

# Organization of Cells

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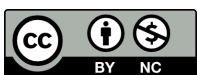
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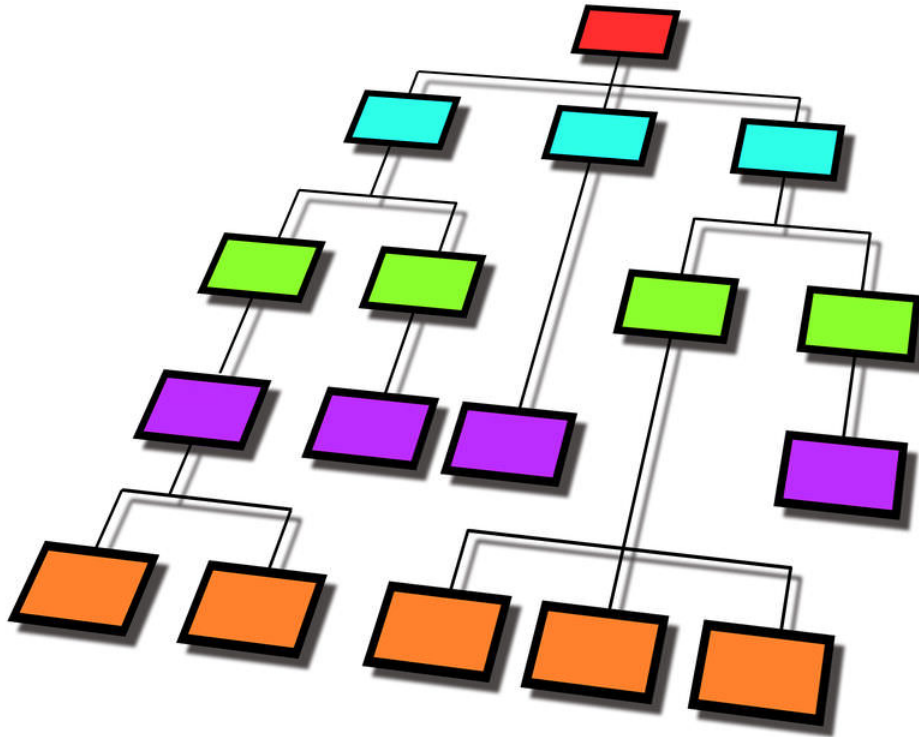
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# CHAPTER 1

# Organization of Cells

- Explain how cells are organized in living things.
- Explain the significance of colonial organisms.
- Describe the origin of multicellular organisms.
- Distinguish a tissue from an organ from an organ system.



## Why be organized?

It can be said organization leads to efficiency. And in you, cells are organized into tissues, which are organized into organs, which are organized into organ systems, which form you. And it can be said that the human body is a very organized and efficient system.

## Organization of Cells

Biological organization exists at all levels in organisms. It can be seen at the smallest level, in the molecules that made up such things as DNA and proteins, to the largest level, in an organism such as a blue whale, the largest mammal on Earth. Similarly, single celled prokaryotes and eukaryotes show order in the way their cells are arranged. Single-celled organisms such as an amoeba are free-floating and independent-living. Their single-celled "bodies" are able to carry out all the processes of life, such as metabolism and respiration, without help from other cells. Some single-celled organisms, such as bacteria, can group together and form a biofilm. A **biofilm** is a large grouping of many bacteria that sticks to a surface and makes a protective coating over itself. Biofilms can show similarities to multicellular organisms. Division of labor is the process in which one group of cells does one job (such as making the "glue" that sticks the biofilm to the surface), while another group of cells does another job (such as taking in nutrients). Multicellular organisms carry out their life processes through division of labor. They have specialized

cells that do specific jobs. However, biofilms are not considered multicellular organisms and are instead called colonial organisms. The difference between a multicellular organism and a colonial organism is that individual organisms from a colony or biofilm can, if separated, survive on their own, while cells from a multicellular organism (e.g., liver cells) cannot.



**FIGURE 1.1**

Colonial algae of the genus *Volvox*.

## Colonial Organisms

**Colonial organisms** were probably one of the first evolutionary steps towards multicellular organisms. Algae of the genus *Volvox* are an example of the border between colonial organisms and multicellular organisms.

Each *Volvox*, shown in **Figure 1.1**, is a colonial organism. It is made up of between 1,000 to 3,000 photosynthetic algae that are grouped together into a hollow sphere. The sphere has a distinct front and back end. The cells have eyespots, which are more developed in the cells near the front. This enables the colony to swim towards light.

