

**Biodiversity** found on Earth today consists of many millions of different biological species, the product of four billion years of evolution. The average half-life of a species is around one million years and 99% of the species that have ever lived on earth are today extinct.

- 1- Genetic diversity - within a species
- 2- Species diversity - diversity among species
- 3- Ecosystem diversity - diversity at a higher level of organization, the ecosystem

|           | Iraq                 |                           | World                |                           |
|-----------|----------------------|---------------------------|----------------------|---------------------------|
|           | Total No. of species | No. of threatened species | Total No. of species | No. of threatened species |
| Mammals   | 81                   | 11                        | 5801                 | 1220                      |
| Birds     | 417                  | 20                        | 11126                | 1492                      |
| Reptiles  | 99                   | 2                         | (10793)<br>7541      | 1367                      |
| Amphibian | 11                   | x                         | (8043) 6771          | 2157                      |
| Fish      | 331<br>(86)          | 2                         | (34200)<br>18449     | 2494                      |
| Total     | 939                  | 35                        | (69963)<br>49688     | 8730                      |

Biologists attempt to classify living things according to their evolutionary relationships.

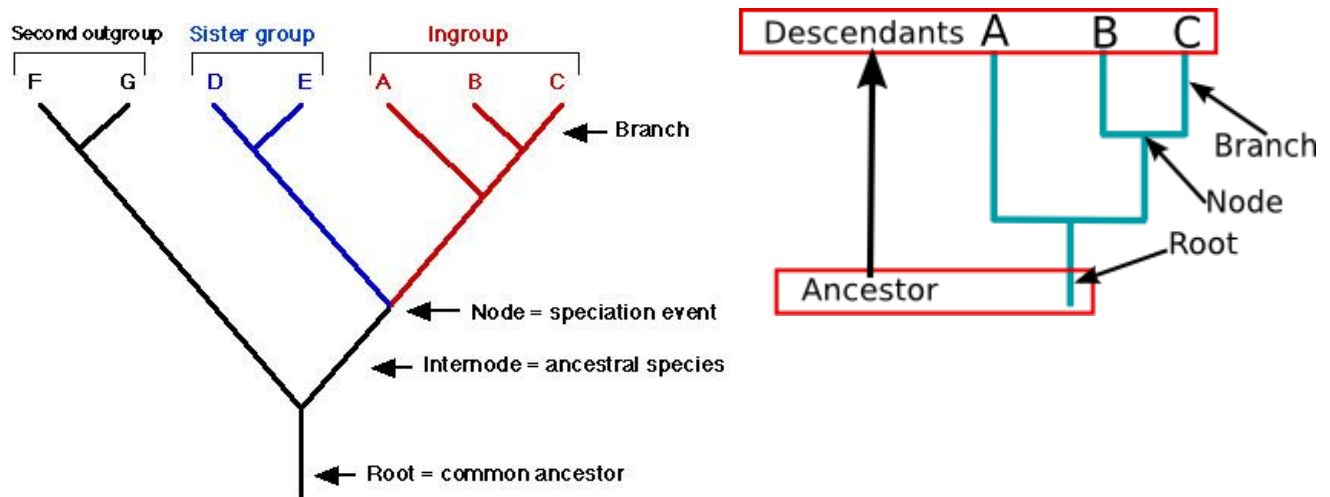
- **Classification system.** Classification involves the recognition of species and the placing of species in a system of higher categories (taxa) that reflect phylogenetic relationships.
1. **Systematics-** The first step in classification is the grouping together of related forms. Simpson (1961) defined systematics as, “the scientific study (is built on the basic fields of morphology, embryology, physiology, ecology, and genetics) of the kinds and diversity of organisms and of any and all relationships among them.”

2. **Taxonomy**- The second is the application of names to the groups. Concerned with applying names to each of the different kinds of organisms.

Thus, **systematics** is the scientific study of classification, whereas **taxonomy** is the business and laws of classifying organisms.

