2 Classification of Living Things

3.1 Purpose of Classification

3.1.1 Estimated Number of Species

1. Scientists have **estimated** that there are around **8.7 million** species of plants and animals in existence.
2. However, only around **1.2 million** species have been **identified** and **described** so far, most of which are insects.
3. One biologist **estimates** that for **each kind** of organism **now alive**, another **400 kinds once lived** but have since become **extinct**.
4. Therefore, as many as **one billion** (1,000,000,000) **different kinds** of living things may have **existed** on the earth at one time or another.

3.1 Purpose of Classification

3.1.2 Sorting Things is Human Nature

1. The **grouping** of **similar things** for a **specific purpose** is called **classification**.
2. For example, a **supermarket manager** classifies the foods in his/her store by storing all the cereals together, all the meats together, all the cookies together, and so on.
3. **Stamp collectors** classify their stamps as they place all the Canadian stamps in one page and all the American stamps in another, and like.
4. The words in a **dictionary** are classified by alphabetical listings.
5. Clearly, we classify things **to make it easier** (i) **to keep track of what we have**, and (ii) **to find particular items**.

3.1 Purpose of Classification

3.1.3 Reason for the Biological Classification

1. Living organisms are **classified** mainly:
   (i) to avoid confusion,
   (ii) to make study of organisms easy,
   (iii) to understand biodiversity better, and
   (iv) to learn about different kinds of plants and animals, their features, similarities and differences.
2. In our **surroundings**, we can see **different** types of **plants**, **insects**, **birds** and animals.
3. **Based on** certain **specialized features**, these living species have been **classified** into their respective categories.

3.2 Biological Classification

3.2.1 Aristotle's Classification System

1. **Aristotle** (300 BC) classified living things **based** on obvious and visible **physical** features.as either
   (i) **Plant**, which were green and did not move or
   (ii) **Animal**, which did move (**Figure 3.1**).

3.2 Biological Classification

Aristotle's Classification System Based on Visible Features

Socrates mentored Plato. Plato mentored Aristotle in philosophy and in the Macedonian village of Mieza, and Aristotle mentored Alexander the Great, who conquered the eastern Mediterranean, Egypt, the Middle East, and parts of Asia in a remarkably short period of time.

Aristotle: Born 384 BC Greece
Died: 322 BC Greece

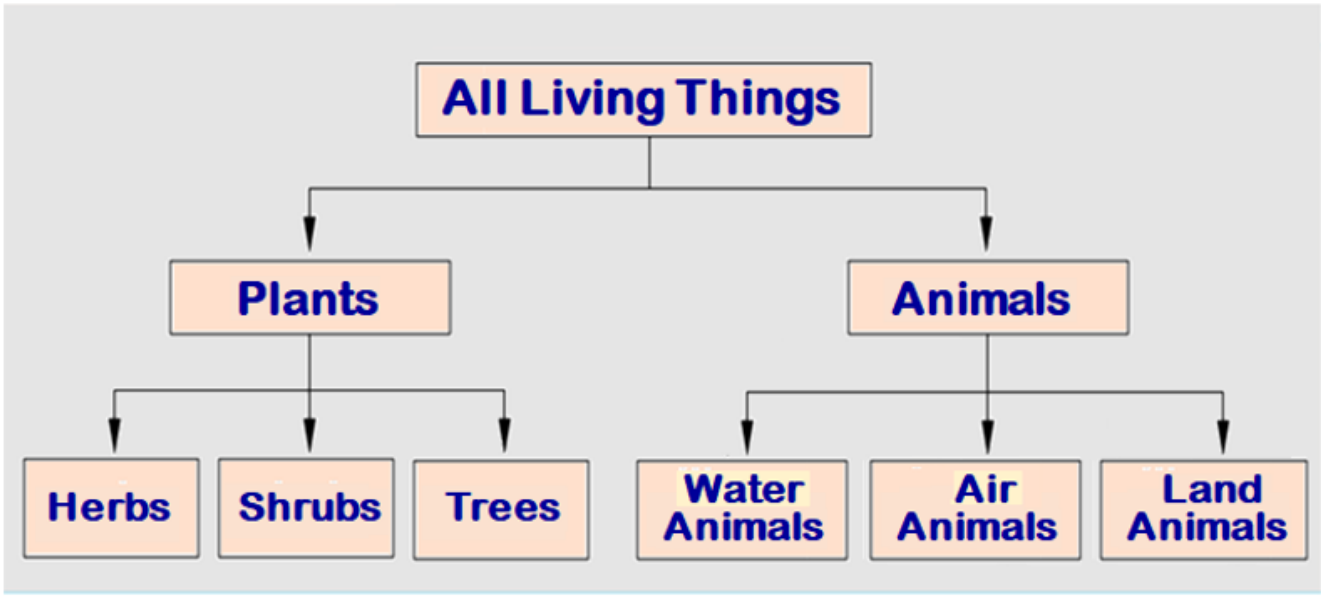


Figure 3.1: Aristotle's classification system based on obvious and visible physical features.

