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BIOLOGY

THE LIVING WORLD

TAXONOMIC HIERARCHY

NOTES

Key Takeaways

- Need for classification of living organisms
- Systematics
- Cladistics
- Neosystematics
- Taxonomy
- Steps of taxonomy
  - Characterisation and identification
  - Nomenclature
    - Monomial nomenclature
    - Binomial nomenclature
    - Trinomial nomenclature
    - Polynomial nomenclature
  - Classification
- Taxonomic categories
  - Kingdom
  - Phylum
  - Class
  - Order
  - Family
  - Genus
  - Species

Need for Classification of Living Organisms

Need for classification

- About 15,000 new organisms are discovered every year.
- Thousands of organisms are yet to be identified and described.
- It is impossible to study each and every individual.
- It is difficult to remember their names, characters, and uses.

Biologists have devised techniques for **identification, naming,** and **grouping** of various organisms depending upon the extent of **similarities** and **dissimilarities** as per certain rules.

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Systematics

- It is the **study of diversity of organisms** and their comparative and evolutionary relationships.
- Systematics originated from Latin word **Systema**, meaning order or sequence.
- The term was coined by **C. Linnaeus**.
- Through systematics, study of one organism gives information about the whole group.

C. Linnaeus

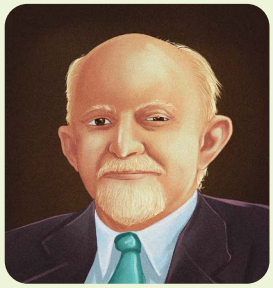
Taxonomy

- As defined by **A.P. de Candolle** in **1813,**
  - The branch of science that deals with the study of **principles and procedures of biological classification** is known as taxonomy.

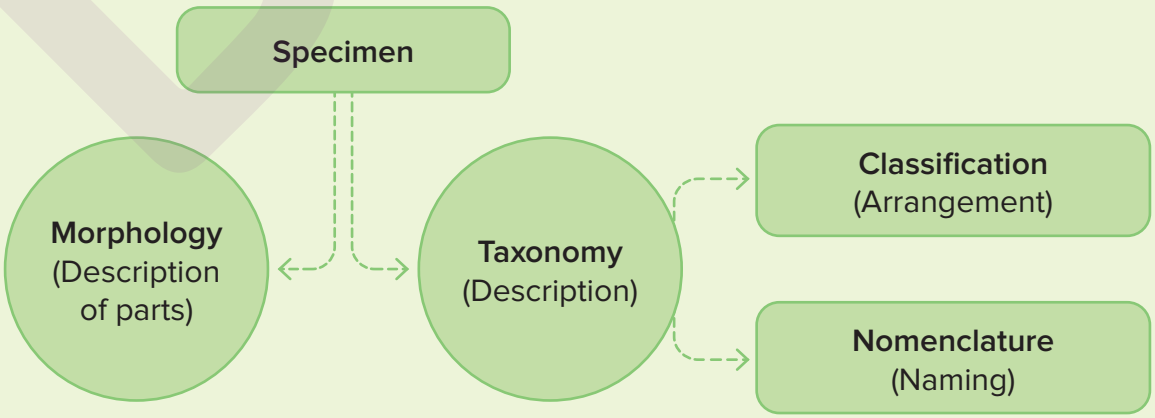
A.P. de Candolle

Difference between Taxonomy, Systematics, and Classification

- Classification, systematics, and taxonomy are often **used interchangeably**.
- According to **G. Simpson,**
  - **Classification** is a **subtopic of systematics** that deals with ordering of organisms into groups.
  - **Taxonomy** is the study of principles and procedures of **classification**.



G. Simpson



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- **Differences between taxonomy and systematics are as follows:**

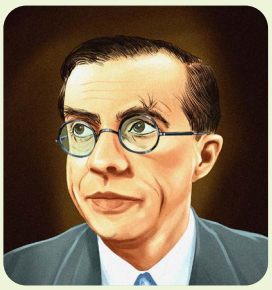
	Taxonomy	Systematics
Definition	Process of classification	Includes taxonomy and nomenclature
Importance	Identifies, names, and describes organisms	Describes evolutionary relationships between organisms
Abiotic conditions	It is indirectly related	It is directly related
Change with time	Subject to change with time	Does not change with time

Cladistics

- It is the classification of organisms according to the **historical order** in which the **evolutionary branches arose**.
- Cladistics gave rise to **new systematics, neosystematics,** or **biosystematics**.

