

Science and Biology

Need to Know...

- How do you conduct science?
- What is biology?
- What are the characteristics of life?

Science

Science is an organized way of gathering and analyzing evidence about the natural world

Science is derived from the Latin word *scientia*, which means “knowledge”

- Science aims to find the best understanding of the natural world that current methods can reveal

- Even though there is no one way to conduct scientific research there are several steps that most people utilize to solve problems in a scientific manner.

Scientific Methodology

Step One = Observing and asking questions

- Scientific observation is noticing and describing events or processes in a careful, orderly way

Observation is more than just looking



Scientific Methodology

Step Two = Making inferences

- An inference is a logical interpretation based on what scientists already know

Scientific Methodology

Step Three = Forming hypotheses

- A hypothesis is a scientific explanation for a set of observations that can be tested in ways that support or reject it

Scientific Methodology

Step Four = Conducting controlled experiments

- A controlled experiment is an experiment in which only one variable is changed

All other variables should be kept unchanged, or controlled

- The independent variable (IV) is the variable that is deliberately changed by the researcher
- The dependent variable (DV) is the variables that is observed and that changes in response to the IV

Scientific Methodology

Step Four = Conducting controlled experiments

- A control group is exposed to the same conditions as the experimental group except for one independent variable

Scientific Methodology

Step Five = Collecting and analyzing data

- Quantitative data are numbers obtained by counting or measuring
- Qualitative data are descriptive and involve characteristics that cannot be counted

Scientific Methodology

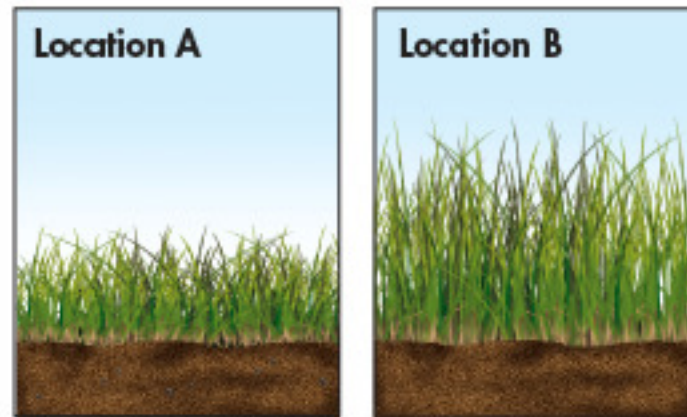
Step Six = Drawing conclusions

- Scientists use experimental data as evidence to support, refute, or revise the hypothesis being tested, and to draw a valid conclusion

Observation and Asking Questions

Researchers observed that marsh grass grows taller in some places than others

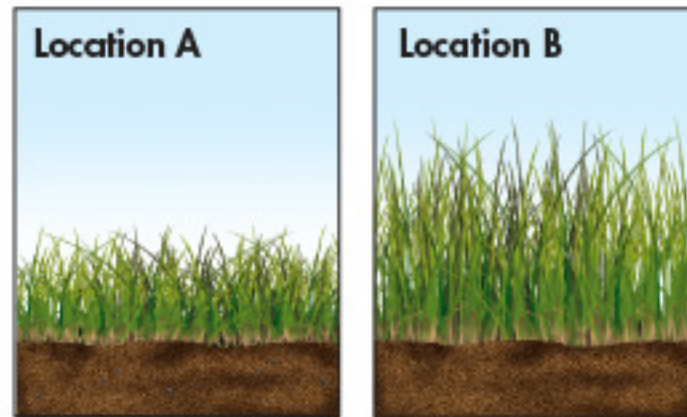
This observation led to a question: Why do marsh grasses grow to different heights in different places?



Inferring and Forming a Hypothesis

Researchers inferred that something limits grass growth in some places

Based on their knowledge of salt marshes, they hypothesized that marsh grass growth is limited by available nitrogen

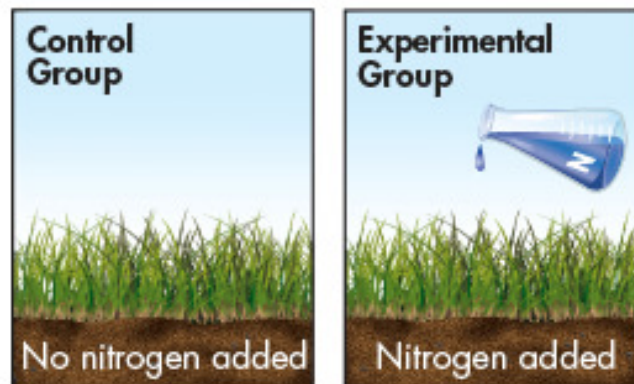


Designing Controlled Experiments

The researchers selected similar plots of marsh grass (all plots had similar plant density, soil type, input of freshwater, and height above average tide level)