## Origin of Multicellularity

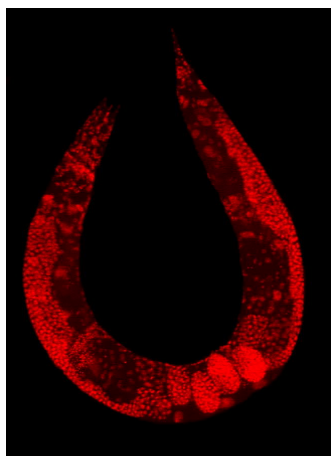
The oldest known multicellular organism is a red algae *Bangiomorpha pubescens*, fossils of which were found in 1.2 billion-year-old rock. As the first organisms were single-celled, these organisms had to evolve into multicellular organisms.

Scientists think that multicellularity arose from cooperation between many organisms of the same species. The **Colonial Theory** proposes that this cooperation led to the development of a multicellular organism. Many examples of cooperation between organisms in nature have been observed. For example, a certain species of amoeba (a single-celled protist) groups together during times of food shortage and forms a colony that moves as one to a new location. Some of these amoebas then become slightly differentiated from each other. *Volvox*, shown in **Figure 1.1**, is another example of a colonial organism. Most scientists accept that the Colonial Theory explains how multicellular organisms evolved.

**Multicellular organisms** are organisms that are made up of more than one type of cell and have specialized cells that are grouped together to carry out specialized functions. Most life that you can see without a microscope is multicellular. As discussed earlier, the cells of a multicellular organism would not survive as independent cells. The body of a multicellular organism, such as a tree or a cat, exhibits organization at several levels: tissues, organs, and organ systems. Similar cells are grouped into tissues, groups of tissues make up organs, and organs with a similar function are grouped into an organ system.

## Levels of Organization in Multicellular Organisms

The simplest living multicellular organisms, sponges, are made of many specialized types of cells that work together for a common goal. Such cell types include digestive cells, tubular pore cells, and epidermal cells. Though the different cell types create a large, organized, multicellular structure — the visible sponge — they are not organized into true interconnected tissues. If a sponge is broken up by passing it through a sieve, the sponge will reform on the other side. However, if the sponge's cells are separated from each other, the individual cell types cannot survive alone. Simpler colonial organisms, such as members of the genus *Volvox*, as shown in **Figure 1.1**, differ in that their individual cells are free-living and can survive on their own if separated from the colony.



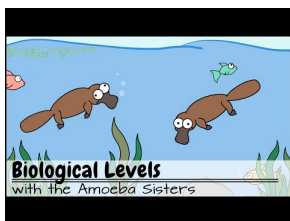
**FIGURE 1.2**

This roundworm, a multicellular organism, was stained to highlight the nuclei of all the cells in its body (red dots).

A **tissue** is a group of connected cells that have a similar function within an organism. More complex organisms such as jellyfish, coral, and sea anemones have a tissue level of organization. For example, jellyfish have tissues that have separate protective, digestive, and sensory functions.

Even more complex organisms, such as the roundworm shown in **Figure 1.2**, while also having differentiated cells and tissues, have an organ level of development. An **organ** is a group of tissues that has a specific function or group of functions. Organs can be as primitive as the brain of a flatworm (a group of nerve cells), as large as the stem of a sequoia (up to 90 meters, or 300 feet, in height), or as complex as a human liver.

The most complex organisms (such as mammals, trees, and flowers) have organ systems. An **organ system** is a group of organs that act together to carry out complex related functions, with each organ focusing on a part of the task. An example is the human digestive system, in which the mouth ingests food, the stomach crushes and liquifies it, the pancreas and gall bladder make and release digestive enzymes, and the intestines absorb nutrients into the blood.



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## Summary

- Single-celled organisms are able to carry out all the processes of life without help from other cells.
- Multicellular organisms carry out their life processes through division of labor. They have specialized cells that do specific jobs.
- The Colonial Theory proposes that cooperation among cells of the same species led to the development of a multicellular organism.
- Multicellular organisms, depending on their complexity, may be organized from cells to tissues, organs, and organ systems.

## Review

1. What is a multicellular organism?
2. What is a cell feature that distinguishes a colonial organism from a multicellular organism?
3. What is the difference between a cell and a tissue?
4. Describe the top two levels of organization of an organism.

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## References

1. Dr. Ralf Wagner. [Volvox algae colony](#) . CC BY 3.0
2. The Evolution of Self-Fertile Hermaphroditism: The Fog Is Clearing. PLoS Biol 3(1): e30. doi:10.1371/journal.pbio.003000. [Stained red nuclei in roundworm](#) . CC BY 2.5