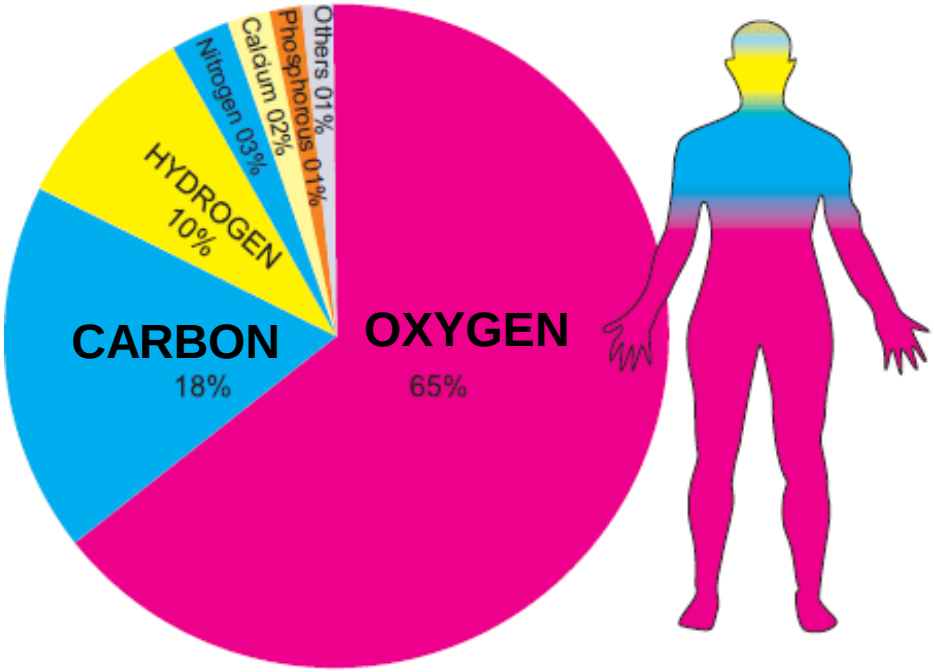
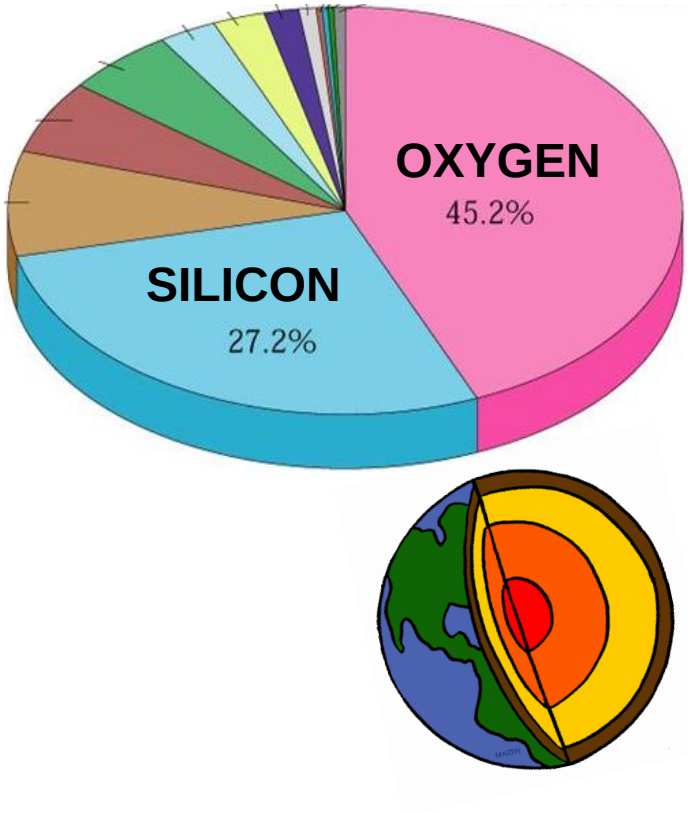
What is Life Made of?

