Bio 1101-Lecture 1

Spring 2017

A View of Life

Outline

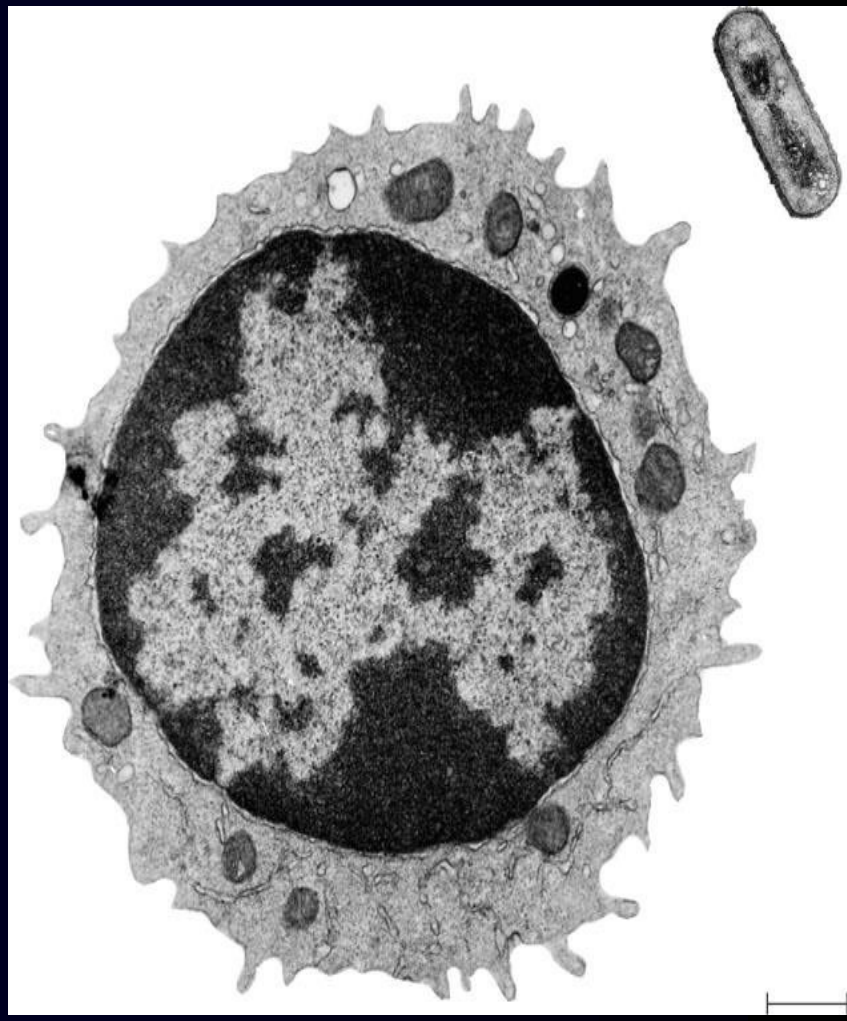
- Define Life
  - Cells
  - Biological Organization – *Emergent properties*
  - Materials and Energy
  - Reproduction and Development
  - Adaptations and Natural Selection
- Ecosystems
  - Nutrient cycling and energy flow
- Classification
  - Biodiversity
  - Organization
- The Scientific Method
  - Observation
  - Hypothesis
  - Data
  - Conclusion
  - Scientific Theory

Defining Life

- **Living things**:
  - Comprised of the same chemical elements e.g. Carbon, Hydrogen, Nitrogen and Oxygen
  - Obey the same physical and chemical laws
  - Living organisms consist of **cells** (Unicellular or Multi-cellular).
    - The **cell** is the basic structural and functional unit of all living things e.g. plants, animals, and fungus
    - Cells are produced from preexisting cells
    - Cells are the **smallest units that perform all vital physiological functions**

=> that's the **CELL THEORY**

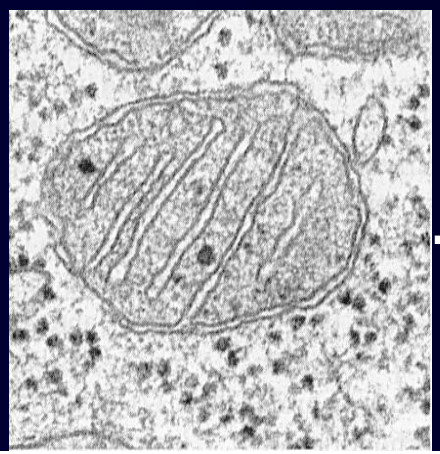
Two types of Cells

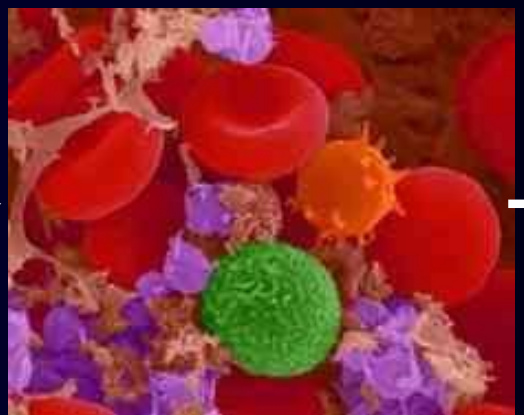


- **<u>Prokaryotic</u>**
  - NO nucleus
  - No membrane- bound *organelles*
  - Simpler, smaller, older
  - Bacteria and Archaea
- **<u>Eukaryotic</u>**
  - HAS a nucleus and membrane-bound organelles
  - More complex, larger, newer
  - Plants, Animal, Fungi, Protists
- Remember… both types have DNA, genes, and are ALIVE!

