


# 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 – 16<sup>th</sup> century: \_\_\_\_\_
  - 16<sup>th</sup>-18<sup>th</sup> 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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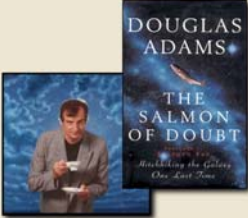
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**Important stages in the history of Biology**  
**16<sup>th</sup>-18<sup>th</sup> century: The scientific revolution and the start of modern sciences**

**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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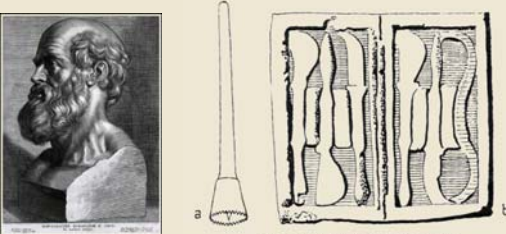
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# History of Biology: Before Darwin

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 scalpel.  
 (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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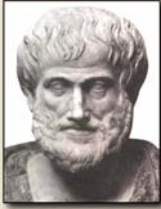
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# History of Biology: Before Darwin

**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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- **Predarwinian and the natural sciences**  
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- **Darwin and evolutionary thought**  
(late 1800's – mid 1900's)
- **Modern theory of evolution**  
(mid 1900's – present)

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**Important stages in the history of Biology**  
**450-16<sup>th</sup> century: Medieval ages**

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



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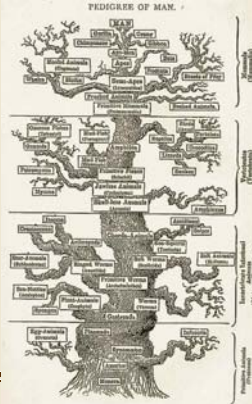
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**Special creation**

- **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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# History of Biology: Before Darwin

Important stages in the history of Biology  
**450-16<sup>th</sup> century: Medieval ages**

- **Europe**
  - 400-700 Early middle ages (Dark Ages)
  - 1000-1300 High middle Ages
  - 1300-1500 \_\_\_\_\_



**Black plague (1347-1351)**

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Important stages in the history of Biology  
**450-16<sup>th</sup> 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  
**450-16<sup>th</sup> 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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# History of Biology: Before Darwin

Important stages in the history of Biology  
**450-16<sup>th</sup> 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 conclusion
7. Publication of findings



Alhazen



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Important stages in the history of Biology  
**450-16<sup>th</sup> century: Medieval ages**

- **Byzantium and Islamic world**
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# History of Biology: Before Darwin

Important stages in the history of Biology  
**16<sup>th</sup>-18<sup>th</sup> 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,
- Andrea Vesalius (1542) - Anatomy
- Harvey (1650's) – \_\_\_\_\_
- Linnaeus (1735) – Systema naturae.

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Important stages in the history of Biology  
**16<sup>th</sup>-18<sup>th</sup> century: The scientific revolution**



Van Leeuwenhoek  
(1632-1723)

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Important stages in the history of Biology  
**16<sup>th</sup>-18<sup>th</sup> century: The scientific revolution**



Andrea Vesalius  
(1514-1564)

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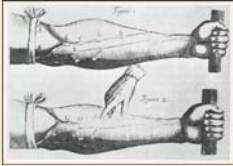

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# History of Biology: Before Darwin

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



Harvey  
(1578-1657)

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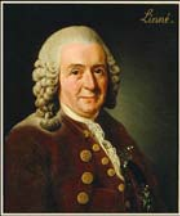
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Important stages in the history of Biology  
**16th-18th century: The scientific revolution**



Linnaeus  
(1707-1778)

First published 1735

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**Types of taxonomies**

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



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# History of Biology: Before Darwin

Some initial definitions about naming

- Classification
- Taxonomy
- Hierarchical
- Systematics



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The "scientific revolution" 16<sup>th</sup> – 18<sup>th</sup> century  
Linnaeus – Taxonomic hierarchy



CAROLI LINNÆI REGNUM ANIMALE

I QUADRUPEDIA.

