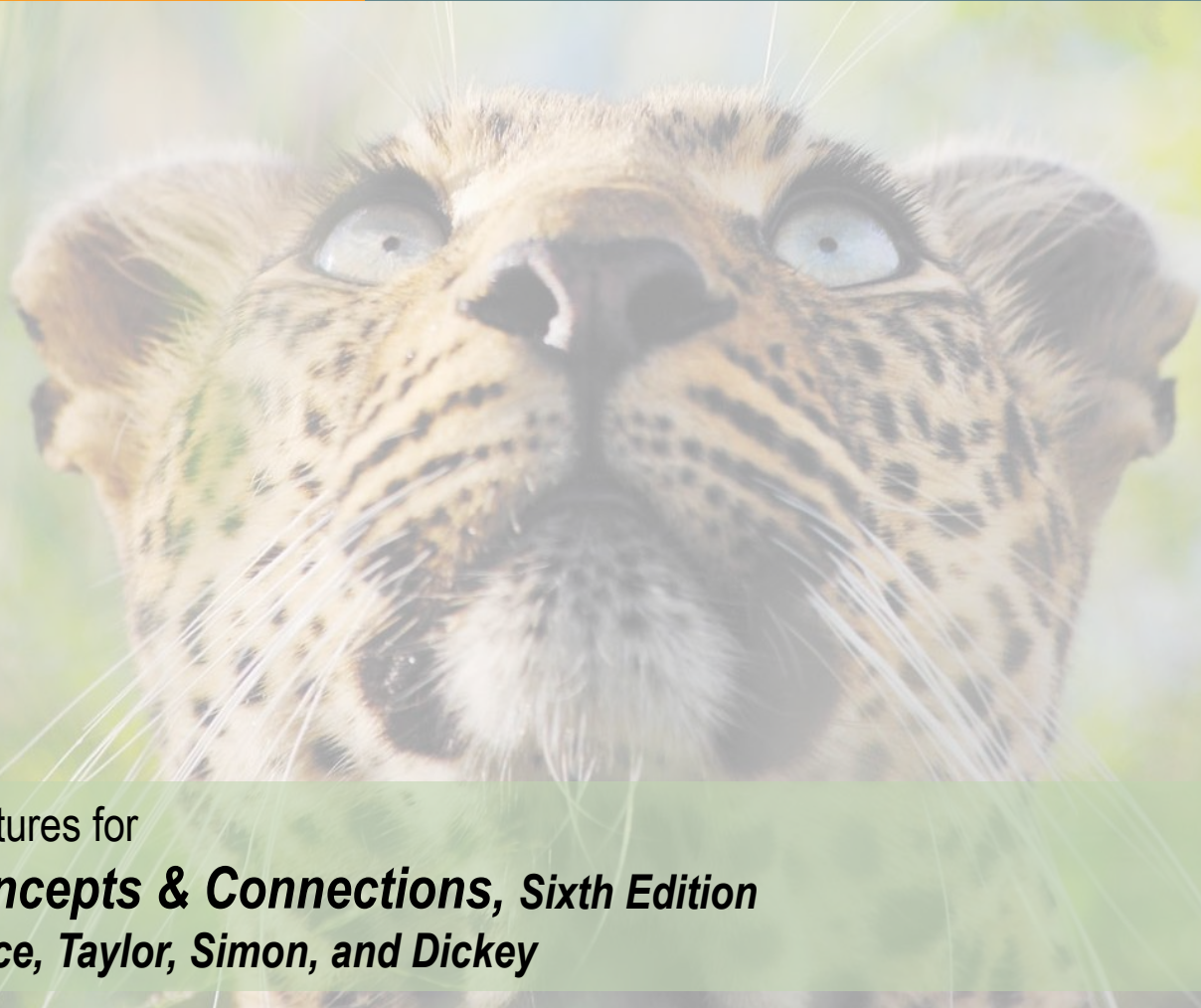


Chapter 1

Biology: Exploring Life

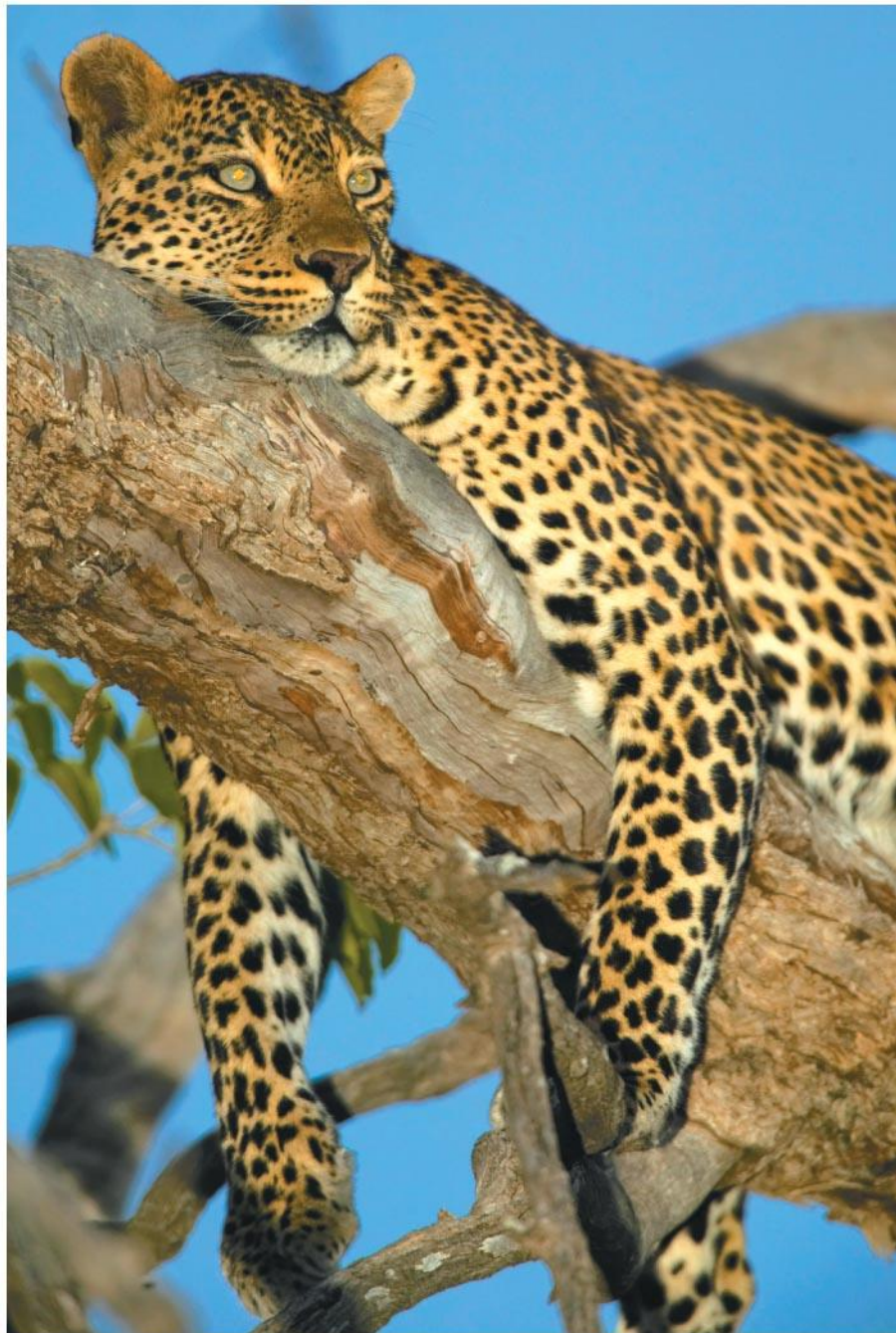


PowerPoint Lectures for
Biology: Concepts & Connections, Sixth Edition
Campbell, Reece, Taylor, Simon, and Dickey

Lecture by Richard L. Myers

Introduction: *Dining in the Trees*

- The leopard is an excellent example of an organism adapted to its environment
 - It survives because of adaptations to its environment
 - Examples are coat camouflage and hunting and climbing ability
 - Adaptations are the result of evolution
 - **Evolution** is the process of change that transforms life
 - **Biology** is the scientific study of life