As a result, the classification of organisms is based primarily on the presence of similarities and differences among groups of *living* organisms. These reflect → **genetic** similarities and differences, and in turn these reflect → **evolutionary origins**.

**Phylogenetics** is a branch of biology that deals with studying and determining the evolutionary relationships, or patterns of descent, of groups of organisms.

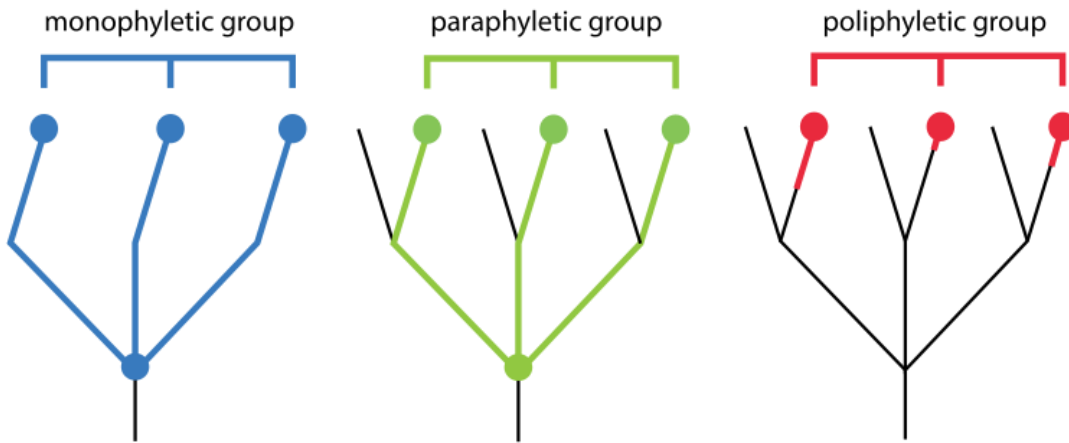


There are three types of phylogenetic groups:

**Monophyletic group**: contains an ancestor and all of its descendants

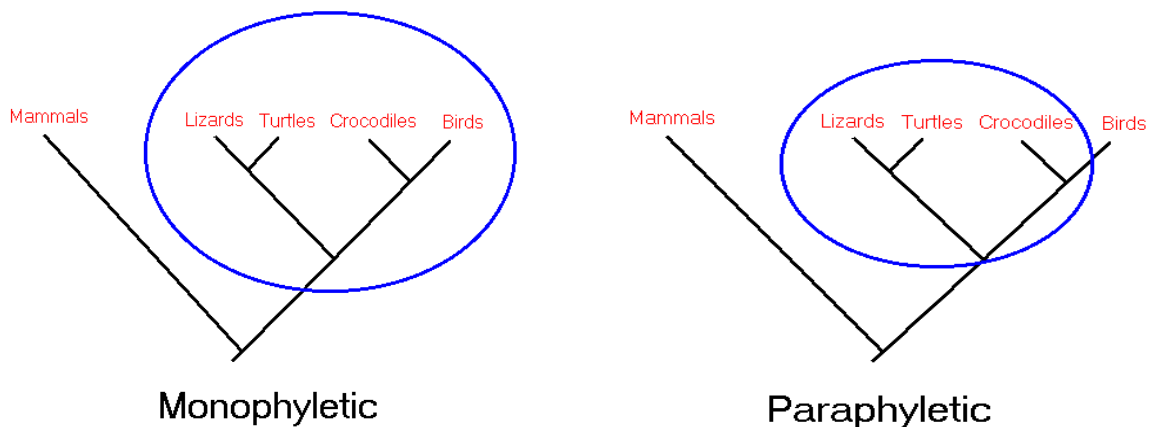
**Paraphyletic group**: contains an ancestor but only some of its descendants