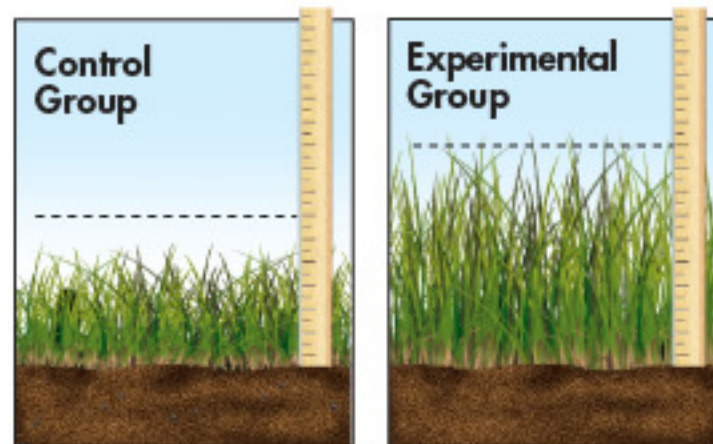
The plots were divided into control and experimental groups and the researchers added nitrogen fertilizer (IV) to the experimental plots

They then observed the growth of marsh grass (DV) in both experimental and control plots



Collecting and Analyzing Data

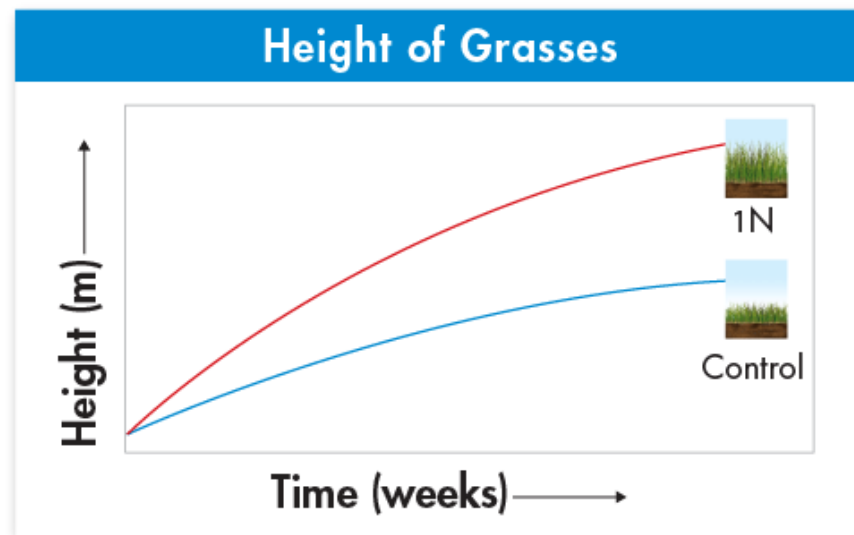
The researchers recorded the height of each group of grasses each week



Drawing Conclusions

Data analysis confirmed that marsh grasses in experimental plots with additional nitrogen fertilizer did, in fact, grow taller and larger than controls

The hypothesis and its predictions were supported



Communicating Results

Scientists share their findings to allow researchers to test and evaluate each other's work

- New findings will also spark new questions
- Peer review is utilized prior to publishing results to look for oversights, unfair influences, fraud, or mistakes in techniques or reasoning

Scientific Theory

A scientific theory is a well-tested explanation that unifies a broad range of observations and hypotheses and that enables scientists to make accurate predictions about new situations

The word theory differs in science and daily life

- Science = A well-tested explanation
- Daily life = An idea or hunch

Limitations of Science

Science does not include ethical or moral viewpoints

Science reports facts; society applies the “good” or “bad”

Limitations of Science

Science can be influenced by bias

- A bias is a particular preference or point of view that is personal, rather than scientific

Biology

Biology is the science that employs scientific methodology to study living things

- What makes something alive?

