Diversity of life – Ordering Life in the Biosphere

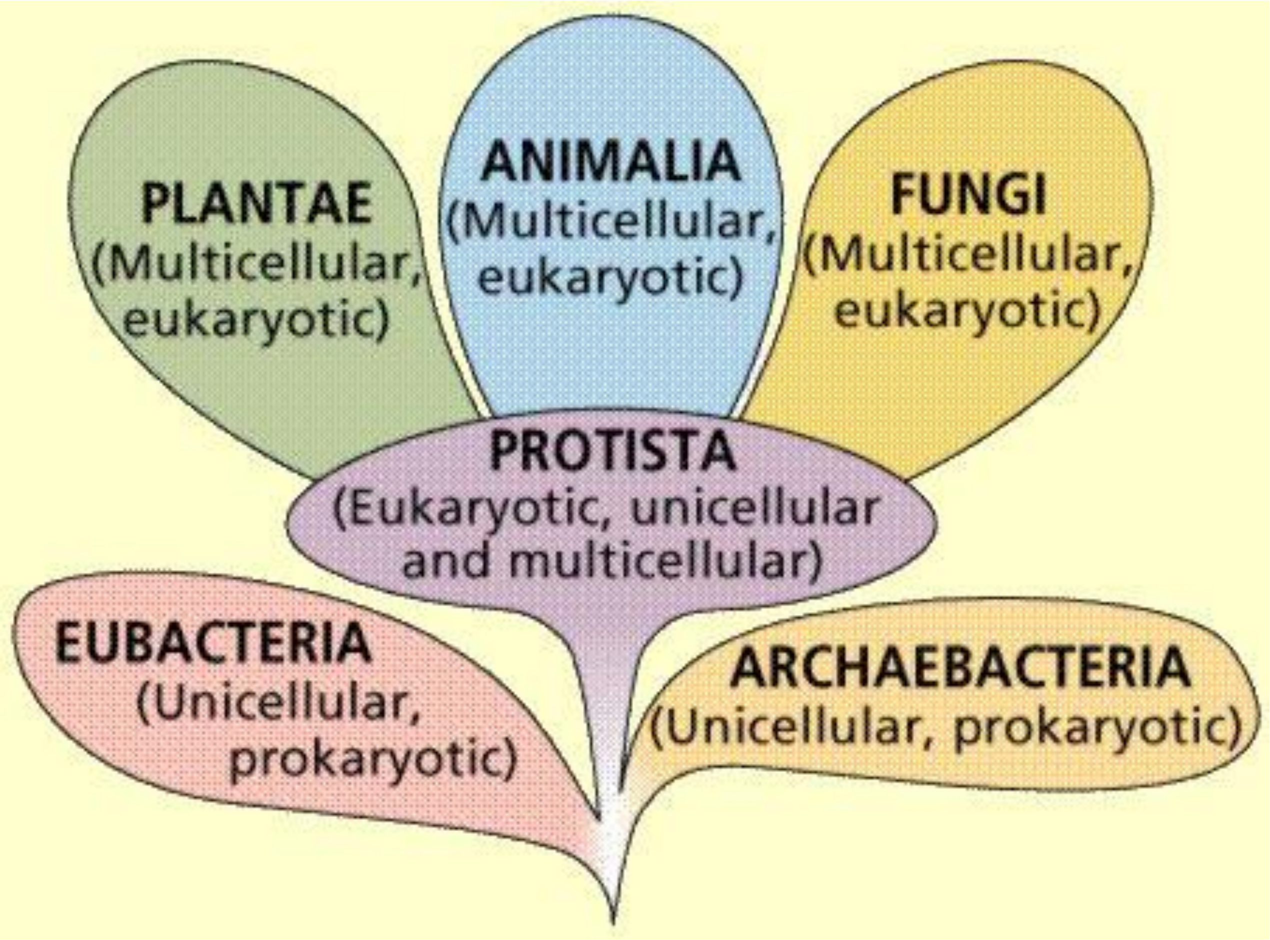
A. Classification Is a Way of Seeing Order in Diversity

1. Definitions:
   a. Diversity: Variation or differences between objects or life.

   b. Classification: Placing items into different groups based on similarities and differences.

