

Lecture 2

Organizing the Diversity of Life

Organizing the Diversity of Life

- Approximately **1.8 million species** have been identified and named to date, and thousands more are identified each year.
 - Estimates of the total number of species that actually exist range from 10 million to over 100 million.
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Grouping Species: The Basic Idea

- **Taxonomy** is the branch of biology that names and classifies species into groups of increasing breadth.
 - A **taxonomic hierarchy** is a system for classifying and organizing living organisms into a series of ranked categories, from the broadest (Domain) to the most specific (Species), to show their relationships and similarities
 - Domains, followed by kingdoms, are the broadest units of classification
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Species Genus Family Order Class Phylum Kingdom Domain

americanus

(American black bear)

Ursus

Ursidae

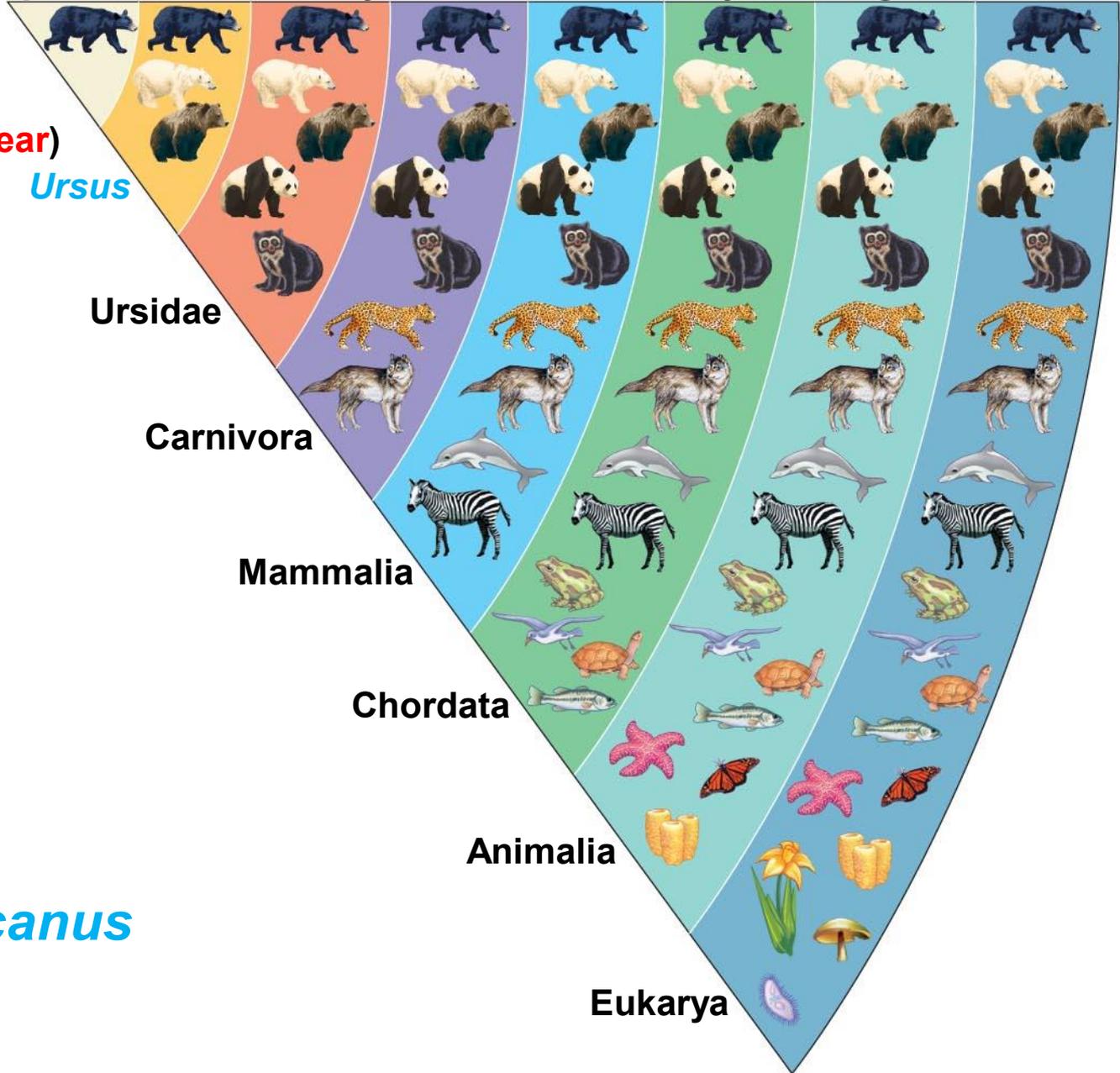
Carnivora

Mammalia

Chordata

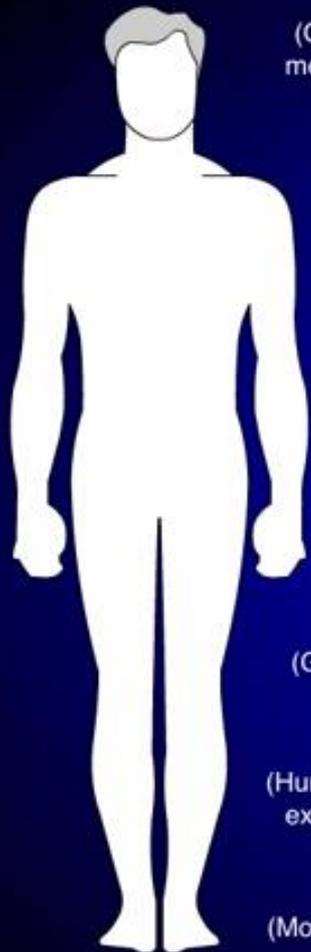
Animalia

Eukarya



Ursus americanus

Homo sapiens



(Organisms with membrane-bound nucleus)

Eukarya

المجال Domain

(Animals)

Animalia

المملكة Kingdom

(Have a backbone)

Chordata

الشعب Phylum

(Have fur & give milk)

Mammalia

فئات Class

(Have nails, short snouts, large brains)

Primate

الرتبة Order

(Great Apes)

Hominidae

العائلة Family

(Humans & related extinct species)

Homo

الجنس Genus

(Modern humans)

