced by genetic program and the importance of emergence (**swarm behaviour**)

LIFE IS MORE THAN THE SUM OF ITS PARTS (NaCl; Na=burst into flames, Cl= poisonous gas, NaCl= no risk of poisoning or explosions, therefore more than the sum of its parts)

This more than the sum bring both Physicalista and Vitalist together
 know there is physical reason for all of these new EMERGENT properties that can not be predicted but can be explained
 Swarm of TSralings: 1 bird can only communicate with 7-8 surrounding birds beleive that the starling swarm is greater than just the little birds, might actually be a way of census for the amount of the birds in the swarm

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Scientific method
Some terms used in doing science

- **Theory and Fact**
- **Hypothesis**
- **Law**
- **Prediction (logical vs chronological)**

Darwin created a theory of evolution (a theory is the strongest statement about a scientific piece of knowledge possibly. Somebody observed this , nmade sure that the theory always works and made observations to prove this. Therefore these theories might be disproved, however in biology the strongest statement is a theory, b/c bio has no fact onlt theories b/c we do not guarantee something to 100% only to 99.99% but always the potential for doubt.

Hypothesis: to general public this a watery guesstimate of whats going on. In science what has happened is that someone has doen extreme amounts of observations in differenat, therefore hpytoheis that have been rigouresly proven it becomes a theory

Why is this not a law: its not universal(not law of evolution, b/c we have only observed it on our little blue planet) maybe on another world is diffent

Mendel has laws: b/c he made a mathematical equation of the poeibility of entities called alleles forming ind fierent offspring etc...

Prediction: a logical consequence of what things are going on aroundthem into the future, a chronological sequence(weather in future etc..)

Logical Prediction:

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Scientific method
Steps or stages

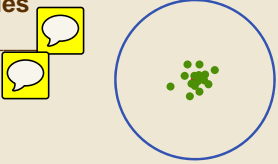
- **A question that needs to be answered**
- **Gather information already known** ALL INFORMATION EVER
- **Develop a hypothesis and test it** I think this happens b/c of this, hypotheses is the proposed solution that explains the observations
- **Interpret the results of the test**
- **Retest**
- **Publish results**

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Additional experimental components

- Controls
- Control of variables
- Sampling of Error
- Repeat the test



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Distribution of scientific facts

- Journal selection
- Manuscript preparation
- Peer review
- Revision
- Publication

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Types of literature – what's the difference




- Primary
- Secondary
- Tertiary

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Stages in an investigation.

- **The question**
- **Gather information**
- **Develop a hypothesis and test it.**
- **Interpret the results of the test**
- **Retest**

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Dr. Houseman research, on bugs, kissing bug, blood/protein in feces

Side study from Honours (which became his phd dissertation), all the way to masters and phd

Special new enzymes b/c swapping from plant eaters but omnivores that have turned predacious, like the tiger beetle, etc...

Uses lysosomal enzymes as main enzymal digestive environment/physiology

Darwin's five theories – Natural selection
Natural selection – Industrial melanism



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The peppered moth story, what did the peppered moth give biology.

Peppered moth story showed us genetics and alleles to promote change, proof was shown

Peppered moth

- **Observation 1:** Original museum collections had all white peppered moths and by 1900 traps collected 90% black.
- **Question 1:** Why did the moths shift from light to dark morphs?

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population genetics: natural selection occurs when you get a change in the allelic diversity of a population.

Natural selection: proof = find proof that an alleles frequency has changed became possible and ability to demonstrate natural selection

So the change in the frequency of the allele in the population!

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Peppered moth

- **Hypothesis 1:** Fitness decreased when the moths that were more visible against the background colour of the trees.
- **Null hypothesis 1:** Fitness remains the same and is not affected by the background.
- **Hypothesis 2:** The bark colour of the trees has changed.
- **Null hypothesis 2:** The bark colour of the trees has not changed.

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Hypothesis= what we believe

~~Null hypothesis= what happens if proven wrong~~

- first demonstration of a heritable trait within a population changing over time

Peppered moth

- **Experiment 1:** Artificially rear light and dark morphs and place on tree and observe survival (fitness)
- **Experiment 2:** Locate light and dark coloured trees.



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White moths were not as 'fit' as black moths, therefore they disappeared into the gene pool
Therefore around black trees black moths survive (industry), white trees and white moths, therefore a correlation is shown. can't blame on industry 'just a correlate, no proof', physical science thinking pushed onto natural sciences.
B/c you haven't tested every possibility its not true, but happened again in Britain as well as in America

Peppered moth

- **Result 1:** Birds selected most visible moths
- **Result 2:** Dark trees showed same distribution as coal based industry



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Peppered moth

- **Question:** Do moths “rest” on backgrounds that match their colouration?
- **Question:** What impact would the clean air act, that reduced pollutant immisions have on the moth population morphs?
- **Question:** What happens to other moths with light and dark colour morphs

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