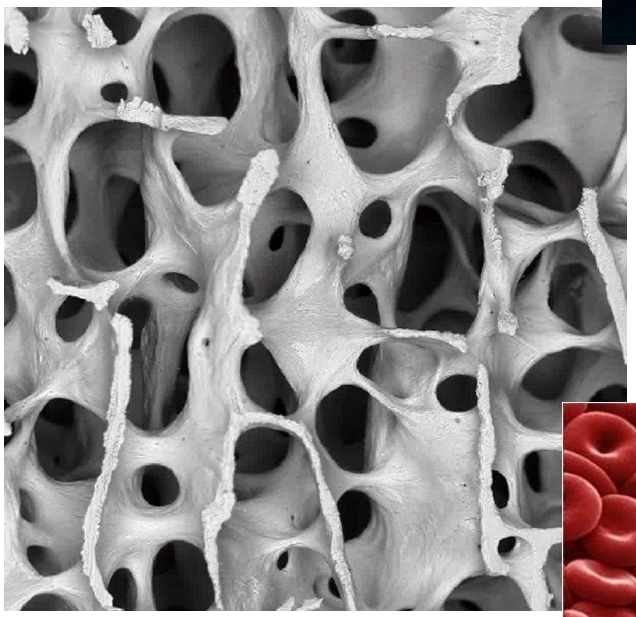
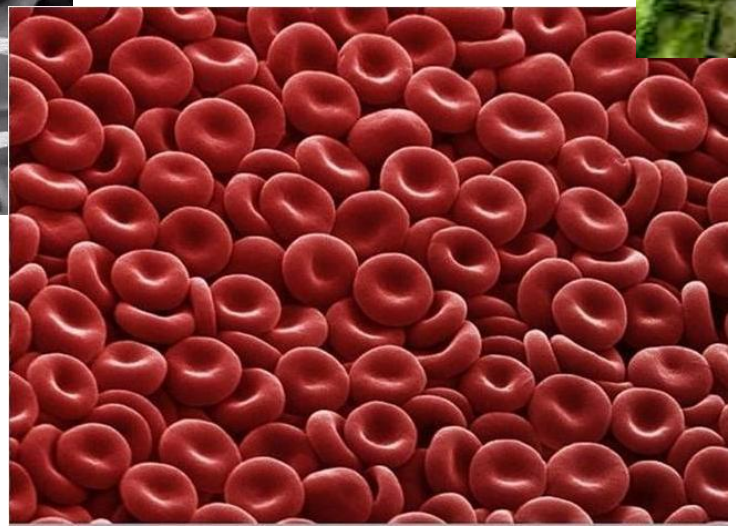
Cells

Cells are the **basic structural, functional, and biological unit** of all known living organisms.

Cells are often called the **"building blocks of life"**.





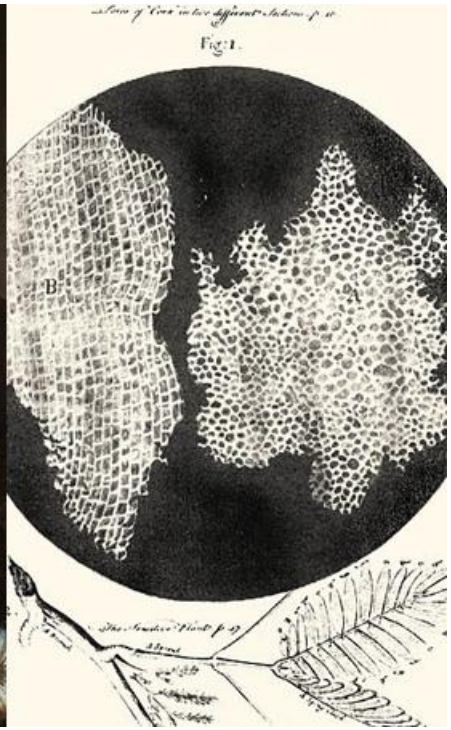
The study of cells is called **cell biology**.