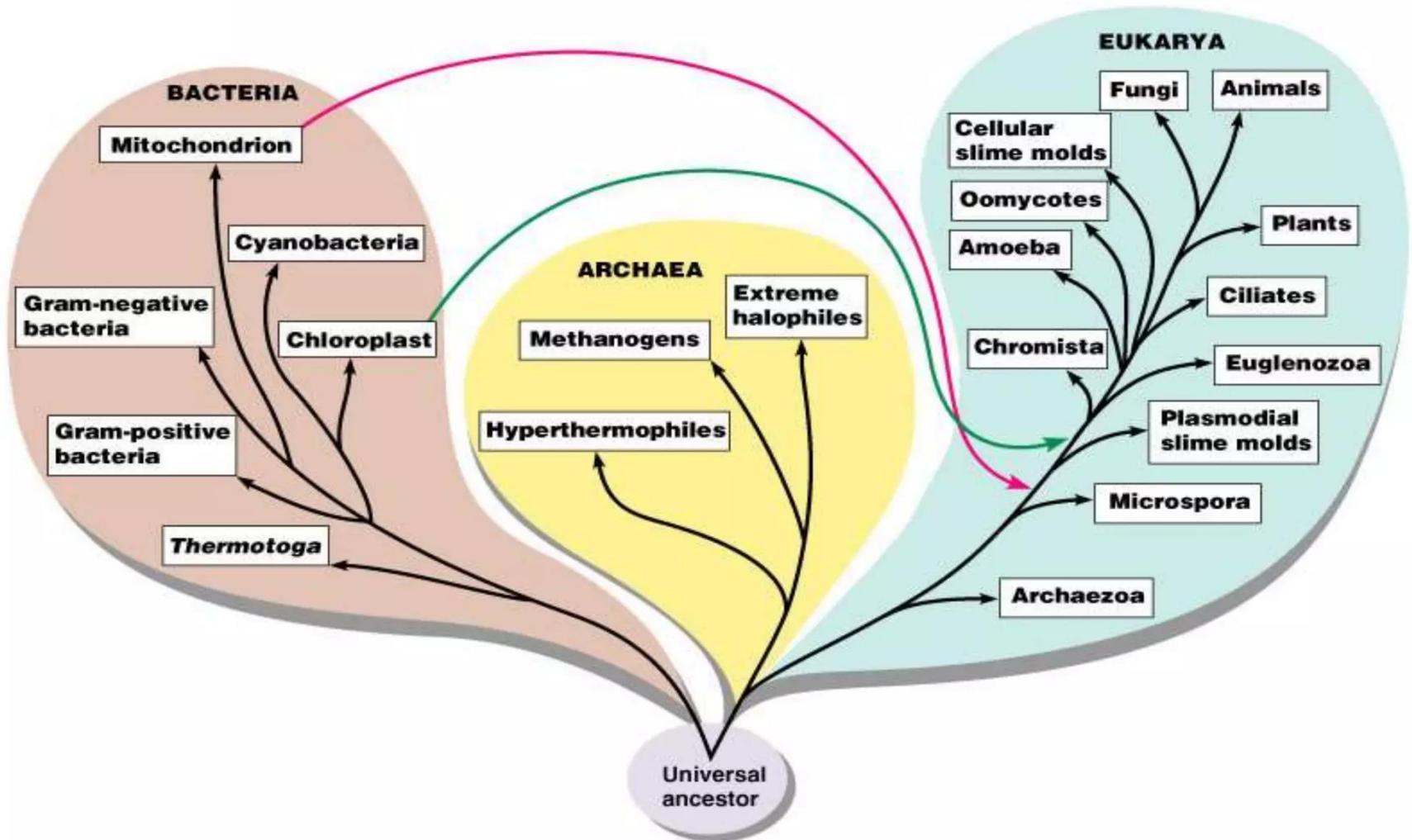
sapiens

نوع Species

The Three Domains of Life

- The three-domain system is currently used, and replaces the **old five-kingdom system** which are: animal, plant, fungi, protist, and monera.
 - **Domain Bacteria**
 - **Domain Archaea** comprise the prokaryotes
 - **Domain Eukarya** includes all eukaryotic organisms
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The Three Domains



Five Kingdom System

1. Animalia
2. Plantae
3. Fungi
4. Protista
5. Monera



SIX Kingdom System



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- The domain **Eukarya** includes three multicellular kingdoms:
 - Plantae
 - Fungi
 - Animalia
 - Other eukaryotic organisms were formerly grouped into a kingdom called **Protista**, though these are now often grouped into many separate kingdoms
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Protists

- **Producers, consumers, decomposers.**
- Are simple eukaryotic organisms that are neither plants nor animals or fungi.
- Are unicellular in nature but can also be found as a colony of cells.
- Most protists live in water, damp terrestrial environments or even as parasites (*Amoeba*).
- Example:
 - **Protozoans** are unicellular organisms.
 - Historically, protozoans were called “animal”protists showed animal-like behaviours.

