The Biological Revolution: What is Life?

The Biological Revolution
Key Concepts

1) The ancient idea of **spontaneous generation**
   was finally disproved in the 19th century.

2) The invention of the **microscope** enabled
   new observations of living beings.

3) **Genes** and **DNA** store and transmit
   hereditary information.

Spontaneous generation states that life can
grow from non-living matter, without parents.

Aristotle: animals could spring spontaneously
from “putrefying earth or vegetable matter”.

The idea remained common in the Renaissance:
“Your serpent of Egypt is bred now of your mud by
the operation of your Sun: so is your Crocodile.”
(Shakespeare, Anthony & Cleopatra, 2, 7)
Francesco Redi argued against spontaneous generation (1668).

- Meat in an open jar → maggots
- Meat in a tightly sealed jar → no maggots
- Meat in a gauze-covered jar → no maggots

Flies beget maggots, which develop into flies, which beget maggots, which...

Louis Pasteur discredited spontaneous generation for micro-organisms (1859).

Two samples of broth (one boiled, one not) put into special "gooseneck" flasks, admitting air but not airborne yeasts.

Unboiled broth quickly fermented, boiled broth did not.

Anton van Leeuwenhoek (1632-1723) used the microscope to advance the study of biology.

⇒ van Leeuwenhoek
van Leeuwenhoek's microscope ⇒

First to observe & describe cells, micro-organisms, spermatazoa, blood flow in capillaries...
Leeuwenhoek’s microscope was to biology what Galileo’s telescope was to astronomy.

Heredity: transmission of characteristics from parents to offspring.

Early scientists observed that children resemble their parents in some ways.

They weren’t sure how that similarity was passed on.

Some thought that acquired characteristics could be passed on.

One outdated idea: the “Homunculus” within human sperm.

The idea that spermatozoa contained prefab humans was put forward in the 17th century.

One problem: children resemble Mom as well as Dad.
Gregor Mendel performed a key set of experiments in heredity (1856 to 1863).

Experiments growing peas led to two important insights:

- Hereditary factors come in pairs, one from each parent.
- One factor must be dominant, the other recessive.

Example: Heritability of flower color in peas

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<th>Cross</th>
<th>Recessive Trait</th>
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Microscopic studies of fertilization: cell nucleus is formed out of material from egg and sperm.

Hereditary factors reside in the cell nucleus.
Microscopic studies of cell division: chromosomes in original cell nucleus are shared between two “daughter” nuclei.

Fleming (1882) examined cell division in salamander cells.
He named the process of division “mitosis”.
He didn’t know at the time that hereditary factors reside in the chromosomes.

Experiments breeding fruit flies (Drosophila) revealed the transmission of sex-linked traits.

Experiments by Morgan & Sturtevant (1910) revealed chromosomes as the site of hereditary factors, or “genes”.

Watson and Crick showed how DNA can store and replicate genetic information (1953).

DNA = Deoxyribonucleic Acid
Chromosomes are long strands of DNA that carry molecular instructions for how to build proteins.
Life is a physical phenomenon governed by understandable laws that make testable predictions.

The same laws of physics work on Earth and in the heavens.

The same laws of chemistry work in living things and in non-living things.

Monday’s Lecture:
The Earth We Stand On

Next week’s reading:
Chapter 4