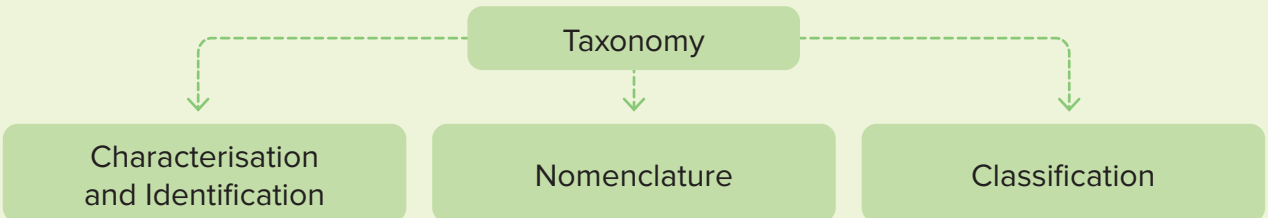
Neosystematics

- The concept was developed by **Sir Julian Huxley** in 1940.
- It is a concept of systematics that considers a species to be the product of evolution.
- It takes into consideration all the known characteristics of organisms and evidence from different fields of biology.
- **Principles** and **techniques** of neosystematics
  - **Species are not isolated**
    - They are related amongst themselves by a common descent and differ from each other due to accumulation of different variations.
  - **Population systematics**
    - Main stress is laid upon subspecies and populations instead of species.
  - **Use of statistical data**
    - It is used to determine primitiveness or advancement of a species.



Sir Julian Huxley

Steps of Taxonomy



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Characterisation and identification

- It involves the **identification** and **characterisation** of an **unknown organism** by comparing it with known organisms.
- It is done with the help of **taxonomical aids**.
- **Identification** is the process of finding the correct name of an organism and placing it in the classification system.

Nomenclature

- It is the process of providing **distinct and proper names** to organisms as per the established universal practices and rules, so that they can be easily **recognised and differentiated** from others.
- **Two types of names** given to organisms are:
  1. **Common or Vernacular names**
     - Naming of organisms started with the appearance of language in human civilisation.
     - Common names are **local names** that are given to the animals and plants in a **particular language** and region by **local people**.
     - Example:

Kannada: Mavina mara
Tamil: Maanga maram
Hindi: Aam ka ped
English: Mango tree

     - **Characteristics of vernacular names are as follows:**
       - These are based on **some peculiarity** of the organisms.
         - Examples: Kandiali and Dodhak
       - These are usually **single word names** and are hence **uninomial**.
       - These are brief names, which are **easy to pronounce** and **remember**, and are given by residents of an area.
     - **Disadvantages of vernacular names are as follows:**
       - Common names **differ from region to region** and language to language.
       - An organism may have **several names** in a given language.
       - A common name may have **different meanings** in different areas.
       - A wrong common name **cannot be easily corrected**.
  2. **Scientific nomenclature**
     - **Characteristics of scientific names**
       - These are **accepted** all over the world.
       - These are based on agreed principles and criteria.
       - They ensure that **only one name** is given to an organism and description of the organism helps other people to arrive at the same name in any part of the world.
       - Each kind of organism representing a species is given a different name to distinguish it from the other.

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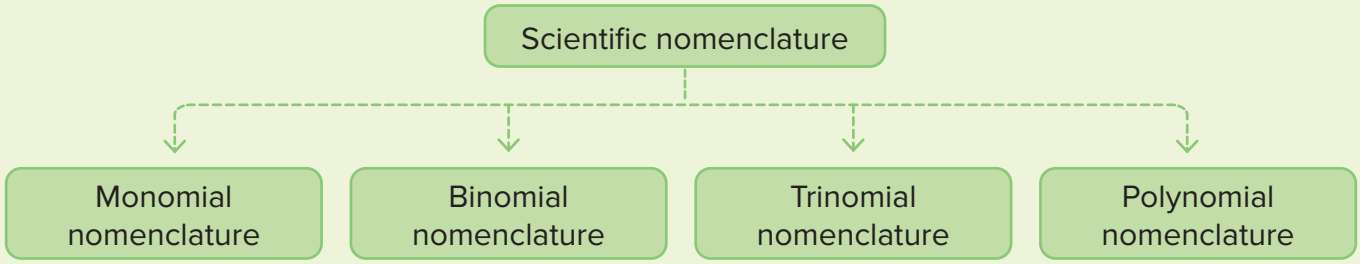

(a) Monomial nomenclature

- One word was used to name organisms.
- Drawback: It became difficult to come up with unique names as more and more organisms were discovered.