3.2 Biological Classification

3.2.1 Aristotle's Classification System

3. Aristotle then classified the **animals** according to **where they lived**, which resulted in **three groupings** (**Figure 3.2**):
   (i) **Water** or Aquatic Animals
   (ii) **Air** or Aerial Animals, and
   (iii) **Land** or Terrestrial Animals.

4. Aristotle classified the **plants** according to the **structure of stems** (**Figure 3.3**):
   (i) Those with soft stems were called **Herbs**,
   (ii) Those with many small woody stems were called **Shrubs**, and
   (iii) Those with a single large woody stem were called **Trees**.

3.2 Biological Classification

Figure 3.2: Aristotle classified the animals according to where they lived.

3.2 Biological Classification

Figure 3.3: Aristotle classified the plants according to the structure of stems.

3.2 Biological Classification

3.2.2 Linnaeus' Classification System

3.2.2.1 Taxonomy

1. **Taxonomy** (Greek '**taxis**' meaning '**arrangement**', and '**nomia**' meaning '**method**') is the science of **naming** and **classifying** living things according to their **similarities** and **differences**.
2. The Swedish botanist **Carolus Linnaeus** is regarded as the Father of Taxonomy (**Figure 3.4**).
3. **Carolus Linnaeus** developed:
   (i) a system known as **Linnaean classification** for categorization of organisms and
   (ii) a system known as **Binomial** nomenclature for naming organisms.

3.2 Biological Classification

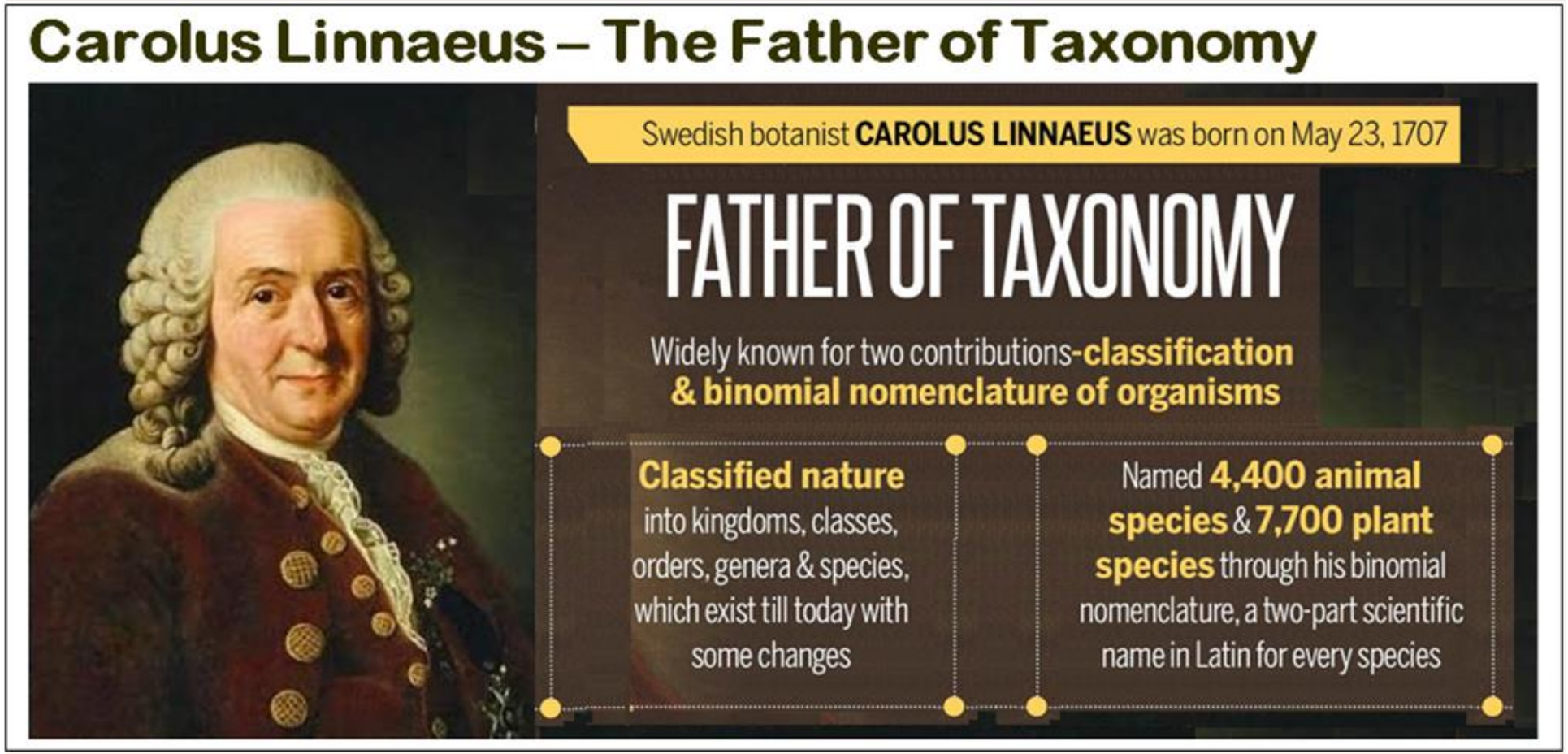


Figure 3.4: Carolus Linnaeus, the Father of Taxonomy, developed a system for classification and introduce the binomial nomenclature for naming organisms.