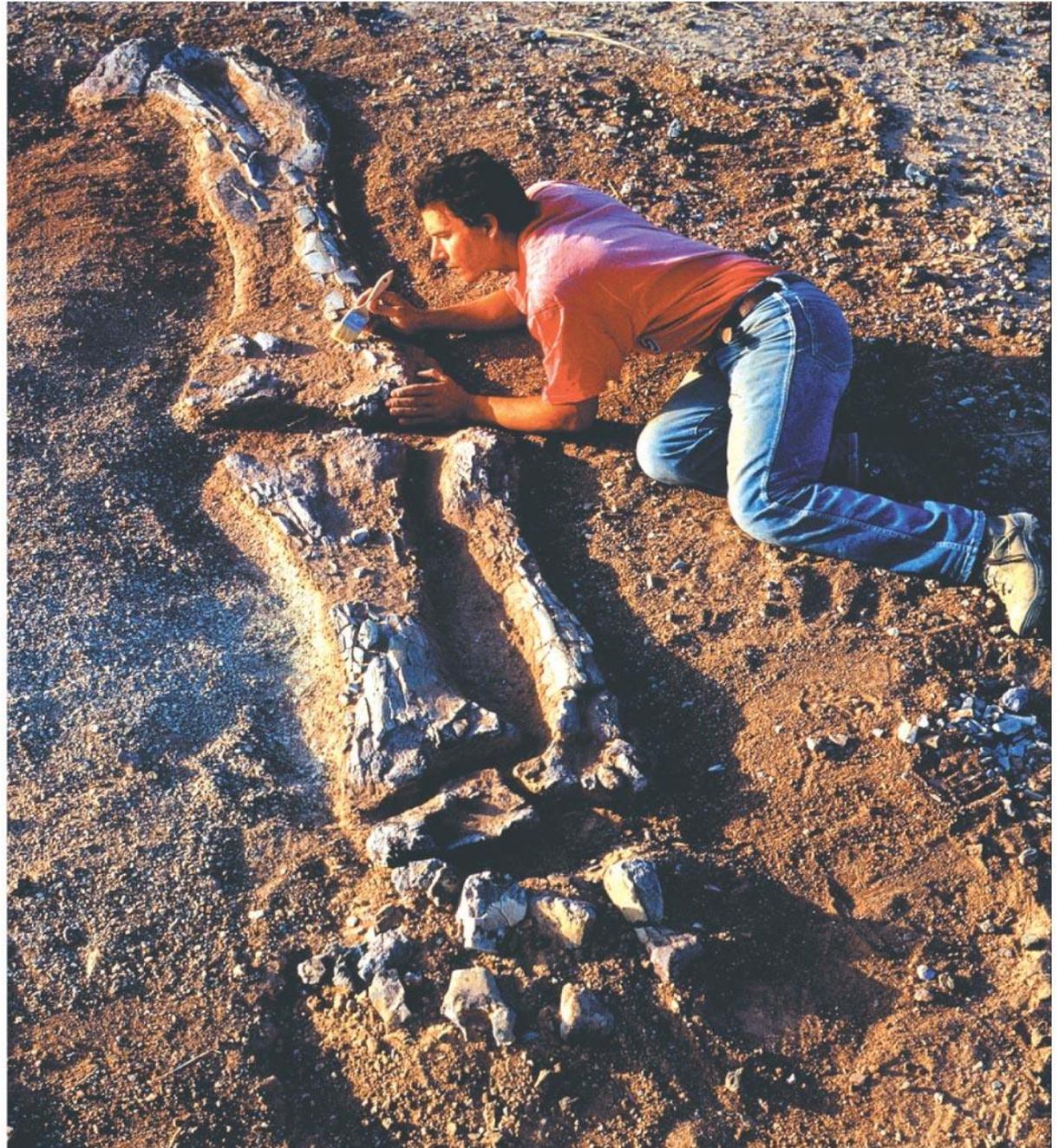
Unity in the Diversity of Life

- **Evolution** explains both **unity**(shared traits) and **diversity** (adaptation).
 - ✓ **Unity**: all organisms share DNA as genetic materials and similar cellular structure.
 - ✓ **Diversity**: differences arise from adaptation to specific environments.
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Charles Darwin and the Theory of Natural Selection

- **Fossils** and other evidence document the evolution of life on Earth over billions of years

Digging into the past



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- Charles Darwin published *On the Origin of Species by Means of Natural Selection* in 1859
 - Darwin made two main points:
 - Species showed evidence of “descent with modification” from common ancestors
 - Natural selection is the mechanism behind “descent with modification”
 - Darwin’s theory explained the duality of unity and diversity
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- Darwin observed that:
