

Biology

ES131

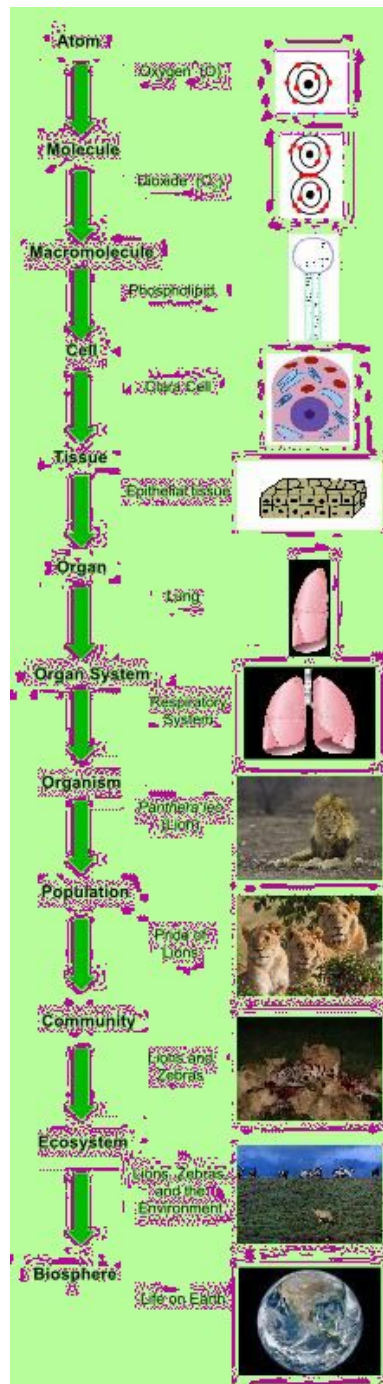
Module 3

Principles of Biology

Biological Hierarchies

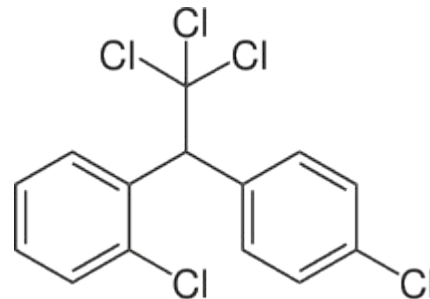
Biological Hierarchy

Biological organization is the hierarchy of complex biological structures and systems that define life using a reductionist approach



Biological Hierarchy

- The basic principle behind the organization is the concept of *emergence*—the properties and functions found at a hierarchical level are not present and irrelevant at the lower levels.
- DDT's (Dichlorodiphenyltrichloroethane) direct insecticidal effect occurs at the sub cellular level, but affects higher levels up to and including multiple ecosystems. Theoretically, a change in one atom could change the entire biosphere.



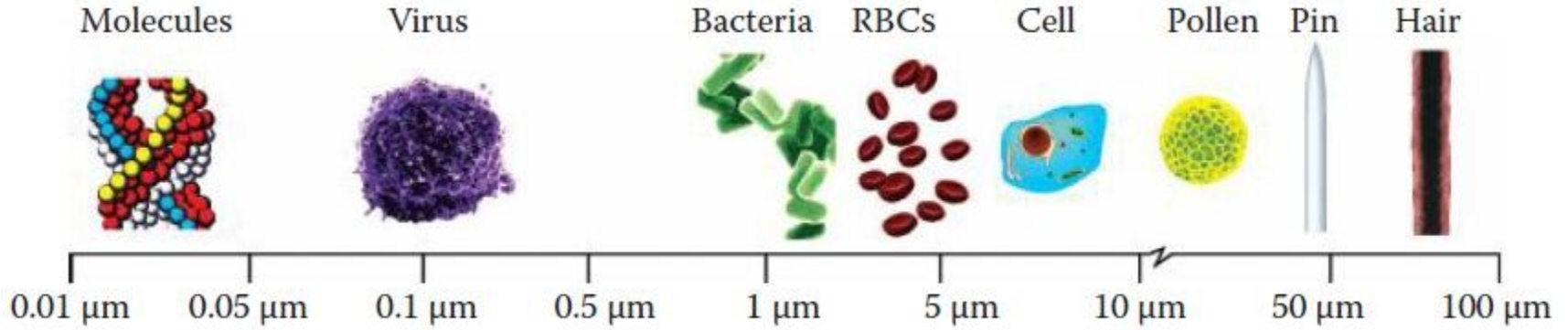
Why is the cell called the basic unit of life?

- At levels lower than cellular level, no biology but chemistry. This is called an *emergent property* where the properties and actions of the whole entity are greater than the sum of its parts.
- Because the cell exhibits all the properties and actions that we would call living, the cell is considered to be the basic biological entity.



