Multicellular organisms

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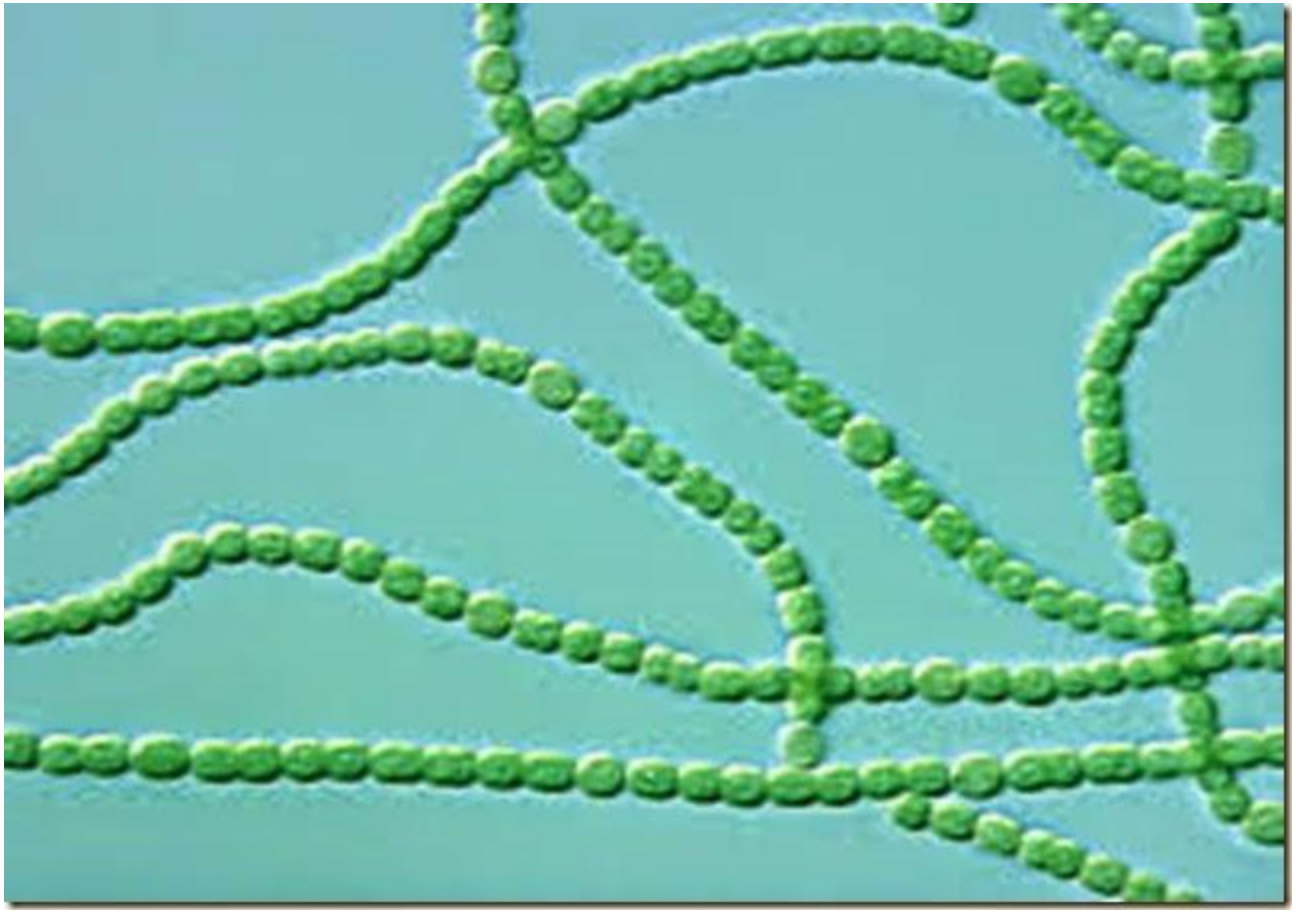
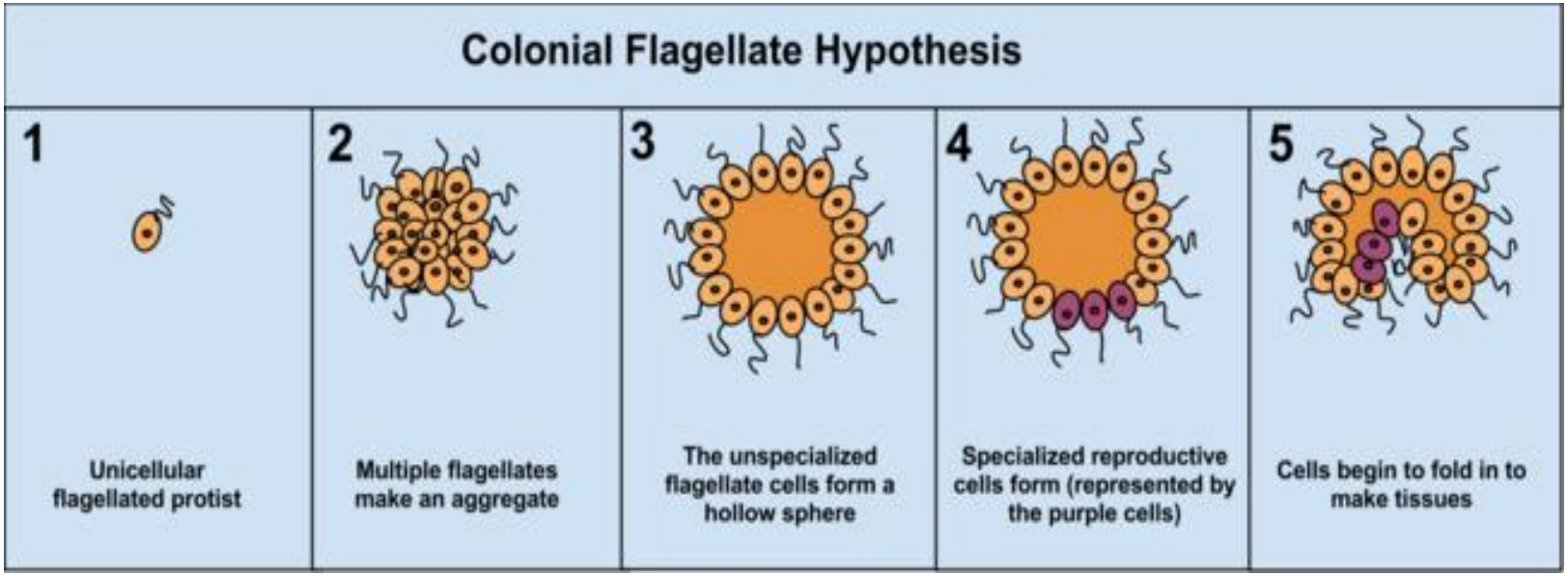
- Multicellular organisms are organisms that consist of more than one cell, in contrast to unicellular organisms.
- All species of animals, land plants and most fungi are multicellular.
- Colonial organisms are the result of many identical individuals joining together to form a colony.
- Multicellular organisms arise in various different ways, for example by cell division or by aggregation of many single cells.
- Multicellularity has evolved independently at least 46 times, including in some prokaryotes. Animals have evolved a considerable diversity of cell types in a multicellular body (100–150 different cell types), compared with 10–20 in plants and fungi.