(b) Trinomial nomenclature

- To recognise subspecies within a species
- Each name had the following three parts:
  - First part indicated the genus
  - Second part indicated the species
  - Third part indicated the subspecies

Example: *Corvus splendens splendens* (Indian crow)

- Drawback: Lack of justification for subspeciation

(c) Polynomial nomenclature

- It involves more than two names.
- Example: *Ranunculus, callicebus retroflexis pedunculis falcatis caule erecto folius compositis*. Roughly meaning the 'buttercup with reflexed sepals, curved flower stalks, erect stem, and compound leaves'.
- Drawbacks are as follows:
  - Not standardised
  - Cumbersome to remember

(d) Binomial nomenclature

- It is the most accepted system.
- It was proposed by **Carolus Linnaeus**.
- He was known for two works, namely *Species Plantarum* (1753) for plants and *Systema Naturae* (1758). These two books are used in naming plants and animals, respectively.
- In *Systema Naturae*, using the binomial nomenclature system, he named 4,400 animal species and 7,700 plant species.
- Two terms are used to name a species of living organism in this system.
  - Generic name
  - Specific epithet

Example: *Mangifera indica* (Mango)

Uses of nomenclature

- It gives a single scientific name to replace multiple vernacular names.
- Description of any organism enables people to arrive at the same name.
- It ensures that a name has not been used for more than one known organism.

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The Rules for Nomenclature

- Biological names are **generally in Latin**. They are Latinised or derived from Latin irrespective of their origin.
- The first word in a biological name represents the **genus**, while the second component denotes the **specific epithet**.
- Both the words in a biological name, when handwritten, are separately underlined or printed in italics to indicate their Latin origin.
- The first word denoting the genus starts with a capital letter, while the specific epithet starts with a small letter.
  Example: *Mangifera indica* Linn.
- Name of the discoverer, in full or in abbreviated form, is written at the end of the biological name. Mango, for example, was first described by Linnaeus and thus Linn. is added at the end of the biological name.
- Binomial along with the name of the author is referred as **Binomial Epithet**.
- Maximum and minimum number of alphabets in genus and species is **12 and 3, respectively**.
- If the name of a species consists of two words, then they **are joined by putting a hyphen (-) between them**.
  Example: *Hibiscus rosa-sinensis* (china rose/shoe flower)

- Principle of priority is followed.
  - The **first valid published name is accepted as binomial** and rest are considered as **synonyms**.

There are 5 different organisations for naming different organisms.

- International Code of Botanical Nomenclature (ICBN) for naming plants
- International Code of Zoological Nomenclature (ICZN) for naming animals
- International Code of Viral Nomenclature (ICVN) for naming viruses
- International Code of Bacteriological Nomenclature (IC Bac N) for naming bacteria
- International Code of Nomenclature for Cultivated Plants (ICNCP) for naming cultigens

Did you know?

Tautonyms

- When names of genus and species are the same, they are not accepted in ICBN but accepted in ICZN.
- Examples: *Malus malus* (apple), *Rattus rattus*

Homonyms

- They are illegitimate.
- A single name is given to two different organisms.
- Example: *Prunus dulsi* (Almond, Plum)

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Almond

Plum

Classification

Early classifications were based on the uses of various organisms.

Early classification system was not very efficient.

Basis of **Modern Classification System**

- External characteristics
- Development process
- Structure of cell
- Ecological information of organisms

Taxonomic Categories/Hierarchy

Taxon

- **Taxon** is a group of one or more populations of an organism or organisms. It can refer to any category in the hierarchy of classification systems.
- The word taxon signifies a taxonomic group of any rank that represents the real biological organisms included in a category.
  - *mays* (species)
  - *roses* (genus)
  - grasses (family)
  - conifers (order)
  - dicots (class)
  - seed plants (division)
- The term was introduced for animal groups by **Adolf Meyer**.
- **H. S. Lam** first proposed the term taxon for plants.
- There is some confusion in the use of taxon and category.
  - ***Zea mays* is a taxon**, while species is a category.
  - Category represents an **abstract term**, while taxon represents the **real organisms**.