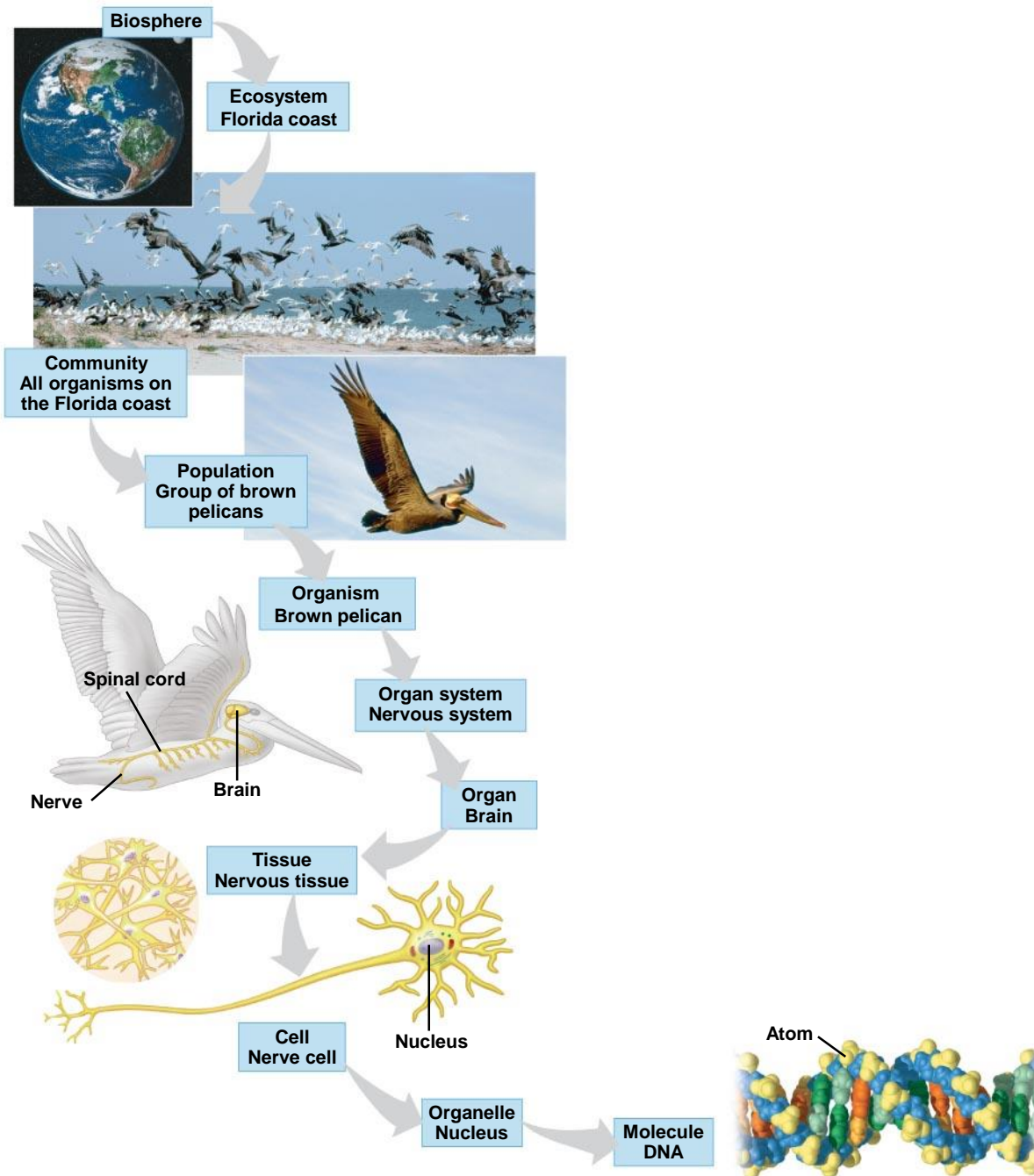
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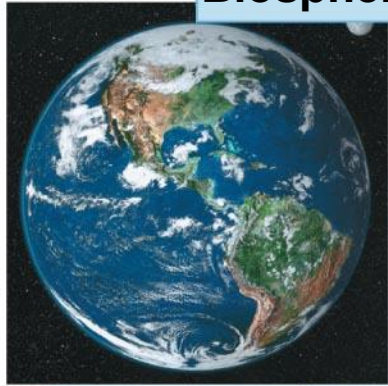
THEMES IN THE STUDY OF BIOLOGY

1.1 In life's hierarchy of organization, new properties emerge at each level

- Life's levels of organization define the scope of biology
 - Life emerges through organization of various levels
 - With addition of each new level, novel properties emerge—called **emergent properties**



Biosphere



**Ecosystem
Florida coast**

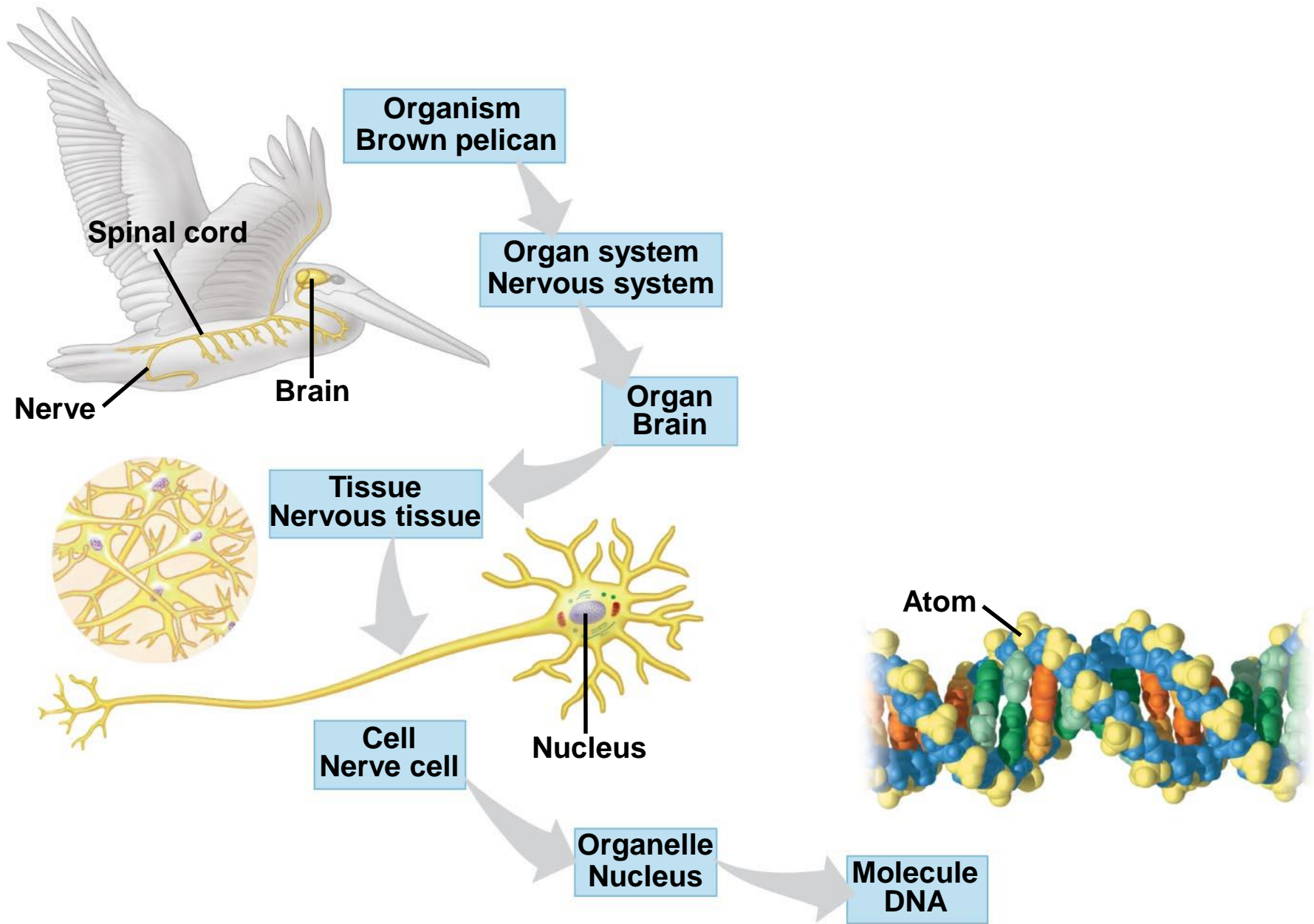


**Community
All organisms on
the Florida coast**

**Population
Group of brown
pelicans**



**Organism
Brown pelican**



1.1 In life's hierarchy of organization, new properties emerge at each level

- The upper tier is a global perspective of life
 - **Biosphere**—all the environments on Earth that support life
 - **Ecosystem**—all the organisms living in a particular area
 - **Community**—the array of organisms living in a particular ecosystem
 - **Population**—all the individuals of a species within a specific area