Monn.	Inde et ipse.	Quadrupes, quadrupes, quadrupes, quadrupes.
Semil.	Quadrupes, quadrupes, quadrupes, quadrupes.	Quadrupes, quadrupes, quadrupes, quadrupes.
Birdipus.	Quadrupes, quadrupes, quadrupes, quadrupes.	Quadrupes, quadrupes, quadrupes, quadrupes.
Urtin.	Quadrupes, quadrupes, quadrupes, quadrupes.	Quadrupes, quadrupes, quadrupes, quadrupes.
Lat.	Quadrupes, quadrupes, quadrupes, quadrupes.	Quadrupes, quadrupes, quadrupes, quadrupes.
Tigul.	Quadrupes, quadrupes, quadrupes, quadrupes.	Quadrupes, quadrupes, quadrupes, quadrupes.
Felis.	Quadrupes, quadrupes, quadrupes, quadrupes.	Quadrupes, quadrupes, quadrupes, quadrupes.
Mulchis.	Quadrupes, quadrupes, quadrupes, quadrupes.	Quadrupes, quadrupes, quadrupes, quadrupes.
Dudiphibis.	Quadrupes, quadrupes, quadrupes, quadrupes.	Quadrupes, quadrupes, quadrupes, quadrupes.

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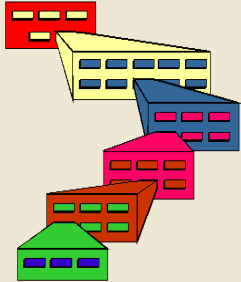
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The "scientific revolution" 16<sup>th</sup> – 18<sup>th</sup> century  
Linnaeus – Taxonomic hierarchy



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

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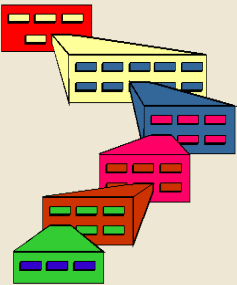
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# History of Biology: Before Darwin

**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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**The “scientific revolution” 16th – 18th century  
Linnaeus – Binomen**



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

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**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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# History of Biology: Before Darwin

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



*Apis mellifera*  
(Honey bee)

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Changing thoughts on what living things are

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

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

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# History of Biology: Before Darwin

**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

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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!)



The top image shows a dragonfly, a large insect with long wings and a segmented body. The bottom image shows a beetle, a smaller insect with a hard shell and six legs.

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**Anatomy of a scientific explanation (theory)**

- **Two parts**
  - Pattern
  - Mechanism or process
- **Questions to be asked**
  - What?
  - How (proximate cause)? or Why (ultimate causes)?

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# History of Biology: Before Darwin

<b>Proximate causes</b> (Physical science-like biology)	<b>Ultimate causes</b> (Natural science-like biology)
<ul style="list-style-type: none"><li>• Phenotype – morphology and behaviour</li><li>• Mechanical (predictable)</li><li>• Here and now</li><li>• Genes in action</li> <li>• Experiments</li></ul>	<ul style="list-style-type: none"><li>• Genotype - Genes and history</li><li>• Variable (probabilistic)</li><li>• Evolutionary past</li><li>• Changes in genetic programs</li><li>• Historical narratives</li></ul>
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<b>Physical science</b>	<b>Natural science</b>
<ul style="list-style-type: none"><li>• Inanimate objects</li><li>• Physical and chemical laws</li><li>• Universal</li><li>• Based on empirical observations</li><li>• Experimentation preferred method</li><li>• Single theory</li><li>• Single falsification enough to abandon a theory</li></ul>	<ul style="list-style-type: none"><li>• Animate objects</li><li>• More than physical and chemical laws (Genetics)</li><li>• Not Universal</li><li>• Based on historical narratives</li><li>• Induction most used method</li><li>• Multiple theories</li><li>• Single falsification not necessary to abandon a theory</li></ul>
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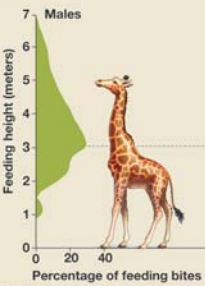
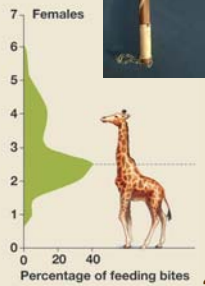
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<b>Multiple theories</b>	Video
<ul style="list-style-type: none"><li>• Food competition</li><li>• Sexual competition</li></ul>	
	
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# History of Biology: Before Darwin

**Changing thoughts on what living things are**

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

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

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**Scientific method**  
**Some terms used in doing science**

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

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**Scientific method**  
**Steps or stages**

- A question that needs to be answered
- Gather information already known
- \_\_\_\_\_
- Interpret the results of the test
- Retest
- Publish results

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# History of Biology: Before Darwin

**Additional experimental components**

- Controls
- Control of variables
- \_\_\_\_\_
- 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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# History of Biology: Before Darwin

**Stages in an investigation.**

- The question
- Gather information
- \_\_\_\_\_
- Interpret the results of the test
- Retest



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**Darwin's five theories – Natural selection**

**Natural selection – Industrial melanism**



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**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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# History of Biology: Before Darwin

## 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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## 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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## Peppered moth

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



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# History of Biology: Before Darwin

## 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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