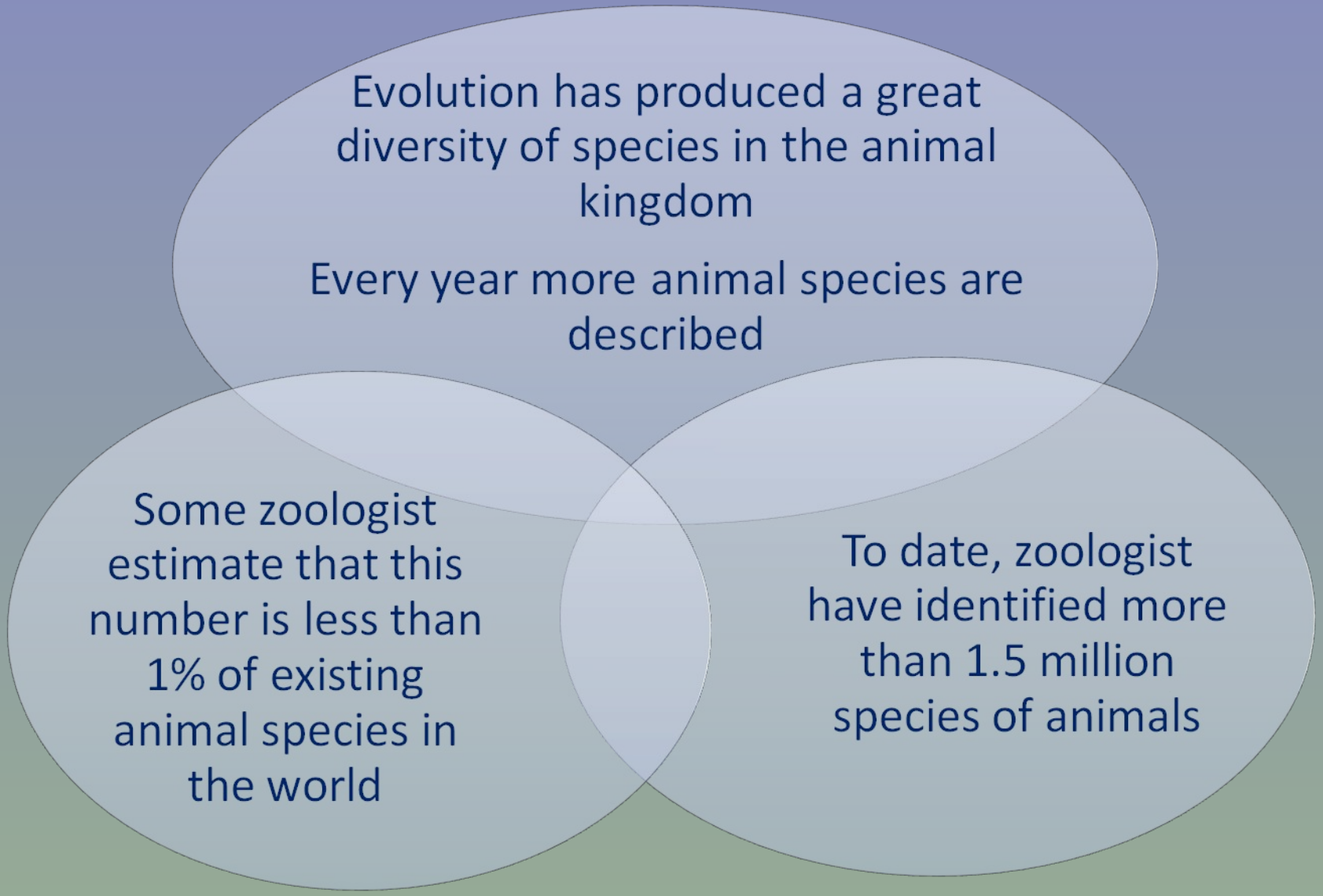
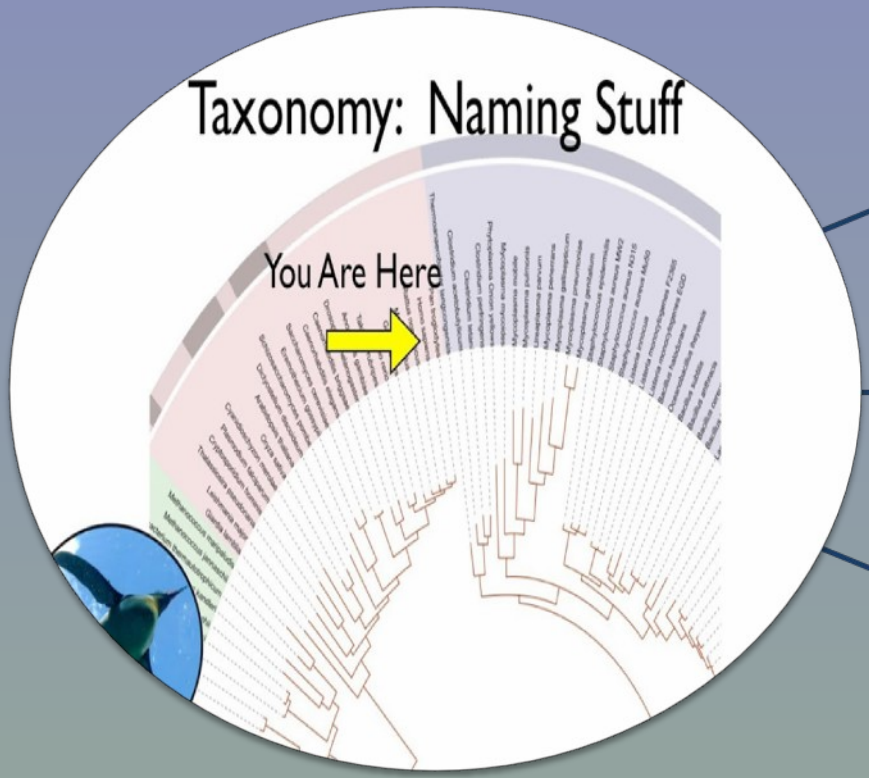
TAXONOMY AND PHYLOGENY OF ANIMALS