 - Individuals in a population have traits that vary
 - Many of these traits are heritable (passed from parents to offspring)
 - More offspring are produced than survive
 - Competition is inevitable
 - Species generally suit their environment
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- Darwin inferred that:
 - Individuals that are best suited to their environment are more likely to survive and reproduce.
 - Over time, more individuals in a population will have the advantageous traits.
 - In other words, the natural environment “selects” for beneficial traits
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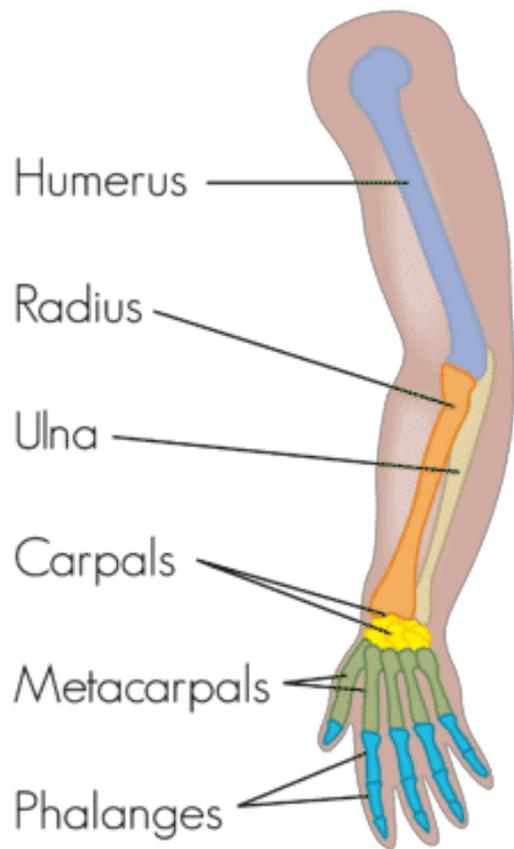
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- Natural selection is often evident in adaptations of organisms to their way of life and environment
 - Bat wings are an example of adaptation during **Eocene** before 60 mys.
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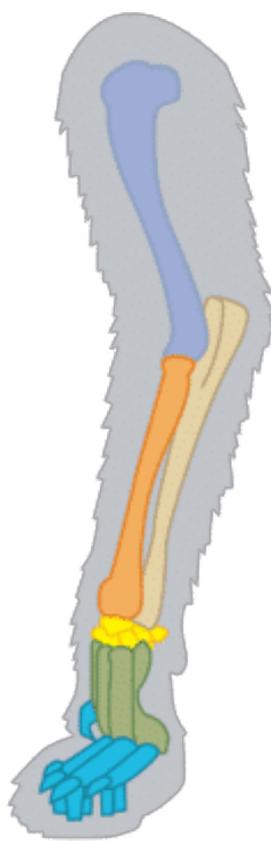
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The Tree of Life

