

Chapter 1a: Exploring Life

(sections 1.1, 1.2, 1.6)

Important Point:

*If you are having trouble understanding lecture material:
Try reading your text before attending lectures.
And take the time to read it well!*

First Things First...

- ❑ Today we will cover chapters 1, 2, & maybe 3
- ❑ These are an intro to biology and a review of general and water chemistry—please read these chapters
- ❑ You will be responsible for these on the first midterm exam (1.1, 1.2, 1.5, 1.6, 2, 3, 4, 5, 6)
- ❑ Section 1.5 of chapter 1 we will cover during the first first lab
- ❑ To view lecture notes go to: www.phage.org/lectures
- ❑ Let me know how I may be able to improve that web page so that it may be more usable

What is Biology?







- ❑ In some ways, biology is the most demanding of all sciences, partly because living systems are so complex and partly because biology is an interdisciplinary science that requires knowledge of chemistry, physics, and mathematics.
- ❑ Modern biology is the decathlon of natural science. And of all the sciences, biology is the most connected to the humanities and social sciences....

What is Biology?

- ❑ No matter what brings you to biology, you will find the study of life to be endlessly challenging and uplifting. But this ever-expanding subject can also be a bit intimidating, even to professional biologists. How, then, can beginning students develop a coherent view of life instead of hopelessly trying to memorize details of a subject that is now far too big to memorize?
- ❑ One approach is to fit the many things you learn from a set of themes that pervade all of biology—ways of thinking about life that will still apply decades from now when much of the specific information fossilized in any textbook will be obsolete.

Themes that Unify Biology

Table 1.1 Eleven Themes that Unify Biology

Theme	Description	Theme	Description
 The cell	All life on Earth is organized into units of structure and function. The two main types of cells are prokaryotic cells (in bacteria and archaea) and eukaryotic cells (in protists, plants, fungi, and animals).	 Unity and diversity	Biologists group the diversity of life into three domains: Bacteria, Archaea, and Eukarya. As diverse as life is, we can also find unity, such as a universal genetic code. The most clearly shared two species are the same characteristics they share.
 Heritable information	The continuity of life depends on the inheritance of biological information in the form of DNA molecules. This genetic information is encoded in the nucleotide sequences of the DNA.	 Evolution	Evolution, biology core theme, explains both the unity and diversity of life. The Darwinian theory of natural selection accounts for adaptation of populations to their environment through the differential reproductive success of varying individuals.
 Emergent properties of biological systems	The living world has a hierarchical organization, extending from molecules to the biosphere. With each step upward in level, systems possess emergent properties as a result of interactions among components at the lower levels.	 Structure and function	Form and function are correlated at all levels of biological organization.

Themes that Unify Biology

Regulation
Feedback mechanisms regulate biological systems. In some cases the regulation maintains a relatively steady state for internal factors such as body temperature.

Interaction with the environment
Organisms are open systems that exchange materials and energy with their surroundings. An organism's environment includes other organisms as well as inorganic factors.

Energy and life
All organisms must perform work, which requires energy. Energy flows from sunlight to producers in ecosystems.

Scientific inquiry
The process of science includes observation-based discovery and the testing of explanations through hypothesis-based inquiry. Scientific credibility depends on the repeatability of observations and experiments.

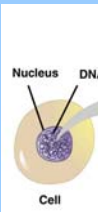
Science, technology, and society
Many technologies are goal-oriented applications of science. The relationships of science and technology to society are now more crucial to understand than ever before.

So What is Biology?

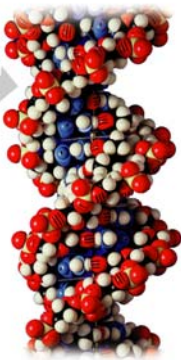
- ❑ Biology is the science that studies Life
- ❑ Life is the manifestation of how organisms live (and why they live)
- ❑ Organisms are complex organic machines that take in energy (and various chemicals).
- ❑ Energy (and chemicals) are utilized by organisms as the raw material for:
 - Growing
 - Protecting themselves
 - Repairing themselves
 - Competing with other organisms
 - Producing offspring

Biochemistry

Nucleus

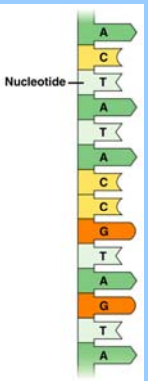


Cell



DNA

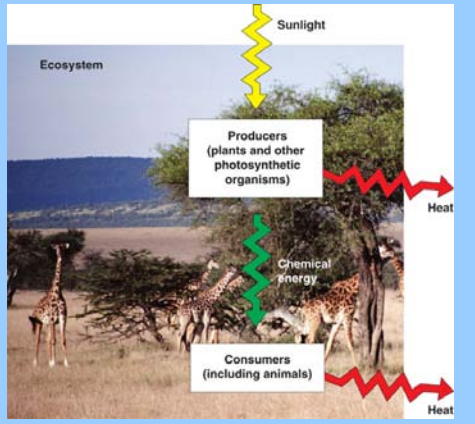
Nucleotide



(a) DNA double helix **(b) Single strand of DNA**

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Energy Transduction



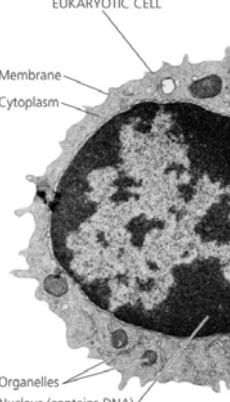
Ecosystem

Sunlight → Producers (plants and other photosynthetic organisms) → Chemical energy → Consumers (including animals)

Heat is lost at the Producer and Consumer stages.