1.1 In life's hierarchy of organization, new properties emerge at each level

- The middle tier is characterized by the organism, an individual living thing, which is composed of
 - **Organ systems**—have specific functions; are composed of organs
 - **Organs**—provide specific functions for the organism
 - **Tissues**—made of groups of similar cells

1.1 In life's hierarchy of organization, new properties emerge at each level

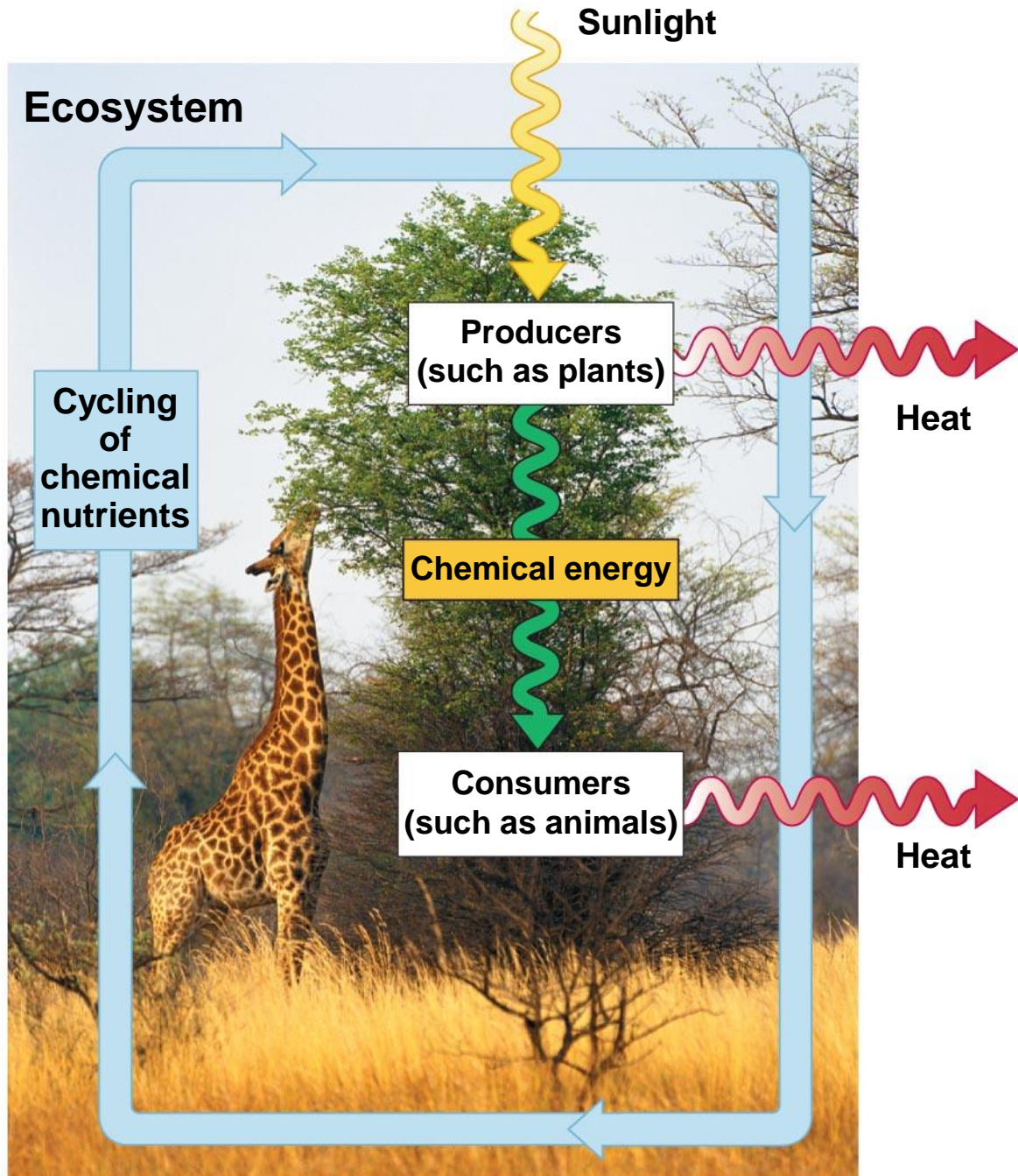
- Life emerges at the level of the cell, the lower tier, which is composed of
 - **Molecules**—clusters of atoms
 - **Organelles**—membrane-bound structures with specific functions
 - **Cells**—living entities distinguished from their environment by a membrane

1.2 Living organisms interact with their environments, exchanging matter and energy

- Life requires interactions between living and nonliving components
 - Photosynthetic organisms provide food and are called **producers**
 - Others eat plants (or animals that profit from plants) and are called **consumers**
- The nonliving components are chemical nutrients required for life

1.2 Living organisms interact with their environments, exchanging matter and energy

- To be successful, an ecosystem must accomplish two things
 - Recycle chemicals necessary for life
 - Move energy through the ecosystem
 - Energy enters as light and exits as heat



1.3 Cells are the structural and functional units of life

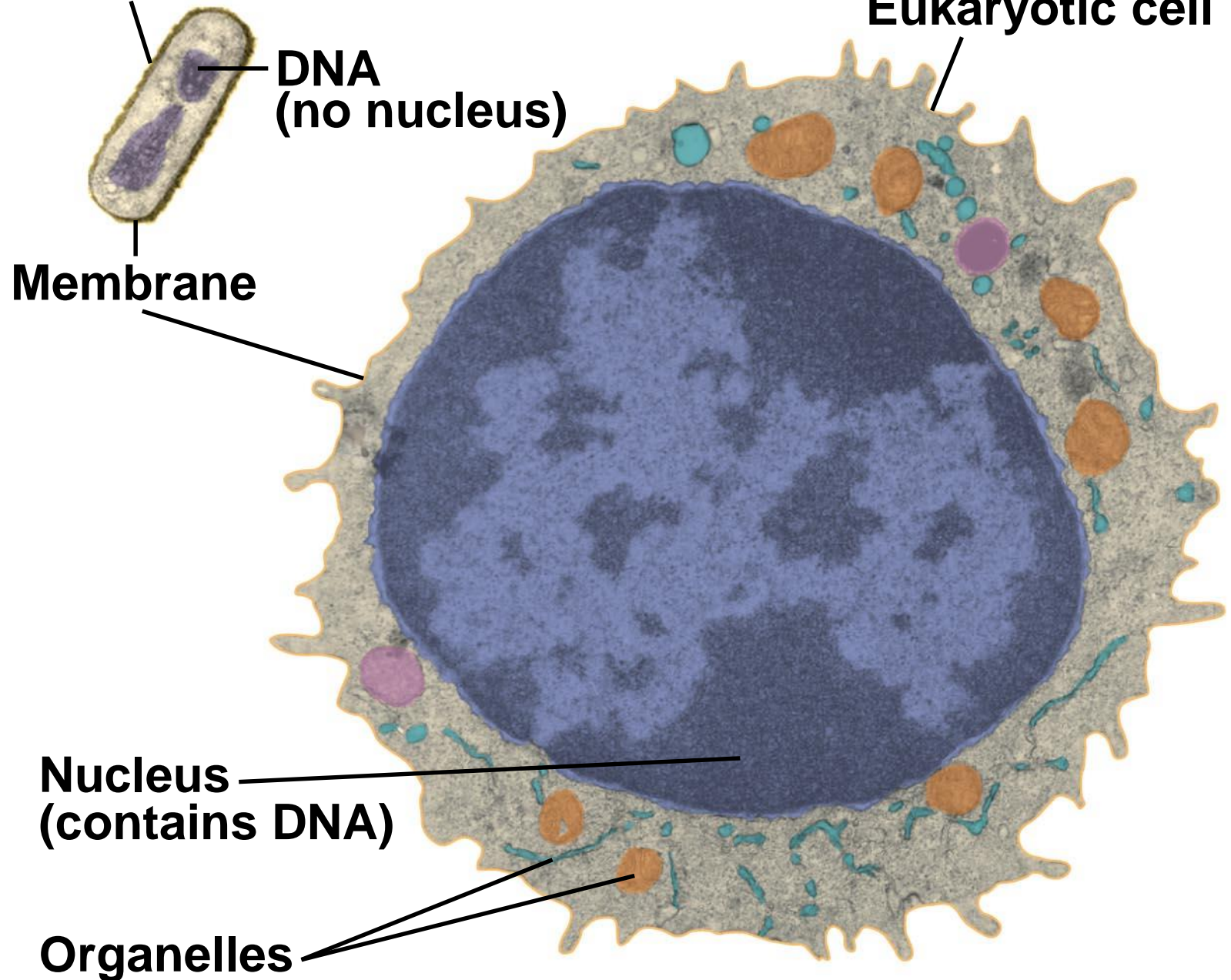
- Form generally fits function
 - By studying a biological structure, you determine what it does and how it works
 - Life emerges from interactions of structures
 - Combinations of structures (components) provide organization called a **system**