3.2 Biological Classification

3.2.2 Linnaeus' Classification System

3.2.2.2 The Basis for Linnaeus Classification

1. There seem to be so **many kinds** of living things and they seem to be so **different** from one another.
2. For example, at first glance a **lion**, a **horses**, a **mouse**, a **human**, and **mice** seem to have little in common (**Figure 3.5**).
3. A **closer look** however, shows that all have **hair**, a distinct **head**, **four limbs**, **two ears**, and **warm blood**.
4. **Linnaeus** decided to use **structural features** as the basis for his classification system.
5. These organisms with very similar structural features were considered to be the **same species**.

3.2 Biological Classification

Figure 3.5: At first glance lions, horses, humans, and mice seem to have little in common but they have many similar structural features.

3.2 Biological Classification

3.2.2 Linnaeus' Classification System

3.2.2.3 Binomial Nomenclature

1. **Linnaeus** also developed a system for **naming** them.
2. He gave each **species** a name that consists of **two words**, and therefore the system is called **binomial nomenclature**.
3. He used **Latin words** for these **names** because all scientists wrote in Latin in time of Linnaeus.
4. Thus, the **human** is ***Homo sapiens*** (Latin: wise man), and the domestic (house) **cat** is ***Felis domesticus*** (Latin: domestic cat).

3.2 Biological Classification

3.2.2.3 Binomial Nomenclature

5. The first word of each name is called the **genus** and the second word is called the **species**; the **genus** begins with a **capital letter** and the **species** does not.
6. The **genus** and **species** are either printed in **italics** or underlined.

3.2 Biological Classification

3.2.2 Linnaeus' Classification System

3.2.2.4 Importance of Scientific Names

1. One reason for using **Latin scientific name** instead of common names is that common names can be confusing or misleading.
2. These are used **locally** and may vary by region or country.
3. For example ***Puma concolor*** (Latin: matching coloured cat) is called a mountain lion, cougar, puma, panther, Yuma puma, Florida panther, eastern cougar, Wisconsin puma, Texas panther and many names (**Figure 3.6**).

3.2 Biological Classification

3.2.2.4 Importance of Scientific Names

4. The **common name** is also **misleading** as it specifies the name of the **number of species** in general and **does not denote** the name of the particular organism.
5. For example, the **fly** is a common name for the **Diptera** order members and this can **mislead** as to their number of flies such as **black**, **hand**, **sand**, etc. (see **Figure 3.6**).

3.2 Biological Classification

Figure 3.6: Common names are misleading because they are used locally and may vary by region (*Puma concolor*), and they do not denote the name of the particular species (fly).

3.3 The Genus and Species Concept

3.3.1 The Genus Concept

1. A **genus** (plural genera) is a group of species that are similar.
2. For example, **maple trees** belong to the genus ***Acer*** because their **leaves** and **other features** are similar but they not identical (**Figure 3.7**).
3. Thus **sugar maple** (*Acer saccharum*), **silver maple** (*Acer saccharinum*), and **red maple** (*Acer rubrum*) belong to the same genus *Acer*.

3.3 The Genus and Species Concept

Figure 3.7: A genus is a group of species that are similar in many ways.