**Polyphyletic group**: contains various organisms with no recent common ancestor

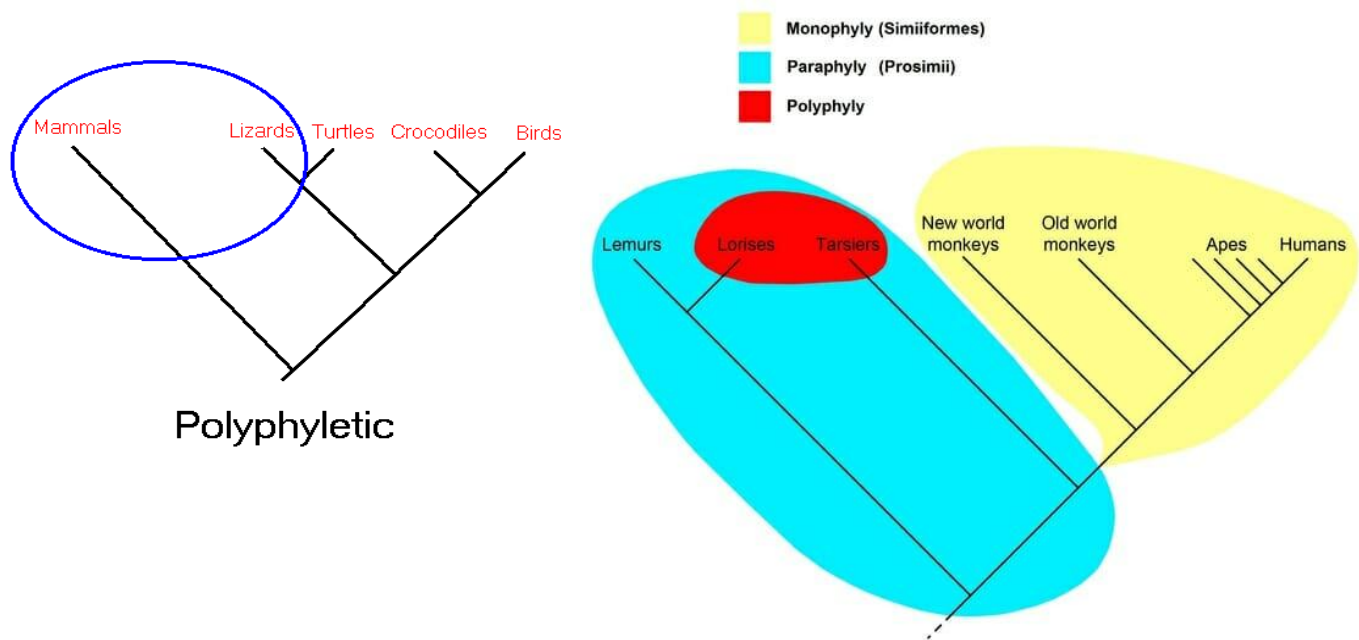


A **monophyletic** groups (Clade), which include all species derived from one common ancestor (For example, turtles, lizards, crocodilians and birds are all derived from a shared common ancestor) or (e.g. all vertebrates are derived from one ancestor, all mammals from common ancestor).

A **paraphyletic** groups, which include some species derived from one common ancestor, but not all species derived from that common ancestor are included (for example, grouping turtles, lizards and crocodiles as "reptiles" and separating that grouping from the birds).



**Polyphyletic** groups, is taxonomic group that contains organisms evolved from different ancestors. For example, the group of warm-blooded animals is polyphyletic, because it contains both mammals and birds, but the most recent common ancestor of mammals and birds was cold-blooded. Warm-bloodedness evolved separately in the ancestors of mammals and the ancestors of birds.



Both **cladograms** and **phylogenetic trees** show the relationships between organisms, but their main difference is how they compare them. Cladograms are concerned with the way organisms are related to common ancestors through shared characteristics. Phylogenetic trees compare organisms over evolutionary time and the amount of change that has occurred over time to figure out the relationships. Both cladograms and phylogenetic trees are drawn using lines to show relationships. The difference is that the length of the lines in a phylogenetic tree represents time while the lines in cladograms are the same length.