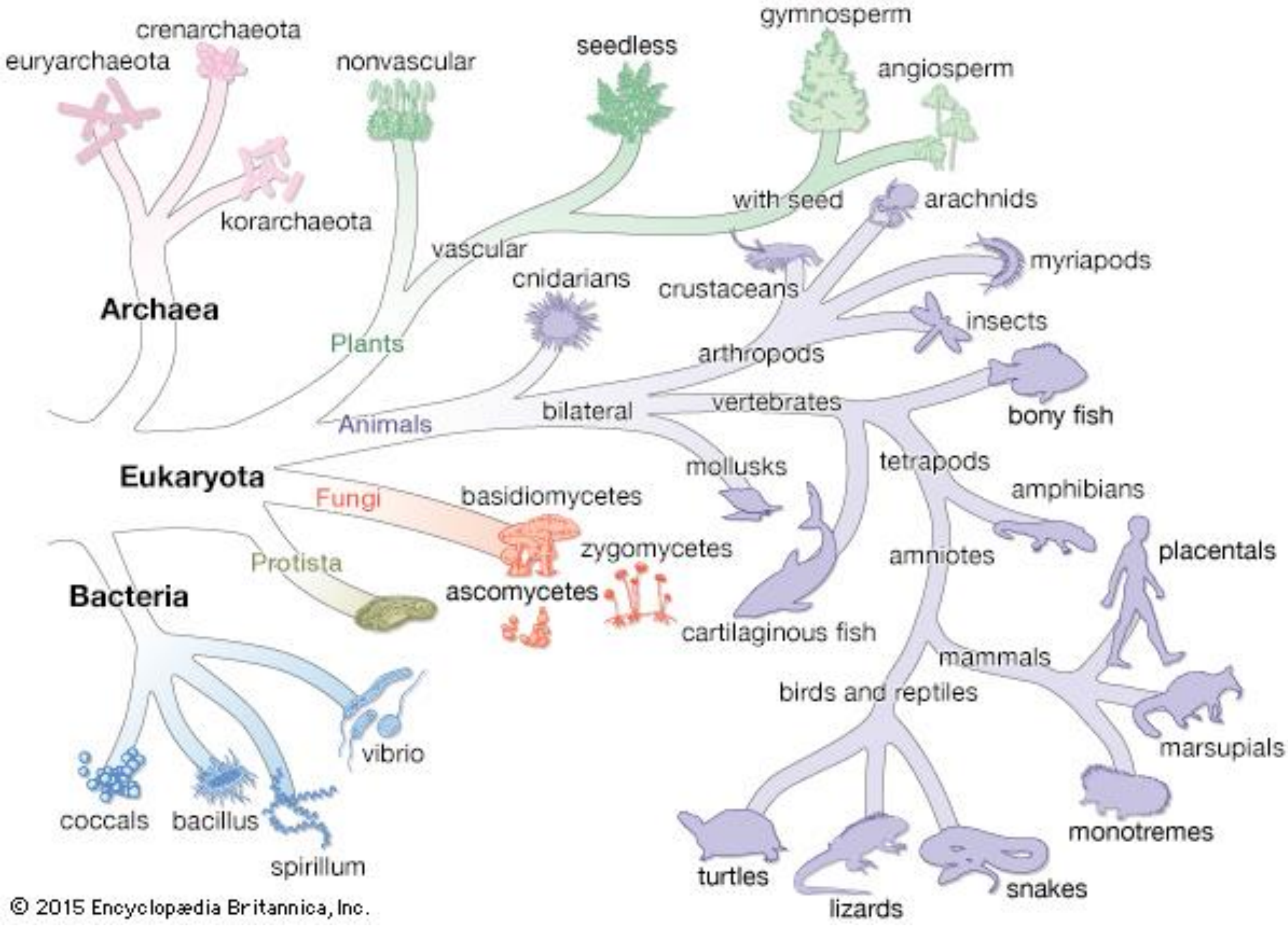
   c. Taxonomy: Classification of life according to similarities.