TAXONOMY

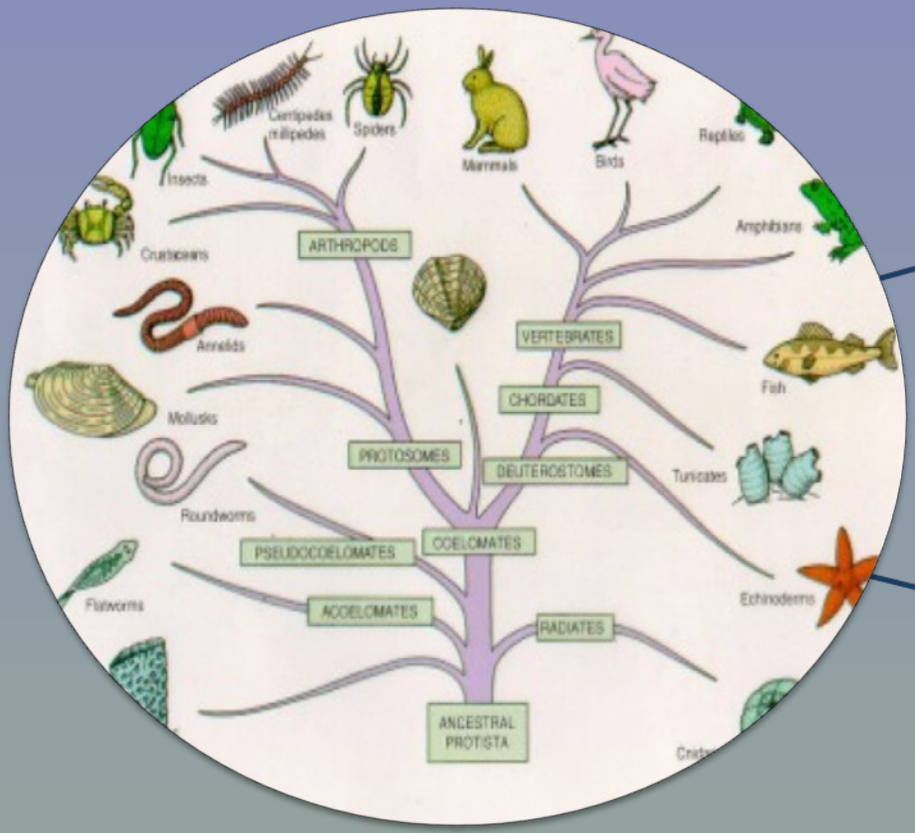


Theory, principles and practice of classification

A classification system

Putting thing into classes

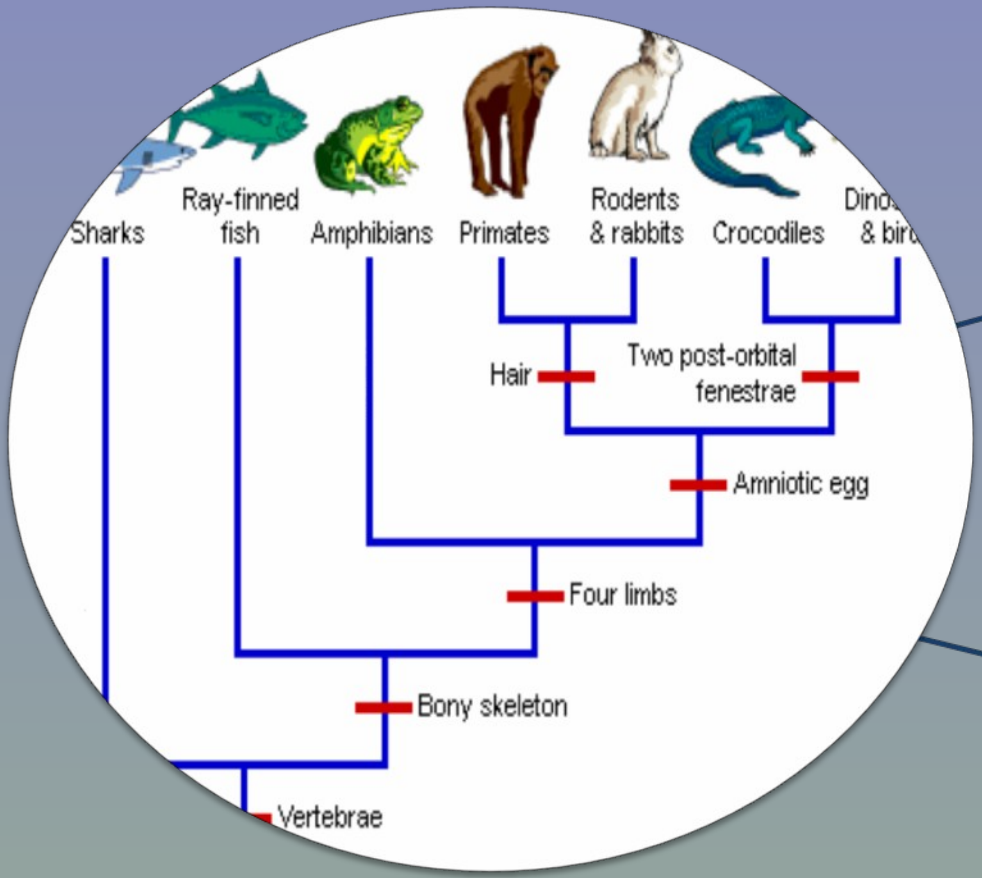
SYSTEMATIC



Science of taxonomy

Reconstruction of phylogeny

PHYLOGENY



The origin and diversification of any taxon

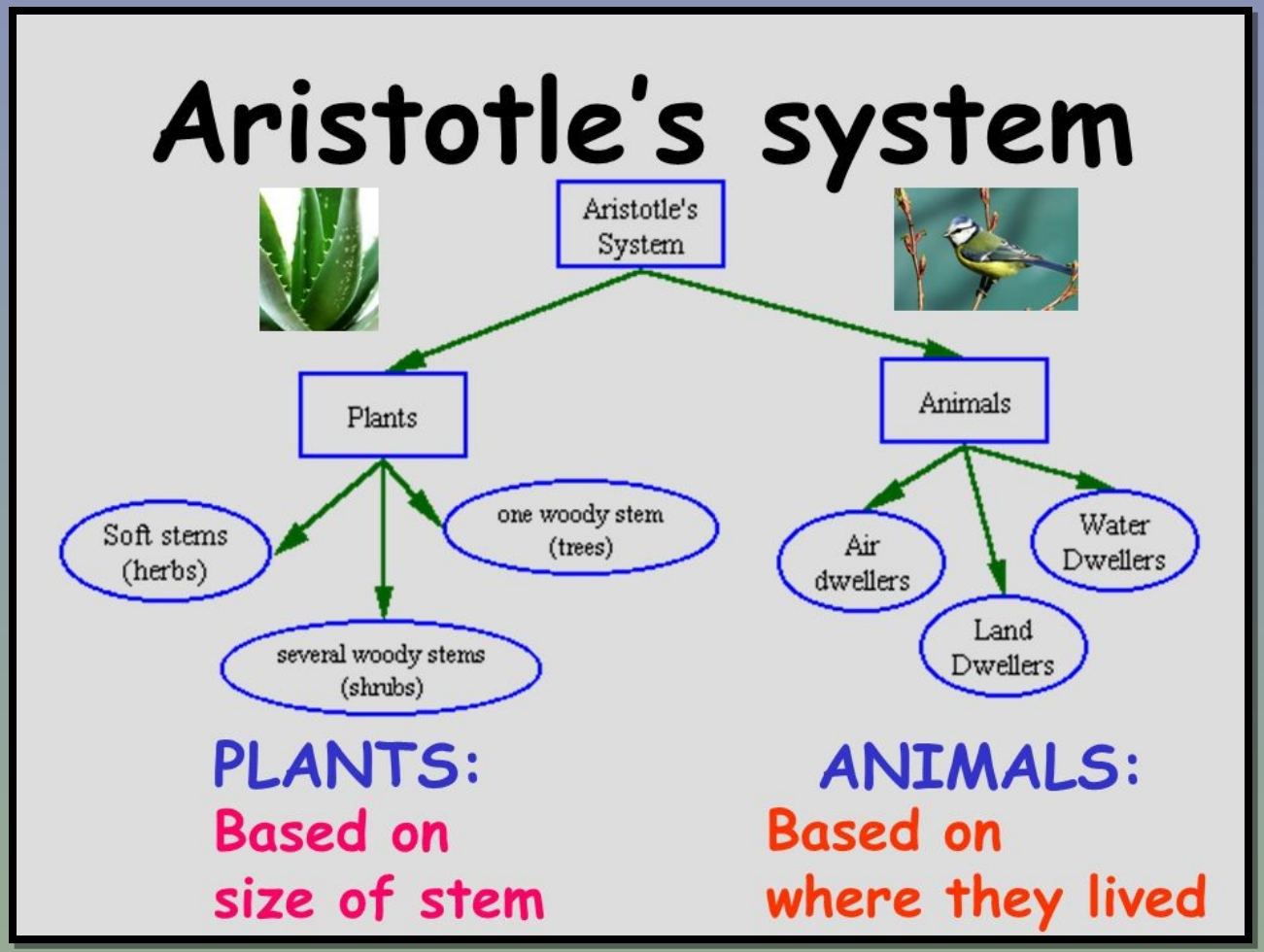
OR

The evolutionary history of any taxon origin and diversification

TAXONOMY	SYSTEMATIC
Mention to the **classification of organisms**	Mention to the study and **classification of organisms** for the determination of the evolutionary relationship of organisms
A branch of systematics	Study the relationship of organisms
Included in the **classification** and **naming** of organisms	Included in the **classification, naming**, cladistics and phylogenetics
Does not interested in the evolutionary history of organisms	Interested in the evolutionary history of organisms
Can change with further studies	Does not change with further studies