Approximate <u>elemental composition</u> **(% of chemical element by mass)**

of a human body…



…vs Earth's crust

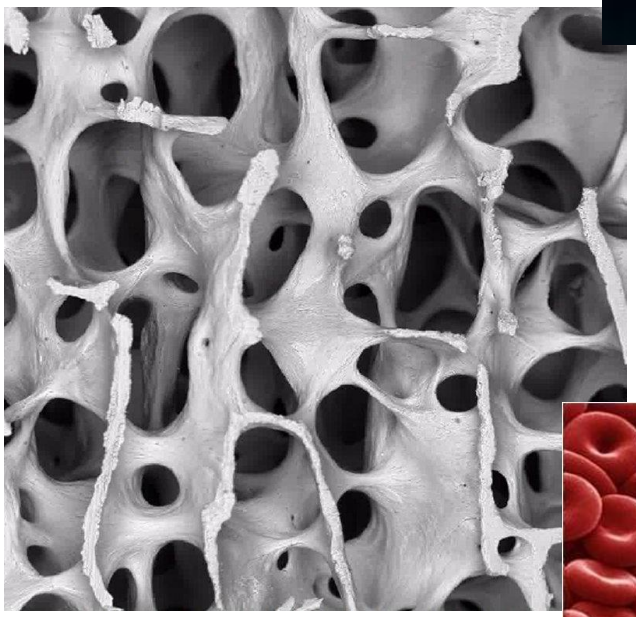


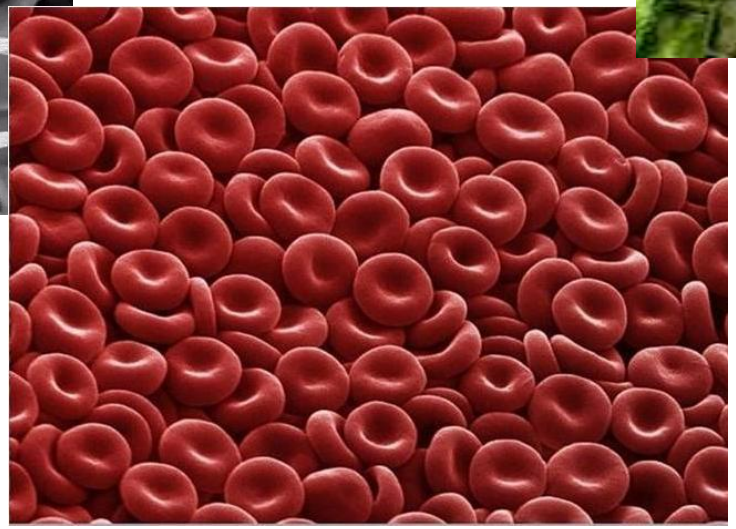
life is carbon-based

Cells

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

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

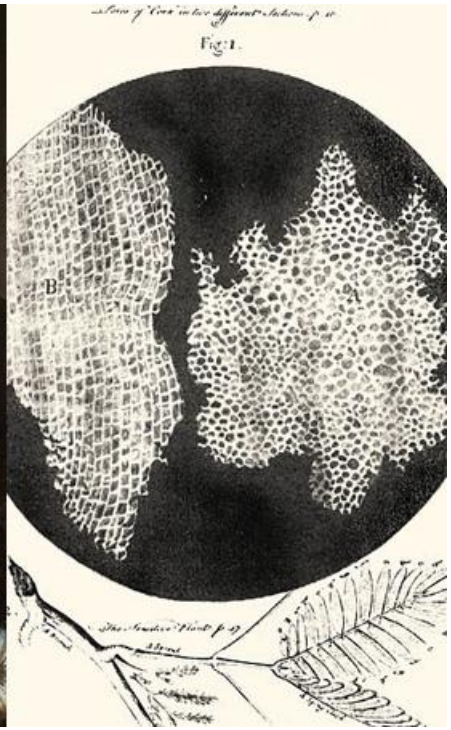


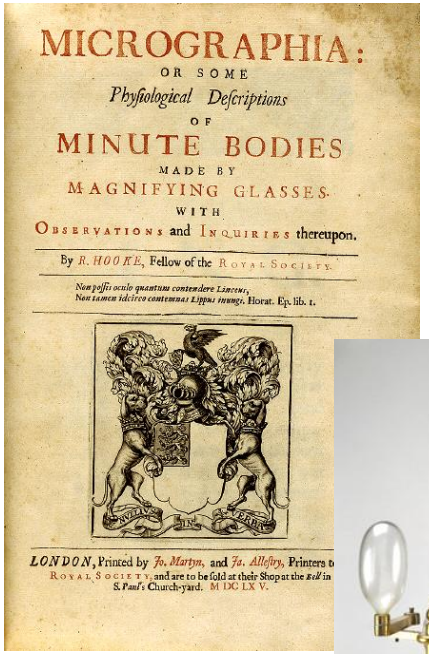


The study of cells is called **cell biology**.

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

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 Sign in
S. Paul's Church-yard. MDCLXV.

***Micrographia*, published in 1665**

Hooke's design microscope system →