2. Why Classify Objects?
   a. Makes information more organized and easier to understand.
      - Are mammals more closely related to fish, birds or reptiles?


PLANTAE
(Multicellular, eukaryotic)
ANIMALIA
(Multicellular, eukaryotic)
FUNGI
(Multicellular, eukaryotic)
PROTISTA
(Eukaryotic, unicellular and multicellular)
EUBACTERIA
(Unicellular, prokaryotic)
ARCHAEBACTERIA
(Unicellular, prokaryotic)

   b. By knowing how organisms are related, we can understand our ancestry and how organisms have and are evolving on earth.

3. Tree of Life


euryarchaeota
crenarchaeota
korarchaeota
Archaea
nonvascular
seedless
gymnosperm
angiosperm
with seed
vascular
Plants
arachnids
crustaceans
myriapods
insects
arthropods
cnidarians
bilateral
vertebrates
Animals
bony fish
mollusks
tetrapods
amphibians
Eukaryota
Fungi
basidiomycetes
zygomycetes
ascomycetes
Protista
Bacteria
amniotes
placentals
cartilaginous fish
mammals
birds and reptiles
marsupials
vibrio
coccals
bacillus
spirillum
monotremes
turtles
lizards
snakes

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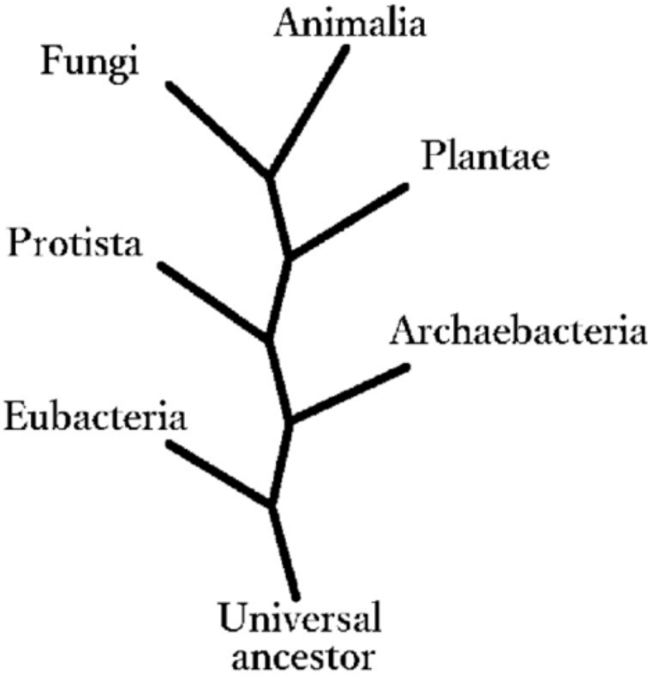
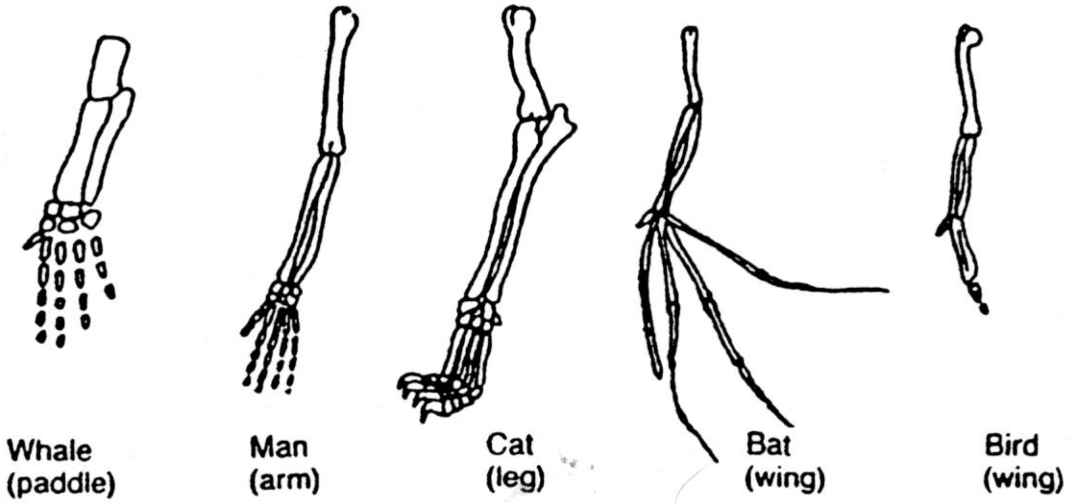