ARISTOTLE' S CLASSIFICATION SYSTEM

First scientist who classified organisms with their **structural similarities**



LINNAEUS'S CLASSIFICATION SYSTEM

He was the first scientist who developed a hierarchal naming structure

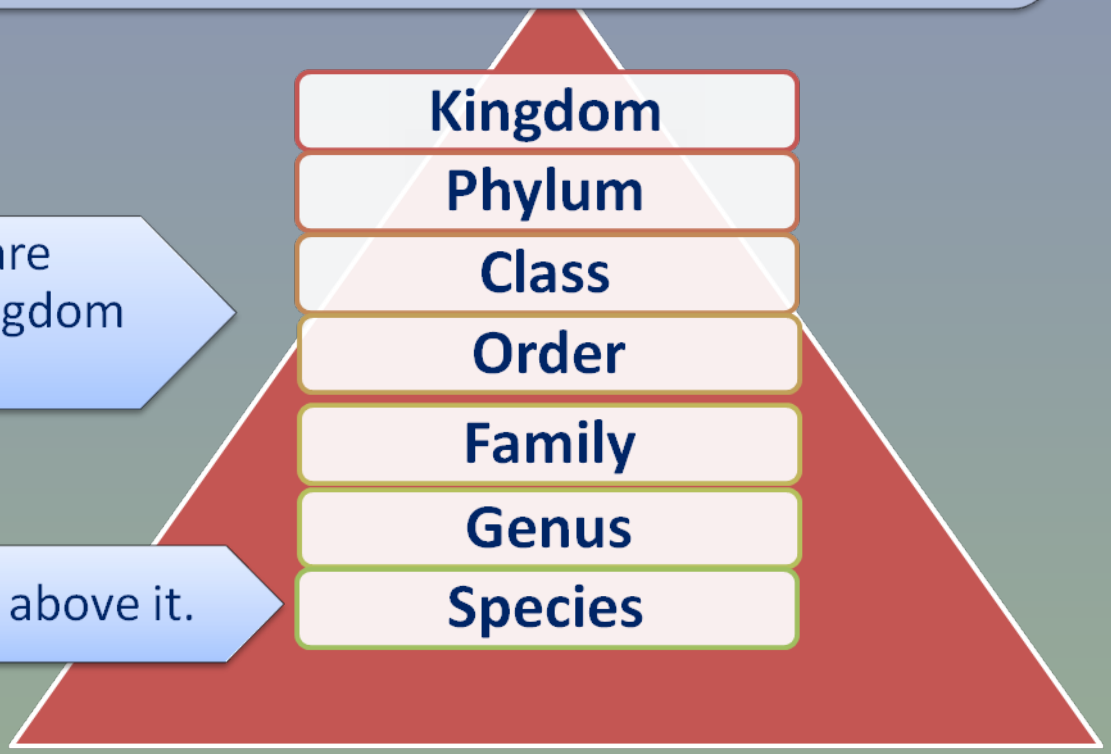
Binominal Nomenclature (Two name)

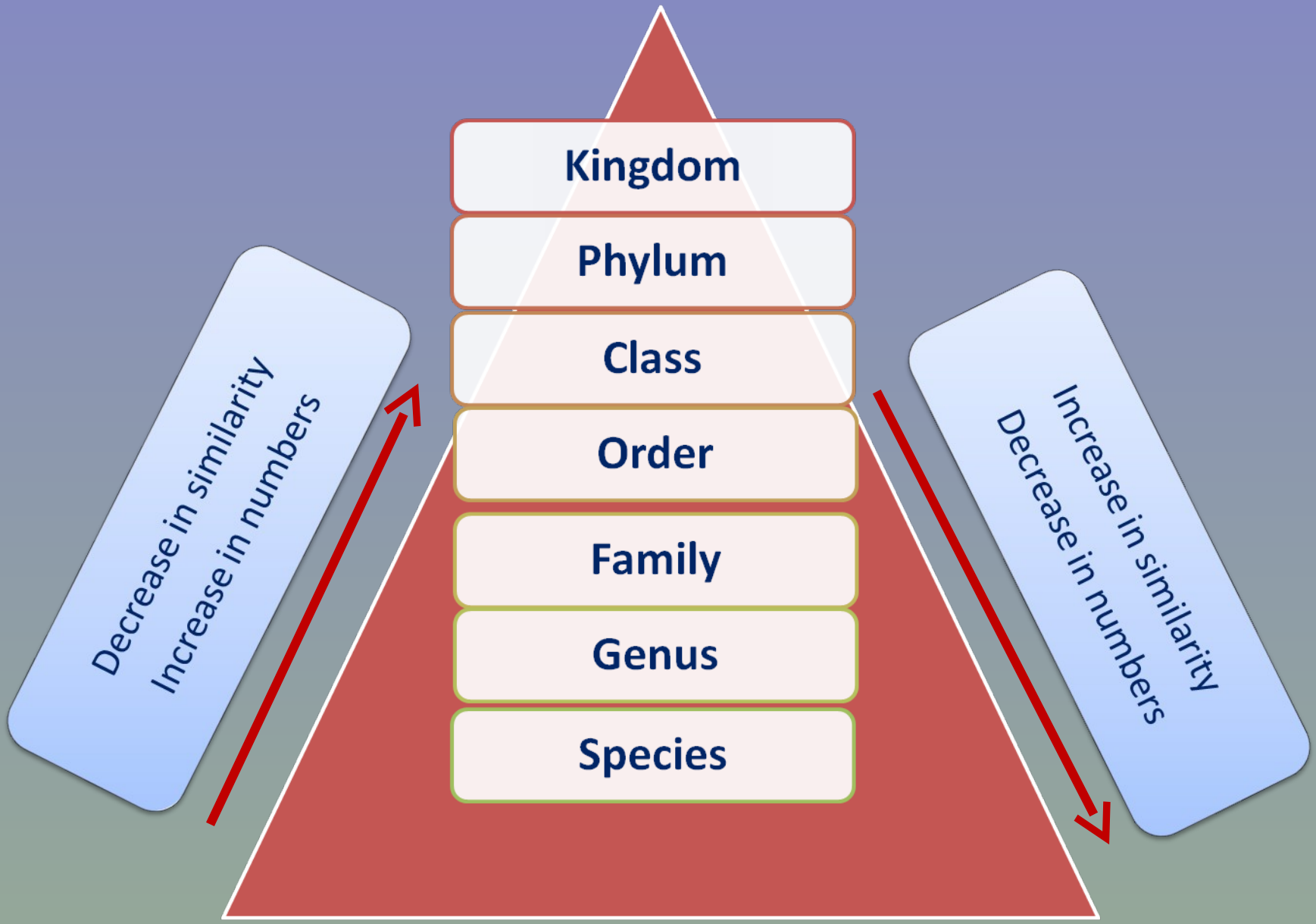
Ex: *Homo* *sapiens*

(Genus) (Species)

Seven mandatory ranks are present in for the animal kingdom since Linnaeus's time.

Each level included in the level above it.



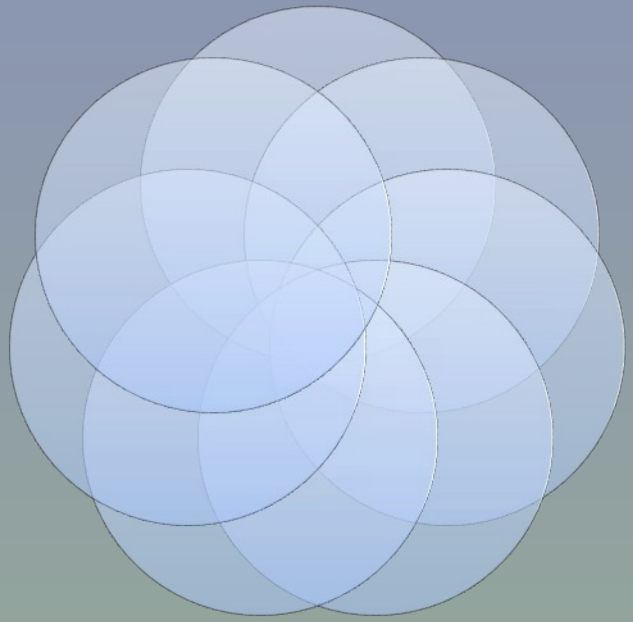

Kingdom
Phylum
Class
Order
Family
Genus
Species
Decrease in similarity
Increase in numbers
Increase in similarity
Decrease in numbers

SPECIES CONCEPT

Typological Species

Biological Species

Ecological Species



Evolutionary Species

Phylogenetic Species

Cohesion Species

TYPOLOGICAL (MORPHOLOGICAL) SPECIES CONCEPT

Species are changeless, distinct and natural types

One species can be separated from another species by physical features.