**Chordates** are defined as organisms that possess a structure called a notochord, at least during some part of their development.

**Anatomy**: Is the study of the structures of the body of living things that are easily viewed with naked eyes.

**Comparative anatomy**: Is the study of the inherited similarities and differences among organisms in structural organization of the body. A comparison of anatomical features of different organisms often provides evidence to support the theory of evolution. Or Comparative anatomy is the study of the evolution of the complex morphological systems possessed by vertebrates.

**Analogous structure**: Are structures that have the same function, but not the same origin. E.g. wings are analogous structures in insects and birds.

**Homologous structure**: Are structures that have the same origin, but not the same function. E.g. vertebrate forearms, human appendix and tails of mammals vs. human coccyx.

**Vestigial organs (Structure)** are reduced and rudimentary organs compared to the same complex structure in other organisms. Human appendix useless and have tailbones.

**Histology**- also known as microscopic anatomy or microanatomy is the branch of biology which studies the microscopic anatomy of tissues.

**Cytology** - a branch of biology dealing with the structure, function, multiplication, pathology, and life history of cells.

**Ancestral** Describes a character that was possessed by the common ancestor of the species on a branch of an evolutionary tree.

**Evolution** is genetic change in a population of organisms over time.

**Natural Selection** is a process that produces descent with modification, or evolution.

**Adaptation**: - Processes that increase an organism's chances of survival and reproductive success in specified environment.

**Ontology**: - Evolutionary history of development, of the individual organisms.

**Protostomes** (in which the blastopore gives rise to the mouth)

**Deuterostomes** in which the blastopore gives rise to the anus, and the mouth arises through secondary invagination of the stomodaeum.

**Species** are groups of interbreeding natural populations that are reproductively isolated from other such groups.

- Type specimens should be placed in permanent archival collections (see below) where they can be examined by future researchers.
- 1- **Holotype** - is the original specimen used to describe a new species for the first time. There is only one holotype (single example illustration of an organism). {A holotype is not necessarily 'typical' of that taxon, although ideally it should be. Sometimes just a fragment of an organism is the holotype }
- 2- **Allotype** - is a specimen of the opposite sex used to describe the species for the first time (often, but not always, at the same time as the holotype).

