Organismal Biology – Main themes.

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

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.

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.

Types of Biology

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

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

Important stages in the history of Biology

400 BCE – 450: Greek and Roman ages

Hippocrates (460-370 BCE)

Important stages in the history of Biology

400 BCE – 450: Greek and Roman ages

Aristotle (384-322 BCE)

Some initial definitions about naming

- Classification
- Taxonomy
- Hierarchical
- Systematics
**Types of taxonomies**

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

**Important stages in the history of Biology**

**400 BCE – 450: Greek and Roman ages**

- Scala naturae - the great chain of being
- Essentialism

**450 - 16th century: Medieval ages**

- Scala naturae - the great chain of being
- Essentialism

**Major events in the history of biology:**

- Predarwinian and the natural sciences (400 BCE – late 1800’s)
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- Modern theory of evolution (mid 1900’s – present)

**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
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 ___________

Black plague (1347-1351)

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

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

- Byzantium and Islamic world
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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

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)
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Avicenna

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- Darwin and evolutionary thought
  - (late 1800’s – mid 1900’s)

- Modern theory of evolution
  - (mid 1900’s – present)
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 (1564-1642) - further proof of earth revolving around the sun
- Boyle (1627-1691) - behavior of gases
- Pascal (1623-1662) - _______________
- Descartes (1596-1650) - geometry
- Van Leeuwenhoek (1632-1723) - first microscope,
- Andrea Vesalius (1514-1564) - Anatomy
- Harvey (1578-1657) - _______________
- Linnaeus (1707-1778) - Systema naturae.

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Some initial definitions about naming

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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

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

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

The fuzzy bee with the greyish thorax, hairless hind legs that are bordered with hairs on both sides
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
- Inanimate objects
- Physical and chemical laws
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- 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

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!)

Anatomy of a scientific explanation (theory)

- Two parts
  - Pattern
  - Mechanism or process
- Questions to be asked
  - What?
  - How (proximate cause)? or Why (ultimate causes)?
History of Biology: Before Darwin

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

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

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)

Multiple theories
- Food competition
- Sexual competition

Scientific method
Some terms used in doing science
- Theory and Fact
- Hypothesis
- Law
- Prediction (logical vs chronological)

Steps or stages
- A question that needs to be answered
- Gather information already known
- Interpret the results of the test
- Retest
- Publish results
History of Biology: Before Darwin

Additional experimental components
- Controls
- Control of variables
- _______________________
- Repeat the test

Distribution of scientific facts
- Journal selection
- Manuscript preparation
- Peer review
- Revision
- Publication

Types of literature – what’s the difference
- Primary
- Secondary
- Tertiary

Stages in an investigation.
- The question
- Gather information
- _______________________
- 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 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.

**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