Chains of cyanobacteria

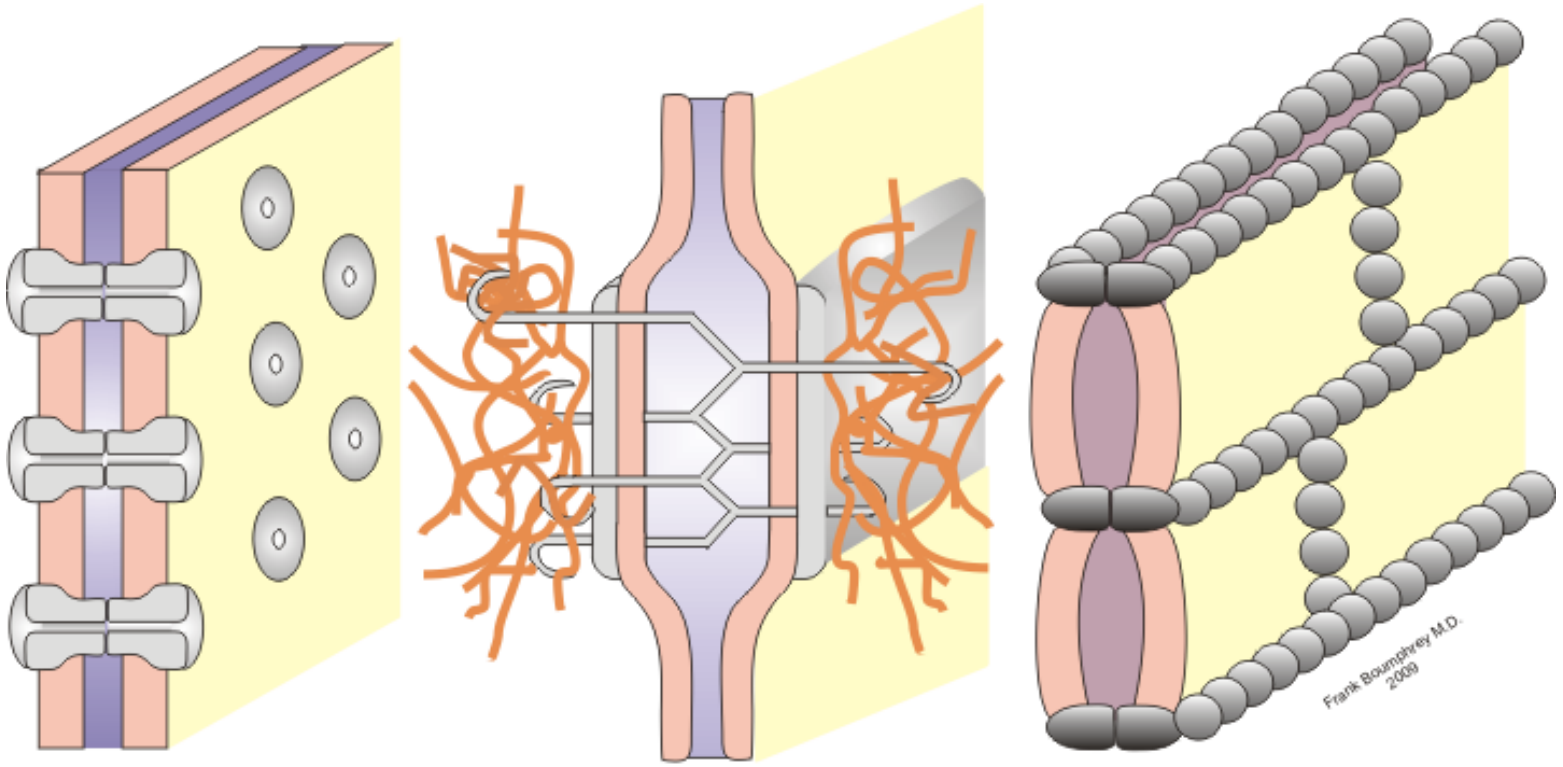


The Colonial Theory

The Colonial Theory of Haeckel, 1874, proposes that the symbiosis of many organisms of the same species led to a multicellular organism.



In a complex multicellular organisms cells adhere to each other and interact to form tissues



Cell adhesion

- **Tight junctions** are multi-protein complexes that hold cells of a same tissue together and prevent movement of water and water-soluble molecules between cells.
- **Gap junctions** are the main site of cell-cell signaling or communication that allow small molecules to diffuse between adjacent cells.
- **Anchoring junctions**: adherens junctions and desmosomes. They provide strength and durability to cells and tissues.

