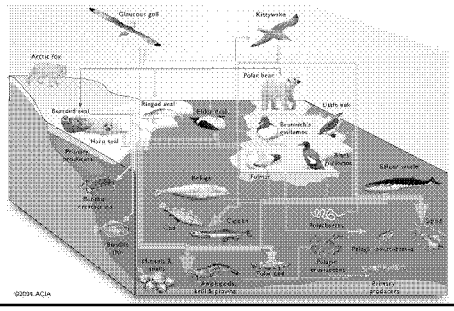
Friday, October 1

The Biological Revolution: What is Life?



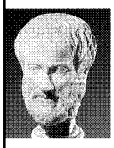
The Biological Revolution Key Concepts

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

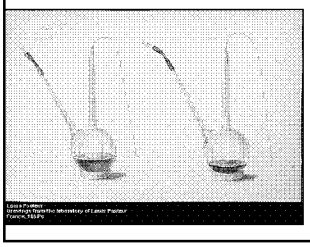
Meat in a tightly sealed jar → no maggots

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).

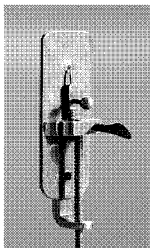
Two samples of broth (one boiled, one not) put into special "gooseneck" flasks, admitting air but not airborne yeasts.



Unboiled broth quickly fermented, boiled broth did not.

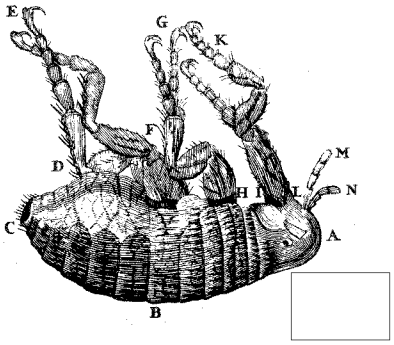
Anton van Leeuwenhoek (1632-1723) used the microscope to advance the study of biology.

⇦ 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.

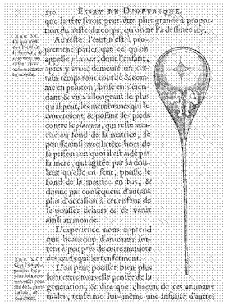
They weren't sure how that similarity was passed on.

Some thought that **acquired characteristics** could be passed on.

One outdated idea: the "Homunculus" within human sperm.

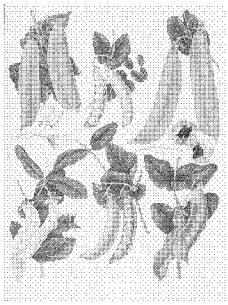
The idea that spermatazoa contained prefab humans was put forward in the 17th century →

One problem: children resemble Mom as well as Dad.



Hartsoeker's homunculus (1694)

Gregor Mendel performed a key set of experiments in heredity (1856 to 1863).

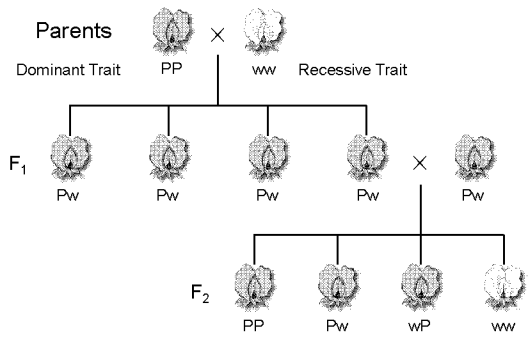


Experiments growing peas led to two important insights:

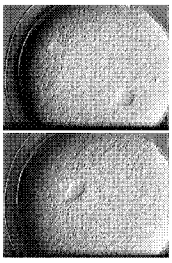
Hereditary factors come in **pairs**, one from each parent.

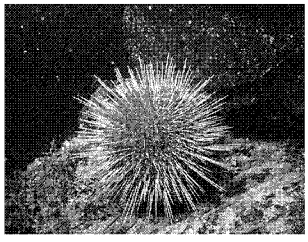
One factor must be **dominant**, the other **recessive**.

Example: Heritability of flower color in peas



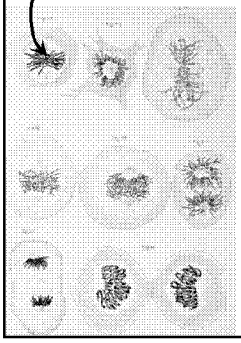
Microscopic studies of fertilization: cell **nucleus** is formed out of material from egg and sperm.





Hereditary factors reside in the cell nucleus.

Microscopic studies of cell division: **chromosomes** in original cell nucleus are shared between two "daughter" nuclei.

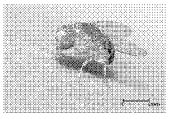


Flemming (1882) examined cell division in salamander cells.

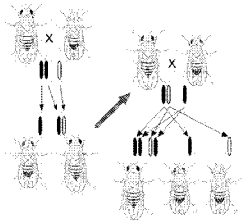
He named the process of division "mitosis".

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".

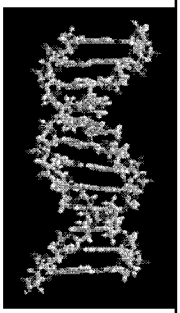


Watson and Crick showed how DNA can store and **replicate** genetic information (1953).

DNA = Deoxyribonucleic Acid

Chromosomes are long strands of DNA that carry molecular instructions for how to build proteins.

Watson & Crick



DNA Molecule

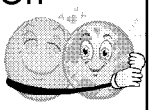
Life is a physical phenomenon governed by understandable laws that make testable predictions.

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