Defining Life

- Living things are organized:
  - Molecules (which are made of atoms)
  - Molecules → Organelles
  - Organelles → **Cells**
  - Cells → Tissues
  - Tissues → Organs
  - Organs → Organism





Defining Life

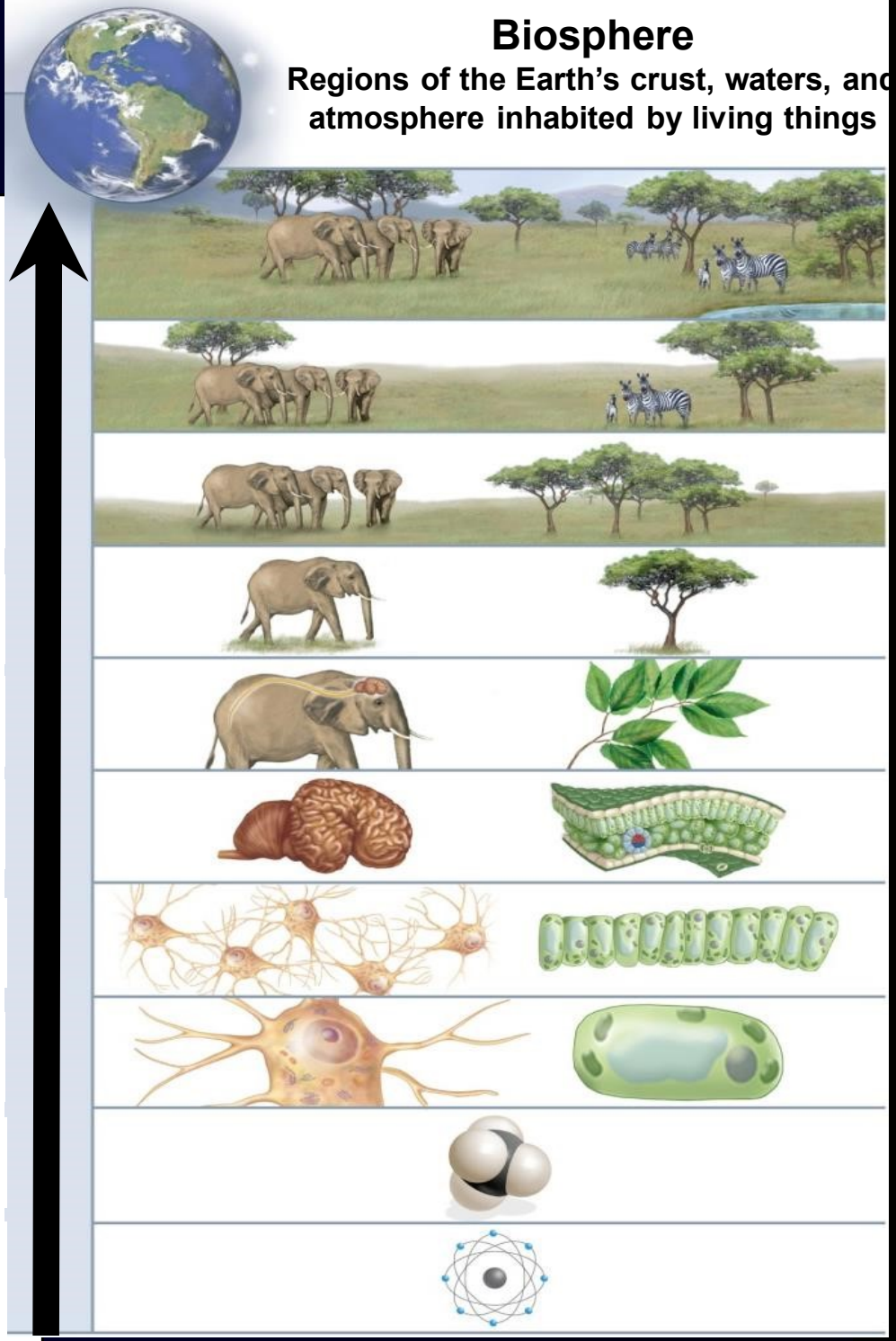
- Organization of Living things (cont.):
  - Organisms → Populations
  - Populations → Communities
  - Communities → **Ecosystems**
  - Ecosystems → Biosphere

Defining Life

- Each level of organization is more complex than the level preceding it : Each level of organization has Emergent Properties
  - ***Emergent properties***:
    - Interactions between the parts making up the whole
    - All emergent properties follow the laws of physics and chemistry

Levels of Biological Organization Fig 1.2

Biosphere
Regions of the Earth's crust, waters, and atmosphere inhabited by living things