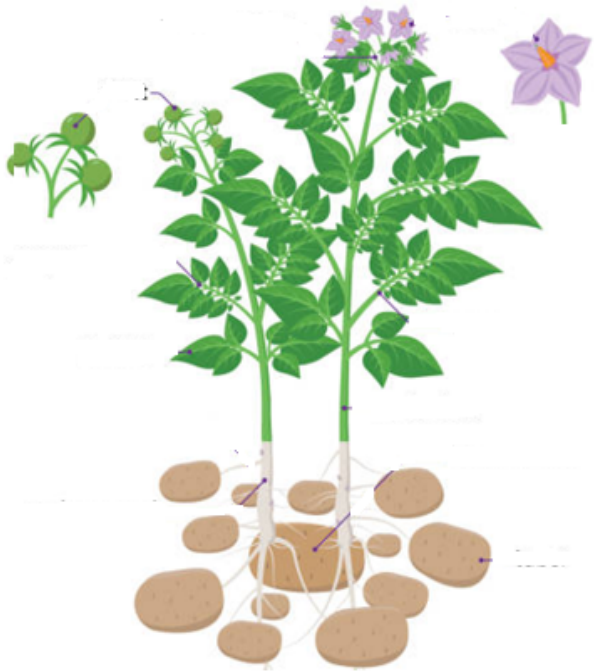
3.3 The Genus and Species Concept

3.3.2 The Species Concept

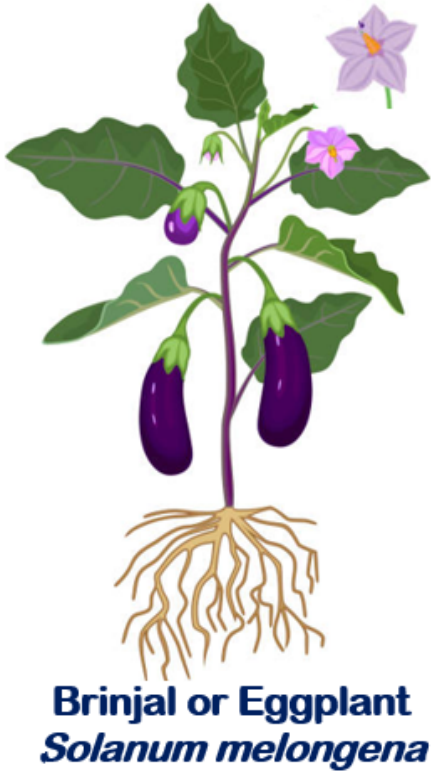
1. **Linnaeus** grouped as a **species** those organisms that he felt were very similar in structural features.
2. In simple terms, a single species is a **distinct kind** of organism, with a characteristic shape, size, behaviour, and habitat that remains constant from year to year.
3. A **species** (plural also species) is defined as a group of individuals that are **alike** in many ways and **interbreed** under natural conditions to produce fertile **offspring** (children).
4. **Potato** (*Solanum tuberosum*) and the **eggplant** or brinjal or egg plant (*Solanum melongena*) belong to the **same genus** because they are **similar** in many ways (**Figure 3.8**).

3.3 The Genus and Species Concept

Species is a Group of Organisms That are Interbreeding



Potato
Solanum tuberosum



Brinjal or Eggplant
Solanum melongena

Eggplant and potato belong to the same genus Solanum, but belong to different species namely *Solanum melongena* and *Solanum tuberosum*.

Eggplant and potato belong to the same genus Solanum because both of them show the common characteristics found in the plants of the genus Solanum, like Phyllotaxy (arrangement of leaves, venation, inflorescence etc.

The main criterion for defining two different species is that they cannot cross reproduce or interbreed and produce fertile offspring.

Figure 3.8: A species is a group of individuals that are alike and interbreed under natural conditions to produce fertile offspring.

3.4 Modern Basis for Classification

3.4.1 Homologous Structure

1. The **homologous structures**, just as **Linnaeus** did, are structures that **show** (i) the **same basic pattern**, (ii) the **same general relationship** to other parts, and (iii) the **same pattern** of development (**Figure 3.9**).
2. However, they **need not** have the **same function**.
3. For example, the **human arm**, the **whale flipper**, and the **bat's wing**, all these appendages are homologous structures that show the same basic pattern.
4. Regardless of whether it is an arm, flipper or wing, these structures are built upon the **same bone structure**.