Cell signaling

Cell signaling allows cells to communicate with adjacent cells, nearby cells (paracrine) and even distant cells (endocrine). Receptor proteins on the cell surface have the ability to bind specific signaling molecules secreted by other cells. This binding induces a conformational change in the receptor which, in turn, elicits a response in the corresponding cell.

Cancer

Multicellular organisms, especially long-living animals, face the challenge of cancer, which occurs when cells fail to regulate their growth within the normal program of development. Changes in tissue morphology can be observed during this process. Cancer in animals has often been described as a loss of multicellularity. Cancer can result from the loss of cell-cell interaction. In normal cells, growth is controlled by contact inhibition in which contact with neighboring cells causes a stunt in cell growth.

A brief history of life on Earth.

Life is a process; therefore studying the history of life is very important in order to understand life existing today. We will revisit history of life on Earth several times during the course

Origin of life

When and *how* life first appeared on Earth? The question is still unanswered. We can only hypothesize.

- *How*? We will speak about the modern theories later in the course.
- *When*? Some scientists think that life on Earth could have first appeared as early as 4.28 billion years ago, soon after ocean formation 4.41 billion years ago, and not long after the formation of the Earth 4.54 billion years ago. The earliest undisputed evidence of life on Earth dates from at least 3.5 billion years ago.

Stromatolites - rock-like structures formed by bacteria.