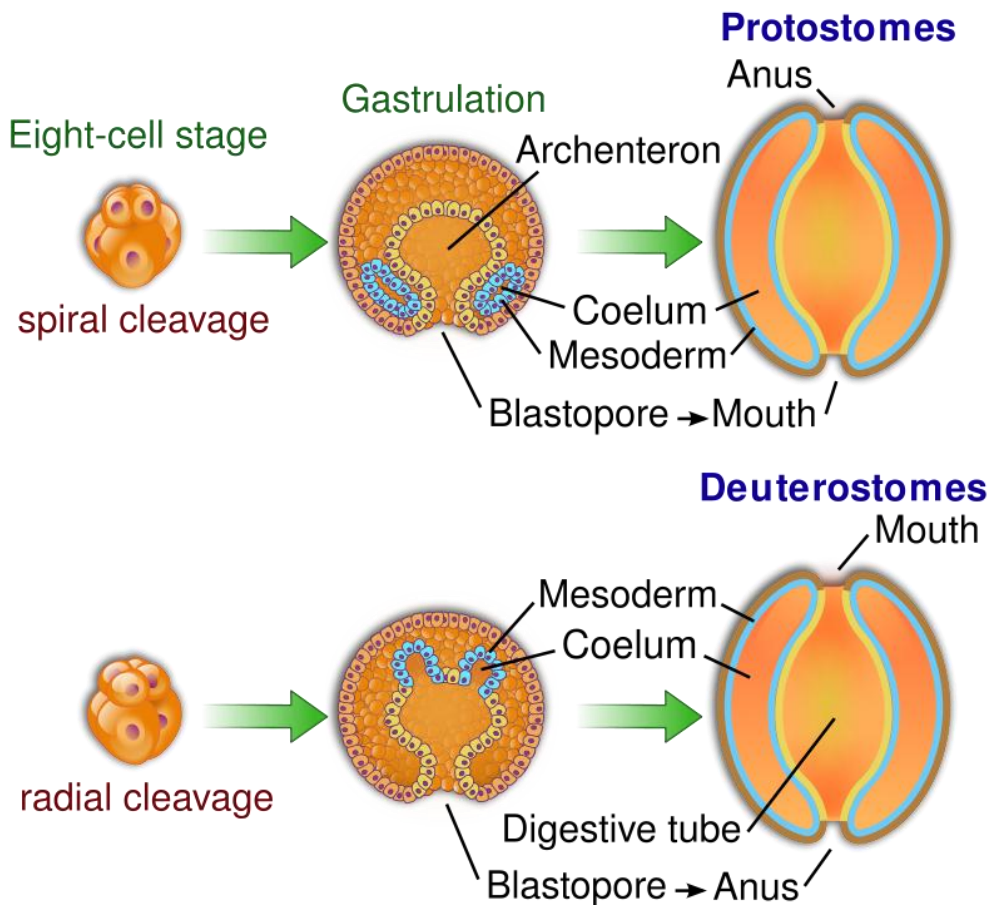
- 3- **Neotype** - is a replacement specimen for the holotype, where the original holotype has been lost, destroyed or was never designated.
- 4- **Paratype** - is a specimen of the original series from which *holotype*, has been selected as the type of a species.
- 5- **Syntype** (Cotype) is a collection of specimens that together serve as the definition of the species where a holotype was never selected.
- 6- **Isosyntype**: - A duplicate of a syntype.
- 7- **Lectotype** (Topotype) - is a single specimen of a syntype (series of specimens) selected to serves as the neotype of the species, where the species was previously defined by the syntype.
- 8- **Topotype** - A specimen of a plant collected from the same locality as the holotype and usually on a different date.
- 9- **Paralectotype** - are the specimens left over from the syntype (series of specimens) once the lectotype have been selected.

|    |                              |   |
|----|------------------------------|---|
| EX | <b>Extinct</b>               | No reasonable doubt that the last individual has died.  |
| EW | <b>Extinct in the wild</b>   | Known only to survive in captivity or as naturalized populations well outside its previous range.                             |
| CR | <b>Critically endangered</b> | The species is in imminent risk of extinction in the wild.  |
| EN | <b>Endangered</b>            | The species is facing an extremely high risk of extinction in the wild.   |
| VU | <b>Vulnerable</b>            | The species is facing a high risk of extinction in the wild.  |
| NT | <b>Near threatened</b>       | The species does not meet any of the criteria that would categories it as risking extinction but it is likely to do so in the |

|    |                       |   |
|----|-----------------------|---|
|    |                       | future.   |
| LC | <b>Least concern</b>  | There are no current identifiable risks to the species.                             |
| DD | <b>Data deficient</b> | There is inadequate information to make an assessment of the risks to this species. |

### Comparative anatomy established by:

- 1- Edward Tyson (1651-1708) Scientist and physician
- 2- Georges Cuvier (1769-1832) Paleontology
- 3- Lamarck (1744-1829) Zoology
- 4- Richard Owen (1804-1892) Anatomy
- 5- Louis Agassiz (1807-1873) Paleontology
- 6- Charles Darwin (1809-1882) Geology & Zoology
- 7- Alfred Russel (1823-1913) Zoology
- 8- Thomas Henry (1825-1895) Zoology







Tasmanian Tiger had been **extinct** since 1936 after the last known individual had died in Hobart Zoo, Tasmania.



The Guam rail (Kako) disappeared from southern Guam in the early 1970s and was **extinct** from the entire island by the late 1980s. This species is now being bred in captivity by the Division of Aquatic and Wildlife Resources on Guam and at some mainland U.S.



Western gorilla  
**Critical endangered**



The California condor is an **endangered** species.