3.4 Modern Basis for Classification

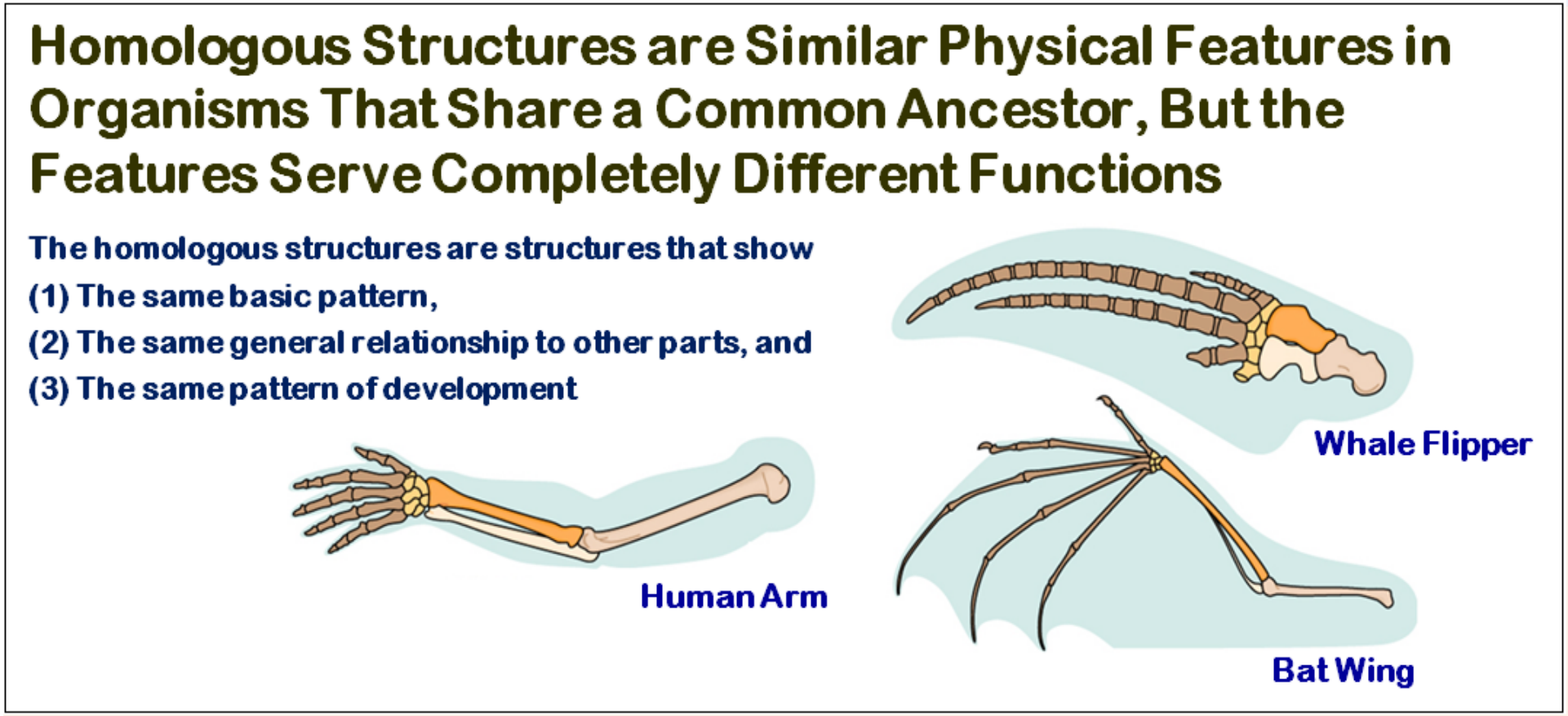


Figure 3.9: Homologous structures are similar physical features in organisms that share a common ancestor, but the features serve completely different functions.

3.4 Modern Basis for Classification

3.4.2 Similar Biochemistry

1. **Biochemistry** is the study of the chemical compounds formed by living things.
2. Many biologists believe that **closely related** organisms form similar chemical compounds in their body and they use this belief to **help classify** organisms.
3. For example, the **horseshoe crab** was, at one time, classified as a close relative of the true crab (**Figure 3.10**).
4. However, chemical analysis showed that its **blood** was more like spider's blood than crab's blood.
5. Thus, the **horseshoe crab** is now classified as a close relative of **spiders**.