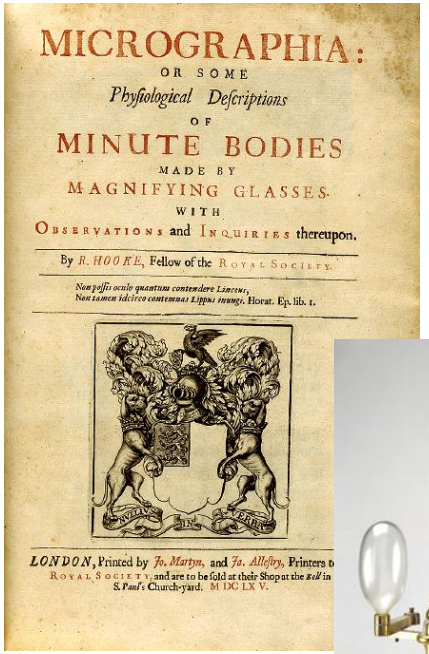
Knowing the **components** of cells **and how cells work** is fundamental to all biological sciences.

Life sciences comprise the fields of science that involve the scientific study of living organisms.

- General and unifying concepts recognized in modern biology:
  - the cell is the basic unit of life
  - gene is the basic unit of heredity
  - evolution is the engine that propels the synthesis and creation of new species
- Although more than 99% of all species ever to have lived are estimated to be extinct, there are currently 10–14 million species of living organisms on the Earth.

Discovery of Cells




MICROGRAPHIA:
OR SOME
Physiological Descriptions
OF
MINUTE BODIES
MADE BY
MAGNIFYING GLASSES.
WITH
OBSERVATIONS and INQUIRIES thereupon.
By *R. HOOKE*, Fellow of the ROYAL SOCIETY.
Non possis oculo quantum contendere Lynceus,
Non tamen idcirco contemnas Lippus inungi. Horat. Ep. lib. 1.
LONDON, Printed by *Jo. Martyn*, and *Ja. Allestry*, Printers to
ROYAL SOCIETY, and are to be sold at their Shop at the *Kell* in
S. *Paul's* Church-yard. MDCLXV.

***Micrographia*, published in 1665**

Hooke's design microscope system

Robert Hooke (1665):

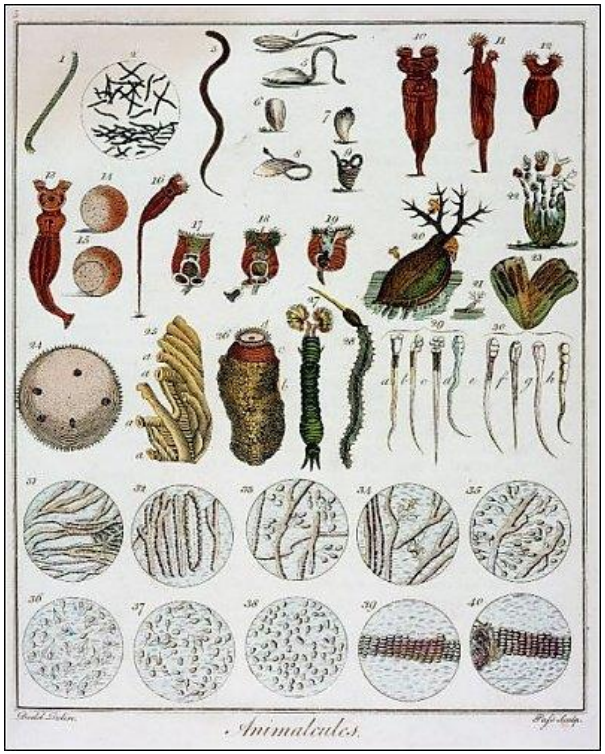
- **Observed a thin slice of cork (dead plant cells) with a microscope.**
- **Described what he observed as "little boxes" (*cells*).**