Robert Hooke (1665):

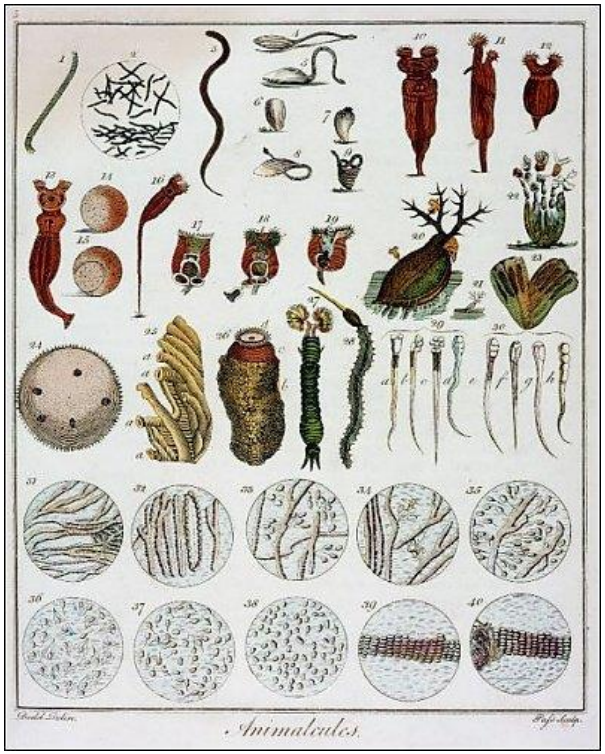
- **Observed a thin slice of cork (dead plant cells) with a microscope.**
- **Described what he observed as "little boxes" (*cells*).**

Discovery of Cells

Antonie van Leeuwenhoek (1675):

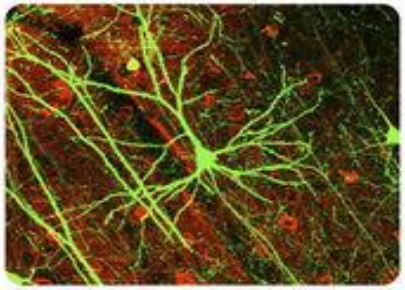
- Discovered a way to create a very small, high-quality glass spheres that became the lenses of his tiny microscopes, with the smallest spheres providing the highest (up to 500X) magnification.

- 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".

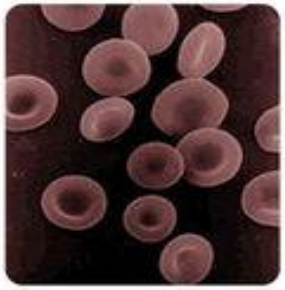


Cell Diversity: Shape

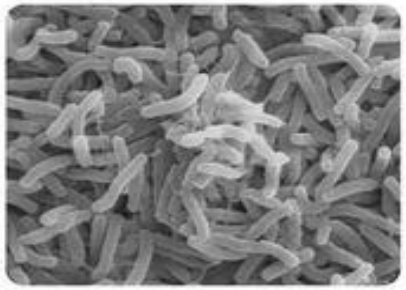
Cells <u>differ widely</u> (and wildly!) in shape…