Biology

Biology is the science that employs scientific methodology to study living things

- The Greek word *bios* = life and *-logy* = study of

Characteristics of Living Things

Living things are based on a universal genetic code

- The genetic code is written in a molecule called DNA
- All living things are fundamentally similar at the molecular level

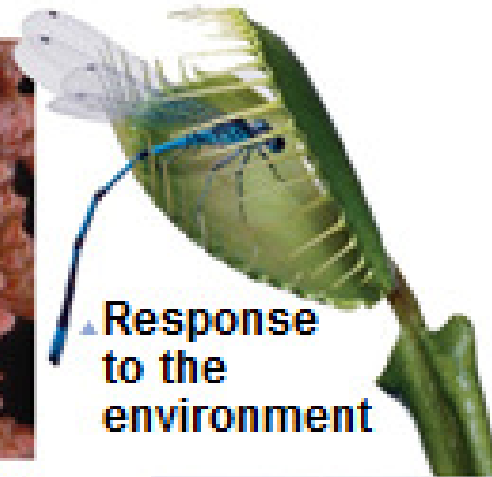
Living things contain carbon-based molecules, store genetic information in DNA, and make proteins

Fig. 1-3

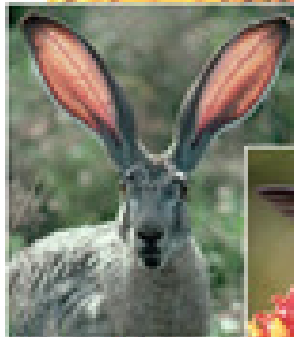
▾ Order



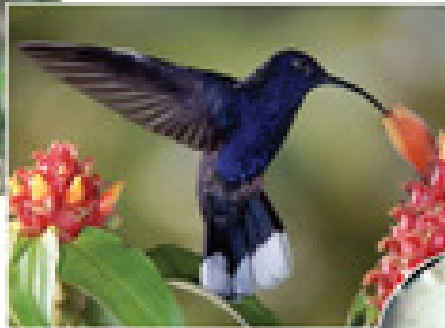
▾ Evolutionary adaptation



▾ Response to the environment



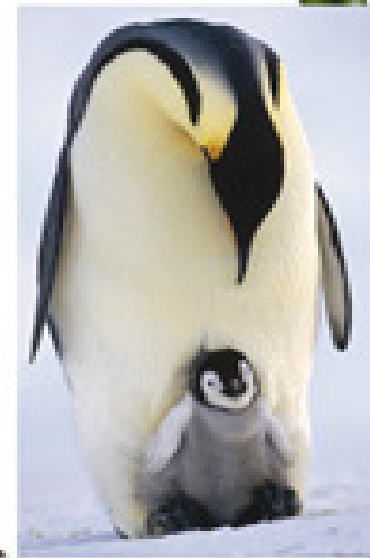
▾ Regulation



▾ Energy processing



▾ Growth and development



▾ Reproduction

Characteristics of Living Things

Living things grow and develop

- Growth is the increase in the amount of living material and the formation of new structures
- Development is all of the changes that take place during one's life

During growth and development, generalized cells typically become more different and specialized for particular functions – Specialized cells build tissues, such as brains, muscles, and digestive organs, that serve various functions

Characteristics of Living Things

Living things respond to their environment

- A stimulus is a signal to which an organism responds

Characteristics of Living Things

Living things reproduce

- Sexual reproduction is when cells from two parents unite to form the first cell of a new organism
- Asexual reproduction is when a single organism produces offspring identical to itself

Characteristics of Living Things

Living things maintain a relatively stable internal environment (even when external conditions change dramatically)

- Homeostasis is the process whereby all living things expend energy to keep conditions inside their cells within certain limits

Characteristics of Living Things

Living things obtain and use material and energy

- The combination of chemical reactions through which an organism builds up or breaks down materials is called metabolism

Life requires matter that serves as nutrients to build body structures, and energy that fuels life's processes

- Some organisms (such as plants) obtain energy from sunlight and take up nutrients from air, water, and soil
- Other organisms (including most animals) eat plants or other animal to obtain both nutrients and energy

Characteristics of Living Things

Living things are made up of one or more cells

- Cells are the smallest units considered fully alive
- Unicellular organisms are living things that consist of only a single cell
- Multicellular organisms are composed of many cells

Characteristics of Living Things

Over generations, groups of organisms evolve

- Evolution is the gradual accumulation of adaptations over time
- Adaptations are any structure, behavior, or internal process that enables an organism to respond to stimuli and better survive in an environment

(a)

Bald Eagle



Spoonbill



Kiwi