

# Major Themes in Biology

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- **Metabolism: A Special Kind of Chemistry** - The word "metabolism" refers to all of the chemical reactions that happen inside a living organism. All organisms interact with their environment, which includes both living and non-living; organic and inorganic components. Material and energy flow back and forth. For instance, plants and some bacteria use water, carbon dioxide and sunlight from their environment to produce sugars which fuel plants and all subsequent food webs.
- **Emergent Properties**- We learn about a biological system such as a cell by studying its parts and the properties that emerge when those parts work together. Life exists in a hierarchical form, from single-celled bacteria to an entire ecosystem. At each higher level, systems become more elaborate, and new properties appear. For example, evolutionary evidence indicates that complex eukaryotes arose from simple prokaryotes living in a symbiotic relationship. The new organism had abilities that neither of the original organisms had on their own. "The whole is greater than the sum of the parts."
- **Structure and Function** - Cells are made of molecules that have shape and properties that determine their function. Single-celled organisms have structures that allow them to survive in their niche. Complex organisms have specialized cells with specific shapes and components that help them carry out their duties together as tissues. Different tissue types work together as organs. At every step of the biological hierarchy, structure and function are connected.
- **Growth, Development and Reproduction** - Living things have diverse life cycles. For complex organisms, this requires differentiation into specialized cells from one original cell. For life to continue, genetic instructions must be passed down from generation to generation. This heritable information is found in the DNA of all organisms, from bacteria to plants to people.
- **Homeostasis** - Organisms use their ability to sense and respond to changes in the environment to maintain stable internal conditions. For example, animals have physiological processes that help them maintain their internal temperature. This regulation also exists on the cellular level, such as a cell's ability to maintain a proper amount of water. This can be on a large scale. For example, births and deaths control animal populations and thus available resources and balance in an ecosystem.
- **Evolution** - Evolution is the unifying theme in biology. It explains changes in populations over many generations. This includes natural selection in which new characteristics appear in response to changes in the environment. For example, bacteria have evolved resistance to antibiotics in response to increased use by humans. Great diversity exists among the three primary domains of living things: Bacteria, Archaea and Eukarya. Cell structure, nutritional requirements and environmental needs differ, but there are similarities too such as the use of DNA to transfer heritable information. A humans and bacteria have many of the same genes! Both the diversity of life and the similarity between living things are a result of evolution.
- **Science and Society** - Through the processes of science, humans learn about the natural world. Technology applies this knowledge in new ways to solve human problems *and* further scientific knowledge. Science uses inquiry, controlled experiments and peer review. Models, (physical, mathematical, conceptual, etc.) help scientists study and understand complex systems. Science and technology inevitably lead to ethical questions that must be considered by all citizens.