One combination of cells considered to be a living unit

The Cell



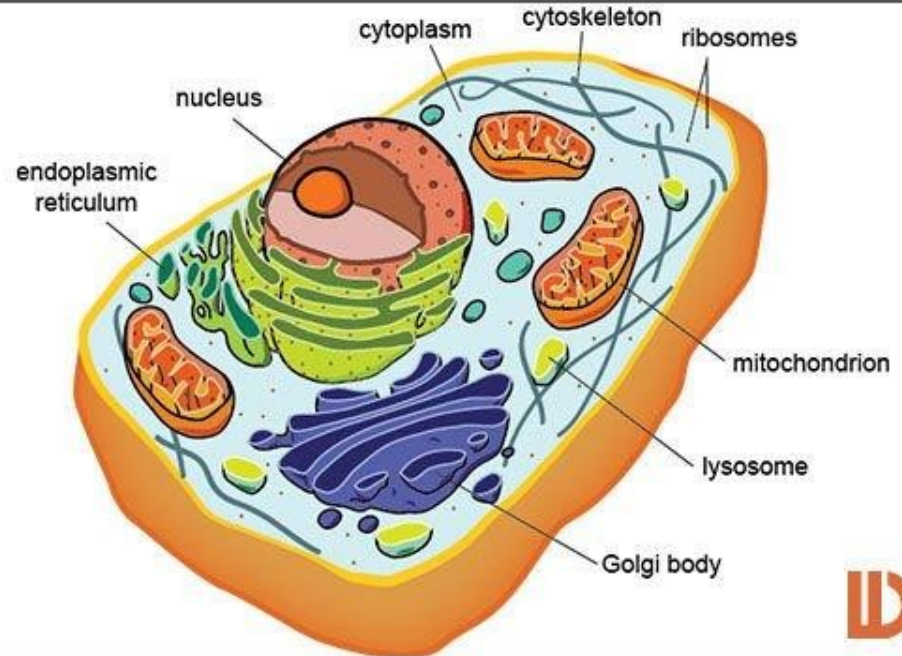
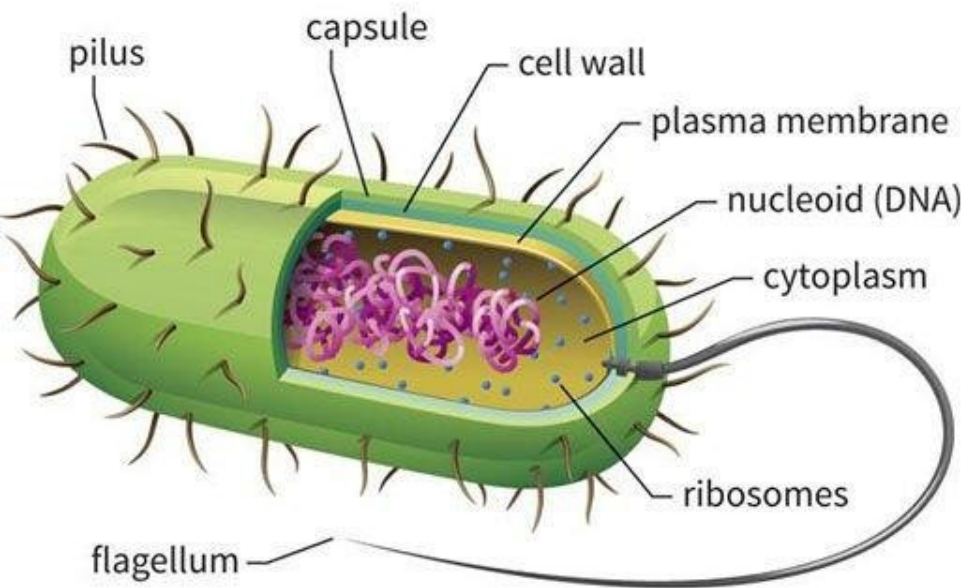
Comparative diagram of different particle sizes showing where typical bacteria fit into the size scheme

Prokaryotic Vs. Eukaryotic Cells

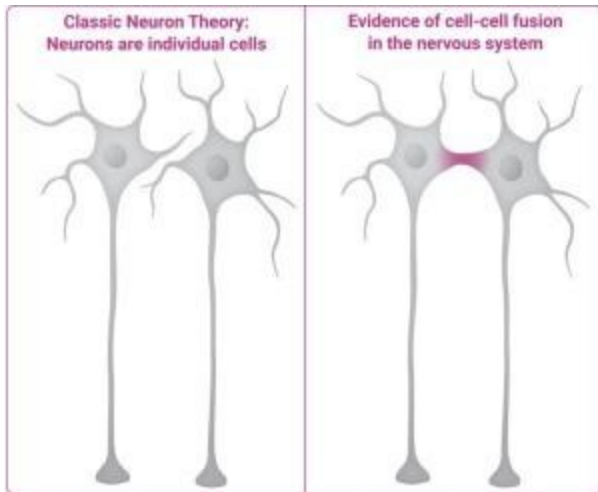
PROKARYOTIC CELL

VS

EUKARYOTIC CELL



Cell Fusion



- If the nuclei fuse and contain DNA from both precursor cells, the resulting hybrid is called a **synkaryon**. If the nuclei remain separate within the cell, the hybrid is called a **heterokaryon**.