Discovery of Cells

Antonie van Leeuwenhoek (1675):

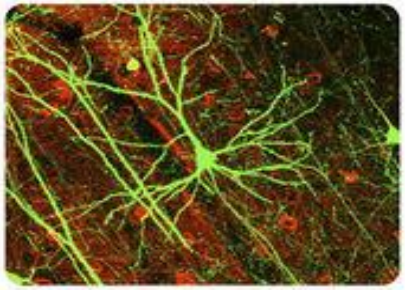
- Discovered a way to create a very small, high-quality glass spheres that became the lenses of his tiny microscopes, with the smallest spheres providing the highest (up to 500X) magnification.

- The first person to observe living cells and describe single-celled organisms (infusoria in 1674, bacteria in 1676) and the vacuole of a plant cell.
- Commonly known as "the Father of Microbiology".

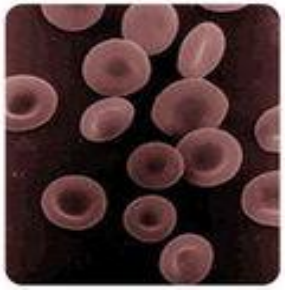


Cell Diversity: Shape

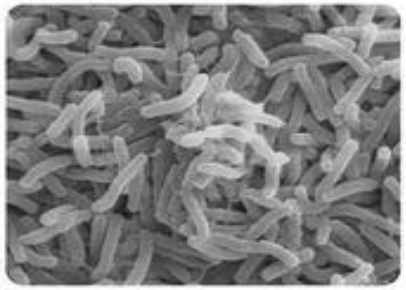
Cells <u>differ widely</u> (and wildly!) in shape…