Cell Biology

EUKARYOTIC CELL



Membrane
Cytoplasm
Organelles
Nucleus (contains DNA)

PROKARYOTIC CELL

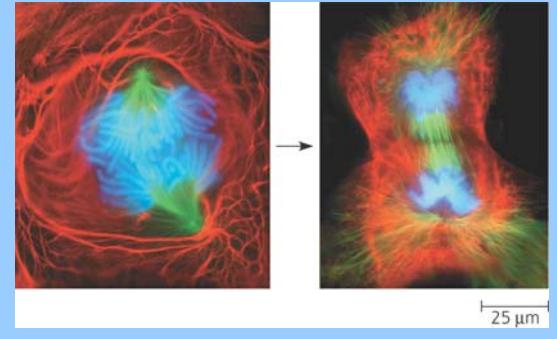


DNA (no nucleus)
Membrane

10 μm
0.1 μm
1 μm

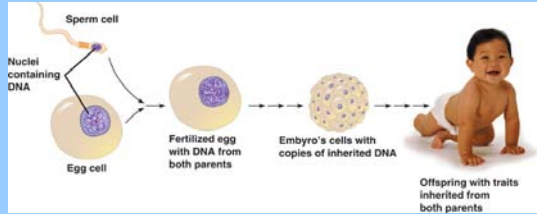
Close-up view of ribosomes, as shown with an electron microscope
Close-up of multiple cells

Cell Division

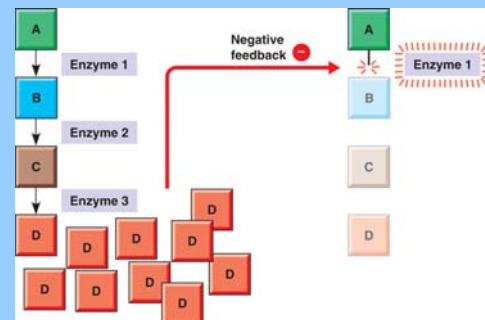


25 μm

Sex & Genetics



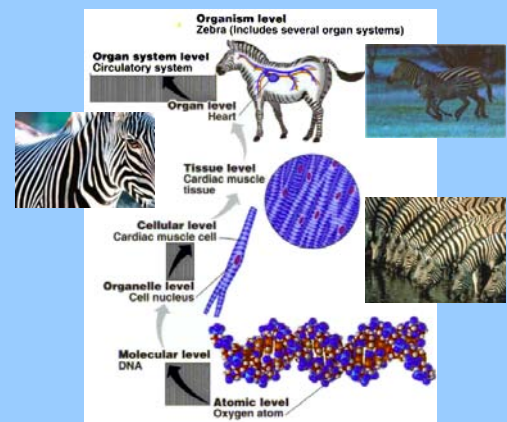
Metabolic Control



Emergent Properties

- ❑ As one goes to higher levels in this hierarchy, new properties emerge that are difficult to predict from properties at lower levels
- ❑ That is, there exist properties of groups of things that are difficult to predict if one studies individual things in more-or-less isolation
- ❑ We will be considering emergent properties all through this course (though not always explicitly)
- ❑ In the next chapter, for example, we consider chemistry so that we may subsequently consider the biological properties (e.g., biochemical properties) that emerge from the underlying chemistry of organisms

Hierarchy of Biological Order

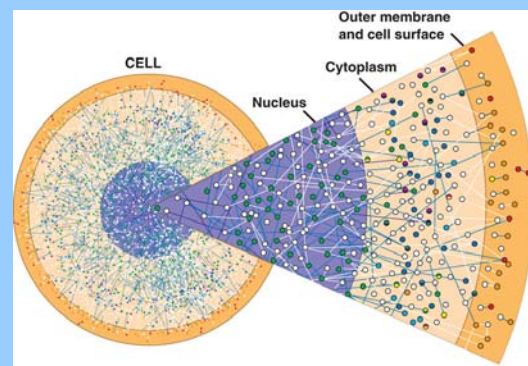


Reduction vs. Systems

- ❑ "Reductionism—reducing complex systems to simpler components that are more manageable to study—is a powerful strategy in biology."
- ❑ However, reductionism is more powerful as a tool than it is as a philosophy (a.k.a., missing the forest for the trees)
- ❑ "The ultimate goal of **systems biology** is to model the dynamic behavior of whole biological systems."
- ❑ This is a building up of understanding of the whole from an understanding of the parts
- ❑ This is discovering the forest by first studying the trees, and the fungi, and the animals, and how each interacts with the other...

Complexity

(example of systems biology shown)



The End