Animalia
Fungi
Plantae
Protista
Archaebacteria
Eubacteria
Universal ancestor

B. Classification is Based on Homologies

1. Homology: similarities based on having common ancestors.

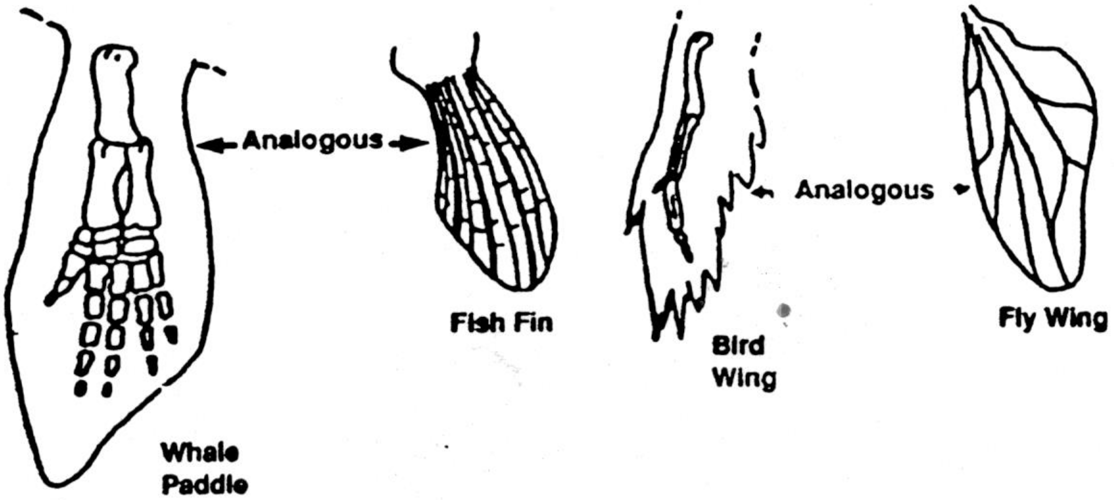
2. Scientists consider homologies such as:
    a. structure
    b. nutrition
    c. biochemistry
    d. embryonic development
    e. cellular and molecular make-up
    f. evolutionary histories
    g. behaviour
    h. ecological interactions

3. Homologous Structures: Structures with common (same) ancestry, but with different uses in various species.


Whale (paddle)
Man (arm)
Cat (leg)
Bat (wing)
Bird (wing)

Homologous organs

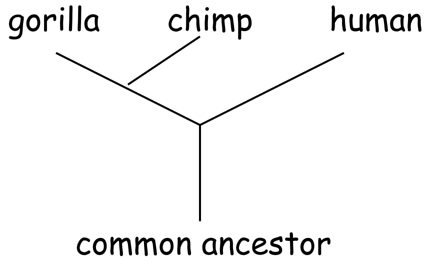
4. Analogous Structures: Structures with similar functions, but without common ancestry.