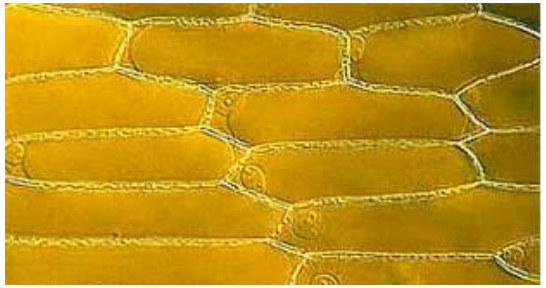
Nerve cell



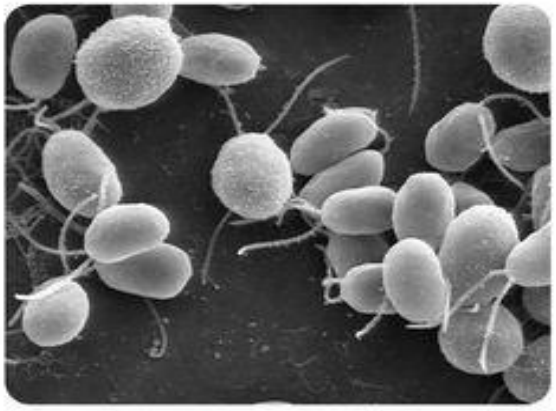
Red blood cells



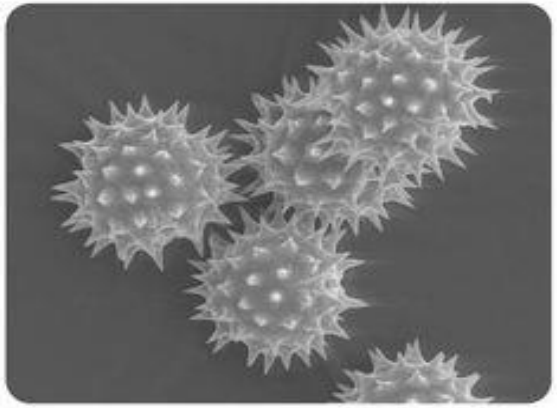
Bacteria



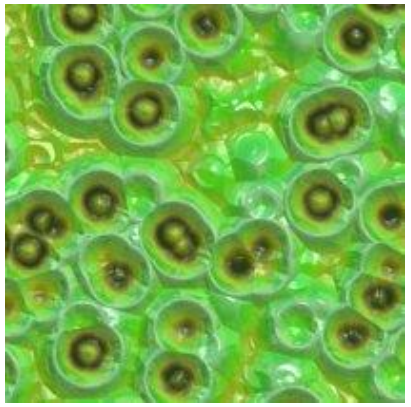
Plant cells



Algae



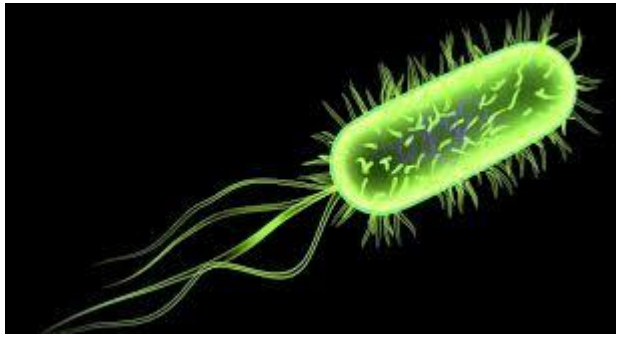
Pollen grains



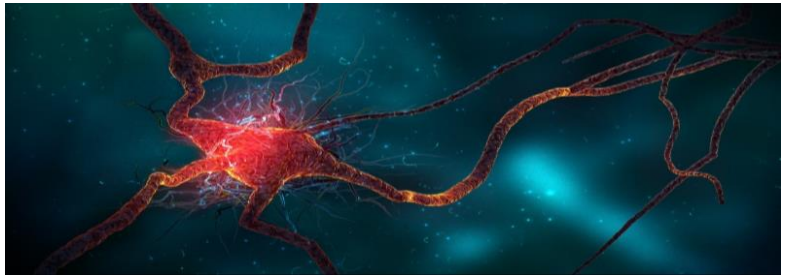
…but <u>most cells</u> are roughly cuboidal or spherical.

Cell Diversity: Size

Smallest: Bacterium
2-10 micrometers



Longest: Giraffe nerve cell
up to 2 meters long



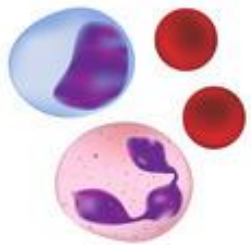
Largest: aquatic alga
Caulerpa taxifolia

Heaviest: Ostrich egg
6x5 inches, 3 pounds

Cell Specialization

In complex multicellular organisms, cells specialize into different cell types that are adapted to particular functions.

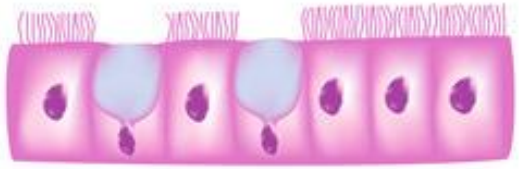
- **In mammals, major cell types include skin cells, muscle cells, neurons, blood cells, stem cells, and others.**
- **Cell types differ both in appearance and function, yet are genetically identical.**
- **Stem cells are *undifferentiated* biological cells that *can differentiate* into specialized cells.**