1.3 Cells are the structural and functional units of life

- Two distinct groups of cells exist
 - **Prokaryotic cells**
 - Simple and small
 - Bacteria are prokaryotic
 - **Eukaryotic cells**
 - Possess organelles separated by membranes
 - Plants, animals, and fungi are eukaryotic

Prokaryotic cell

Eukaryotic cell



**DNA
(no nucleus)**

Membrane

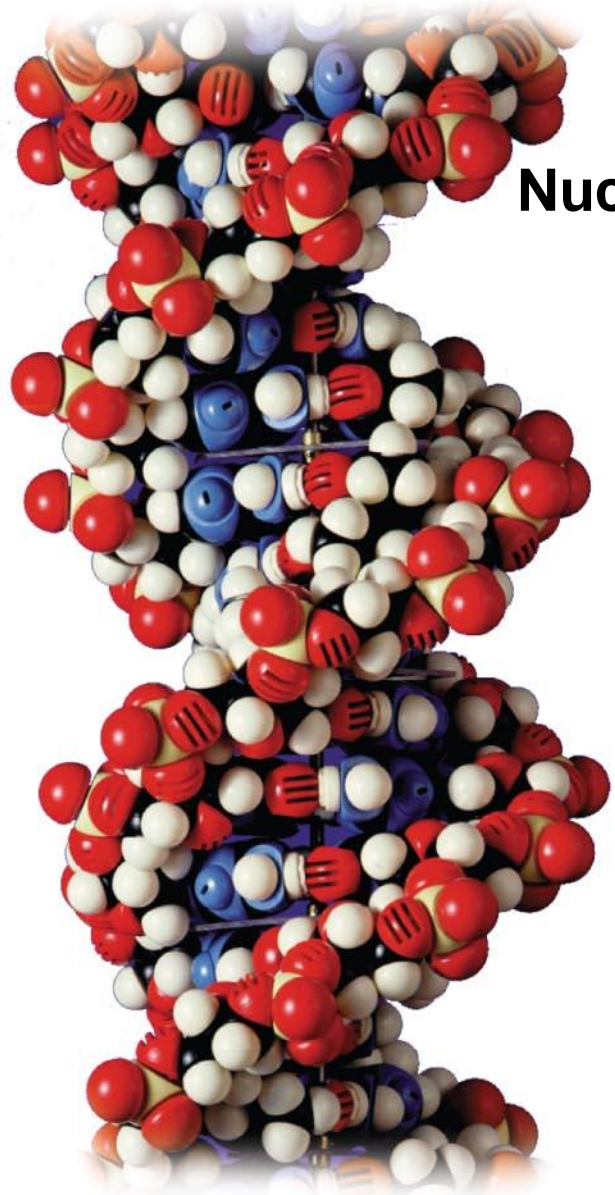
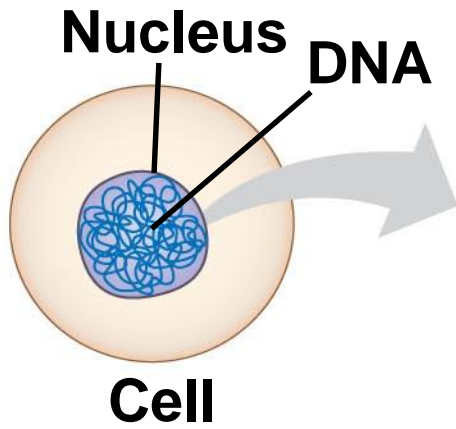
**Nucleus
(contains DNA)**

Organelles

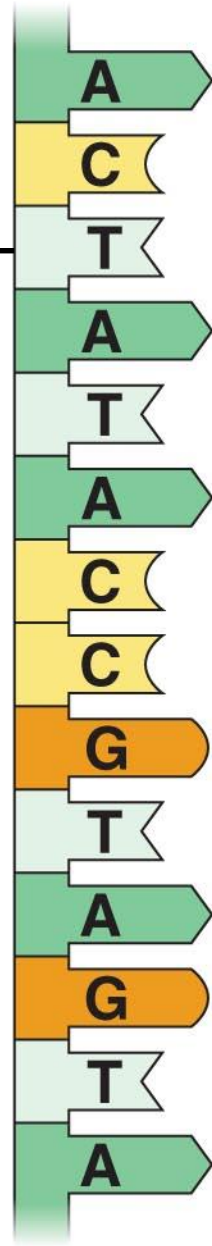
EVOLUTION, THE CORE THEME OF BIOLOGY

1.4 The unity of life: All forms of life have common features

- DNA is the genetic (hereditary) material of all cells
 - A **gene** is a discrete unit of DNA
 - The chemical structure of DNA accounts for its function
 - The diversity of life results from differences in DNA structure from individual to individual



Nucleotide



(a) DNA double helix

(b) Single strand of DNA

1.4 The unity of life: All forms of life have common features

- All living things share common properties
 - **Order**—the complex organization of living things
 - **Regulation**—an ability to maintain an internal environment consistent with life
 - **Growth and development**—consistent growth and development controlled by DNA
 - **Energy processing**—acquiring energy and transforming it to a form useful for the organism

1.4 The unity of life: All forms of life have common features

- Common properties continued
 - **Response to the environment**—an ability to respond to environmental stimuli
 - **Reproduction**—the ability to perpetuate the species
 - **Evolutionary adaptation**—acquisition of traits that best suit the organism to its environment