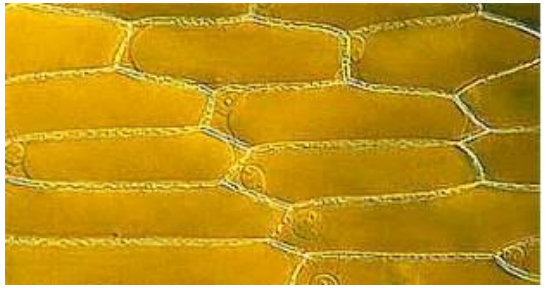
Nerve cell



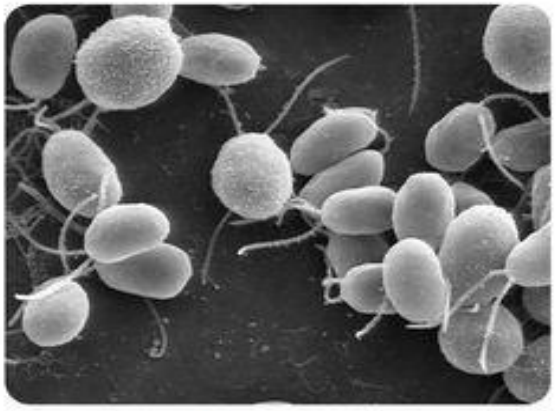
Red blood cells



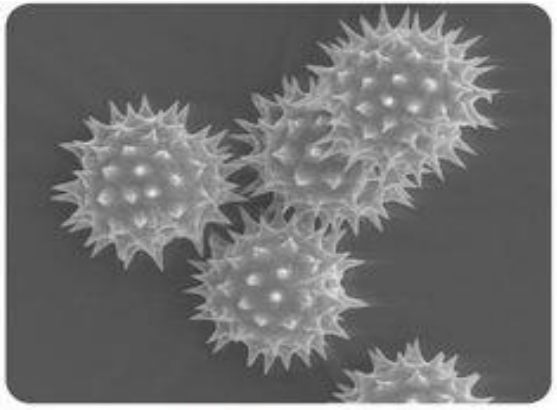
Bacteria



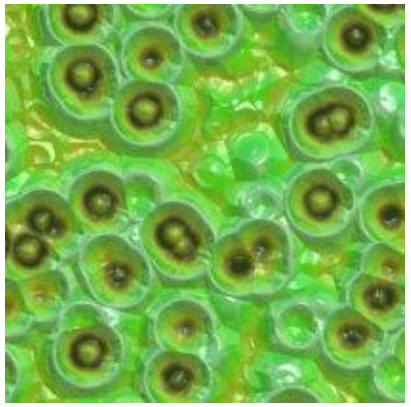
Plant cells



Algae



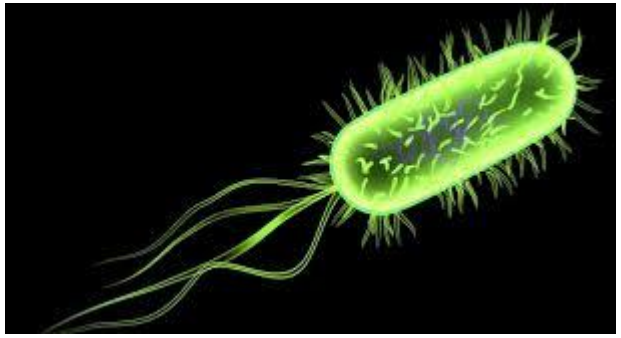
Pollen grains



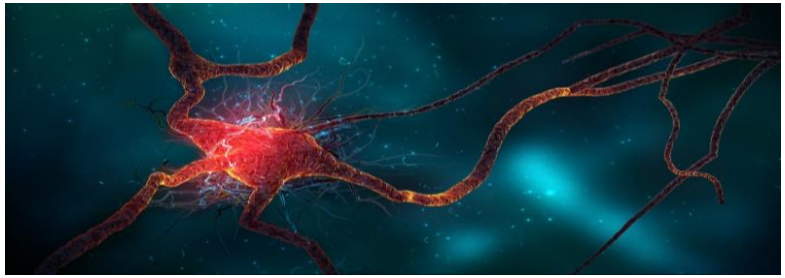
…but <u>most cells</u> are roughly cuboidal or spherical.