3.4 Modern Basis for Classification

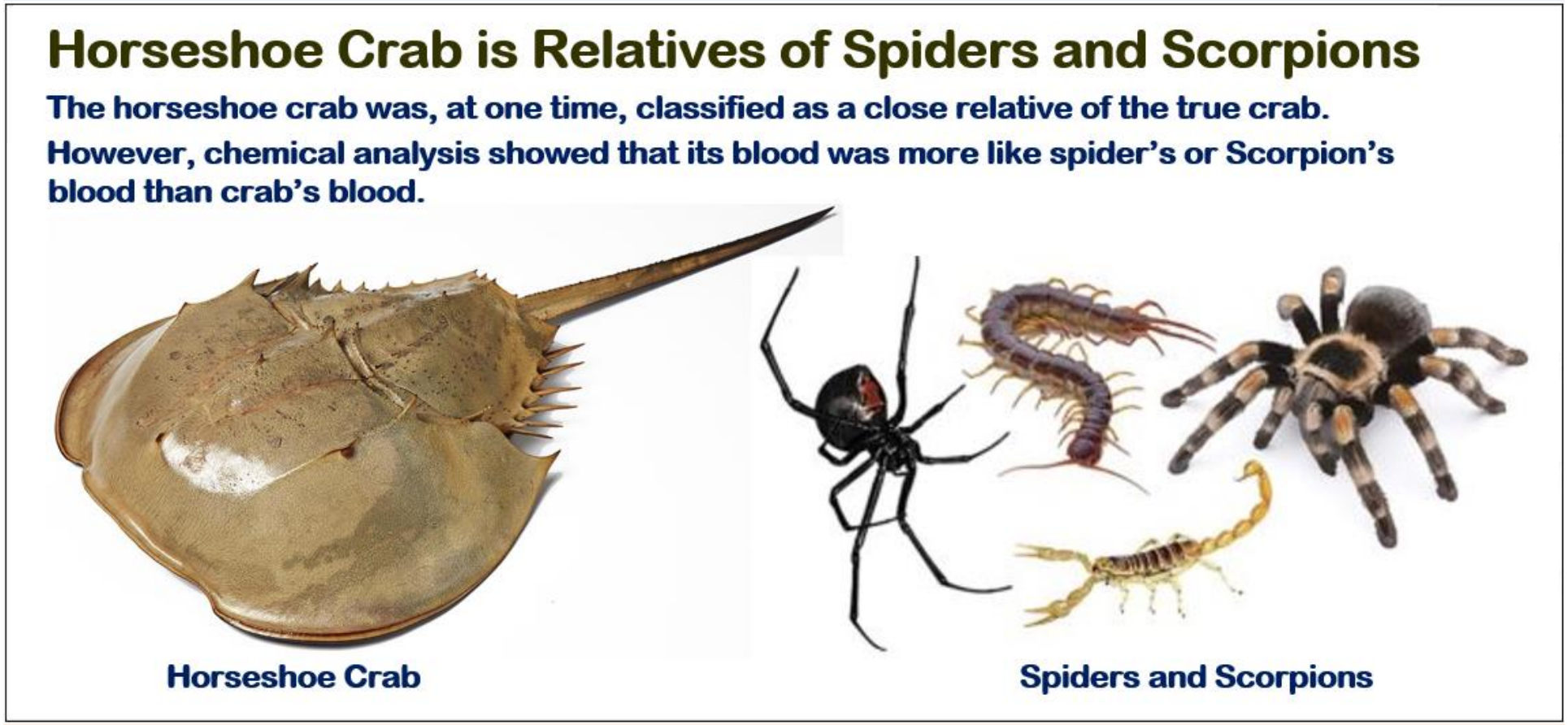


Figure 3.10: Despite the common name horseshoe crab, it is not a crab but an arthropod and their closest living relatives are spiders and scorpions.

3.4 Modern Basis for Classification

3.4.3 Genetic Similarity

1. Most biologists agree that **DNA** or **genetic similarity** is the best evidence that organisms are closely related.
2. Thus it seems reasonable to assume that the **greater** the **similarity of DNA** among organisms, the more **closely** they may be related.
3. All **human beings** are **99.9** percent identical in their genetic makeup (**Figure 3.11**).

3.4 Modern Basis for Classification

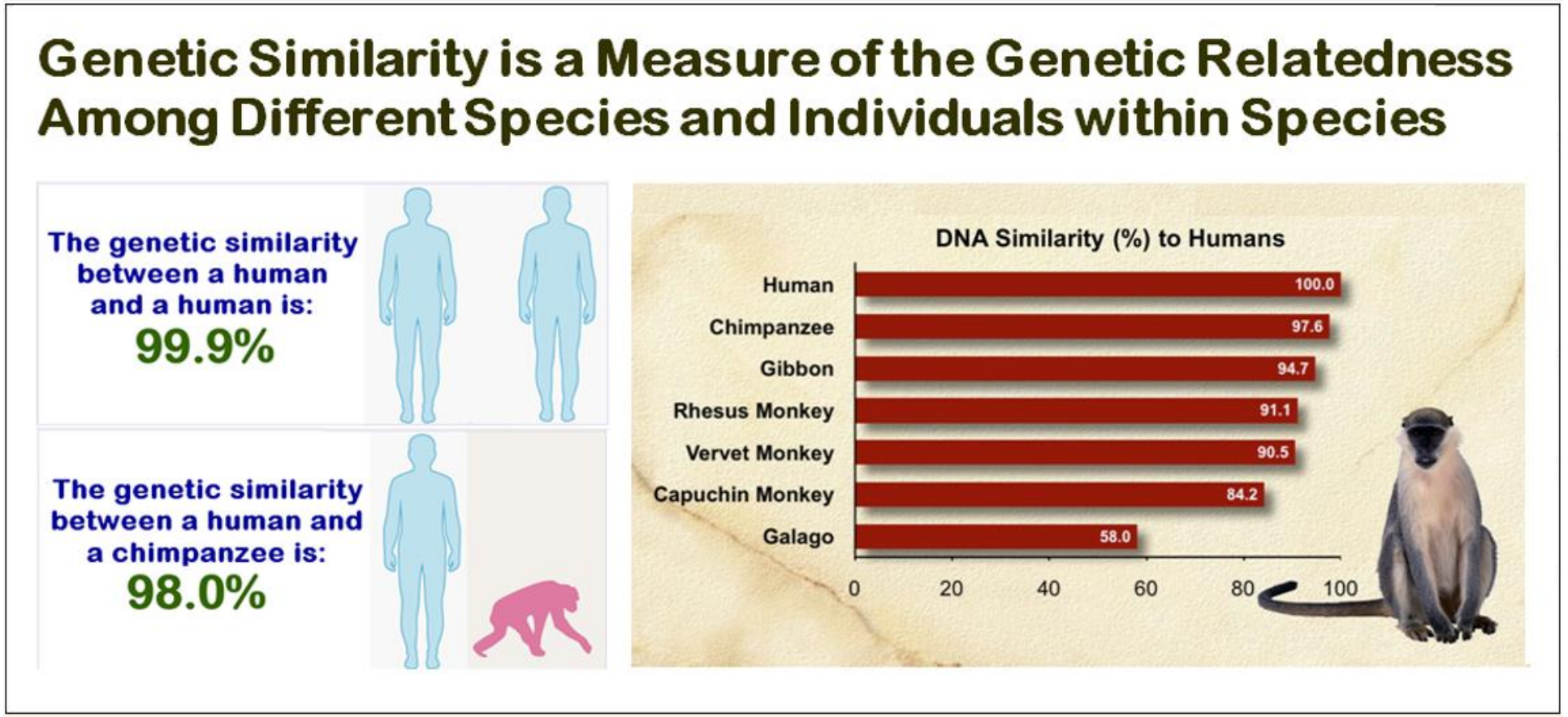


Figure 3.11: Genetic similarity is a measure of the genetic relatedness among different species and individuals within species.