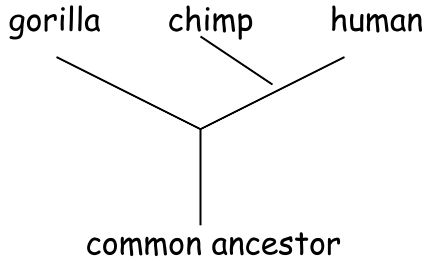
5. Biochemical Homologies: Similarities in biochemical molecules such as proteins, nucleic acid (DNA) and enzymes. For example, the greater the similarities in DNA, the more closely related the two organisms are.

6. Biochemical homologies have changed how scientists see the relatedness of some organisms. There are more DNA similarities between humans and chimps than there are between gorillas and chimps. This suggests humans are the chimps closest evolutionary relative and not gorillas as was originally thought based on appearance (structural homologies).

Relatedness between chimps and gorillas based on structural homologies.



Relatedness between chimps and gorillas based on biochemical homologies.



C. Early Classification

1. Early Humans
   - Good plants and animals
   - Bad plants and animals

2. Aristotle

   Plants
   - Herbs (soft stem)
   - Shrubs (woody stem)
   - Trees (woody trunk)

   Animals
   - Land dwellers (terrestrial)
   - Water dwellers (aquatic or marine)
   - Air dwellers (aerial)

3. John Ray (England 1627 – 1705)
   - Was the first to include the idea of species.

4. Carolus Linnaeus (Sweden 1707 – 1778)
   - He recognized species as the basis of natural grouping. The key to his system was structural similarity. Credited with the modern scientific binomial naming system.

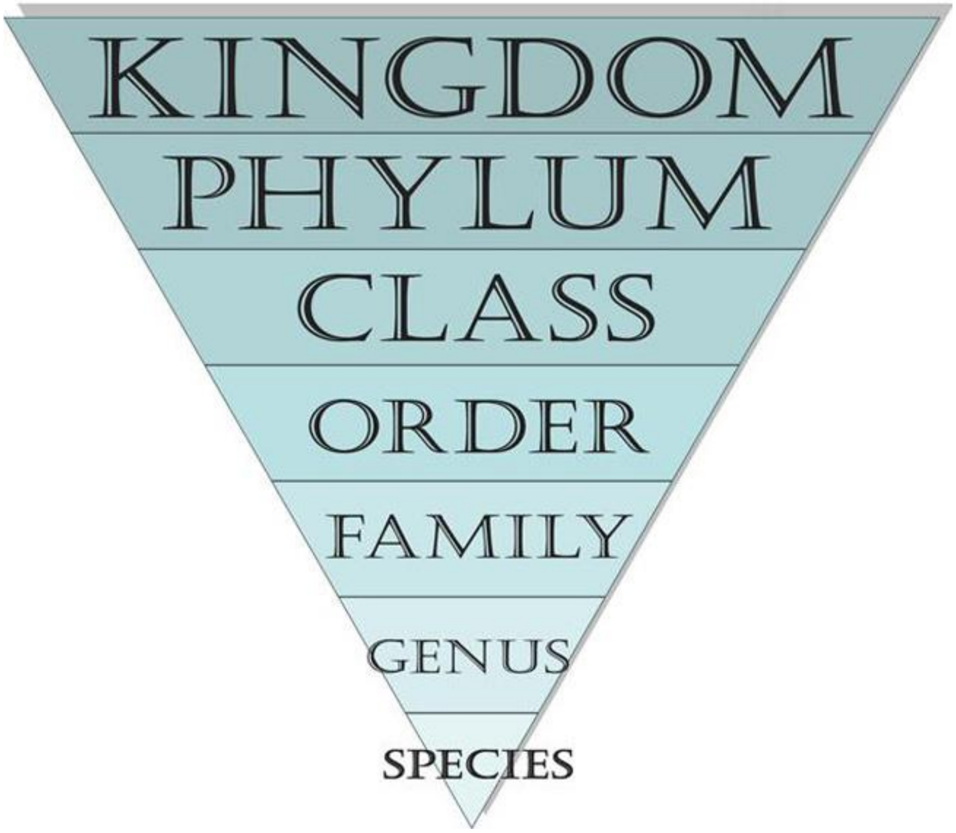
D. Modern Classification

All Living things are classified into seven taxonomic groups or “taxa”:

Kingdom	Katy	King	(very few characteristics shared, very BROAD)
Phylum	Perry	Phillip	
Class	Came	Came	
Order	Over	Over	
Family	For	For	
Genus	Grape	Genes	
Species	Soda	Special	(many characteristics shared most SPECIFIC)

Note: Species is defined as a group of organisms that:

1) interbreed under natural conditions
2) are reproductively isolated from other groups
3) share a common gene pool
4) produce fertile offspring



To help you better understand the concept of classification levels or taxa use the following as an analogy or example. How geographically close are you located to other people?

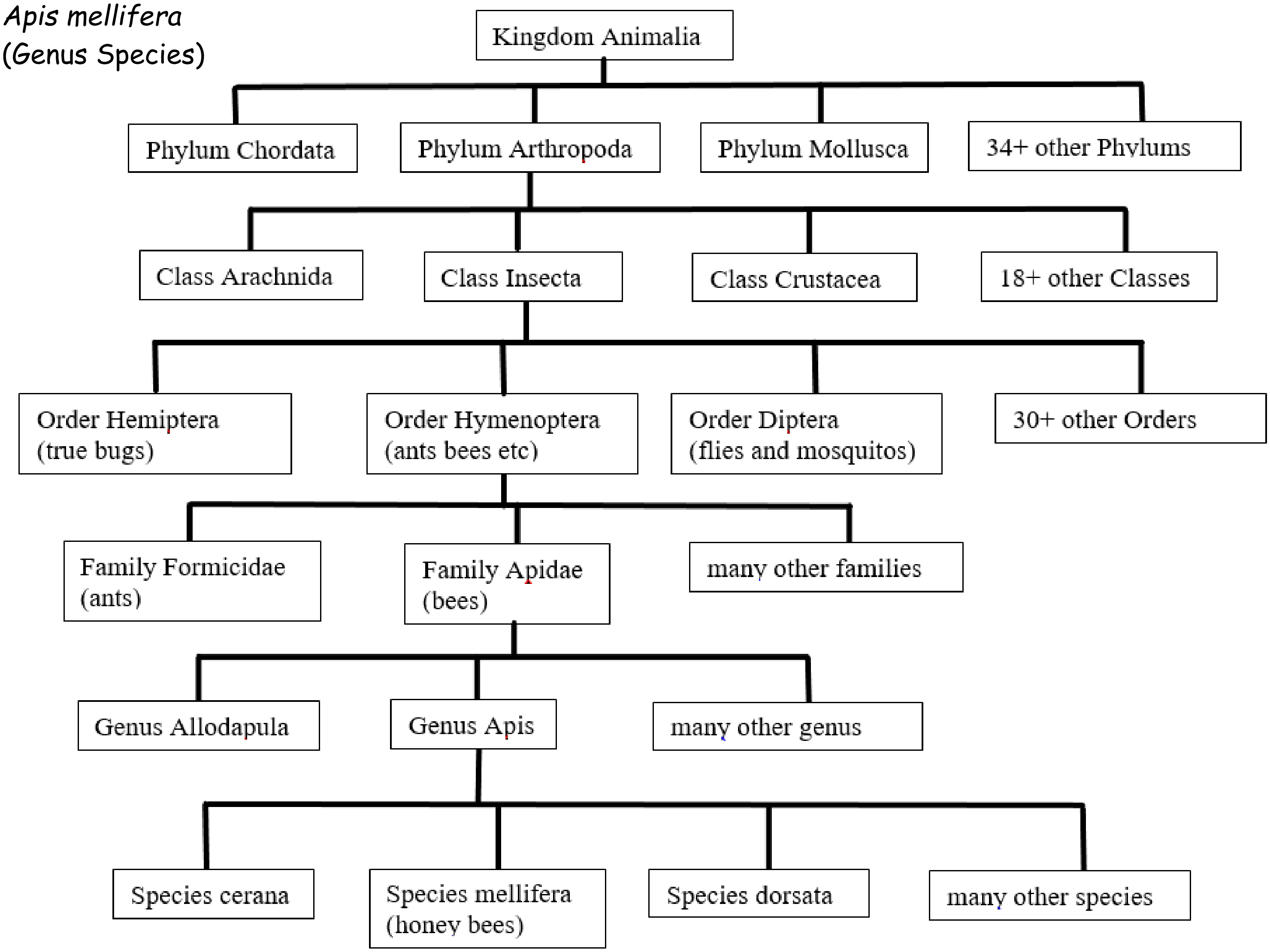
Kingdom is like what **Country** you live in.
Phylum is like what **Province** you live in.
Class is like what **City** you live in.
Order is like what **Neighborhood** you live in.
Family is like what **Street** you live in.
Genus is like what **House** you live in.
Species is like what **Room** you live in.