Cell Diversity: Size

Smallest: Bacterium
2-10 micrometers



Longest: Giraffe nerve cell
up to 2 meters long



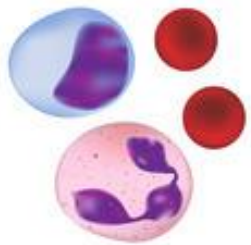
Largest: aquatic alga
Caulerpa taxifolia

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.

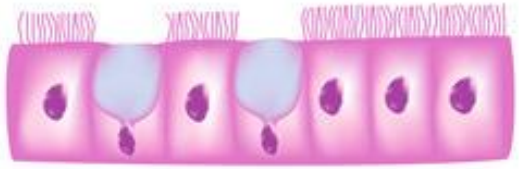
- **In mammals, major cell types include skin cells, muscle cells, neurons, blood cells, stem cells, and others.**
- **Cell types differ both in appearance and function, yet are genetically identical.**
- **Stem cells are *undifferentiated* biological cells that *can differentiate* into specialized cells.**



Blood cells

Surface skin cells

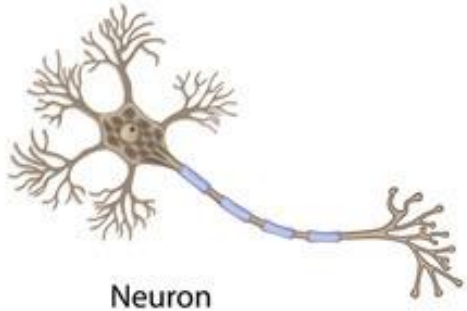
Bone cell



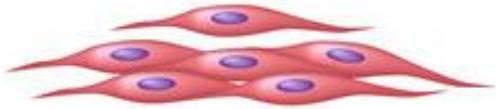
Columnar epithelial and Goblet cells

Cardiac muscle cell

Skeletal muscle cells



Neuron



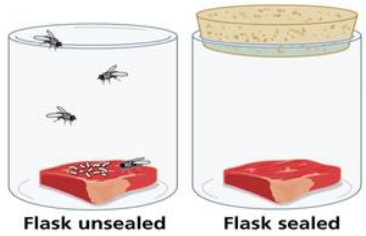
Smooth muscle cells

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.**

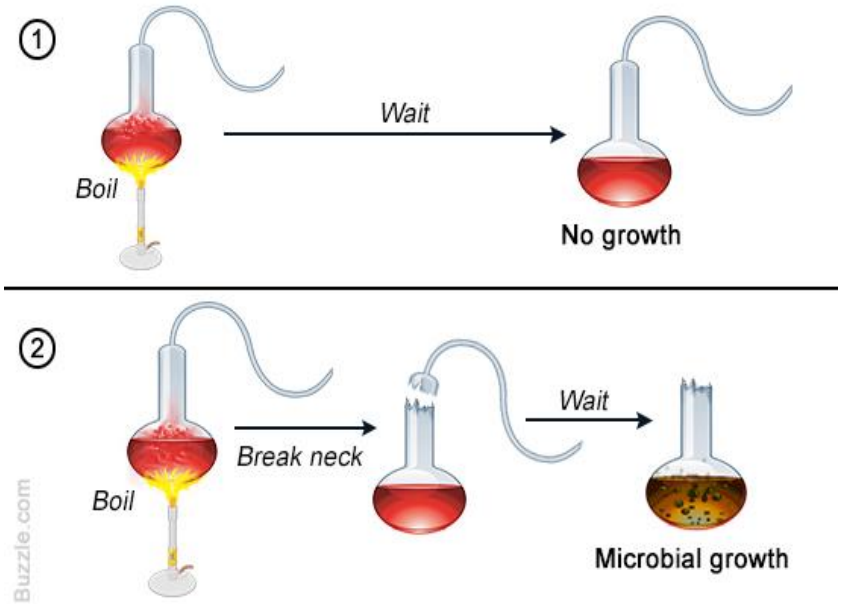
- **All cells have the same basic chemical composition.**



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**.