History of Biology before Darwin

BIO1130 Organismal Biology
Jon G. Houseman

Organismal Biology – Main themes.

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

Major events in the history of Biology

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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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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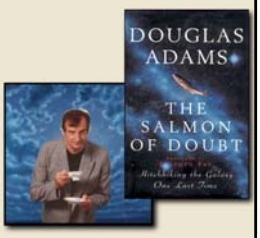
Important stages in the history of Biology

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)

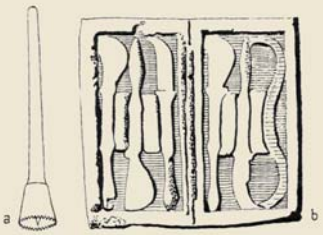

FIG. 15. Types of instruments used by Greek surgeons
(a) Simple trephine with centre pin. (b) Case of scalpels.
(c) Sixteenth-century instrument of ancient type. (d) Relief in the Asclepieion, Athens.

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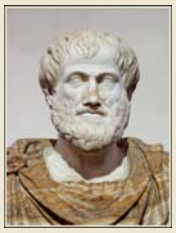
Important stages in the history of Biology

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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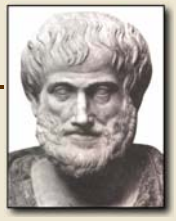
Types of taxonomies

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



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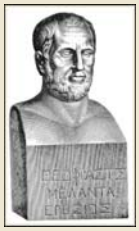
Important stages in the history of Biology

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 cha of being**
- **Essentialism**

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

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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

450-16th century: Medieval ages

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

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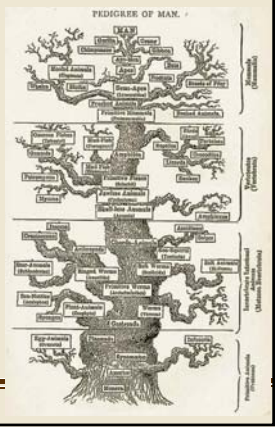
Special creation

- 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
  - 1300-1500 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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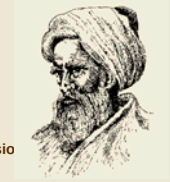
Important stages in the history of Biology

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 conclusio
7. Publication of findings



Alhazen

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450-16th century: Medieval ages

- Byzantium and Islamic world
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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 sub
- Boyle (1627-1691) – behaviour of gases
- Pascal (1623-1662) –
- Descartes (1596-165 ometry

- Van Leeuwenhoek (1673) – first microscope,
- Andrea Vesalius (1542) – Anatomy
- Harvey (1650's) –
- Linnaeus (1735) – ma 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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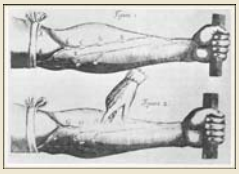
Important stages in the history of Biology

16th-18th century: The scientific revolution

Harvey
(1578-1657)



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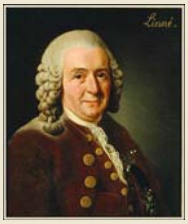
Important stages in the history of Biology

16th-18th century: The scientific revolution



Linnaeus
(1707-1778)

First published 1735

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Types of taxonomies

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

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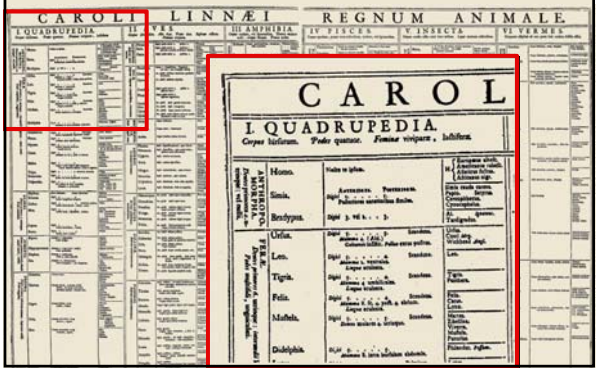
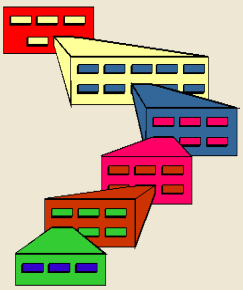
Some initial definitions about naming

- Classification
- Taxonomy
- Hierarchical
- Systematics

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

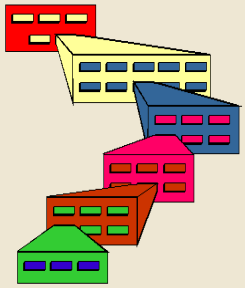


The "scientific revolution" 16th – 18th century
Linnaeus – Taxanomic hierarchy



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

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



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

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

Apis mellifera
(Honey bee)

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)

Physical science

- Inanimate objects
- Physical and chemical laws
- Universal

Natural science

- Animate objects
- More than physical and chemical laws (Genetics)
- Not Universal

Physical science	Natural science
• Inanimate objects	• Animate objects
• Physical and chemical laws	• More than physical and chemical laws (Genetics)
• Universal	• Not Universal
• Based on empirical observations	• Based on historical narratives
• Experimentation preferred method (Deduction)	• 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!)

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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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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

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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

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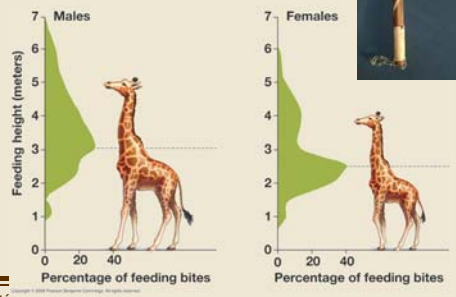
Multiple theories

- Food competition
- Sexual competition

Video 1, 2



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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)

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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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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 diffence

- Primary
- Secondary
- Tertiary

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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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Peppered moth

- **Hypothesis 1:** Fitness decreased when the moths that were more visible against the background colour of the trees.
- **Null hypothesis1:** 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.

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.

Peppered moth

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

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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