If you are an NFL fan then you might find it helpful to think about the taxa in terms of the following. Thinking of Patrick Mahomes.

Kingdom is like the League he plays in (NFL)
Phylum is like the Conference he plays in (AFC)
Class is like the Division he plays in (AFC West)
Order is like the Team he plays for (Kansas City Chiefs)
Family is like whether he plays Offence or Defence (Offence)
Genus is like the positional group he belongs to (Quarterbacks)
Species is the individual player (Patrick Mahomes)

Let’s look at the classification of the honeybee as an example.
Keep in mind there are over 7.7 million animal species.

Apis mellifera
(Genus Species)


Kingdom Animalia
Phylum Chordata
Phylum Arthropoda
Phylum Mollusca
34+ other Phylums
Class Arachnida
Class Insecta
Class Crustacea
18+ other Classes
Order Hemiptera (true bugs)
Order Hymenoptera (ants bees etc)
Order Diptera (flies and mosquitos)
30+ other Orders
Family Formicidae (ants)
Family Apidae (bees)
many other families
Genus Allodapula
Genus Apis
many other genus
Species cerana
Species mellifera (honey bees)
Species dorsata
many other species

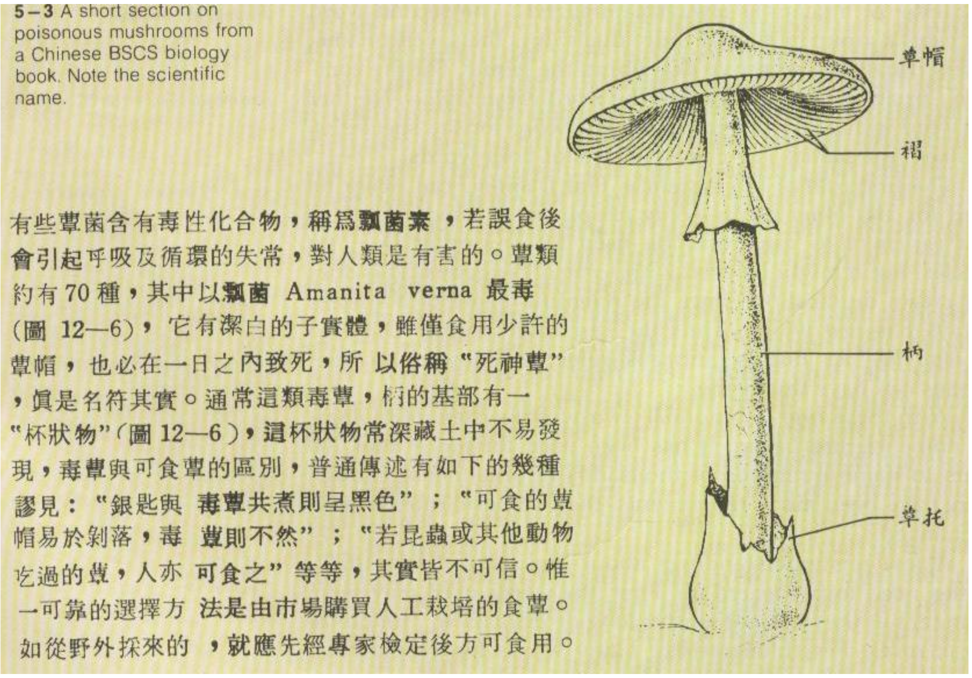
Animal Example	Taxonomic Rank	Plant Example
Animalia	**Kingdom**	Plantae
Chordata	**Phylum**	Angiospermophyta
Mammalia	**Class**	Eudicotidae
Primate	**Order**	Ranunculales
Hominidae	**Family**	Ranunculacae
Homo	**Genus**	*Ranunculus*
sapiens	**Species**	*acris*
Human	Common Name	Buttercup

