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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Many of these specifications were only recently introduced, since bio is always neglected in the science community

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: Medival ages
  - 16th-18th century: Renaissance and the scientific revolution
- **Darwin and evolutionary thought**
  (late 1800's – mid 1900's)
- **Modern theory of evolution and more**
  (mid 1900's – present)

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Rome collapsed because it had overextended itself

Commerce returned after 1200 years in the medival ages

However the infrastructure collapsed again which became

the dark ages. During the dark ages science was continued

in the islamic regions. Then Europe came back, invaded,

and stole all the findings for themselves which became the

Renaissance period.

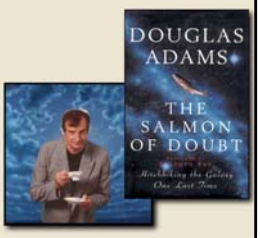
Important stages in the history of Biology

16th-18th century: The scientific revolution and the start of modern sciences

Douglas Adams 1952-2001

Four ages of sand

- First - Telescope 1608
- Second - Microscope 1678
- Third - Computer chip 1961
- Fourth - Fiber optics 1980s



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Innovative

Debunked all the biblical teachings in terms of evolution

and how life formed on earth

Third age brought a lot more faster and effecient methods

and info storage

Data could be transmitted through optic fibres with little to

no damage and great speed

Also helped with communication because people can converse over various programs.

Major events in the history of Biology: Predarwinian

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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)

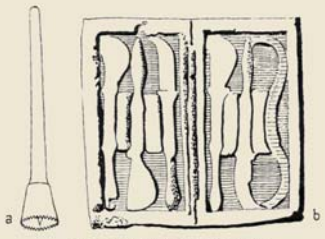

FIG. 15. Types of instruments used by Greek surgeons
(a) Simple trephine with centre pin. (b) Case of scalpels.
(c) Sixteenth-century instrument of ancient type. (d) Relief in the Asclepieion, Athens.

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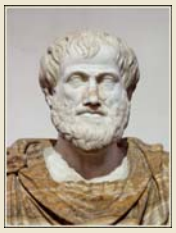
Hippocratic corpus; travelled and compiled information about human biology and disease. Became a giant human biology textbook. Considered the founder of medicine.

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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Organized the living word and put man at the top as the perfect being because they resembled the gods

4th: everything that lay eggs 5th: octopus

6th: sea animals with crunchy outsides

7th: insects 8th: other things that lived under shells

jelly fish, sponges he didnt know what do with them so he put it on the side. Then at the bottom he put plants

Known as a great philospher because he the first person to attempt to organize the living word a.k.a "the ladder of life"

Some initial definitions about naming

- **Classification**
- **Taxonomy**
- **Hierarchical**
- **Systematics**

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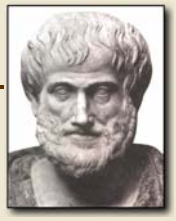
Aristotle, Hippocrates, and Theo all organized humans, animals, and plants in some fashion. This is referred to as classification. Taxonomoy is a set of rules of which they organize their findings

Types of taxonomies

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



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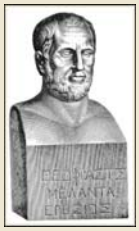
Artificial taxonomy was not necessarily based on biology

Folk taxonomy is a group of people with no writing but a certain individual that mentally noted all the important knowledge

ex. shaman

Important stages in the history of Biology

400 BCE – 450: Greek and Roman ages



Theophrastus
(371-287 BCE)

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Why are plants so important?

Plants had medicainal properties, food sources, fibre to manufacture

His work was still relevant 1600 years later because he grouped the plants by the structure of their flowers and he did it correctly!

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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Major events in the history of biology:

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  - 16th-18th century: _____
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  (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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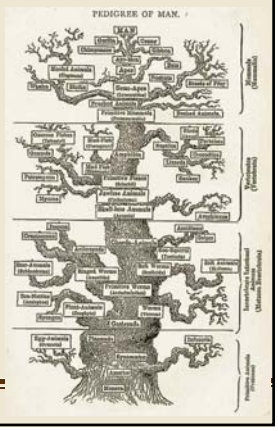
Essentialism: every organism had a certain essence.

There's an essence passed from generations that makes a horse a horse or a frog a frog. This specified essence makes each organism its own and unique from each other

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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Saturday Oct 23 4004 BCE (estimated from dates in the bible)

The world is only 6000 years old

So far everyone knows there was a certain designer that created everything in a chain and they all had a certain essence

Put humans at the top

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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The Black Plague wiped out almost all of Europe

We celebrate the Black Plague because it encouraged communities to move away from one another in order to avoid getting sick.