- Such fused hybrids —

- a. possibly have a major role in the differentiation of fetal cells during early development
- b. may also have a survival advantage by introducing superior DNA from one species into another

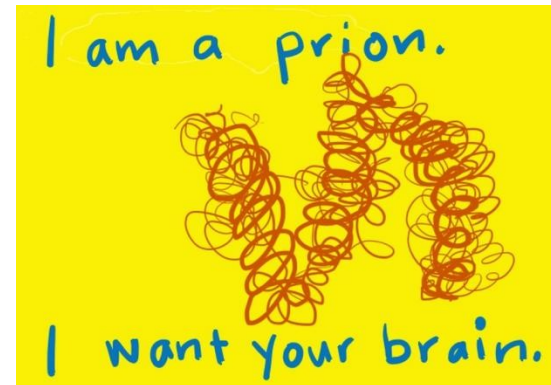
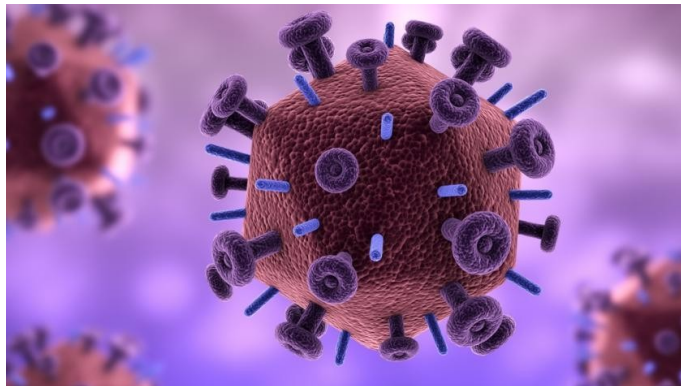


What is Life?



What is Life?

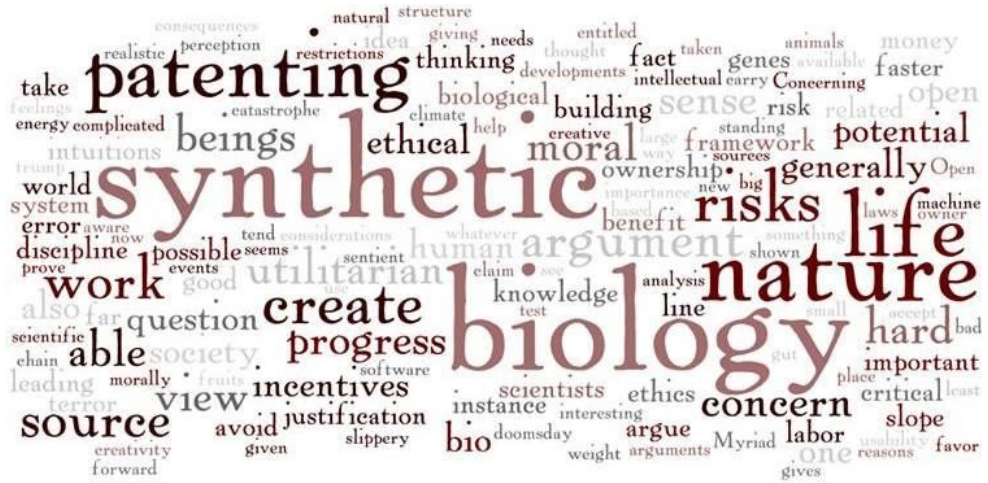
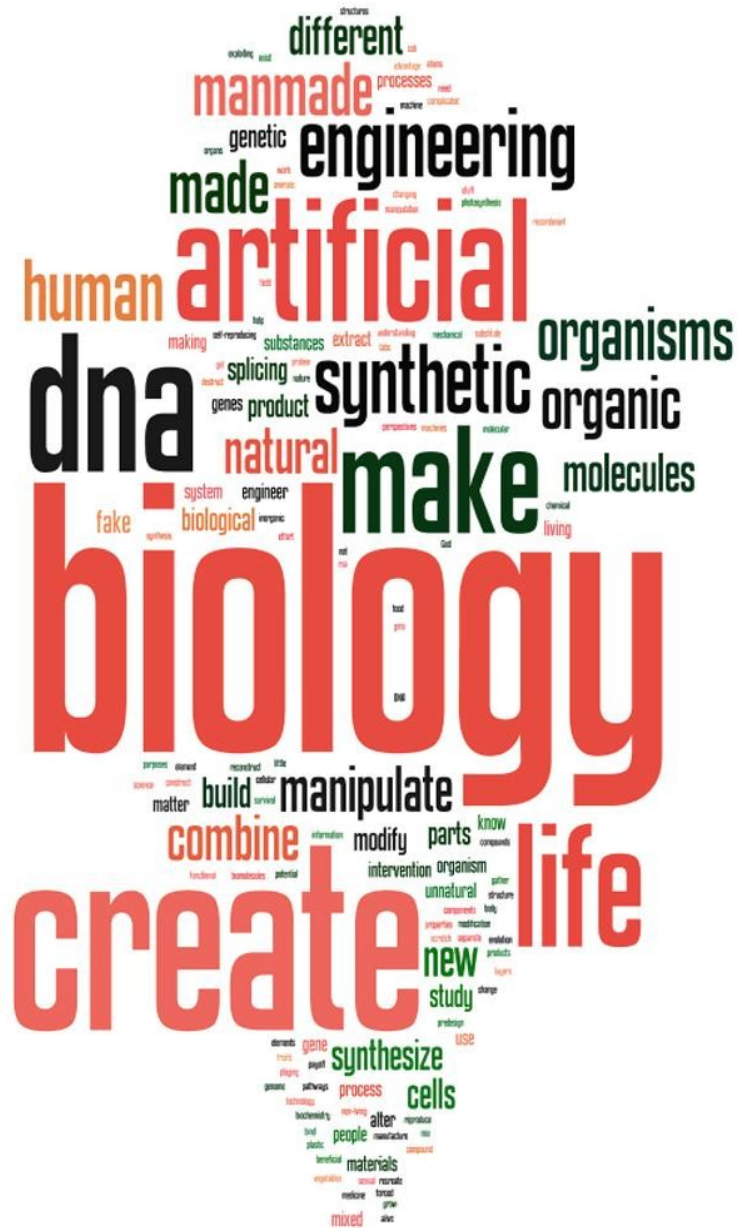
- The separation between living and nonliving is not sharp
- Viruses are little more than RNA enclosed in a protein coat. Yet, they reproduce in the right environment of a host cell.
- Prions are bits of protein that become active within cells, and also reproduce.