Recognized by their morphological features.

Phenotypic differences are important (useful for fossils species)

Problems: This concept cannot explain the **sibling species.**

Sibling Species: are different species, and they cannot interbreed

BIOLOGICAL SPECIES CONCEPT

This concept was put forward by Dobzhanzky and Mayr, inspired by Darwin's theory of evolution

A species is a **reproductive community** of populations that occupies a specific niche in nature (Mayr, 1982).

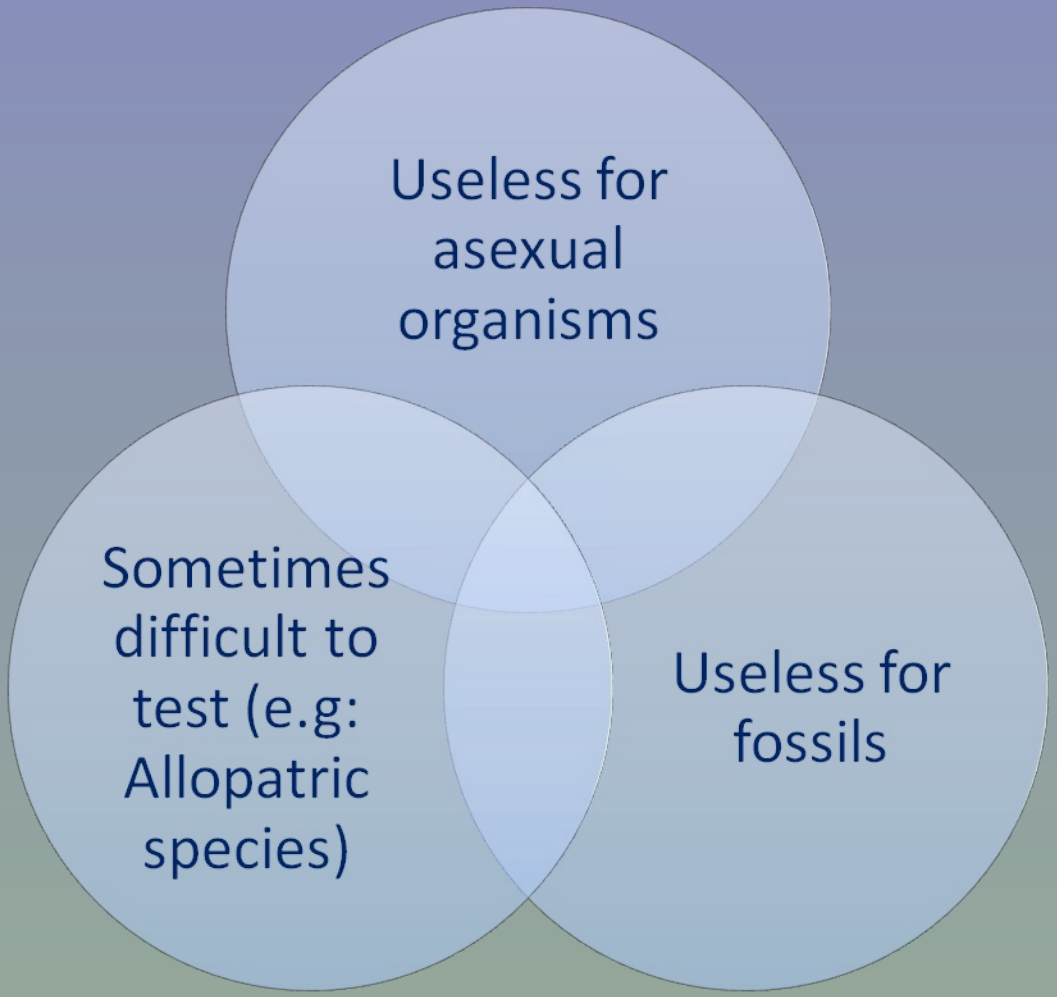
***Common characteristics**

***Genetically compatible**

***Interbreed under natural conditions**

*Produce **vileable, fertile offspring**

PROBLEMS


Useless for asexual organisms
Sometimes difficult to test (e.g: Allopatric species)
Useless for fossils

ECOLOGICAL SPECIES CONCEPT

A species is a group of organisms which phenetically similar that occupy the same ecological niche (Van Valen, 1976)

Two species may be similar in appearance but distinguisable based on

“what they eat”

“where they live”

ADVANTAGE

The environment plays in controlling morphological development

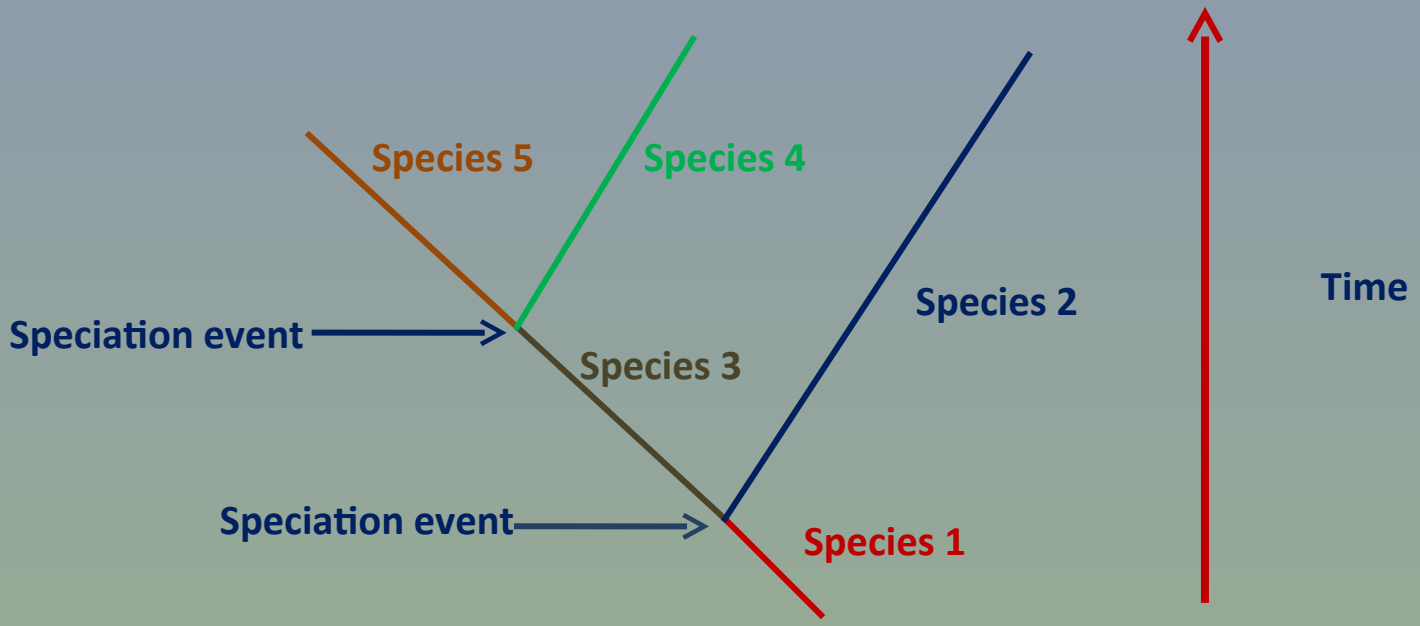
DISADVANTAGE

- Cryptic (Sibling) Species
- Ecological niches tend to be assumed and are difficult to define, and describe completely
- Many taxa exploit overlapping resources
- Ecological morph within species

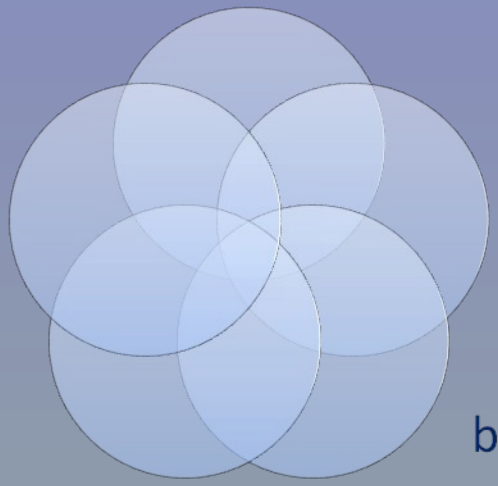
EVOLUTIONARY SPECIES CONCEPT

This concept was put forward by Simpson (1961) and development by Wiley (1978)

A species is a single lineage of ancestor-descendant populations of organisms that maintains its identity from other such lineages, and that has its own evolutionary tendencies and historical fate (Wiley, 1982).