3.5 Classification Scheme

3.5.1 The Main Classification Groups (Taxa)

1. There are seven main taxa (singular taxon) or classification groups (**Figure 3.12**).
2. **Species:** Species (plural also species) is a group of individuals that are alike in many ways and interbreed under natural conditions to produce fertile offspring (children).
3. **Genus:** Genus (plural genera) is a group of species that are closely similar in structure and evolutionary origin.
4. **Family:** Family is a group of similar kinds of genera, *i.e.*, similar genera are grouped to form a taxon called Family.
5. **Order:** Similar families are grouped to form a taxon called Order.

3.5 Classification Scheme

3.5.1 The Main Classification Groups (Taxa)

6. **Class:** Similar orders are grouped to form a taxon called Class.
7. **Phylum or Division:** Similar classes are grouped to form a taxon called Phylum or Division; zoologists favour phylum and botanists favour division.
8. **Kingdom:** All the divisions that contain animals are grouped in the kingdom Animalia, and all the phyla or divisions that contain plants are grouped in the kingdom Plantae.

3.5 Classification Scheme

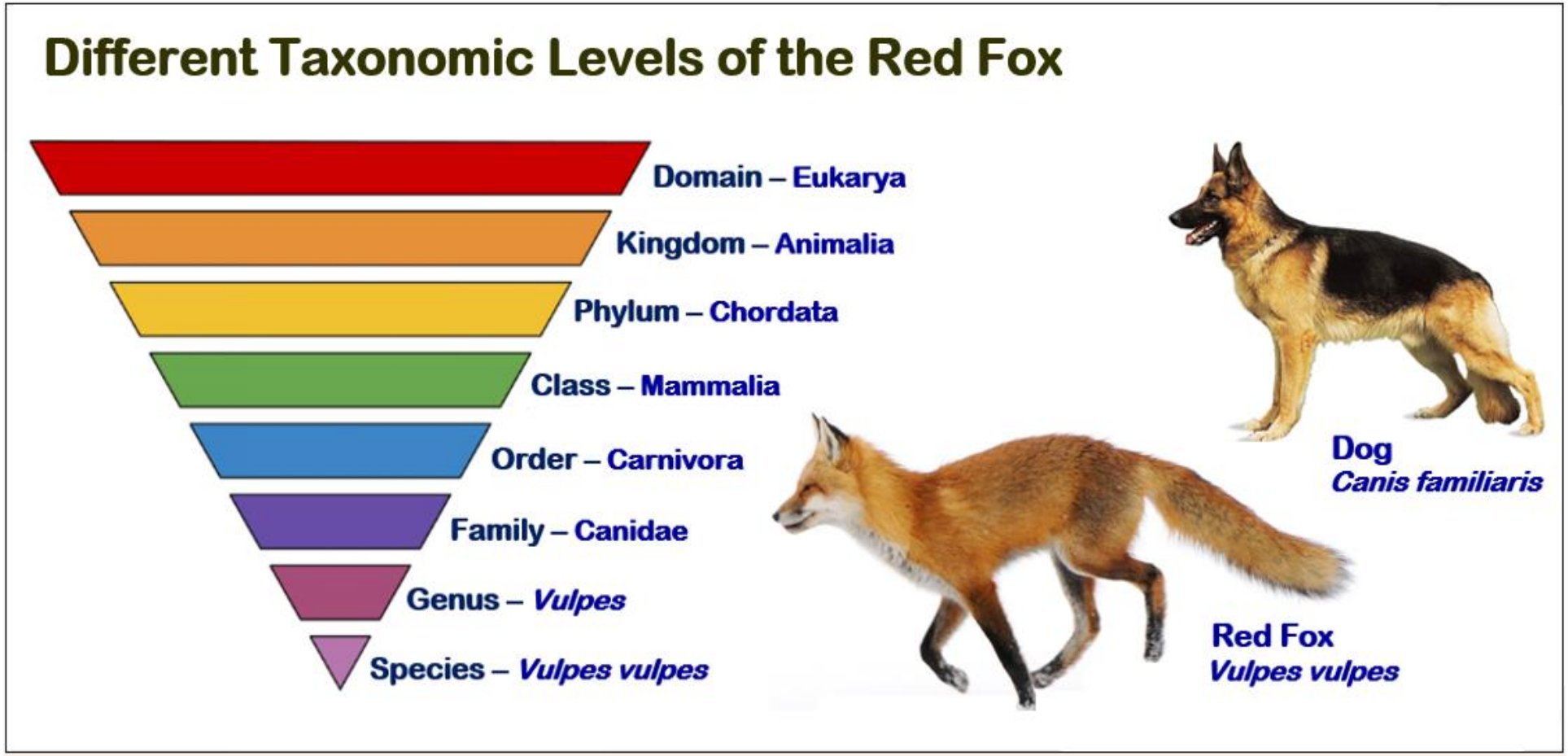


Figure 3.12: Different taxonomic levels of the red fox.