Ecosystem
A community plus the physical environment

Community
Interacting populations in a particular area

Population
Organisms of the same species in a particular area

Organism
An individual; complex individuals contain organ systems

Organ System
Composed of several organs working together

Organ
Composed of tissues functioning together for a specific task

Tissue
A group of cells with a common structure and function

Cell
The structural and functional unit of all living things

Molecule
Union of two or more atoms of the same or different elements

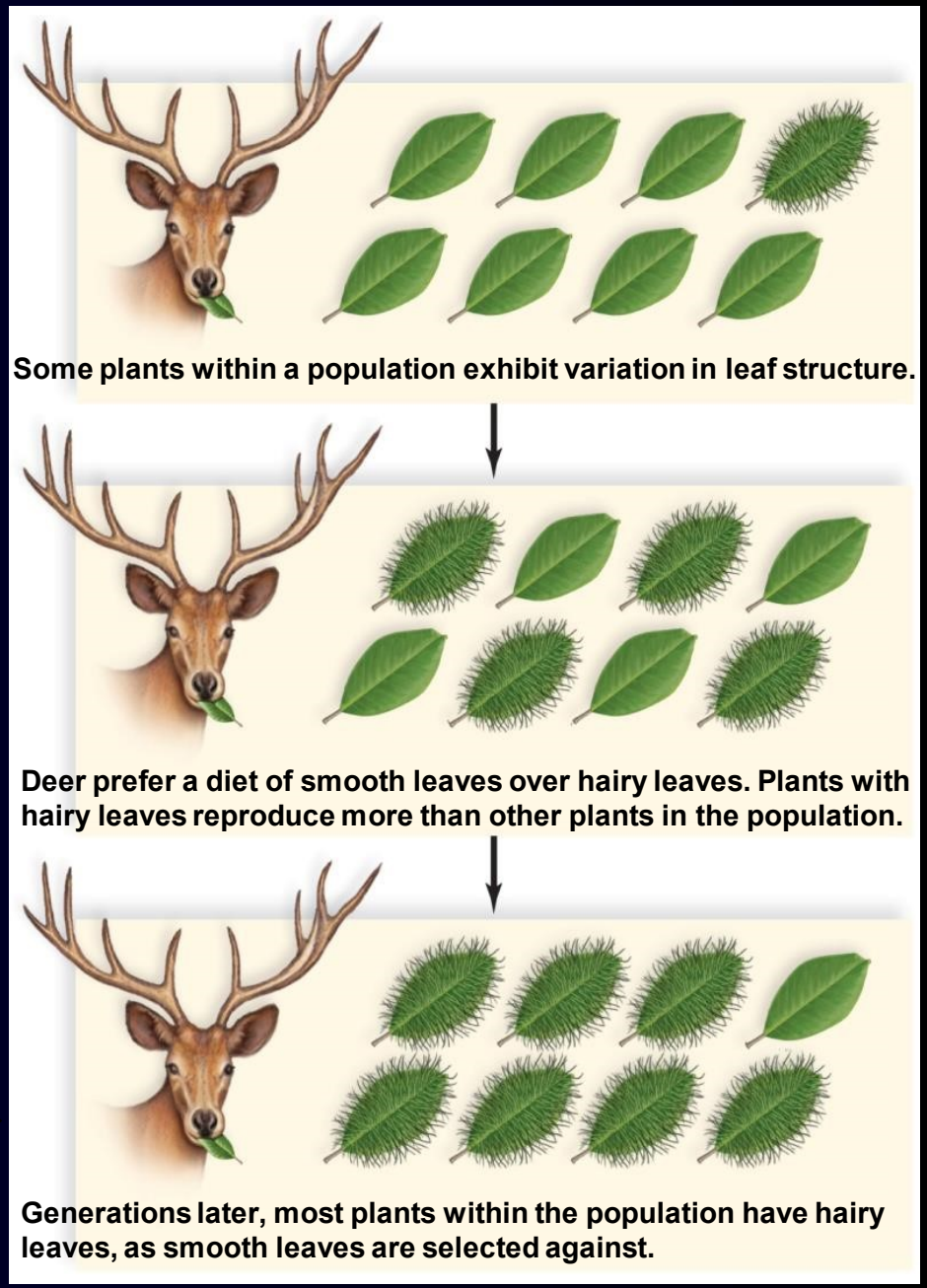
Atom
Smallest unit of an element composed of electrons, protons, and neutrons

Living Things Are:

- **Organized ✓**
- **Energetic** – Living things **Acquire & Process Food** required to maintaining organization and conducting life-sustaining processes
- **Responsive** Living things **interact** with the environment and **respond** to changes in the environment
- **Reproductive**: Living things **Reproduce and Develop**
- **Adapted :** Living things respond to environmental changes by developing new **adaptations**

Adaptation

- Any modification that makes an organism more suited to its way of life
- However, organisms very similar at basic level
  - Suggests living things descended from same ancestor
  - Descent with modification - **Evolution**
  - Caused by **natural selection**