PLAY

Video: Sea Horses



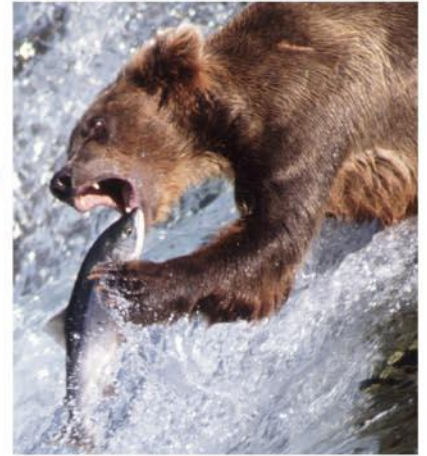
(1) Order



(2) Regulation



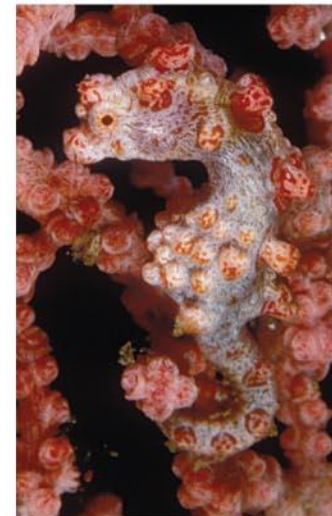
(3) Growth and development



(5) Response to the environment



(6) Reproduction



(7) Evolutionary adaptation



(1) Order

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(2) Regulation

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(3) Growth and development

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(4) Energy processing

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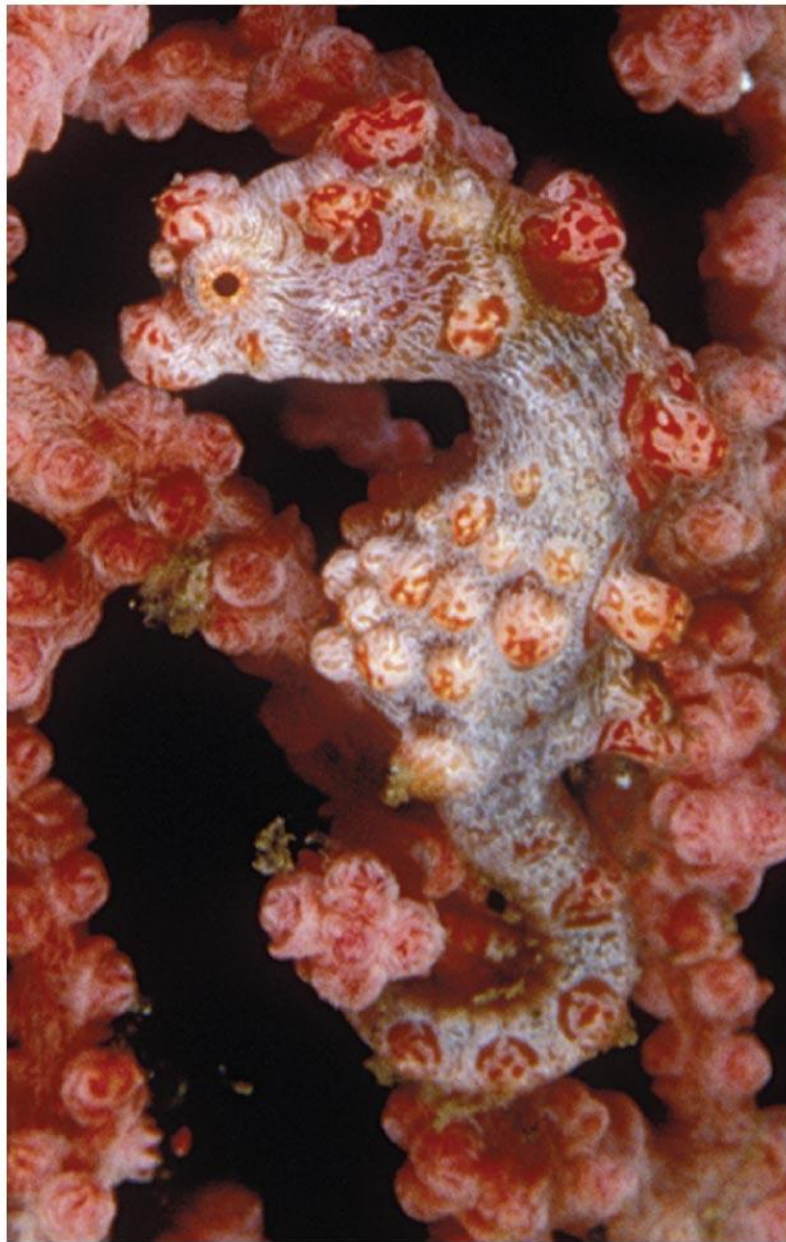


(5) Response to the environment



(6) Reproduction

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(7) Evolutionary adaptation

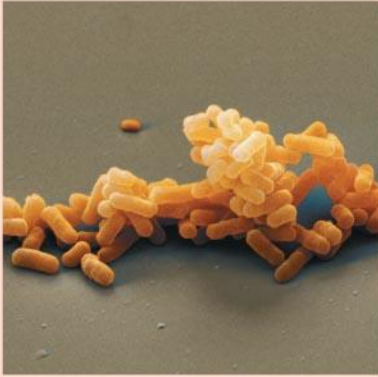
1.5 The diversity of life can be arranged into three domains

- The three domains (groups) of life
 - **Bacteria**—prokaryotic, and most are unicellular and microscopic
 - **Archaea**—like bacteria, are prokaryotic, and most are unicellular and microscopic
 - **Eukarya**—are eukaryotic and contain a nucleus and organelles

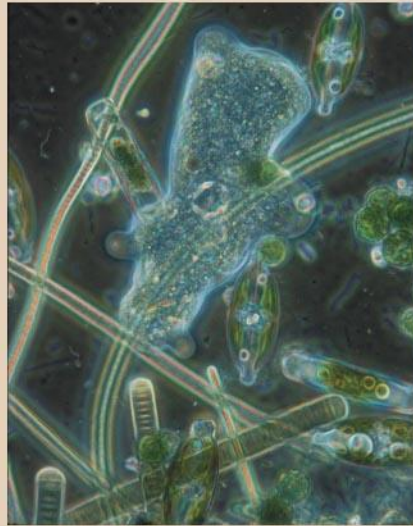


Domain Eukarya

Domain Bacteria



Bacteria (multiple kingdoms)

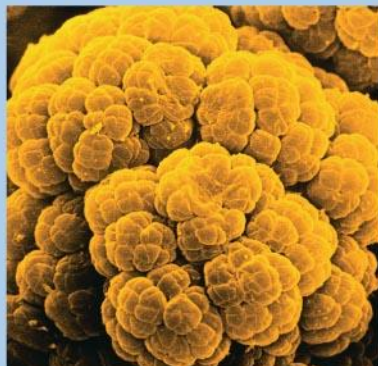


Protists (multiple kingdoms)



Kingdom Plantae

Domain Archaea



Archaea (multiple kingdoms)



Kingdom Fungi



Kingdom Animalia



Bacteria (multiple kingdoms)

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Archaea (multiple kingdoms)

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Protists (multiple kingdoms)

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Kingdom Plantae

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Kingdom Fungi

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Kingdom Animalia

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1.6 Evolution explains the unity and diversity of life

- In 1859, Charles Darwin published *On the Origin of Species by Means of Natural Selection*
 - The book accomplished two things
 - Presented evidence to support the idea of **evolution**
 - Proposed a mechanism for evolution called **natural selection**

PLAY

Video: Galapágos Island Overview

PLAY

Video: Galapágos Sea Lion

PLAY

Video: Galapágos Marine Iguana

PLAY

Video: Galapágos Tortoise





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1.6 Evolution explains the unity and diversity of life

- Natural selection was inferred by connecting two observations
 - Individuals within a population inherit different characteristics and vary from other individuals
 - A particular population of individuals produces more offspring than will survive to produce offspring of their own

PLAY

Video: Blue-footed Boobies Courtship Ritual

PLAY

Video: Albatross Courtship Ritual

PLAY

Video: Soaring Hawk

1.6 Evolution explains the unity and diversity of life

- Natural selection is an editing mechanism
 - It results from exposure of heritable variations to environmental factors that favor some individuals over others
 - Over time this results in evolution of new species adapted to particular environments
 - **Evolution** is biology's core theme and explains unity and diversity of life



