Biology is the subject of life and living organisms. And perhaps, most importantly today, how we humans interact with and impact the lives of each other and the other organisms that share our earth. By studying the hundreds of thousands of living organisms with which humans share this earth, biologists try to answer questions about diversity and about the common characteristics of living organisms. We try, in science to make "sense" of all we see in our world around us. We shall look at some of the "themes" of biology this term; others will have to wait for other courses.

But, for a beginning, let's look at what "life" is - some of the characteristics of living organisms, and then look a bit at how science asks questions about the world in which we live. These topics are addressed in the introductory chapter of your textbook.

Characteristics of Life

Living Organisms are virtually everywhere on earth, and are found in all sizes, shapes and colors. From bacteria to aspen groves, blue whales and California redwood trees, there is a remarkable array of living organisms to catalog (or classify) and observe on earth.

All of us have some understanding of what it is to be alive and what non-living stuff is. However, coming up with a good definition of life is not so easy. There are a number of things we can state which are characteristics of living organisms, the sum of which can be of help to us in distinguishing life from non-life:

Although both living and non-living things share the same fundamental properties of matter and energy (which we shall look at) living organisms and non-living materials differ in the degree to which energy is used and materials are organized. To help us determine how life and non-life can be distinguished we can study some of the following common "features" of living organisms:

DNA

Your text states that DNA is the signature molecule of life. By this we mean that all living organisms have a **common molecular inheritance** based on the nucleic acid, DNA. DNA contain the instructions for the structure and function of cells, the common structural component of living organisms. DNA guides growth, development and maintenance of tissues and organs of multicellular organisms. DNA instructions are passed from generation to generation (inherited) by the process of reproduction.

Energy
All organisms require energy input to maintain the processes of life. Living organisms must have the capacity to obtain and convert energy from their surroundings to grow and maintain themselves. In biology this is known as **metabolism**.

Response to Stimuli
Organisms constantly sense changes in their surroundings and make controlled responses to those changes. Organisms have specialized **receptors** that detect environmental **stimuli**, and their cells adjust metabolism in response to signals from receptors. This constant monitoring and interaction between cells and their environment is called **homeostasis**.

Cellular Organization
Living organisms have an **organized** structure, composed of cells. All living organisms are composed of one or more cells, the smallest unit of life.

Life Organization
Organisms can be unicellular, aggregates or multicellular, in which cells become specialized and interdependent, organized into tissues and organs under controlled conditions.

Groups of organisms form populations and groups of different populations (or species) living in the same geographical area form communities and ecosystems. This is our life on earth.

Interdependence of Life
Just as the cells of multicellular organisms are dependent upon each other for the survival of the organism, life on earth involves an interdependence of energy and nutrients in ecological processes. Much of biology focuses on the linking of life processes:

- The dependence of life processes on each other
- The interaction of organisms with their environment
- The changes that occur in groups of organisms through time
- The mechanisms of evolution as a foundation for change

While looking for the unity of life processes, we recognize the great diversity of appearance and behavior of species on this earth, as well. Species differ greatly in their adaptations to the many distinct environments on earth. Both the unity and diversity of organisms can be explained by the mechanisms of evolution.

Diversity of Life

For thousands of years humans have categorized living organisms into groups sharing some kind of common features. In the 1700's, Linnaeus proposed a hierarchical scheme, which we continue to follow. For some time, biologists grouped organisms into general groups, called **Kingdoms**, based on broad general features (which are not so easy to see all of the time). Recently, biologists added a new category above Kingdom, called **Domain**. Your textbook uses Domains in its classification of living organisms. There are three Domains:

- Domain Archaea
- Domain Eubacteria
- Domain Eukarya
    - Kingdom Plantae
    - Kingdom Animalia
    - Kingdom Fungi
    - Kingdom Protista

At times during Biology 101, we will have reason to look a little more closely at the characteristics of these domains and kingdoms, and for those who go on to study diversity in other courses, you'll have the opportunity for greater observations. Unfortunately, we do not have time in Biology 101 to study the wonderful diversity of life on earth in any detail. Biology 102, and Biology 202 and 203 have diversity sections.

Evolution as the Guiding theme of Biology

Both the unity and diversity of organisms is explained by the mechanisms of evolution. The processes of evolution outline the mechanisms by which species genetically change from generation to generation, in response to the "forces" of their surroundings which favor some genetic trait over another less suited to the surroundings in which the organisms live. We shall spend some time this term looking at the mechanisms of evolution, as well as seeing the results of evolution as we study the structure and functioning of cells.

How Biologists Ask Questions

Before we leave our introduction, we need to mention how biologists look at the world around them. Each of us is curious about any number of things. Often when we are curious we ask questions to try and find out whatever it is that we are curious about.

Biologists try and find answers to their questions about living things by using the scientific method of problem solving, or some variant of this method, to study the processes of life.

Scientific Principles

A Scientific Principle is an idea supported by repeated experiments and observations. The assumptions behind which scientific principles are based have been thoroughly tested and found valid over many years.

How the Scientific Process Works:

- Find something about which you are curious and ask a question about it
- Make observations about whatever it is you are questioning to produce a "model" or preliminary explanation for your question
- Based on your observations and model, make a **testable hypothesis** (reasoned guess) by using the information available to make a general statement (called the hypothesis).
- Predict what will happen if the hypothesis is correct
- Test the hypothesis by models, controlled experiments and observations
- Repeat tests to see if results are consistent with the hypothesis
- Objectively note results and drawing conclusions
- Examine alternative hypotheses in the same manner

Scientists work in as many different ways as there are scientists; but all share a critical attitude that requires being shown, not being told, and a logic to their thinking. Conclusions drawn support evidence and observations using deductive (making inferences about specifics based on hypothesis, or an "if-then" process) and inductive (making a general statement based on specific tests) reasoning.

Science is limited to questions that can be tested. Experimental design is important. When possible, science uses controlled studies, in which the **control** group is a standard for comparison with the **experimental** group. The **variables** of the experiment are aspects, events or objects that may differ or change over time. When testing a hypothesis, scientists are as prepared to find the hypothesis false as they are for validating the hypothesis.

Tested and supported hypotheses in science are known as theories. In this sense, theory is not the same as in some fields where theory means a speculation. A science theory has tested evidence that supports and lacks evidence that disproves it. Other fields may look at issues and ideas that are untestable. These ideas are not appropriate for science.

This term, in Biology 101 we will look at some of these life processes. Chapter One of your text reviews many of the ideas I've mentioned here. Read this chapter with thought. Much of what is written there may help you think more deeply and with greater understanding of what we are to do in Biology 101 as well as in subsequent biology courses you will take.