Evolution, the Unifying Concept of Biology

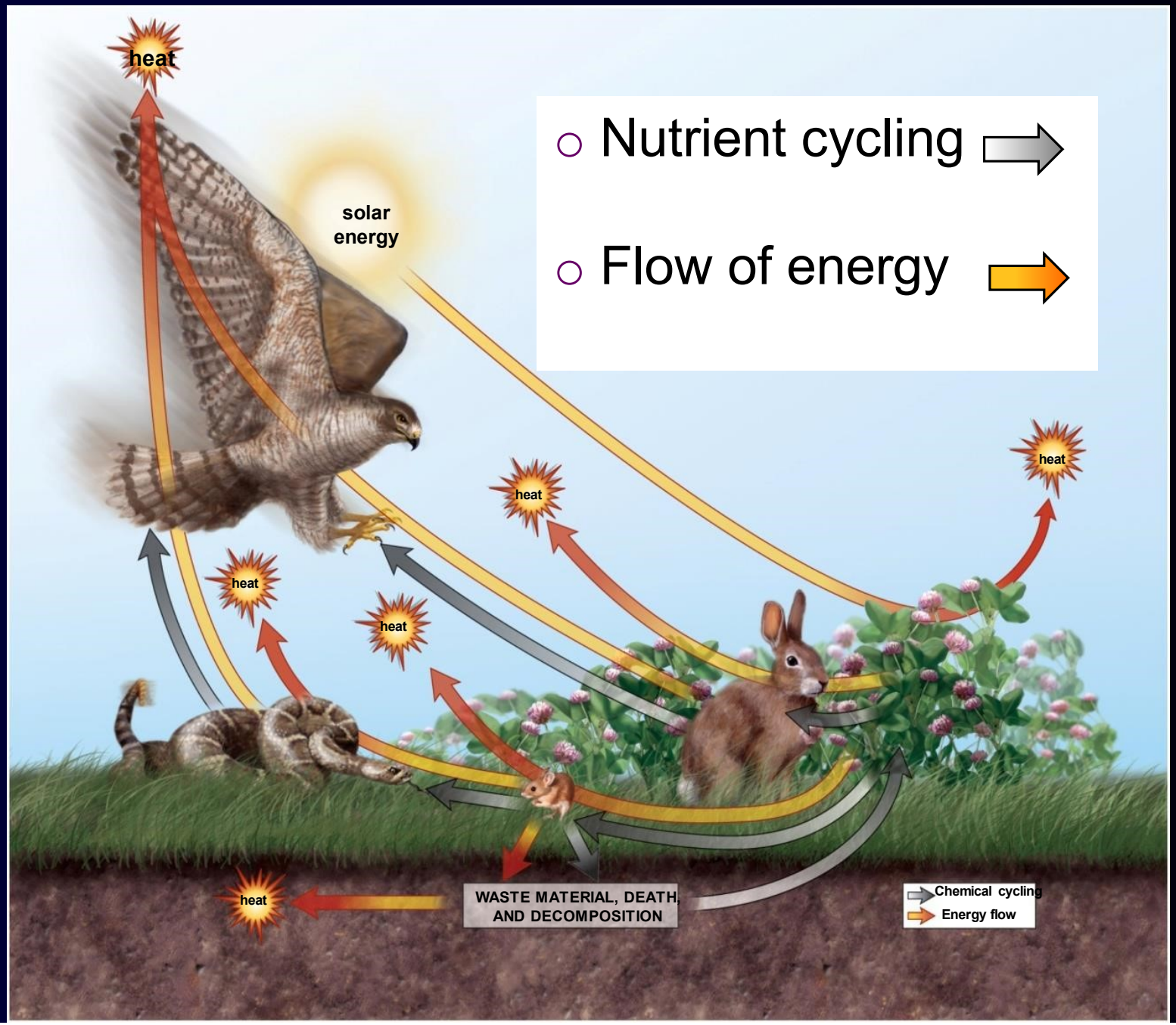
- Despite diversity, organisms share the same basic characteristics
  - Composed of cells organized in a similar manner
  - Their genes are composed of DNA
  - Carry out the same metabolic reactions to acquire energy
- This suggests that they are descended from a **common ancestor**

Organization of the Biosphere

Biosphere - zone of air, land, and water where organisms exist

- **Population** - Members of a species within an area
- **Community** - A local collection of interacting populations
- **Ecosystem** – A community plus its physical environment
    - How chemicals are cycled and re-used by organisms
    - How energy flows, from photosynthetic plants to top predators