Benefits



Allopatric species

Clear conceptually

Through time

Applies to both asexual and sexual species

Problems

Application (difficult to know the future)

Asexual species (too many independent lineages)

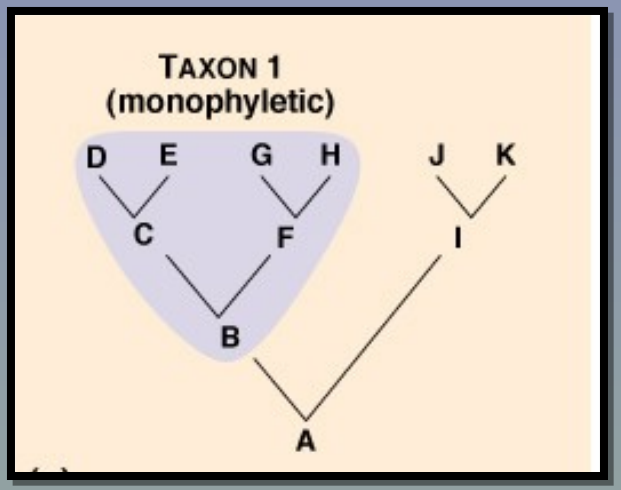
COHESION SPECIES CONCEPT

This concept was put forward by Templeton (1989). He updated the evolutionary species concept to form this concept because of **natural selection** and **genetic drift**.

A species is the most inclusive population of individuals having the potential for phenotypic cohesion through intrinsic cohesion mechanisms (Templeton, 1989).

PHYLOGENETIC SPECIES CONCEPT

According to this concept, species are defined as the smallest diagnosable monophyletic group, and share and unique common ancestor.



Common ancestor

Advantages

Applied to extinct species

Give important information about relationship among organisms

Disadvantages

Evolutionary histories are not known for all species

THEORIES OF TAXONOMY

A theory of taxonomy sets up **PRINCIPLES**

Identify

Classify (Categorized)

TAXONOMIC GROUPS

There are two popular taxonomic theories used by taxonomist present

Evolutionary Taxonomy

Phylogenetic Systematics (Cladistics)

Similarity

Based on evolutionary principles

Difference

How to use evolutionary principles

Evolutionary Taxonomy

- Arisen **earlier than phylogenetic systematic**
- Well-known **in the 1940s**

Phylogenetic Systematics (Cladistics)

- Arose **in the 1960s**
- Replaced evolutinary taxonomy

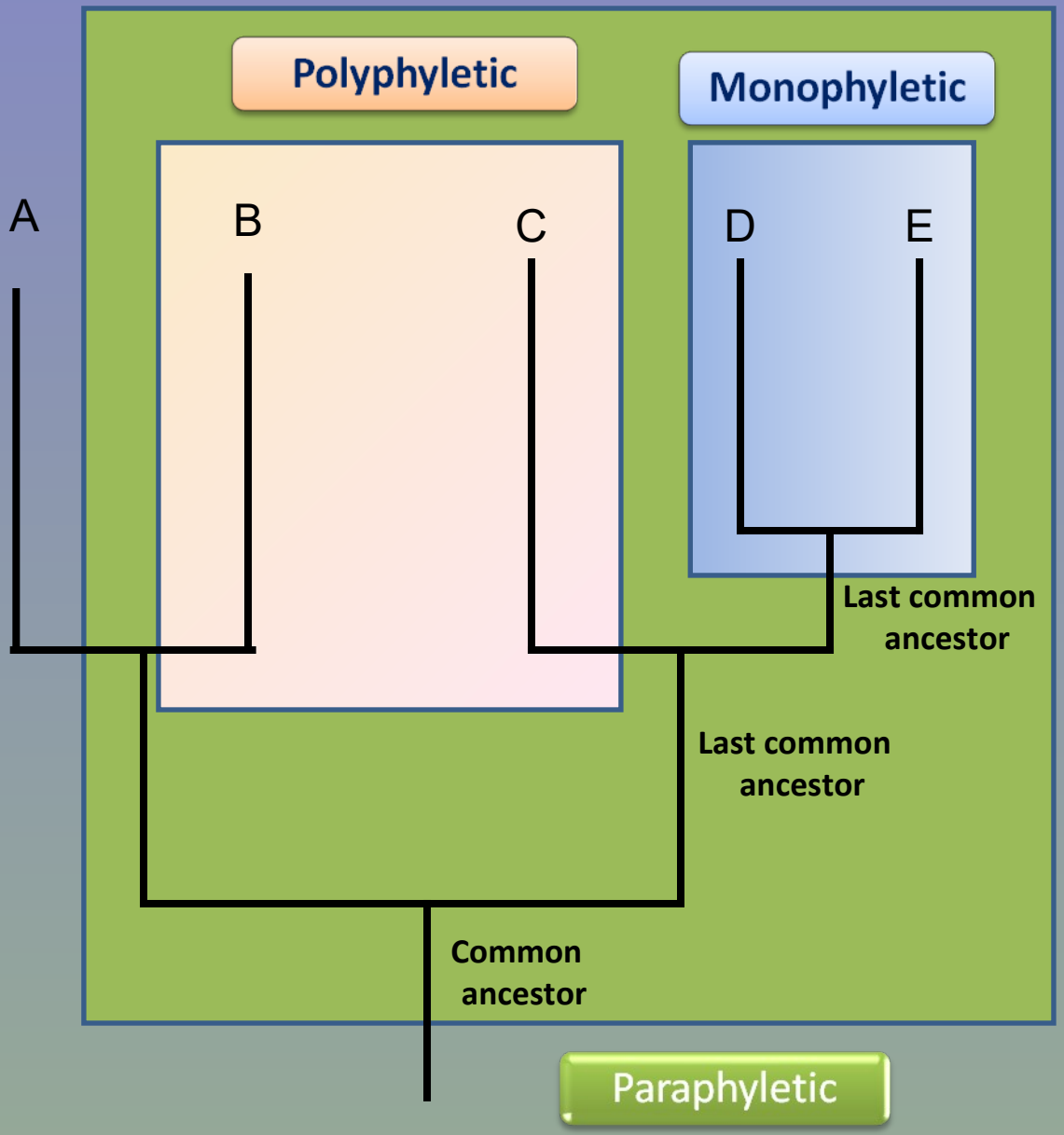
The relationship between a taxonomic group and a phylogenetic tree (cladogram) is important for both theories

This relationship can take one of **three forms**

Monophyly (Monophyletic)
All members of the taxon is derived from **a unique common ancestor**

Paraphyly (Paraphyletic)
Taxon is included **an ancestor** and **a group of organisms descended** from it

Polyphyly (Polyphyletic)
Taxon is composed of unrelated organisms descended from **more than one ancestor**


Polyphyletic
Monophyletic
A
B
C
D
E
Last common ancestor
Last common ancestor
Common ancestor
Paraphyletic