What is Life?

- Life is a condition characterized by order and complex organization, reproduction, growth and development, utilization of energy for its own purposes, responses to environmental stimuli, maintenance of relatively steady internal environment, and evolutionary adaptation (Campbell, 1999).
- A self-sustained chemical system capable of undergoing Darwinian evolution (NASA, 2001)
- A process that spontaneously organizes matter to higher levels of complexity and then maintains that complexity in potentially destructive environments (Anbar, 2001)

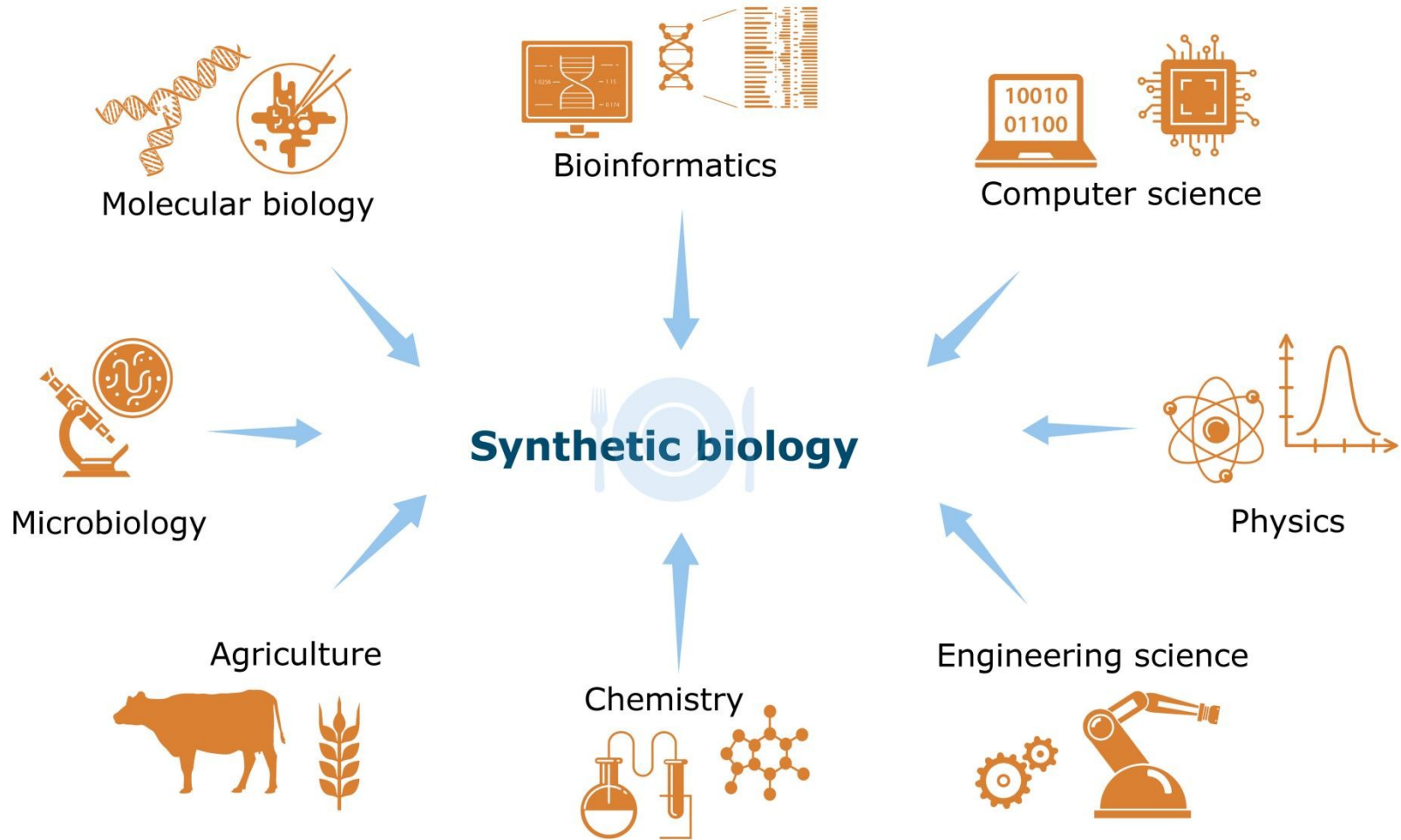
What is the need to define Life?