Ecosystems: Two major dynamic processes



- Nutrient cycling
- Flow of energy

Classification

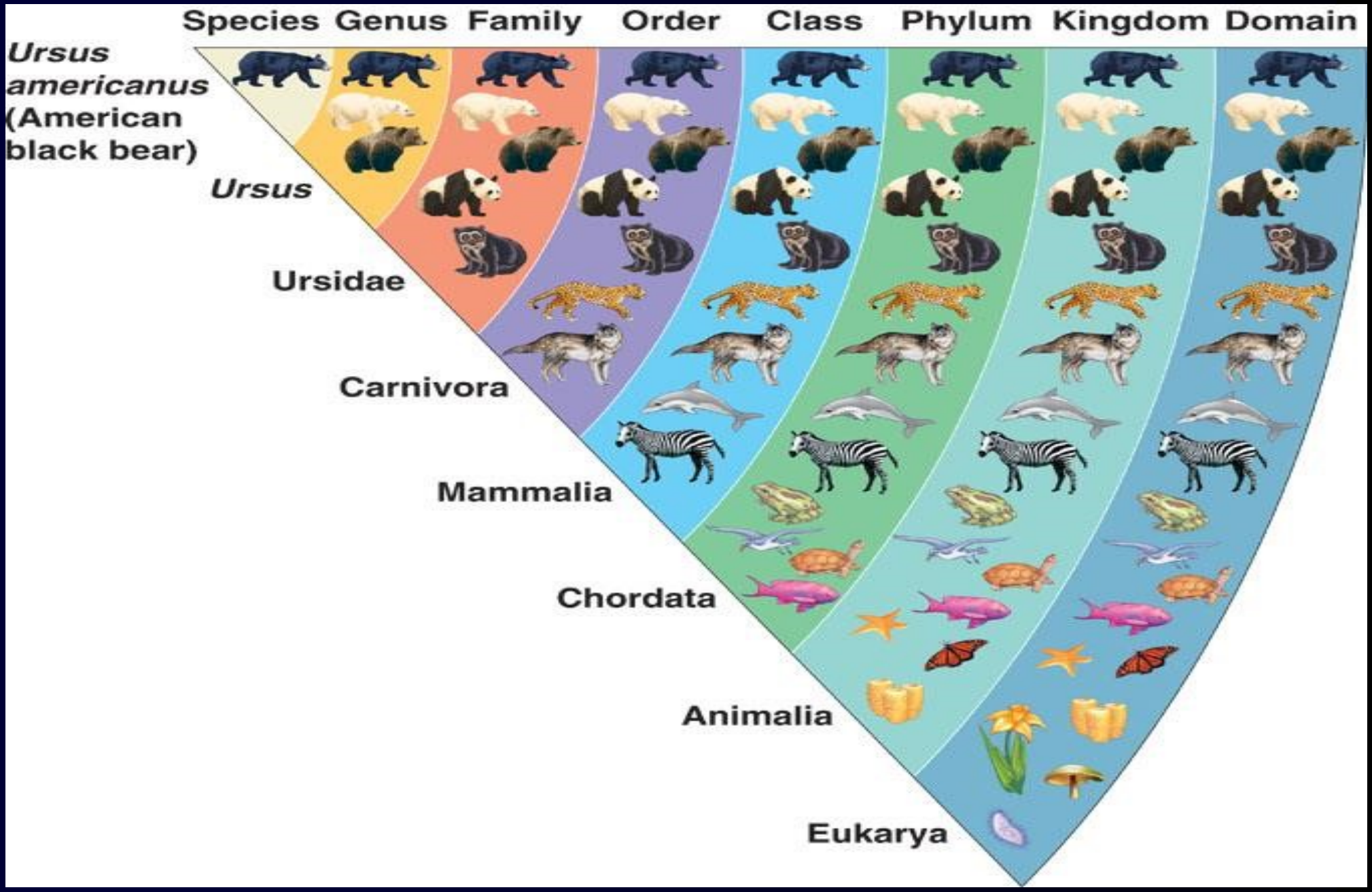
- **Biodiversity** is the total number of species, the variability of their genes, and the communities in which they live.
  - Abundance of species estimated about 15 million.
  - 2 million species have been identified and named

- **Taxonomy**:
  - Discipline of identifying and classifying organisms according to certain rules
  - Hierarchical levels (taxa) based on hypothesized evolutionary relationships

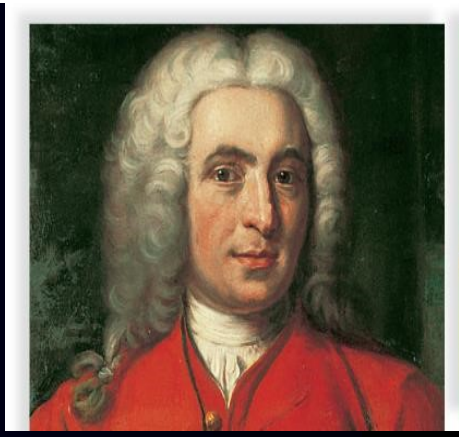
Classification Categories

- Modern taxonomists use the following classification:
  - Domain – (Prokaryote, Archea, Eukaryote)
  - Domain – one or more kingdoms
  - Kingdom – one or more phyla
  - Phylum – one or more classes
  - Class – one or more orders
  - Order – one or more families
  - Family – one or more genera
  - Genus – one or more species
  - Species – most specific
  - Dear - Kids – Play – Chess – On – Funny – Green- Squares
- Levels of classification are from most inclusive to least inclusive:
  - A level (e.g. phylum) includes more species than the level below it (e.g. class), and fewer species than the one above it (e.g. kingdom)

Example: Taxonomy of Bears



Taxonomy: Binomial System



- Mid-eighteenth century, **Linnaeus** developed the **binomial system of nomenclature**
- Universal
- Latin-based
  - First word represents **genus** of organism e.g. *Homo*
  - Second word is **specific epithet** of a species within the genus e.g. *Sapiens*
  - Always italicized as a *Genus species* (*Homo sapiens*)
  - Genus may be abbreviated e.g. *H. sapieans* or *Escherichia Coli as E. Coli*
  - Genus name can be used alone to refer to a group of related species → *Ursus* - Brown bear

Levels of Classification

TABLE 1.1

Levels of Classification

Category	*Human*	*Corn*
Domain	Eukarya	Eukarya
Kingdom	Animalia	Plantae
Phylum	Chordata	Anthophyta
Class	Mammalia	Monocotyledones
Order	Primates	Commelinales
Family	Hominidae	Poaceae
Genus	*Homo*	*Zea*
Species*	*H. sapiens*	*Z. mays*

*To specify an organism, you must use the full binomial name, such as *Homo sapiens*.