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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Al-Jahiz already touched on Evolution of Natural Selection in such an early era and "Survival of the Fittest"

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

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 sub**
- **Boyle** (1627-1691) **– behaviour of gases**
- **Pascal** (1623-1662) – origins of Calculus
- **Descartes** (1596-1650) **– geometry**

- **Van Leeuwenhoek** (1673) **– first microscope,**
- **Andrea Vesalius** (1542) **- Anatomy**
- **Harvey (1650's) –** Anatomy & Physiology
- **Linnaeus** (1735) **– Systema naturae.**

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Copernicus did not want his findings published till after he dies because he could have faced ex communication However Galileo comes after him and he did not fear the punishment and published his findings, he was then ex communicated. However the church later acknowledged this.

Important stages in the history of Biology

16th-18th century: The scientific revolution

Van Leeuwenhoek
(1632-1723)

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Leeuwenhoek invented the microscope.Leeuwenhoek found many little animals and bacteria in the water which then again went against the church.

Important stages in the history of Biology

16th-18th century: The scientific revolution

Andrea Vesalius
(1514-1564)

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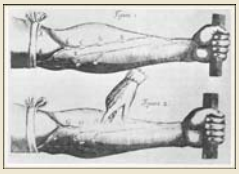
Worked with muscles and human bio

Important stages in the history of Biology

16th-18th century: The scientific revolution

Harvey
(1578-1657)



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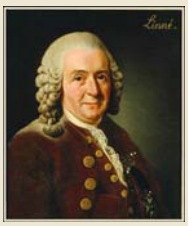
Worked with physiology and how the heart pumped blood

Important stages in the history of Biology

16th-18th century: The scientific revolution



Linnaeus
(1707-1778)

First published 1735

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Tries to find a way to organize and looked for commonalities in the living world.However he put it in a heiarchy.

Types of taxonomies

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

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Folk: word of mouth

Artifical

Mechanical

All of the three levels dont actually contain much biology just yet

Some initial definitions about naming

- Classification
- Taxonomy
- Hierarchical
- Systematics

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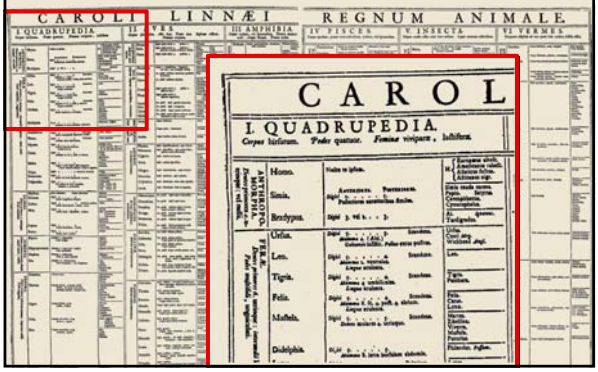
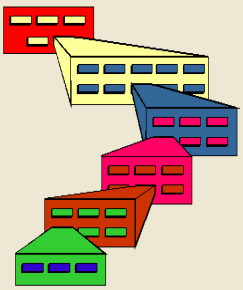
The "scientific revolution" 16th – 18th century
Linnaeus – Taxonomic hierarchy



6 major catagories all further specified

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



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

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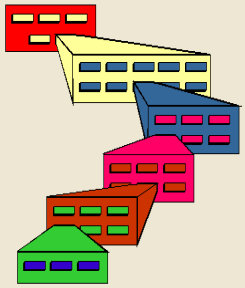
The "scientific revolution" 16th – 18th century
Linnaeus – Taxanomic hierarchy



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)

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Binomen (2 parts): A noun + adjective

Always written in latin and italisized because all terms in diff.

language are put in italics.

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)

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Big division at the end of the scientific evolution between Physicalists

and Vitalists.

Vitalists has a connection to Essentialism

Physical science	Natural science
• Inanimate objects	• Animate objects
• Physical and chemical laws	• More than physical and chemical laws (Genetics)
• Universal	• Not Universal

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Why has general biology not progressed in the 17000s?

Because the Physical world and the Natural world were butting heads

Natural science is not universal because they haven't found life anywhere

else.

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

Deduction

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!)

Physicalists made very broad, general laws that had not been

100% proven

Anatomy of a scientific explanation (theory)

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

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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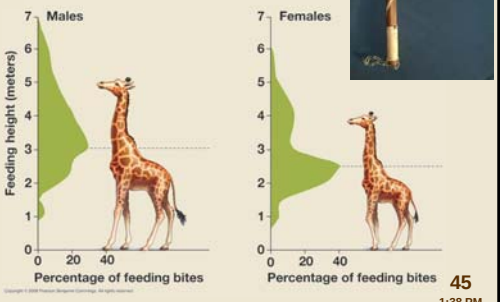
Multiple theories

- Food competition
- Sexual competition

Video



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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
- Develop a hypothesis and test it
- Interpret the results of the test
- Retest
- Publish results

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Additional experimental components

- Controls
- Control of variables
- Sampling 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 diffence

- 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

Darwin's five theories – Natural selection

Natural selection – Industrial melanism

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?

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.

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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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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