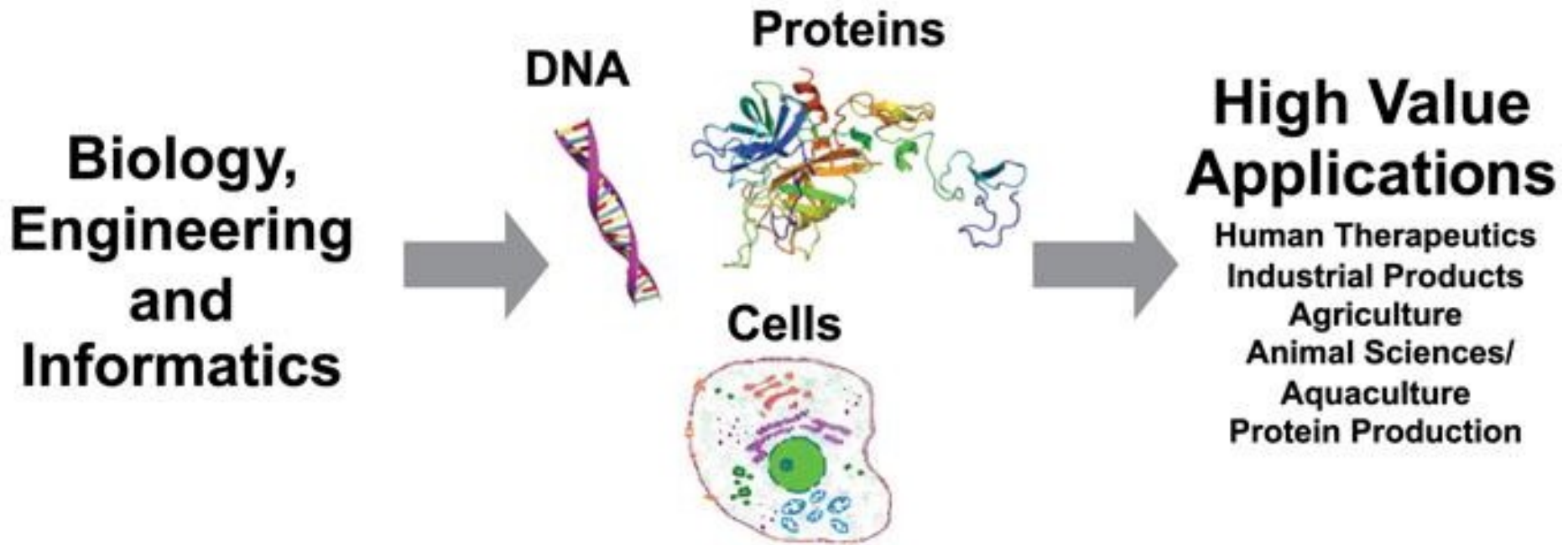
Synthetic Biology

- Synthetic biology is a new interdisciplinary area that involves the application of engineering principles to biology.
- It aims at the (re-) design and fabrication of biological components and systems that do not already exist in the natural world.
- It aims to build artificial biological systems for research, engineering and medical applications.