Scientific Names

- **Binomial nomenclature** (two-word names)- used to assign each organism with two part name e.g. *Homo Sapiens*
- Universal
- Latin-based
  - First word represents **genus** of organism e.g. *Homo*
  - Second word is **specific epithet** of a species within the genus e.g. *Sapiens*
  - Always italicized as a *Genus species* (*Homo sapiens*)
  - Genus may be abbreviated e.g. *Escherichia Coli as E. Coli*

Domains

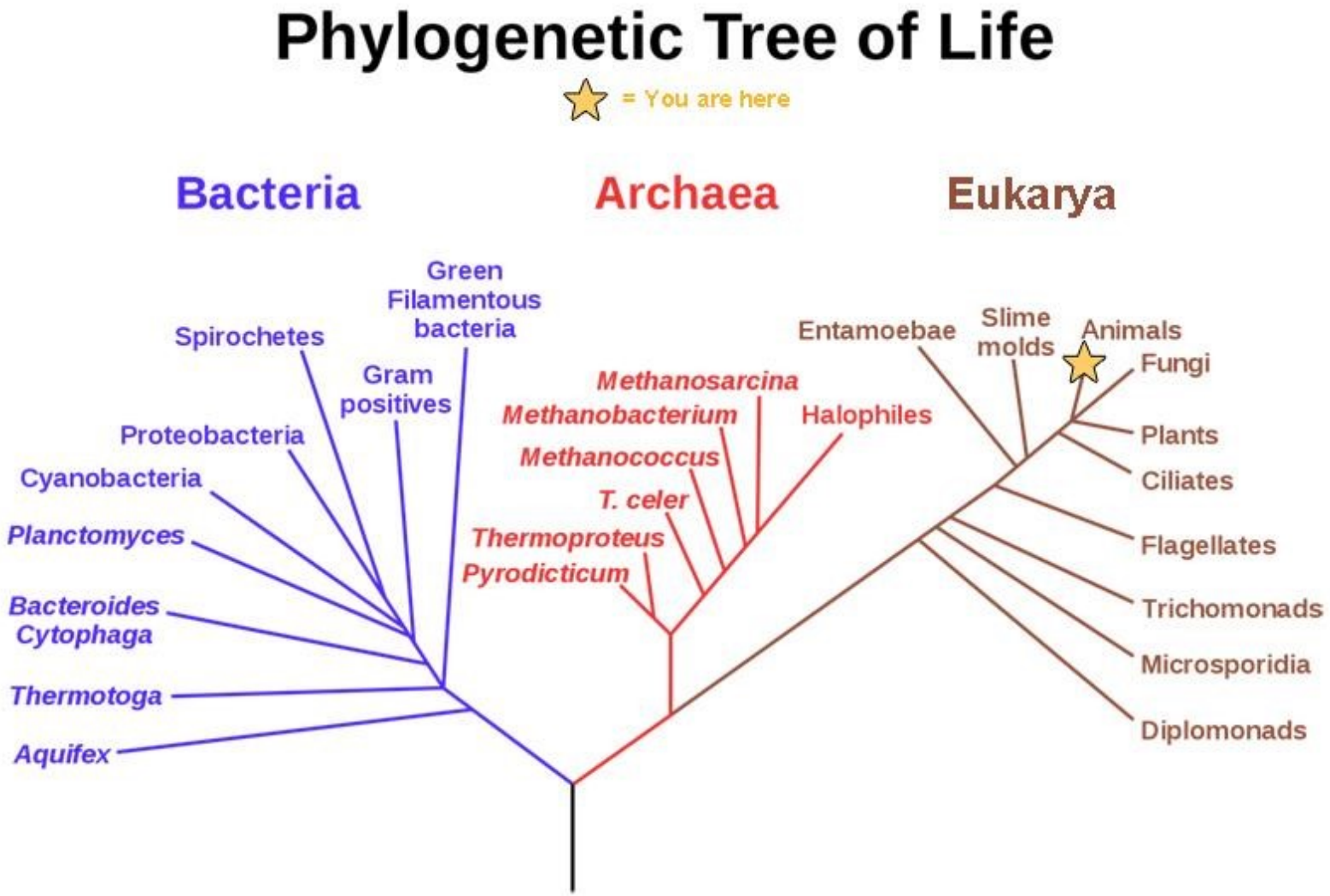
- Bacteria
  - Microscopic unicellular prokaryotes
  - Kingdoms still being worked out

Escherichia coli, a bacterium

- Archaea
  - Bacteria-like unicellular prokaryotes
  - Extreme aquatic environments
  - Kingdoms still being worked out