1 Population with varied inherited traits



2 Elimination of individuals with certain traits

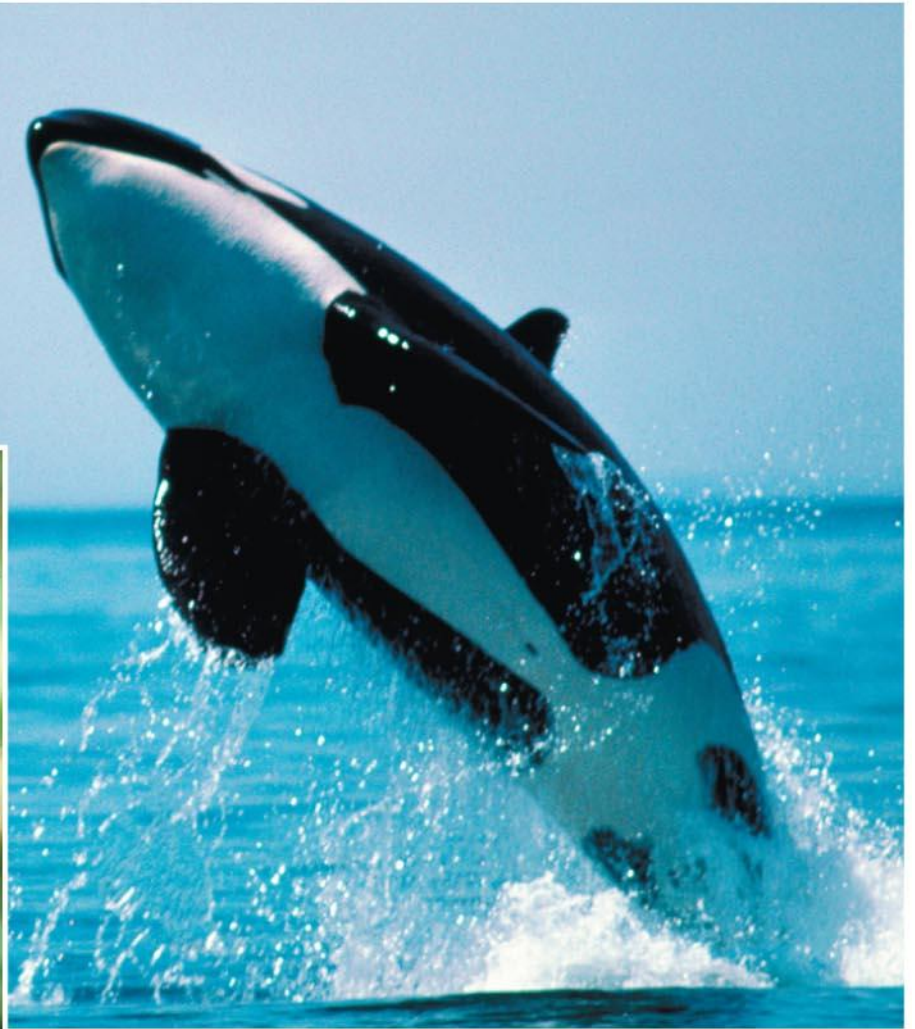


3 Reproduction of survivors



Pangolin

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Killer whale



Pangolin

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Killer whale

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THE PROCESS OF SCIENCE

1.7 Scientists use two main approaches to learn about nature

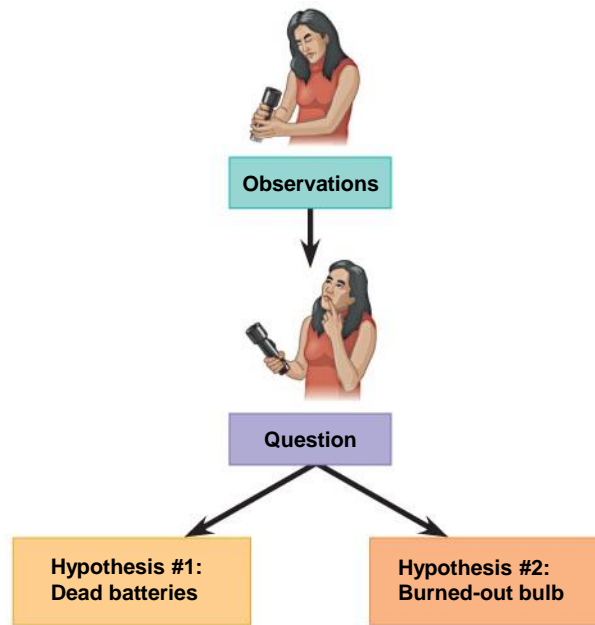
- Two approaches are used to understand natural causes for natural phenomena
 - **Discovery science**—uses verifiable observations and measurements to describe science
 - **Hypothesis-based science**—uses the data from discovery science to explain science
 - This requires proposing and testing of hypotheses

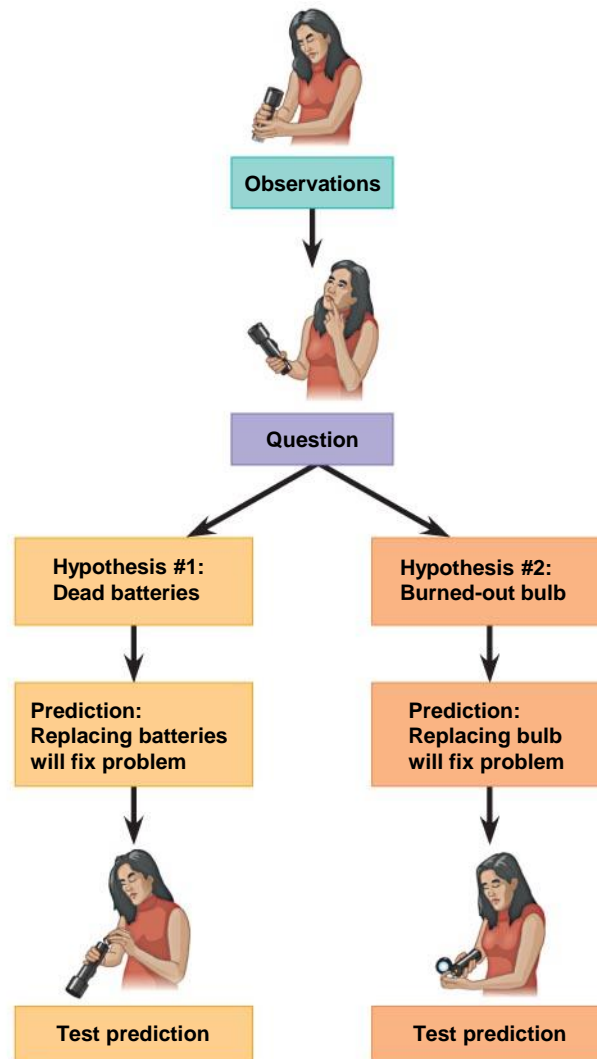
1.7 Scientists use two main approaches to learn about nature

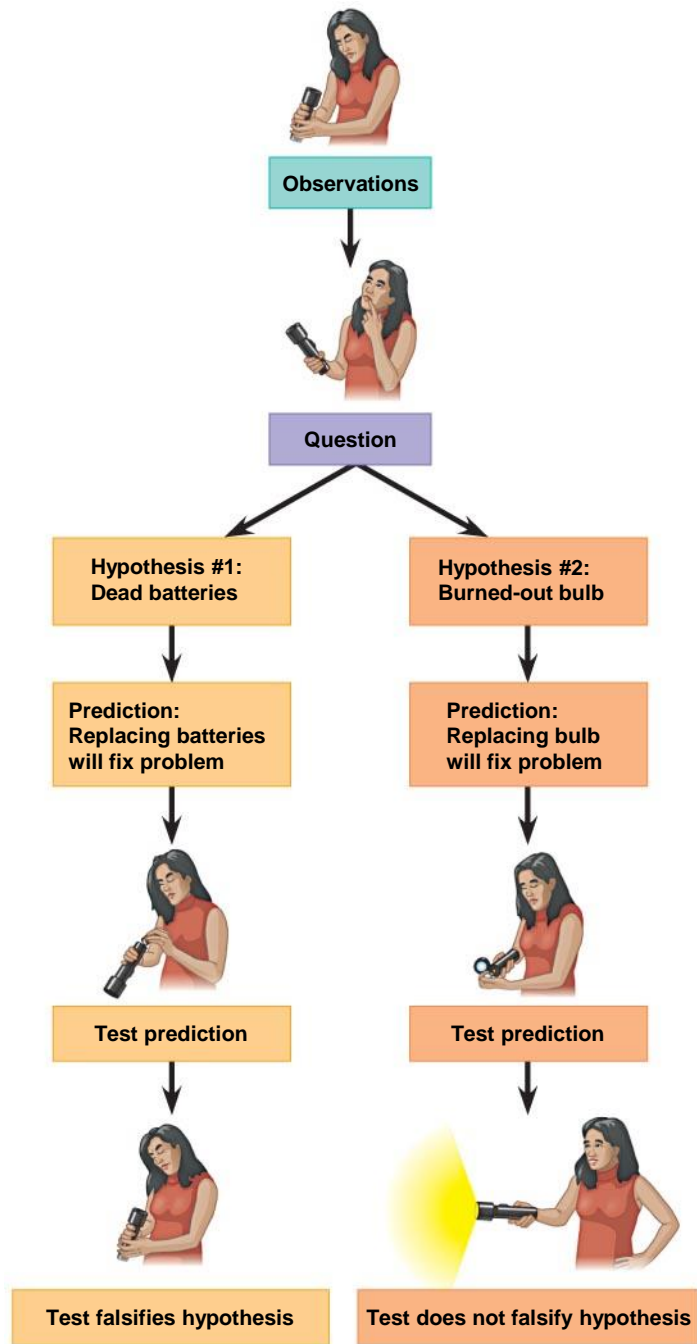
- There is a difference between a theory and a hypothesis
 - A **hypothesis** is a proposed explanation for a set of observations
 - A **theory** is supported by a large and usually growing body of evidence

1.8 With hypothesis-based science, we pose and test hypotheses

- We solve everyday problems by using hypotheses
 - An example would be the reasoning we use to answer the question, “Why doesn’t the flashlight work?”
 - Using deductive reasoning we realize that the problem is either the (1) bulb or (2) batteries.
 - The hypothesis must be testable
 - The hypothesis must be falsifiable









Observations



Question



**Hypothesis #1:
Dead batteries**

**Hypothesis #2:
Burned-out bulb**

**Hypothesis #1:
Dead batteries**

**Prediction:
Replacing batteries
will fix problem**



Test prediction



Test falsifies hypothesis

**Hypothesis #2:
Burned-out bulb**

**Prediction:
Replacing bulb
will fix problem**



Test prediction



Test does not falsify hypothesis

1.8 With hypothesis-based science, we pose and test hypotheses

- Another hypothesis: Mimicry helps protect nonpoisonous king snakes from predators where poisonous coral snakes also live
 - The hypothesis predicts that predators learn to avoid the warning coloration of coral snakes