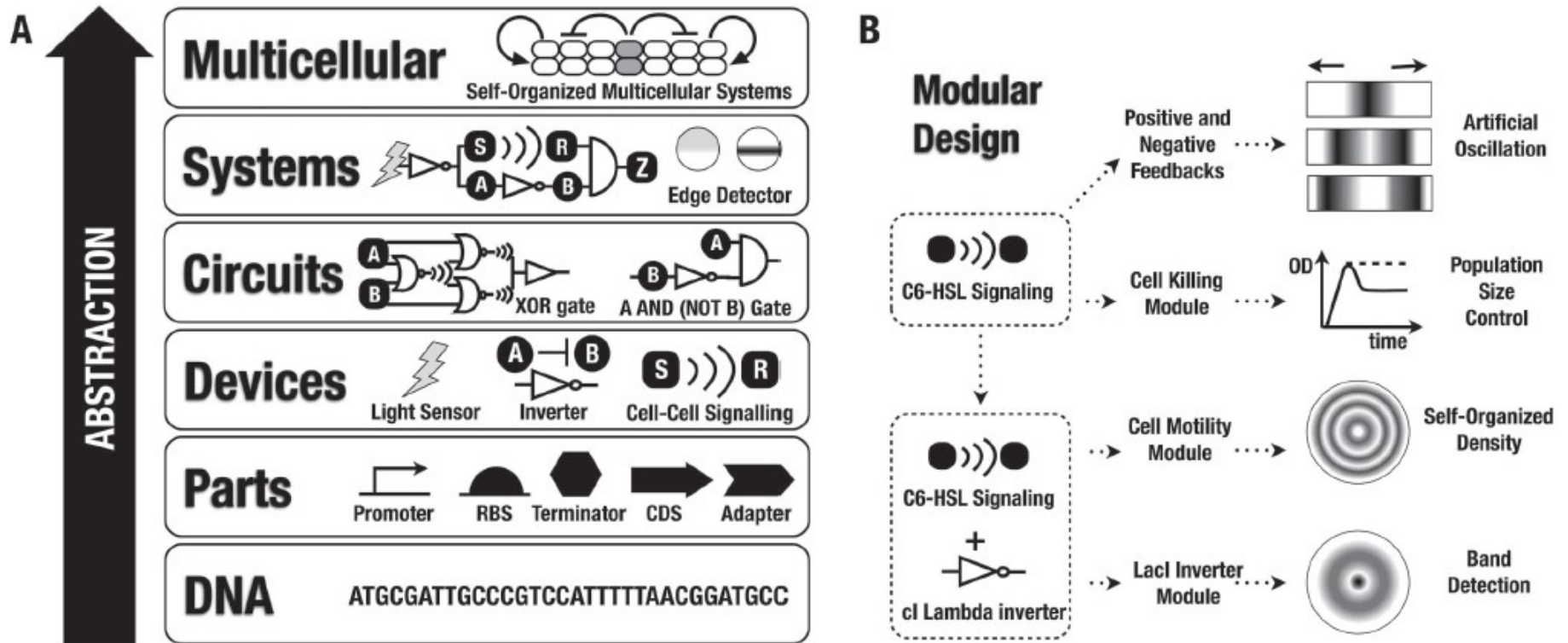
Synthetic Biology



Synthetic Biology



Synthetic Biology

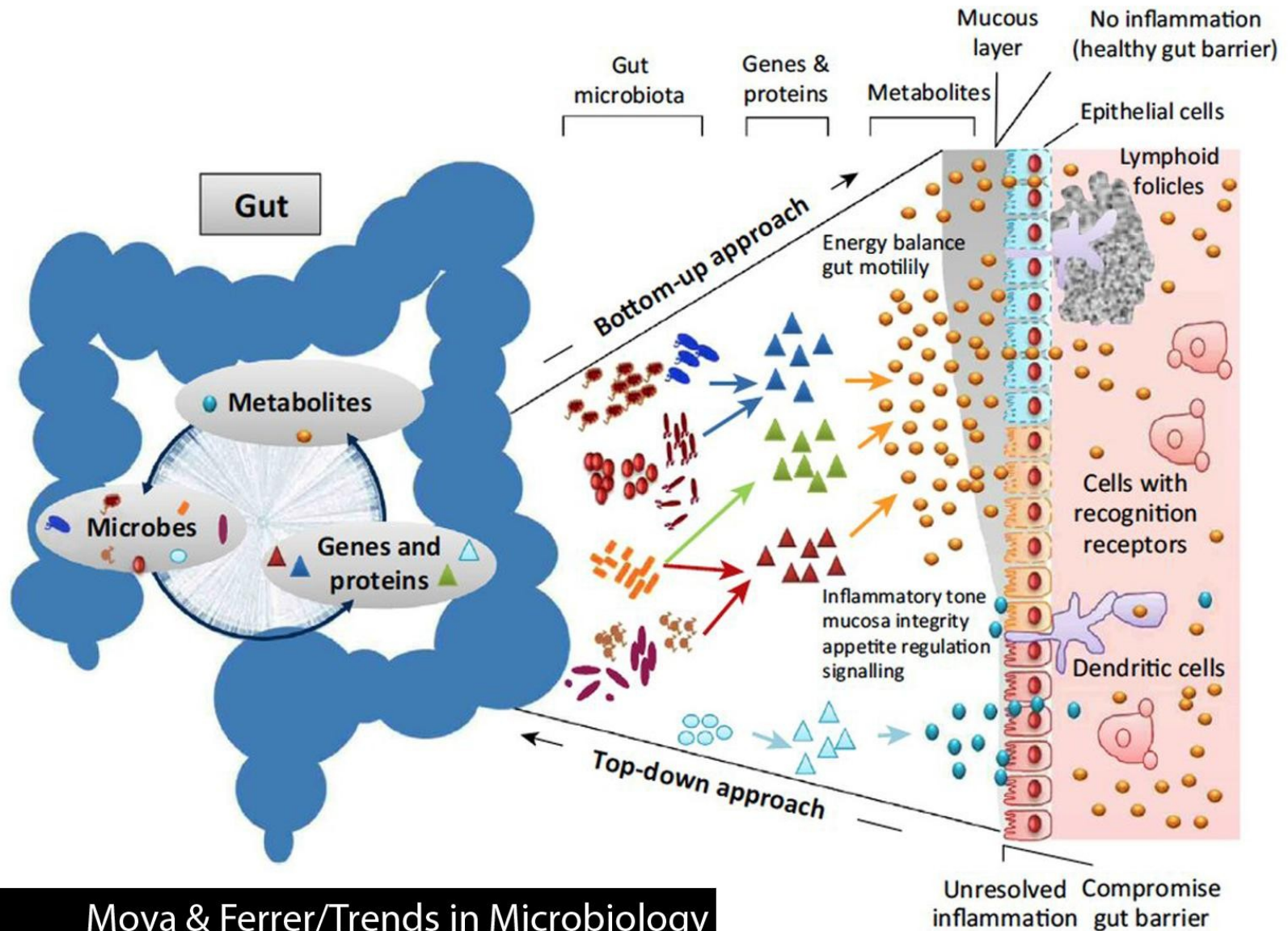


Bottom-up Approach

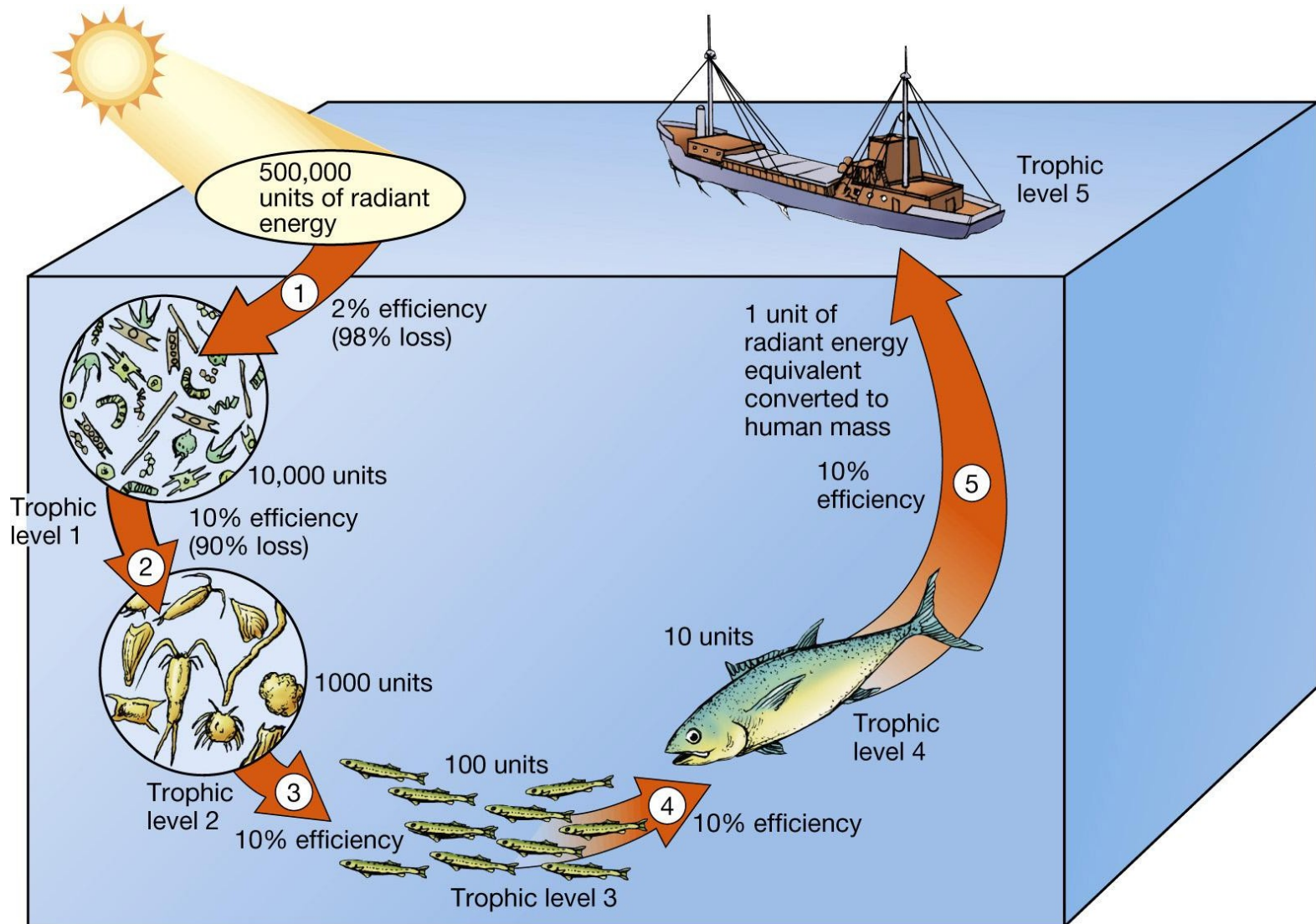
Ecology on Micro- and Macroscales

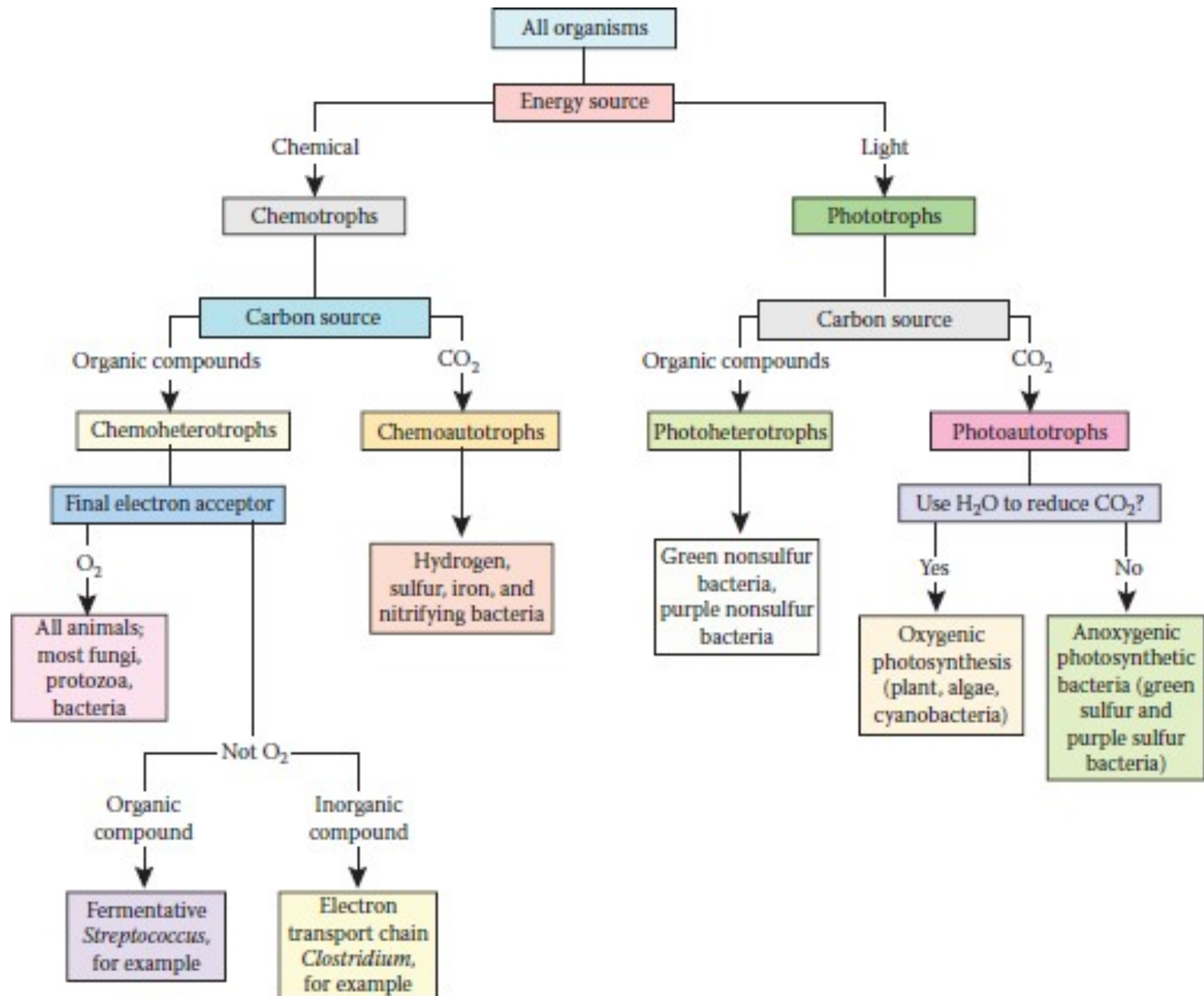
- **Ecology** as popularly defined is the study of communities of organisms and how they all fit together (May and Seger, 1986).
- **Micro-ecology:** Ecology at molecular/ within organism level
- **Macro-ecology:** population- or ecosystem-level and above

Human Gut Ecosystem



Food Pyramid – Process in Ecology





Biology – Simple or Complex?

- The study of biology has not revolutionized the fields of physics and chemistry. Rather, it has reaffirmed them.
- Engineering predictions about biological phenomena are usually based upon (mostly empirical) mathematical equations.
- Apparent simplicity but underlying complexity

Overview of a model to predict human performance