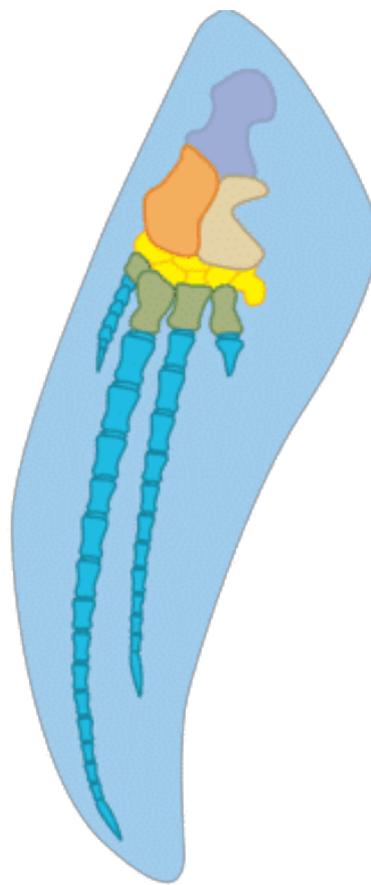
- “Unity in diversity” arises from “descent with modification”
 - For example, the forelimb of the bat, human, horse and the whale flipper all share a common skeletal architecture
 - Fossils provide additional evidence of anatomical unity from descent with modification
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HUMAN