1.8 With hypothesis-based science, we pose and test hypotheses

- Experimentation supports the prediction of the mimicry hypothesis—nonpoisonous snakes that mimic coloration of coral snakes are attacked less frequently
 - The experiment has a **control group** using brown artificial snakes for comparison
 - The **experimental group** is artificial snakes with the red, black, and yellow ring pattern of king snakes







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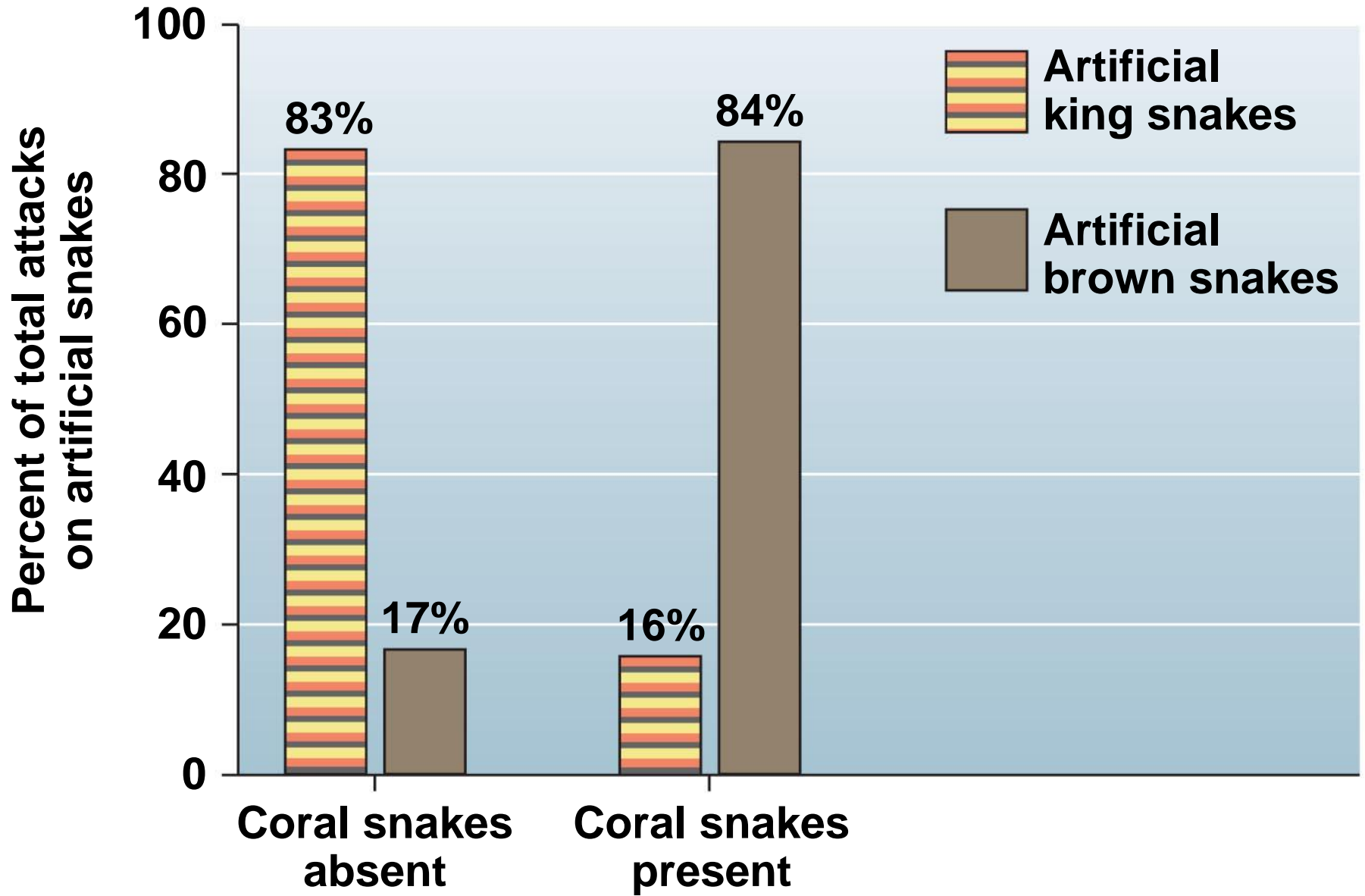




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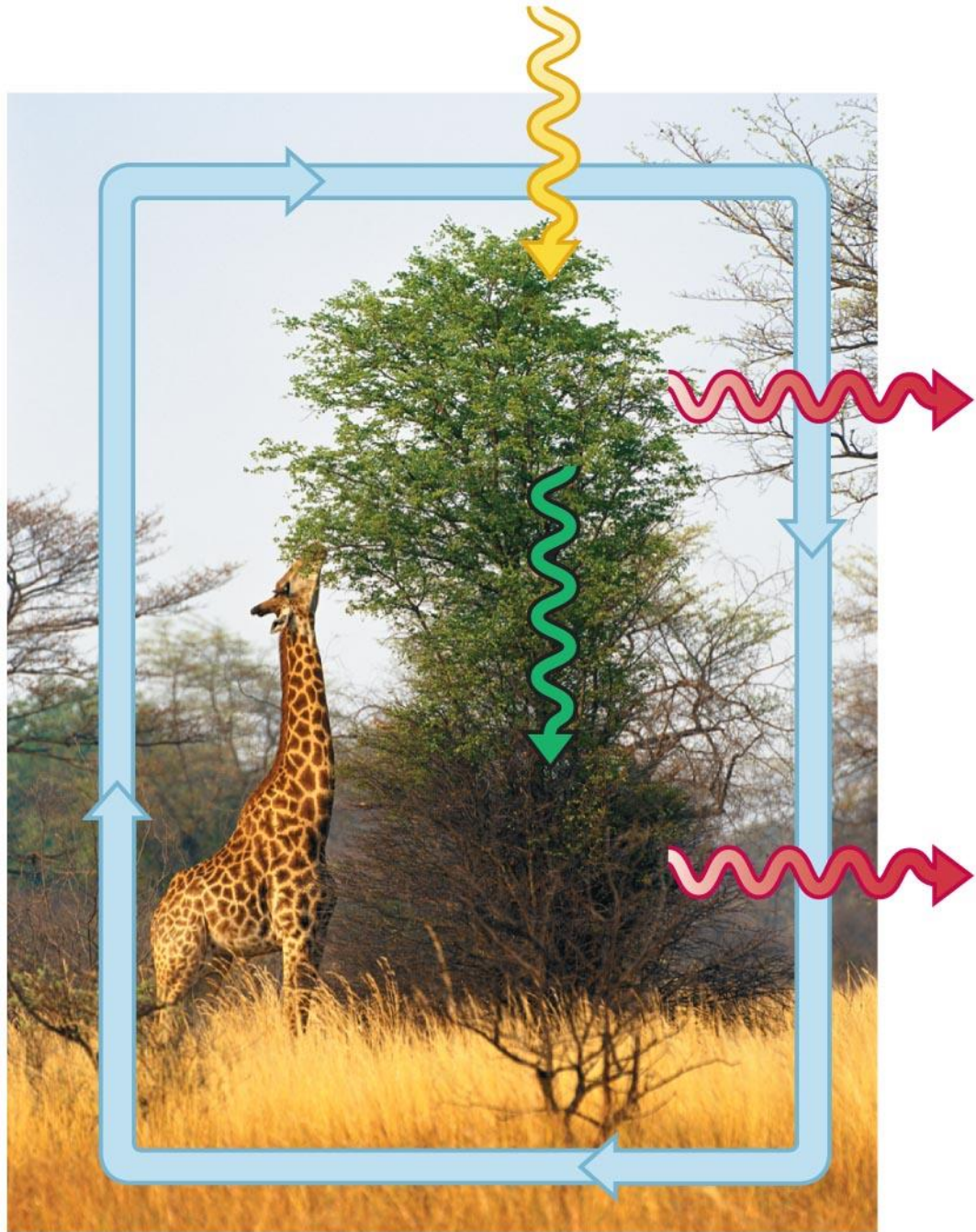
BIOLOGY AND EVERYDAY LIFE

1.9 CONNECTION: Biology, technology, and society are connected in important ways

- Many of today's global issues relate to biology (science)
 - Many of these issues resulted from applications of **technology**
 - Science and technology are interdependent, but their goals differ
 - Science wants to understand natural phenomena
 - Technology applies science for a specific purpose