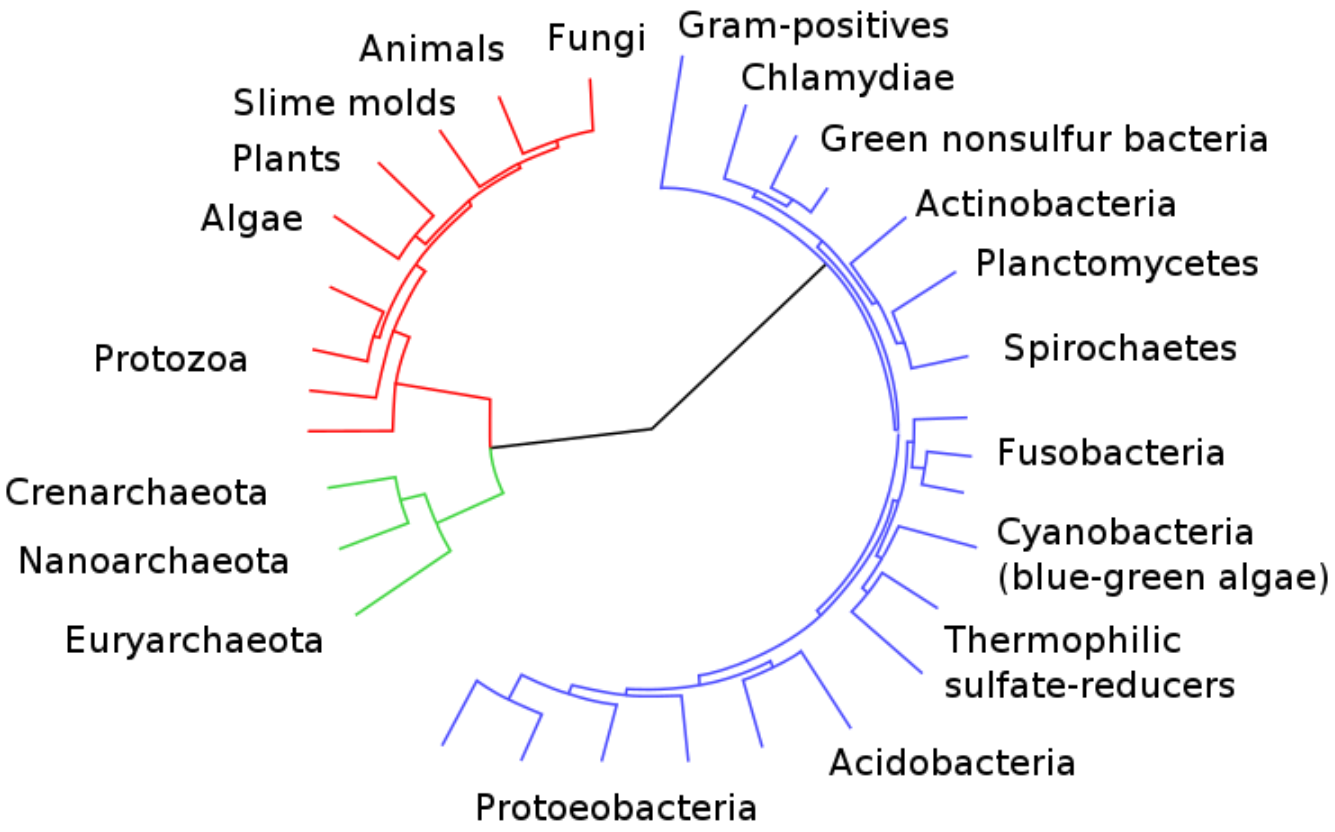
Modern stromatolites

Strelley Pool Australian Archaean Stromatolites – 3.43 billion years old

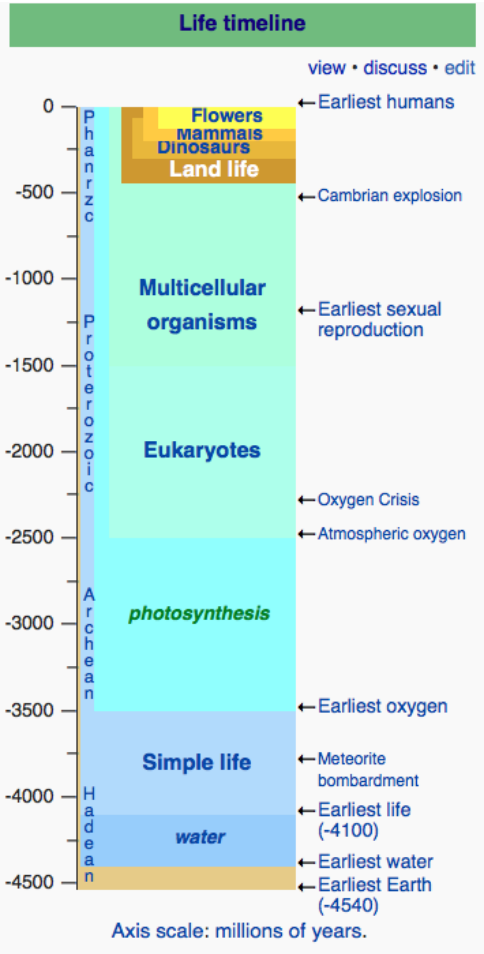
The last universal common ancestor (LUCA)

- The genetic code is universal. This fact indicates that all modern life evolved from a common ancestor.
- Scientists in 2016 reported identifying a set of 355 genes believed to be present in the last universal common ancestor (LUCA) of all living organisms. LUCA should not be assumed to be the first living organism on Earth. The LUCA is estimated to have lived some 3.5 to 3.8 billion years ago (sometime in the Paleoarchean era). The composition of the LUCA is not directly accessible as a fossil, but can be studied by comparing the genomes of its descendents, organisms living today.

Modern evolutionary tree



Timeline of the evolutionary history of life



The Great Oxygenation Event

- Before photosynthesis evolved, Earth's atmosphere had no free oxygen (O_2). Photosynthetic prokaryotic organisms that produced O_2 as a waste product lived long before the first build-up of free oxygen in the atmosphere, perhaps as early as 3.5 billion years ago.
- **The Great Oxygenation Event** was the biologically induced appearance of dioxygen (O_2) in Earth's atmosphere. Although geological, isotopic, and chemical evidence suggest that this major environmental change happened around 2.45 billion years ago.
- The increased production of oxygen set Earth's original atmosphere off balance. Free oxygen is toxic to obligate anaerobic organisms, and the rising concentrations may have destroyed most such organisms at the time. Cyanobacteria were therefore responsible for one of the most significant mass extinctions in Earth's history. Besides marine cyanobacteria, there is also evidence of cyanobacteria on land.