Blood cells

Surface skin cells

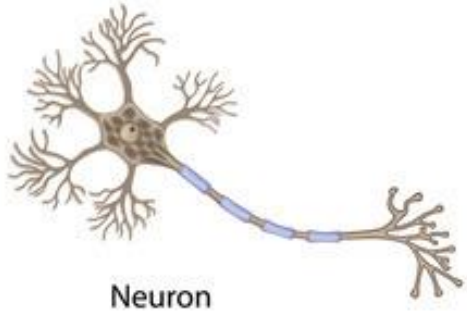
Bone cell



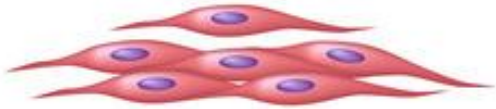
Columnar epithelial and Goblet cells

Cardiac muscle cell

Skeletal muscle cells



Neuron



Smooth muscle cells

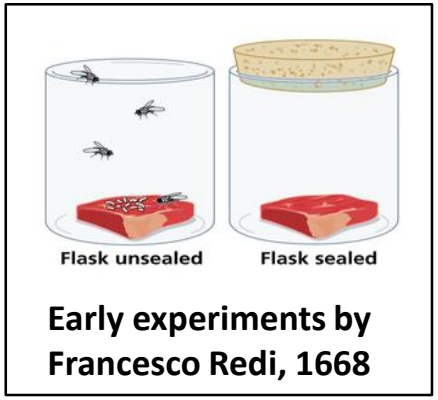
Development of Cell Theory

Cell theory is a scientific theory which describes the properties of cells as basic units of structure and reproduction in all organisms.

- **Matthias Schleiden (1838): concluded that all plants are composed of cells.**
- **Theodor Schwann (1839): concluded that all animals are composed of cells.**
- **Rudolph Virchow (1855): determined that cells come only from other cells.**

Cell Theory

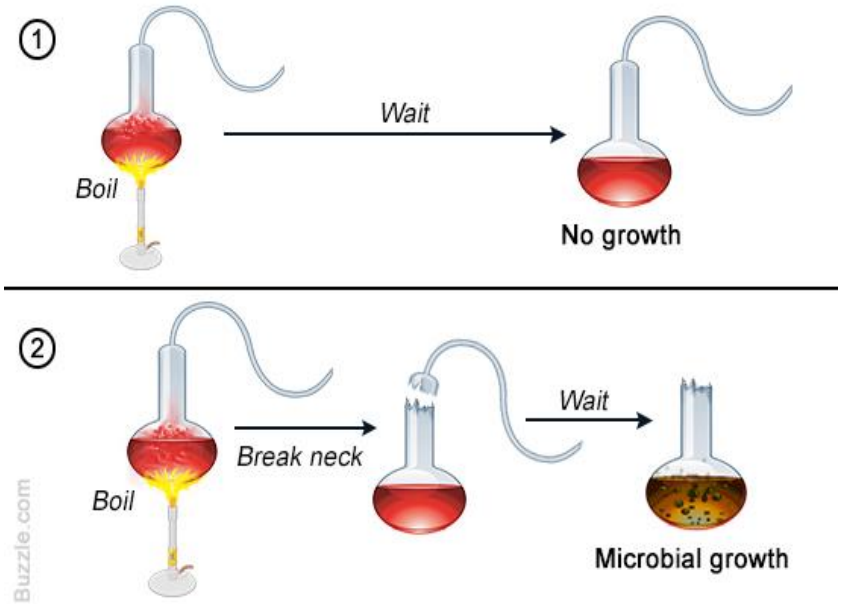
- **All living things are composed of cells** (organisms may be *unicellular* or *multicellular*).
- Cells are the **basic unit of structure and function** in living things.
- **Energy flow** (*metabolism* and *biochemistry*) occurs within cells.
- **Heredity information** (in the form of *DNA*) is contained inside cells and is passed on from cell to cell.
- **Cell activity** depends on the activity of sub-cellular structures.
- The **activity of an organism** depends on the total activity of independent cells.
- **All cells** have the **same basic chemical composition**.
- **New cells** are produced **from existing cells *only***.