1.10 EVOLUTION CONNECTION: Evolution is connected to our everyday lives

- How is evolution connected to our everyday lives?
 - It explains how all living species descended from ancestral species
 - Differences between DNA of individuals, species, and populations reflect evolutionary change
 - The environment matters because it is a selective force that drives evolution
 - An understanding of evolution helps us fight disease and develop conservation efforts





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Observations

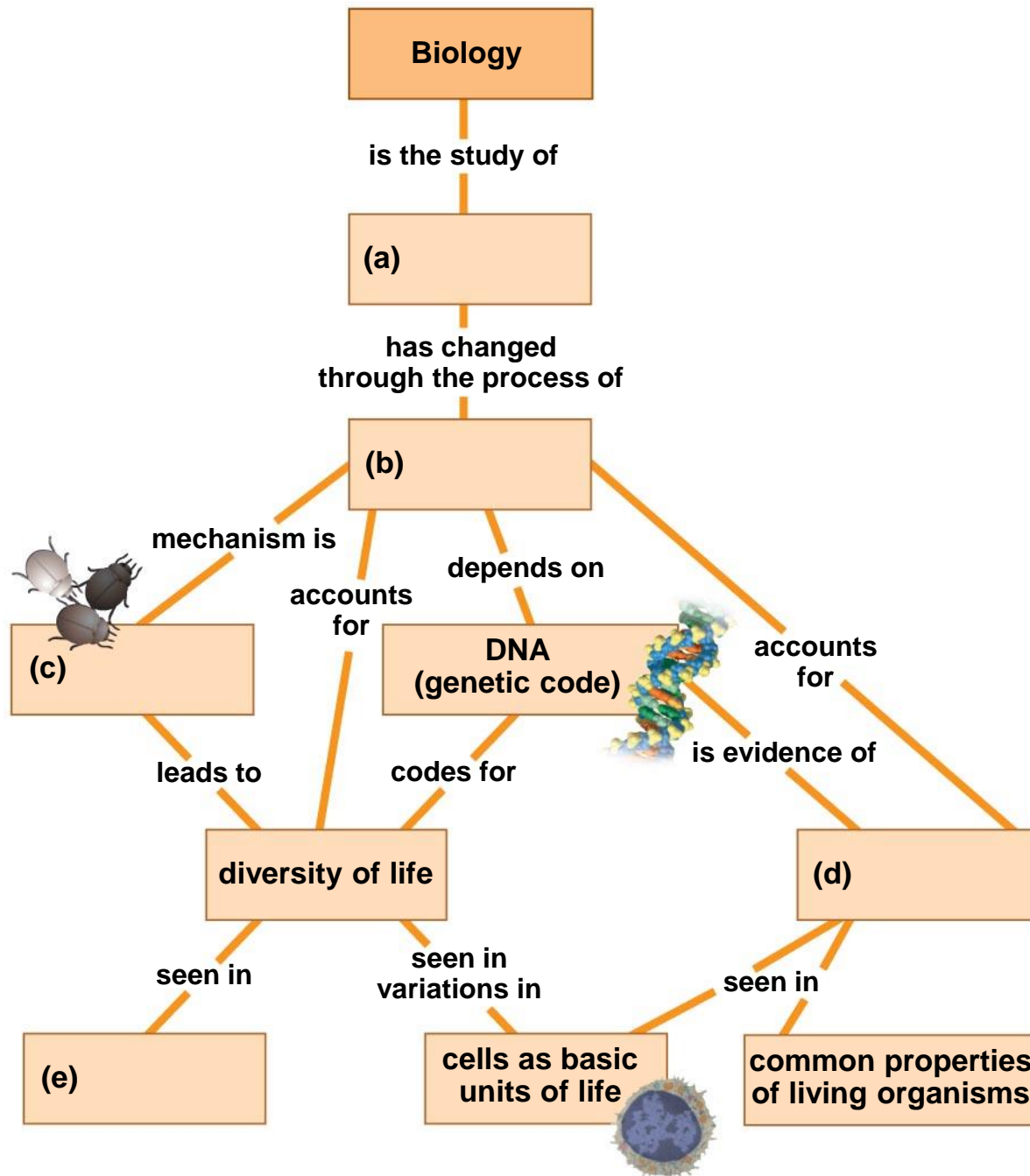
**Individual
variation**

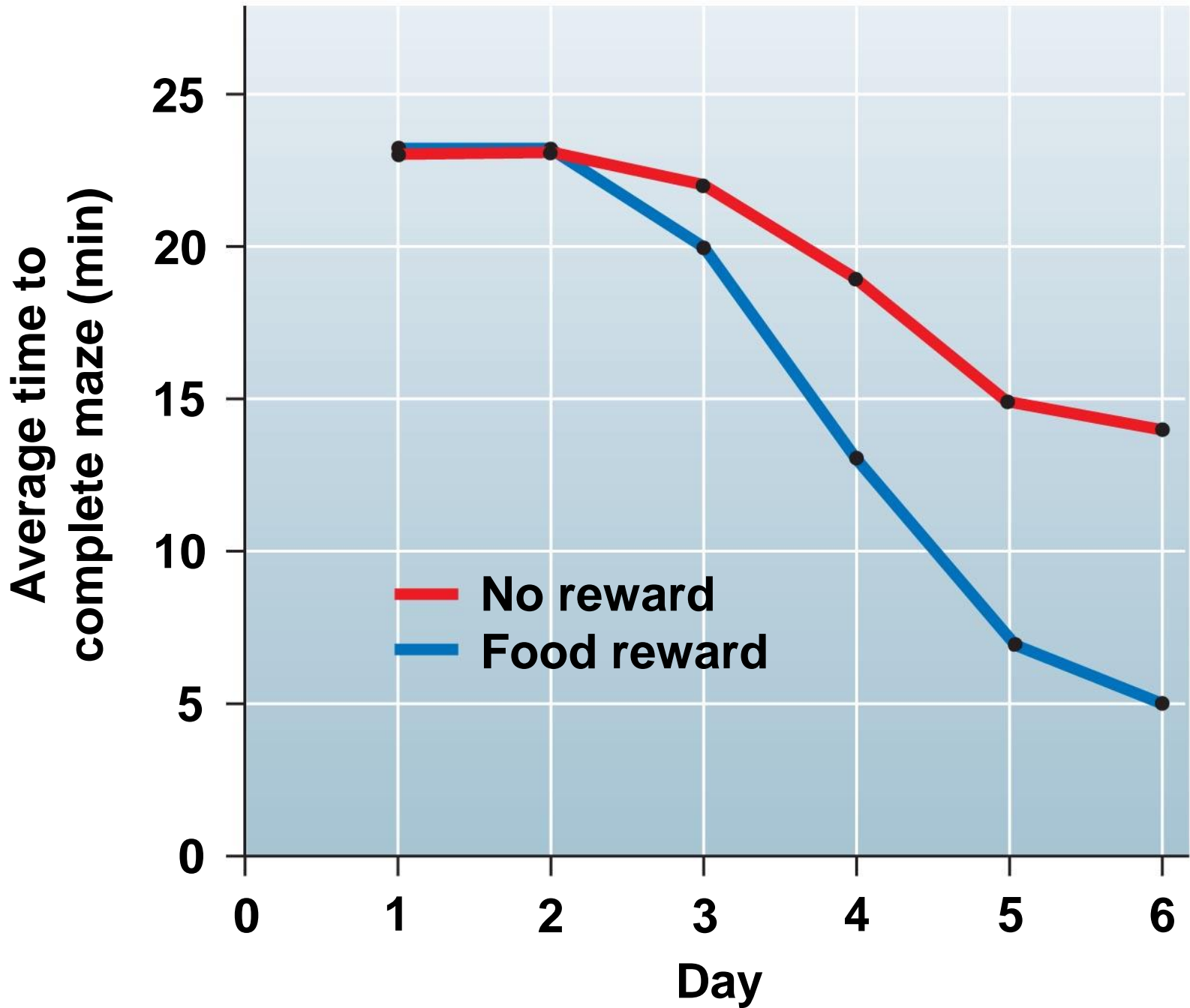
**Overproduction
of offspring**

Inferences

**Natural selection:
unequal reproductive
success**

**Evolution
of adaptations
in a population**





You should now be able to

1. Describe life's hierarchy of organization
2. Describe living organisms' interactions with their environments
3. Describe the structural and functional aspects of cells
4. Explain how the theory of evolution accounts for the unity and diversity of life
5. Distinguish between discovery science and hypothesis-based science
6. Describe ways in which biology, technology, and society are connected