CAT

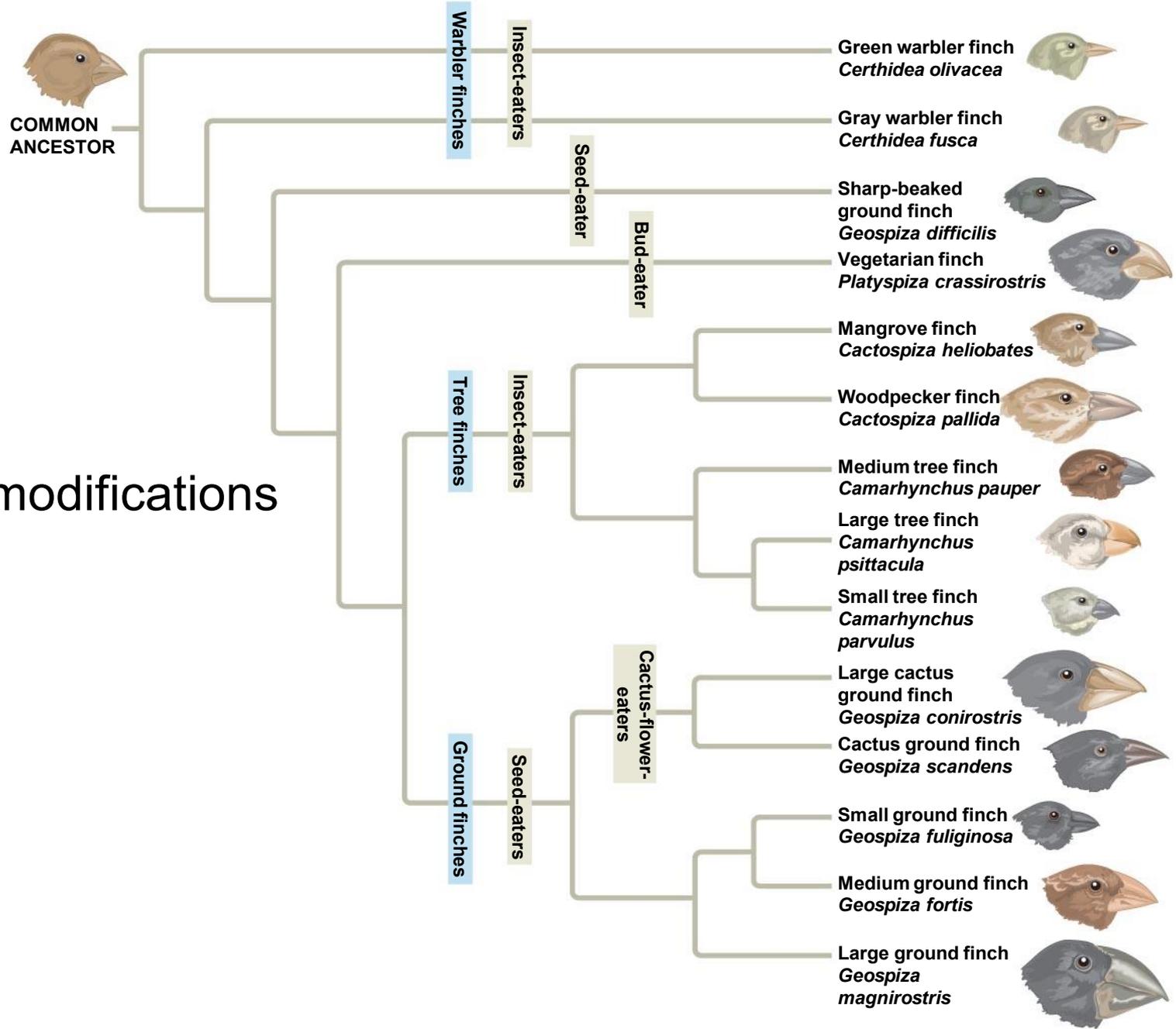


WHALE



BAT

Beak modifications



Scientists use two main forms of inquiry in their study of nature

- The word *Science* is derived from Latin and means “to know”
 - **Inquiry** is the search for information and explanation
 - There are two main types of scientific inquiry: **discovery science** and **hypothesis-based science**
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Discovery Science

- **Discovery science** describes natural structures and processes. Like DNA structure and Gravity.
 - This approach is based on observation and the analysis of data
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Types of Data

- **Data** are recorded observations or items of information
 - Data fall into two categories
 - ***Qualitative***, or descriptions rather than measurements
 - ***Quantitative***, or recorded measurements, which are sometimes organized into tables and graphs
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Hypothesis-Based Science

- Observations can lead us to ask **questions** and **propose hypothetical explanations** called **hypotheses**

The Role of Hypotheses in Inquiry

- A **hypothesis** is a tentative answer to a well-framed question
 - A scientific hypothesis leads to predictions that can be tested by observation or experimentation
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- For example,
 - Observation: Your flashlight doesn't work
 - Question: Why doesn't your flashlight work?
 - Hypothesis 1: The batteries are dead
 - Hypothesis 2: The bulb is burnt out
 - Both these hypotheses are testable
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Observations



Question



**Hypothesis #1:
Dead batteries**

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

**Hypothesis #1:
Dead batteries**

**Prediction:
Replacing batteries
will fix problem**



Test prediction



Test falsifies hypothesis

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

**Prediction:
Replacing bulb
will fix problem**



Test prediction



Test does not falsify hypothesis

Deduction: The “If...Then” Logic of Hypothesis Based Science

- **Deductive reasoning** uses general premises to make specific predictions
 - For example, *if* organisms are made of cells (premise 1), and humans are organisms (premise 2), *then* humans are composed of cells (deductive prediction)
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Theories in Science

- In the context of science, a **theory** is:
 - Broader in scope than a hypothesis
 - General, and can lead to new testable hypotheses
 - Supported by a large body of evidence in comparison to a hypothesis
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Science, Technology, and Society

- The goal of **science** is to understand natural phenomena
 - The goal of **technology** is to *apply* scientific knowledge for some specific purpose
 - Science and technology are interdependent
 - Biology is marked by “discoveries,” while technology is marked by “inventions”
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- The combination of science and technology has dramatic effects on **society**
 - For example, the discovery of DNA by James Watson and Francis Crick allowed for advances in DNA technology such as testing for hereditary diseases
 - Ethical issues can arise from new technology, but have as much to do with politics, economics, and cultural values as with science and technology
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