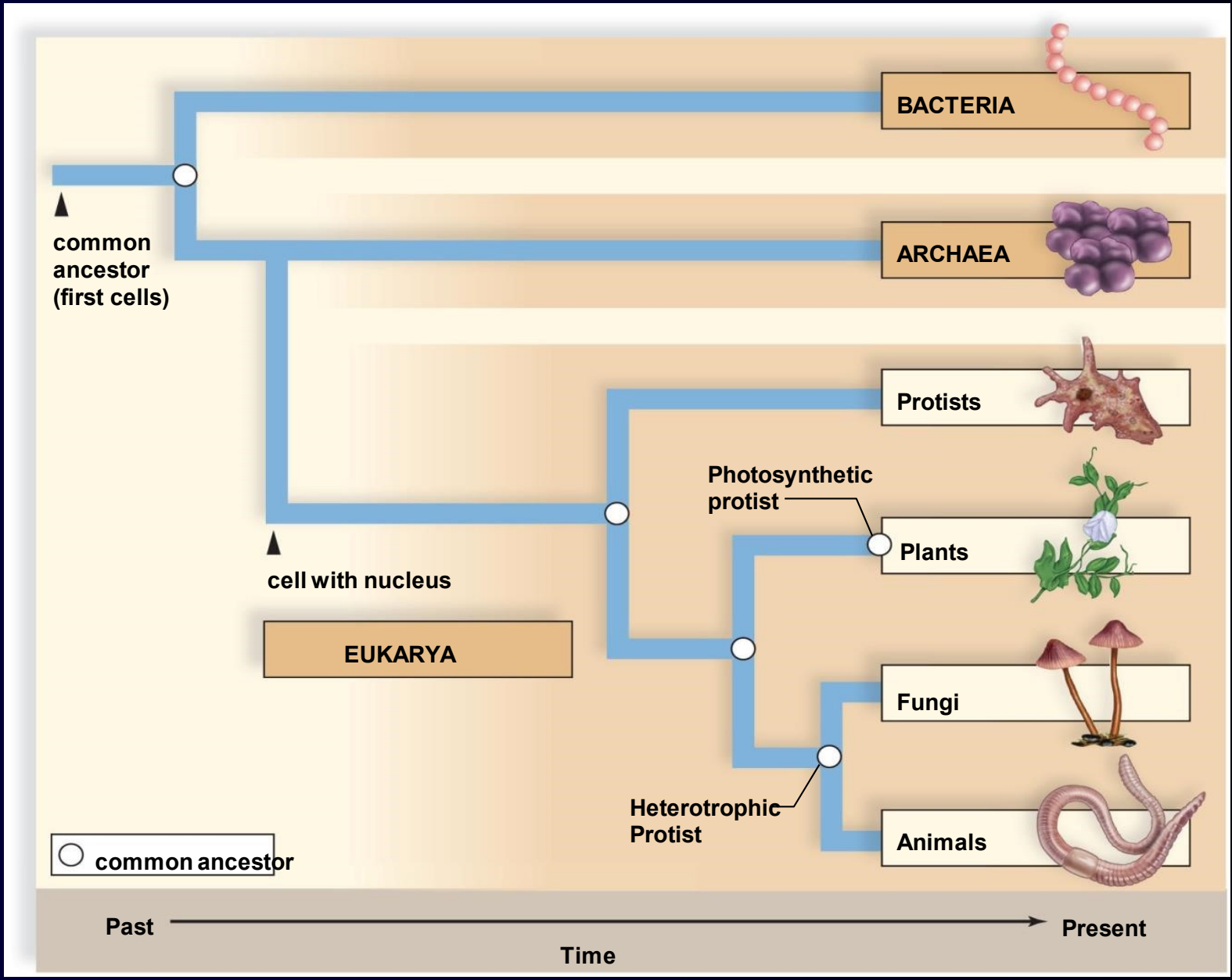
Methanosarcina mazei, an archaeon

- Eukarya
  - Eukaryotes – Familiar organisms
  - Four kingdoms: Protista, Plantae, Fungi, Animalia



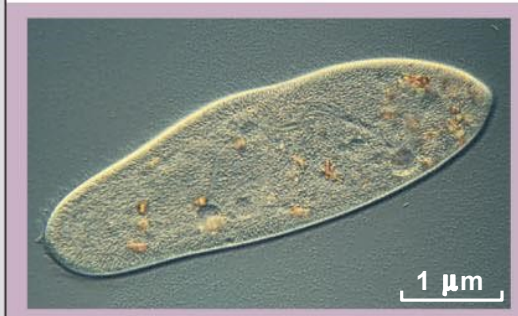
https://en.wikipedia.org/wiki/Timeline_of_the_evolutionary_history_of_life

Evolutionary Tree of Life



The Eukaryote Kingdoms

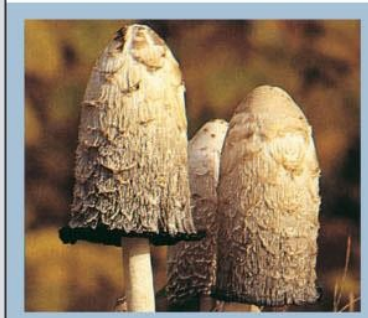
Protists



Paramecium, a unicellular protozoan

- Algae, protozoans, slime molds, and water molds
- Complex single cell (sometimes filaments, colonies, or even multicellular)
- Absorb, photosynthesize, or ingest food

KINGDOM: Fungi



Coprinus, a shaggy mane mushroom

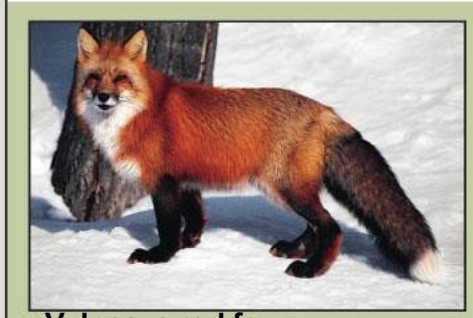
- Molds, mushrooms, yeasts, and ringworms
- Mostly multicellular filaments with specialized, complex cells
- Absorb food1

KINGDOM: Plants

Passiflora, passion flower, a flo

- Certain algae, mosses, ferns, conifers, and flowering plants
- Multicellular, usually with specialized tissues, containing complex cells
- Photosynthesize food