EVOLUTIONARY TAXONOMY

Simpson

Include **two main principles**

Mayr

common descent

amount of **adaptive evolutionary change**

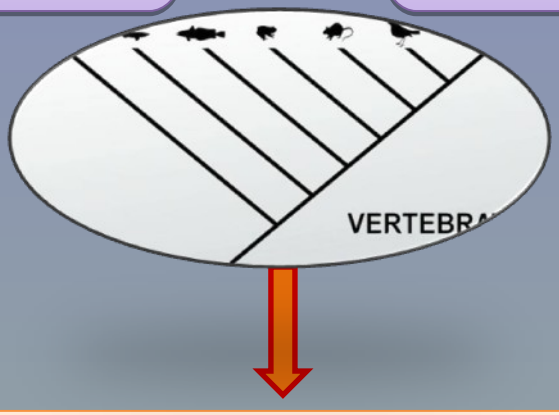
Evolutionary taxa must have **a unique evolutionary origin** and must show **original adaptive features**
Either **monophyletic** or **paraphyletic**

PHYLOGENETIC SYSTEMATICS
CLADISTICS

Henning

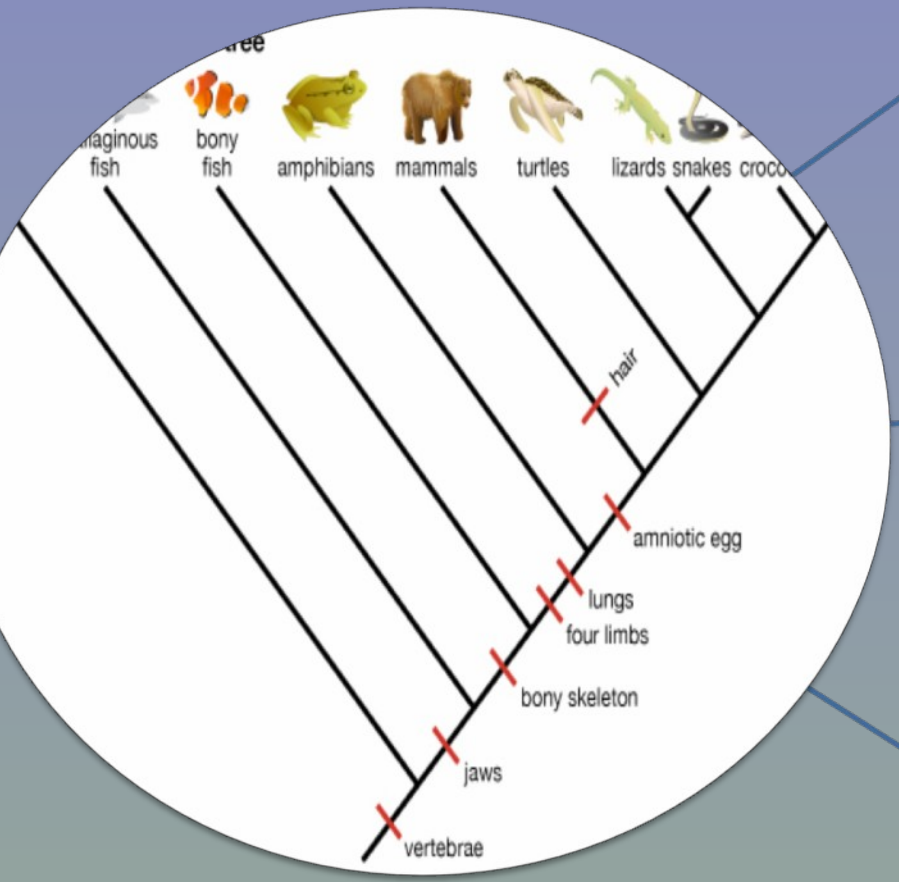
Common descent

Cladogram



All taxa must be **monophyletic**

Informs the construction of phylogenetic trees based on **shared characteristics**



Fossils

Molecular data

Genetic data

To infer evolutionary relationships

GEOLOGICAL TIME SCALE AND BILOGICAL EVENTS

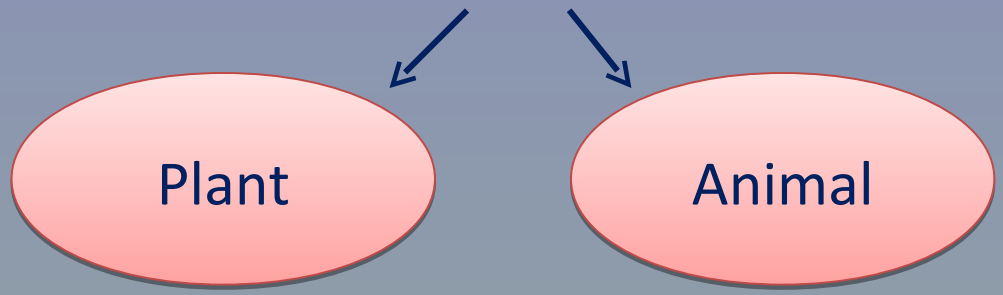
EON: Largest, most general division of time

	PHANEROZOIC	**Visible Life**
PROTEROZOIC	**PRECAMBRIAN**	Multi-cellular organisms
ARCHEAN		Prokaryotic cells; Earliest known fossils
HADEAN		Earth before life

EONS	ERAS	PERIOD		MYRB	IMPORTANT VERTEBRATE EVENTS
PHANEROZOIC	CENOZOIC	QUARTERNERY	HOLOCENE	0,01	TODAY
			PLEISTOCENE	2,6	First modern humans (*Homo*)
		TERTIARY	PLIOCENE	5,3	First upright Hominids; Large carnivores;
			MIOCENE	23	First apes (without tail); First Old World monkeys; Abundant grazing mammals
			OLIGOCENE	33,9	First New World Monkeys
			EOCENE	56	First horses, whales, bats, monkeys; Dispersal of placental mammal families
			PALEOCENE	66	Great predatory land birds; First prosomians
				66	Diversificatiion of mamals
			Great Extintion		
	MESOZOIC	CRETACEOUS		145	Peak of dinosaurs and marine reptiles followed by extinction; Early dispersal of marsupial and placental mammals
		JURASSIC		201	First birds; Dinosaurs abundant
		TRIASSIC		252	First dinosaurs; First true mammals
			Great Extintion		
	PALEOZOIC	PERMIAN		299	Dispersal of reptiles; Early Synapsids common; Displacement of ampbians
		CARBONIFEROUS		359	First amniotes; Dispersal of amphibians; Sharks abundant
		DEVONIAN		419	First tetrapods on land; First bony ray-finned formed; lobe-finned fishes
		SILURIAN		443	First jawed fishes
		ORDOVICIAN		485	Fishes begin dispersal
		CAMBRIAN		541	Earliest Chordates; Earliest Vertebrates
PROTEROZOIC				2500	Multi-cellular organisms
ARCHEAN				4000	Earliest known fossils

MAJOR DIVISION OF LIFE

From Aristotle's time to late 1800, living organisms classified in **two kingdoms:**



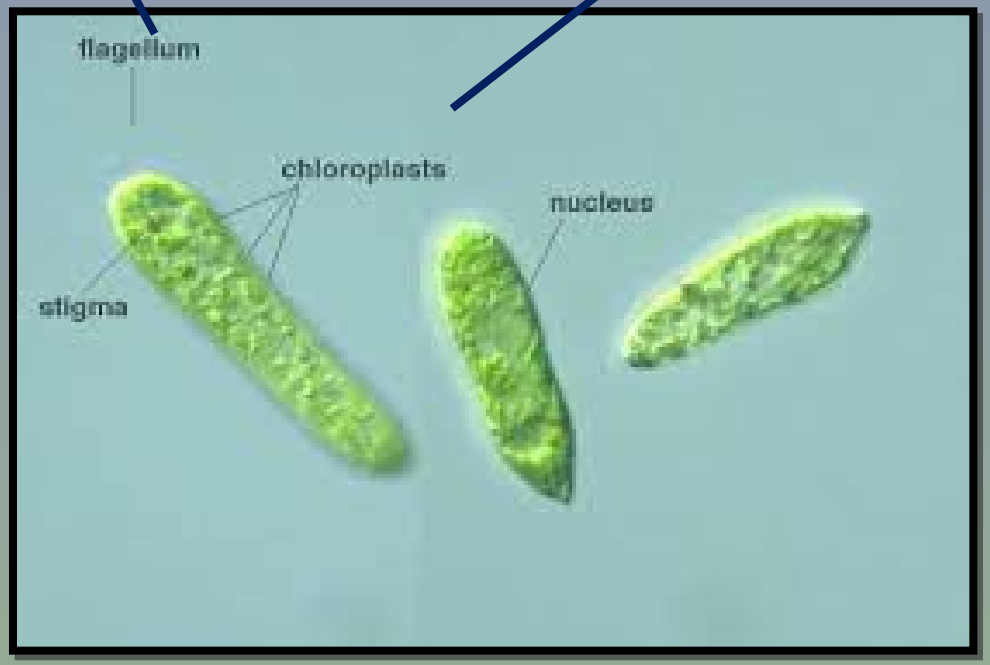
The two-kingdom system had serious problems

Ex: Fungi → Some botanist put this group into the plant, whereas some zoologist put it into the animal kingdom.