E. Problems in Classification

- Classification is artificial. We classify for our convenience.
- Different biologists have different ideas about classification thus systems vary.
- Classification evolves as new information emerges.
  - Crocodile is classified as a reptile due to sharp teeth and having scales BUT new evidence indicates that a crocodile is more closely related to birds than to reptiles (lizard, snake, turtle, etc)
  - Other reptiles evolved from a more distant ancestor, therefore, should birds be classified as reptiles?
- Some organisms are asexual; therefore they don't fit the definition of species.
  - Recall, to be a species, organisms must be able to interbreed and produce fertile offspring.

F. Biologists Use a Binomial System

1. Scientific Naming vs. Common Naming of Organisms
   - Latin is used in binomial Nomenclature because it is a dead language (it is not used today so meanings of the words cannot change or evolve) and therefore scientists all over the world can refer to organisms by the same name.
   - Latin was the language of scholars.
   - It is precise and descriptive.



5–3 A short section on poisonous mushrooms from a Chinese BSCS biology book. Note the scientific name.

有些蕈菌含有毒性化合物，**稱爲瓢菌素** ，若誤食後會引起呼吸及循環的失常，對人類是有害的。蕈類約有 70 種，其中以**瓢菌** Amanita verna 最毒(圖 12—6)，它有潔白的子實體，雖僅食用少許的蕈帽，也必在一日之內致死，所以俗稱“死神蕈”，眞是名符其實。通常這類毒蕈，柄的基部有一“杯狀物”(圖 12—6)，這杯狀物常深藏土中不易發現，毒蕈與可食蕈的區別，普通傳述有如下的幾種謬見：“銀匙與毒蕈共煮則呈黑色”；“可食的蕈帽易於剝落，毒蕈則不然”；“若昆蟲或其他動物吃過的蕈，人亦可食之”等等，其實皆不可信。惟一可靠的選擇方法是由市場購買人工栽培的食蕈。如從野外採來的，就應先經專家檢定後方可食用。

Problems with Common Names

- Different species are often given the same common name.
  - Betula papyrifera is called Paper, Canoe and White Birch in different areas
- One species may have more than one common name.
  - Felis concolor refers to cougar, puma, panther, and mountain lion
- Common names are often misleading.

  Examples: horned toad is not a toad, it's a lizard, a star fish is not a fish.

2. Examples of Binomial Nomenclature (genus species)

North American Black Bear	*Ursus americanus*
Grizzly Bear	*Ursus horribilis*
Alaskan Brown Bear	*Ursus arctos*
Polar Bear	*Ursus maritimus*
Panda Bear (in bear family but different genus)	*Ailuropoda melanoleuca*
Koala Bear (actually a marsupial)	*Phascolarctos cinereus*

G. Rules for Binomial Nomenclature (2 Name System ie. Scientific Naming)

1. Genus is written first and is capitalized
2. Species is written second and is never capitalized.
3. Both names must be underlined or italicized.

Example

Homo sapiens or Homo sapiens

H. Dichotomous Keys

1. A Dichotomous Key is a key or chart that involves deciding between two characteristics at a time in order to properly classify organisms. The key uses a series of "go to" instructions until the proper identification is reached.