KINGDOM: Animals



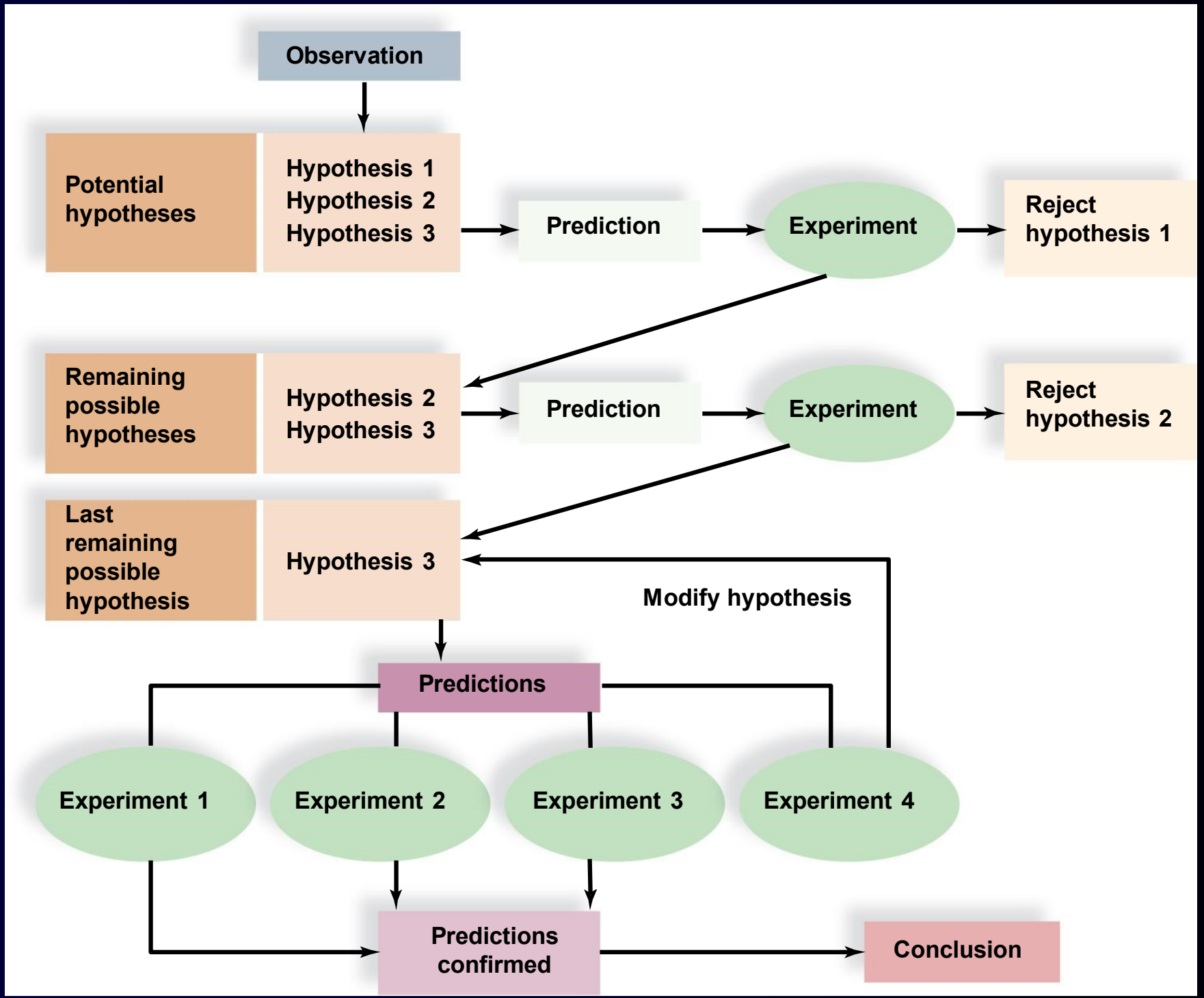
Vulpes, a red fox

- Sponges, worms, insects, fishes, frogs, turtles, birds, and mammals
- Multicellular with specialized tissues containing complex cells
- Ingest food

The Scientific Method

- Scientific method is a standard series of steps in gaining new knowledge through research.

1. Begins with **observation**
2. **Hypothesis**
   - A tentative explanation for what was observed, developed through inductively reasoning to combine isolated facts into a cohesive whole
3. **Experimentation**
   - Purpose is to challenge the hypothesis. Designed through deductively reasoning from general to specific ("if, then" logic)
   - **control group** and an **experimental group**
4. **Results or Data**
5. The results are **analyzed** and **interpreted**
6. **Conclusions** are what the scientist thinks caused the



Scientific Theory

- **Scientific Theory:**
  - Joins together two or more related hypotheses
  - Supported by broad range of observations, experiments, and data
- **Scientific Principle / Law:**
  - Widely accepted set of theories
  - No serious challenges to validity

Themes that Unify Biology

- **Evolution** ~ *biology's core theme; differential reproductive success*
- **Emergent Properties** ~ *hierarchy of life*
- **The Cell** ~ *all organism's basic structure*
- **Heritable Information** ~ *DNA*
- **Structure & Function** ~ *form and function*
- **Environmental Interaction** ~ *organisms are open systems*
- **Regulation** ~ *feedback mechanisms*
- **Energy & Life** ~ flow of energy from sunlight to producers then consumers
- **Unity & Diversity** ~ *universal genetic code*
- **Scientific Inquiry** ~ *observation; testing; repeatability*
- **Science, Technology & Society** ~ *functions of our world*