Euglena

It is mobile like animals

It has chlorophyll and made photosynthesis



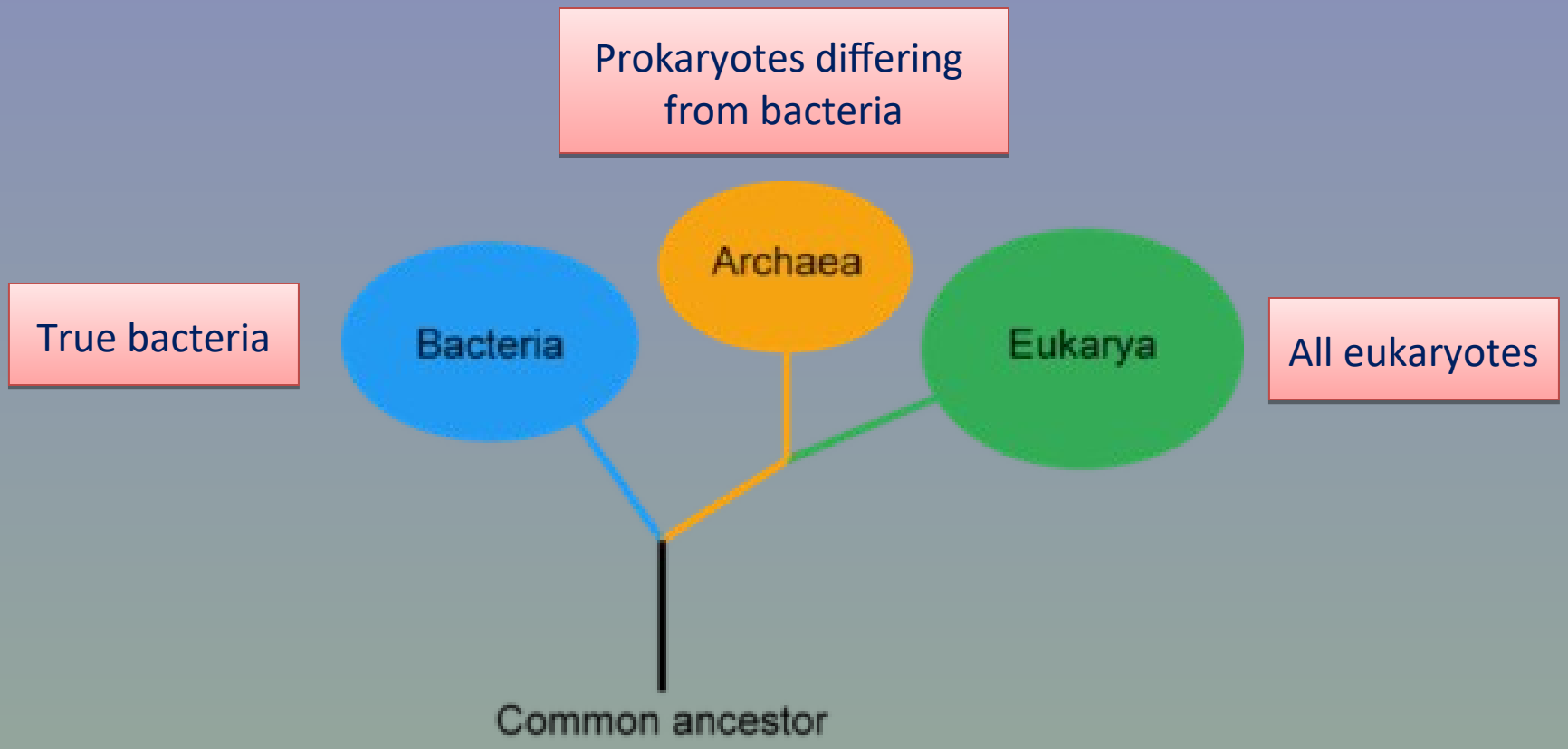
To solve the **classifying problem of unicellular organisms**, some scienstist has been suggest several alternative systems.

Haeckel suggested **PROTISTA** kingdom in 1866 which includes all unicellular organisms

The nuclei of the bacteria and cyanobacteria are not surrounded by membrane. Due to the lack of this structure, these groups classified in different kingdom called **MONERA**

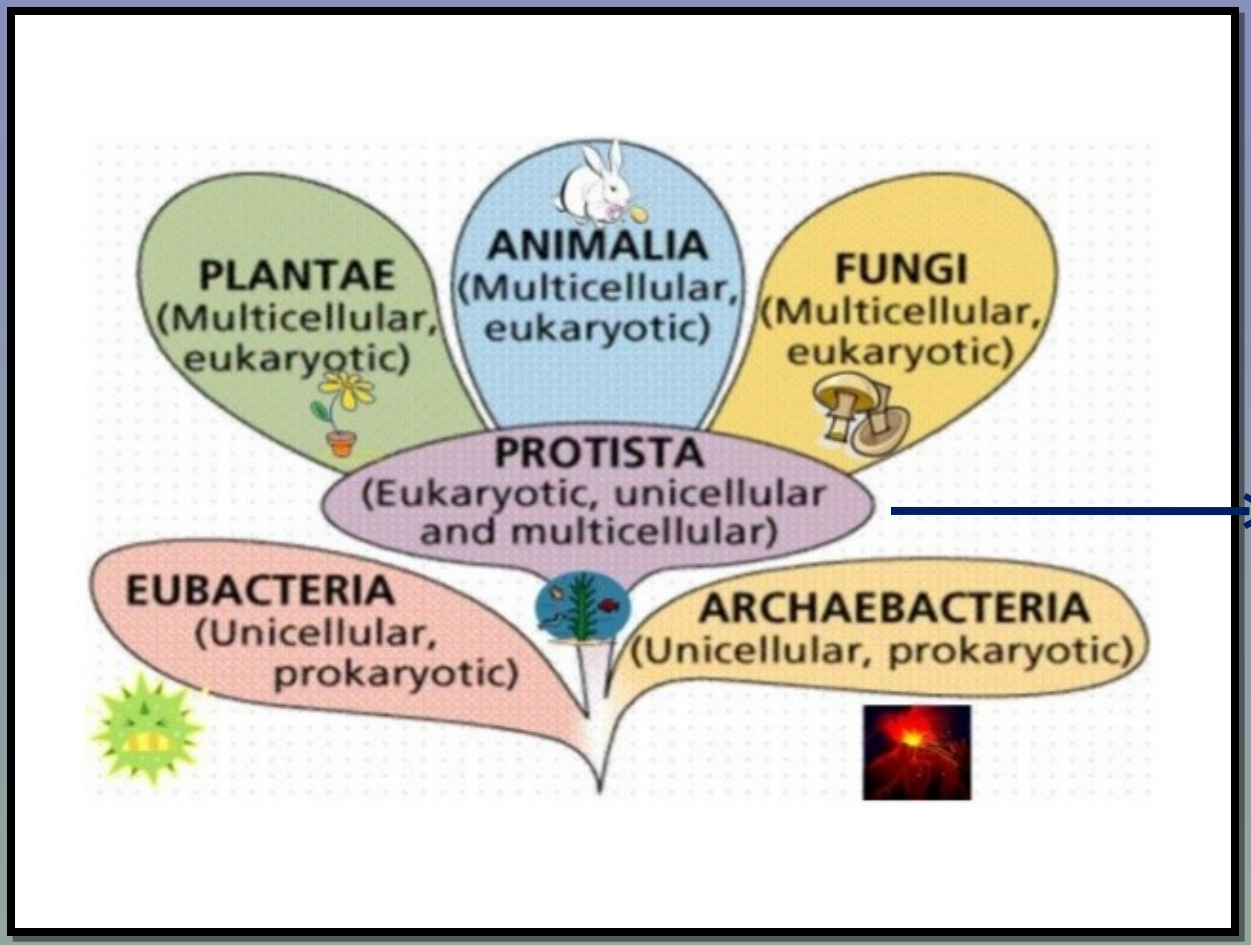
All Prokaryotic organisms

Based on the phylogenetic information, all life-forms divided into three **DOMAINS**



DOMAIN: An informal taxonomic rank above kingdom

Today, **six kingdoms** are accepted.