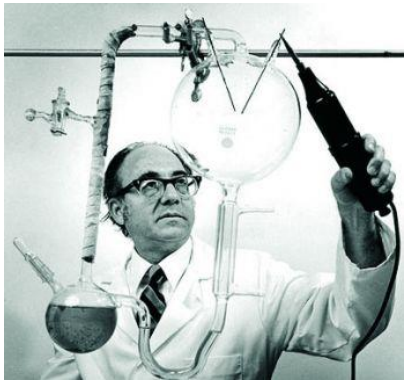
Early experiments by Francesco Redi, 1668

Swan-neck flasks experiment, Louis Pasteur 1864

- **Demonstrated that organisms such as bacteria and fungi *do not spontaneously appear* in sterile, nutrient-rich media, but only invade them from outside.**
- The theory of Spontaneous Generation (1861): *living things can originate from non-living*.
- Pasteur exposed boiled broths to air in vessels that had open long s-shaped necks that would not allow dust particles to pass to the growth medium.

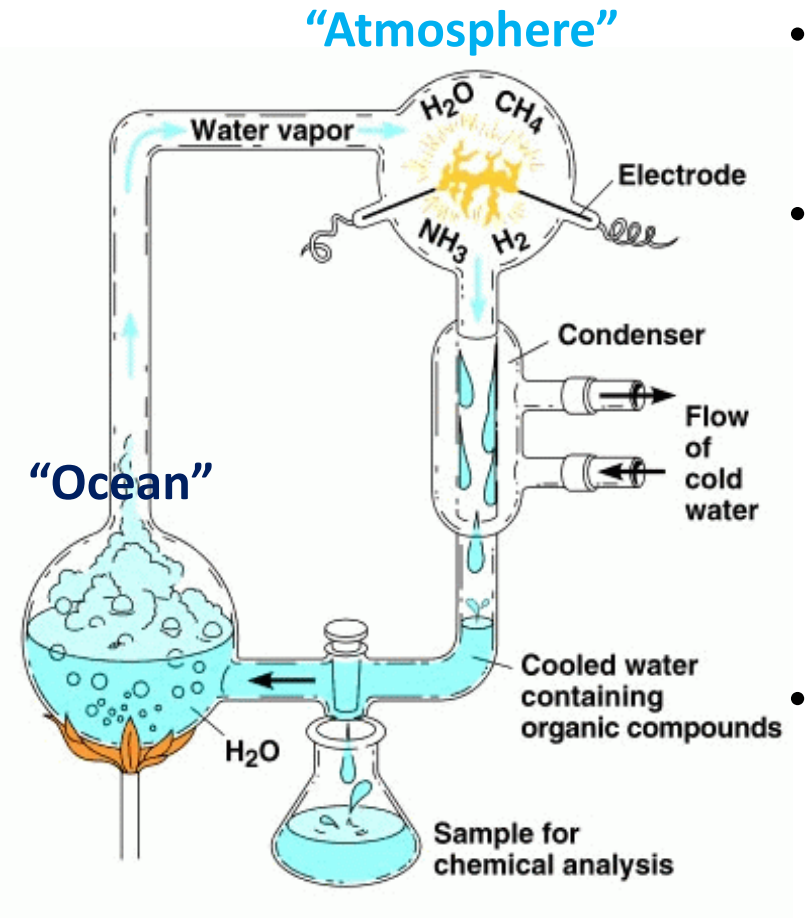


- **Nothing grew** in the broths unless the flasks were broken open, thus **disproving the theory of spontaneous generation**.



Miller–Urey experiment, 1953: chemical origins of life

Stanley L. Miller Harold C. Urey



- **Test for the occurrence of chemical origins of life by simulating the conditions thought at the time to be present on the early Earth.**
- **The experiment used water (H_2O), methane (CH_4), ammonia (NH_3), and hydrogen (H_2) all sealed inside a sterile loop array of glass flasks; one flask was half-full of liquid water ("ocean") and another flask contained a pair of electrodes. The liquid water was heated to induce evaporation, sparks were fired between the electrodes to simulate "lightning through the atmosphere" and water vapor; then water could "precipitate" that is condense and trickle back into the first flask in a continuous cycle.**
- **After two weeks: 10–15% of the carbon was now in the form of organic compounds; >20 amino acids formed; sugars were also formed. However, *nucleic acids were not formed* within the reaction…**