3.5 Classification Scheme

3.5.2 Five Kingdom Classification System

1. It became very difficult to group some living things into plants and animals, so early in the past century the two kingdoms were **expanded** into **five** kingdoms (**Figure 3.13**):
   (i) **Monera** (the prokaryotes),
   (ii) **Protista** (the single-celled eukaryotes),
   (iii) **Fungi** (fungus and related organisms),
   (iv) **Plantae** (the plants),
   (v) **Animalia** (the animals).
2. The **five-kingdom** system was developed by **Robert H Whittaker** in 1969 and was built on the work of previous biologists such as Carolus Linnaeus.

3.5 Classification Scheme

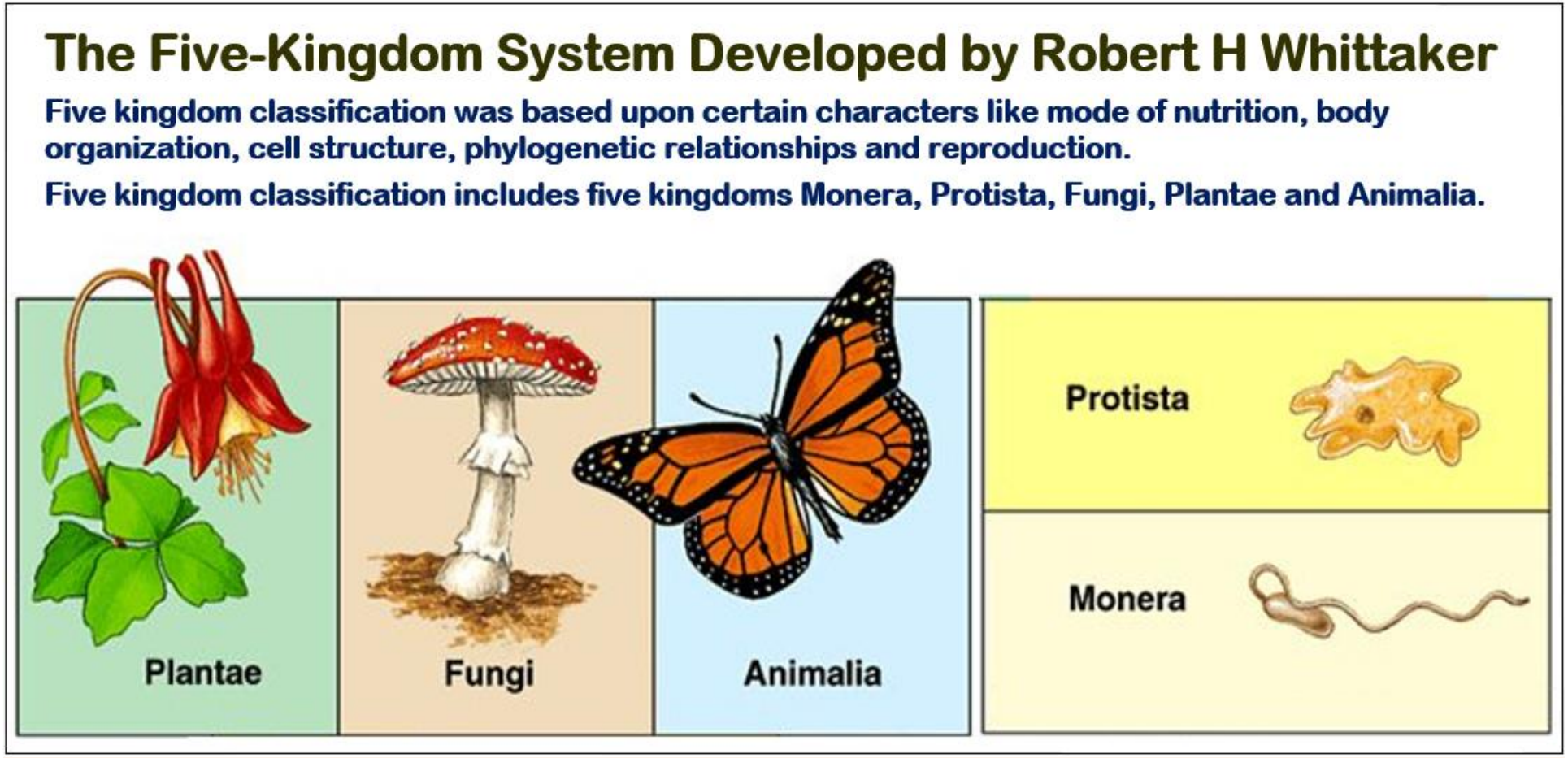


Figure 3.13: The five-kingdom system was developed by Robert H Whittaker.

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