Within these kingdoms, **Plantae, Animalia**, and **Fungi, Protista** becomes **a paraphyletic group**

Some Fundamental Features Used in Animal Classification

1. Levels of Organizations
2. Symmmetry
3. Body Cavity (Coelom)
4. Embryological Development (Germ Layer)
5. Embryonic Development of the Mouth
6. Segmentation
7. Skeleton
8. Sexuality
9. Digestive System
10. Larvae
11. DNA, RNA and Proteins

1. Level of Organizations

Protoplasmic Level of Organization

- The unicellular organism which are the simplest eukaryotic organisms place at this group.
- **All life functions are limited with the single cell.**
- Protoplasma is differentiated into organelles for manage to make specialized functions.

Cellular Level of Organization

- The simplest metazoans (such as *Volvox*, Sponges) place in this group.
- **A division of task is clear.**
- **Some cells are functionally differentiated to form different task** (Ex: Some cells are concerned with reproduction whereas the others with nutrition).

Cell-Tissue Level of Organization

- **Similar cells organized to form a common function to form tissue** (Ex. Muscle tissue).
- Cnidaria (Ex: Jellyfish) are place into this group.

Tissue-Organ Level of Organization

- **A group of tissue that have been adapted to perform a specific function are called ORGANS.**
- Organs are usually composed of two or more types of tissue and have more specialized function than tissues.
- Platyhelmintes (Flatworms) are represented at this level with well-defined organs such as reproductive organs, eyespots, etc.

Organ-System Level of Organization

- **It is the highest level of organization.**
- **One or more organs work together as organ systems to perform a body function.**
- Eleven different kinds of organ systems are described in metazoans: Skeletal, muscular, integumentary, digestive, respiratory, circulatory, excretory, nervous, endocrine, immune and reproduction.

2. ANIMAL SYMMETRY

Symmetry is balanced distribution of paired body parts in animals.

1. **Asymmetry:** An animal that is **irregular in shape** and **has not got general body plan**

Spherical Symmetry: Any plane passing through center divides the body into equivalent halves.

Radial Symmetry: The animal can be divided into **similar halves** by more than two planes passing through the **longitudinal axis.**

Bilateral Symmetry: An animal can be divided into **two mirrored portions (left and right)** along sagittal plane.

BODY PLAN

- Some terms such as **anterior, posterior, dorsal, ventral, medial, frontal , proximal, lateral, distal** are used to show the regions of bilaterally symmetrical animals.

3. BODY CAVITIES

- A body cavity is **an internal space of an animal body.**
- A true body cavity is called a **coelom** that is derived from mesoderm.
- Triploblastic animals can be divided into three groups due to the present or absent of coelom Ç

  Acoelomate

  Pseudocoelomate

  Coelomate

Acoelomate: Mesodermal cell completely fill the blastocoel.

- **There is no body cavity between the digestive tract and the external body wall.**
- The region between the ectodermal epidermis and the endodermal digestive tract is filled with parenchyma.
- Platyhelmnintes and Nemertia

Pseudocoelomate: Mesodermal cells line the outer edge of the blastocoel.

- **They have a body cavity which is derived from blastocoel between the gut and body wall.**
- **Mesoderm partially surrounding the cavity.**
- Nematoda (Round worms)

Coelomate: Body cavity is **completely** lined with **peritoneum** (a thin cellular membrane) derived from mesoderm.

- Coelomic cavity is bounded with mesoderm.
- Echinoderms, Arthropods, Annelids, Chordates, etc.

4. GERM LAYERS

- Embryonic germ layers are **endoderm, mesoderm** and **ectoderm.**
- Animal that develops from two embryonic germ layers (endoderm and ectoderm) are called **Diploblastic**.
- Cnidarians are diploblastic animals.

- Animal that develops from three embryonic germ layers (endoderm, mesoderm and ectoderm) are called **Triploblastic**.
- Most animals are triploblastic
- Triploblastic animals are divided into **Deuterostomia** and **Protostomia** according to their particular embryonic development stage.

5. Embryonic Development of Mouth

Protostomia: The mouth develops before the anus at embryonic stage. **Blastopore becomes the mouth.**

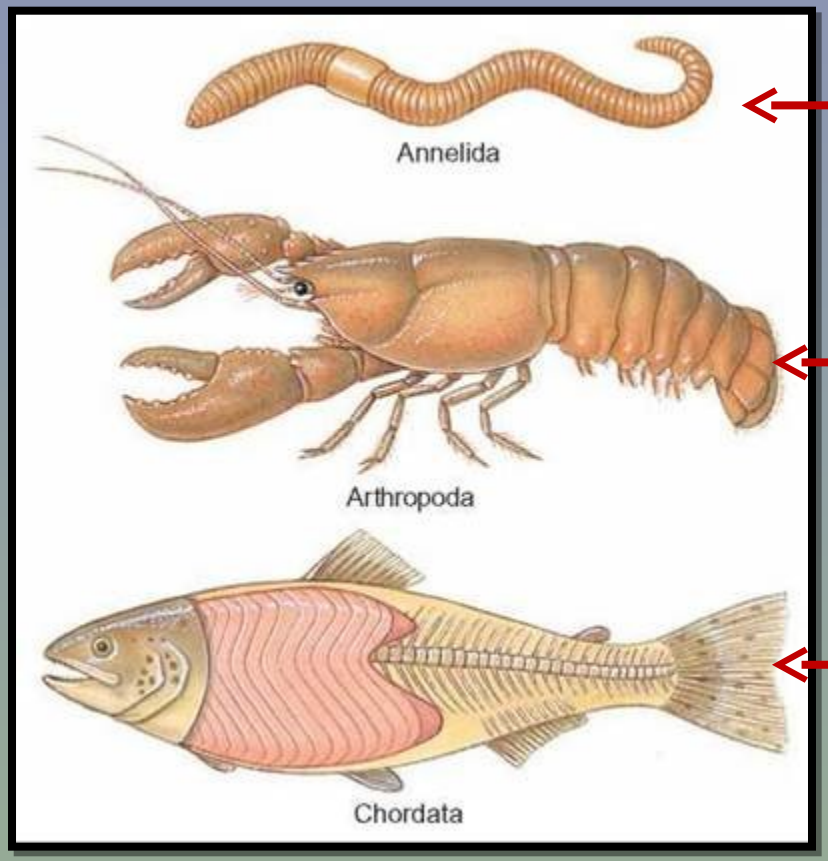
Ex: Mollusks, Annelids, Arthropods

Deuterostomia: The anus develops from the first opening in the embryo and the mouth develops later. **Blastopore becomes the anus.**

Ex: Echinoderms, Hemichordates, Chordates

6. SEGMENTATION (METAMERISM)

It is a serial repetition of similar body segments along the longitudinal axis of the body



Both in internal and external

External

Internal

SKELETON

Endoskeleton

Exoskeleton

SEXUALITY

Monoecious: Both male and female gonads in the same organisms (Hermaphroditic)

Dioecious: Male and female gonads in seperate individuals

DIGESTIVE SYSTEM-GUT CAVITY

A few diploblasts and triploblasts have a blind or incomplete gut cavity . In these organisms food must **enter** and **exit** the same opening.

Most forms possess a complete gut (Two opening: Mouth and anus)