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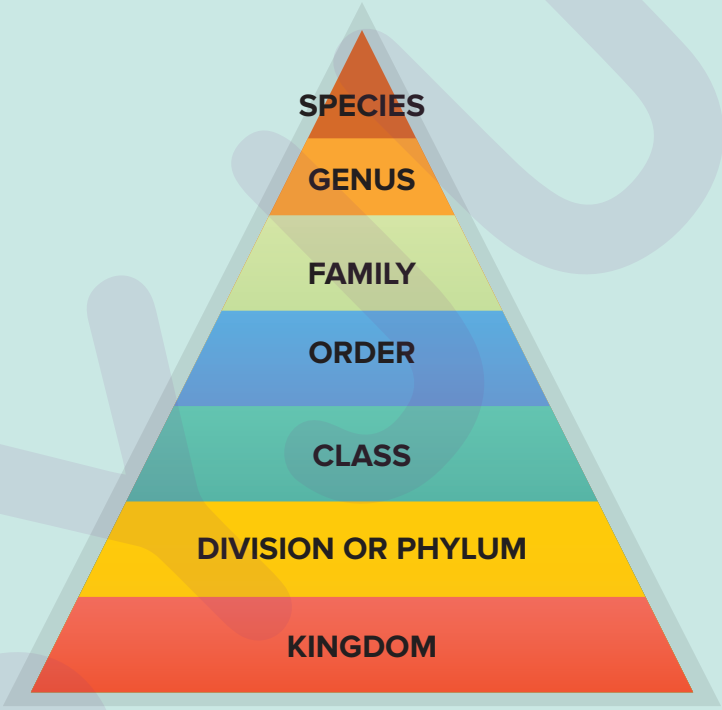
Taxonomic hierarchy

- It is also known as **Linnaean hierarchy** because it was first proposed by Linnaeus.
  - Linnaeus first used only **five categories**.

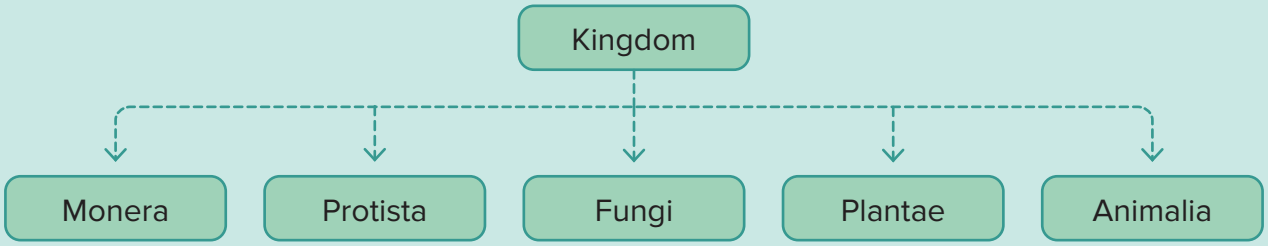
Class
Order
Genus
Species
Variety

- Later, the last one was discarded and three more were added. Now, there are **seven obligate categories**.



Kingdom

- It is the highest category of classification in which certain common fundamental characters are used as the basis of classification.
- Example: Kingdom Animalia comprises organisms that are multicellular, heterotrophic, and eukaryotic.
- **R.H Whittaker** came up with a **five-kingdom classification** that is widely accepted today.



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Phylum/Division

- A phylum is a category below kingdom, where classification is based on common features. Organisms in a phylum share the same set of characteristics that distinguishes them from another phylum.
- The category phylum is known as **division** in the kingdom Plantae.
- Example:

- Example: **Kingdom Animalia > Phylum Chordata**

Class

- This is the category below phylum.
- Category between phylum and class is **subphylum.**
- Category between subphylum and class is a **superclass**.
- A super class is composed of one or more classes, and ranks below a subphylum.
- Example: **Kingdom Animalia > Phylum Chordata (has notochord) > Subphylum Vertebrata > Class Pisces and Aves**
- **Human beings** fall under the class **Mammalia**.

Order

- This is the category that comes below class. A group of closely related orders form a class.
- Example:

  Kingdom Animalia > Phylum Chordata (has notochord) > Subphylum Vertebrata > Superclass Tetrapoda (bears four limbs) > Class Mammalia > Order Primate or Primates

- Another example is the order Carnivora, which comprises flesh eating animals like tiger, cat, and dog.

Family

- This category is below order.
- A group of closely related families form an order.
- Example:

  Kingdom Animalia > Phylum Chordata (has notochord) > Subphylum Vertebrata > Superclass Tetrapoda (bears four limbs) > Class Mammalia > Order Primate > Orangutan Family Hominidae and Subfamily Ponginae

Genus

- It is the category below family and forms the first word of a scientific name.
- Category below family but above genus is a subfamily.
- A group of closely related species form a genus.
- Example:

  Kingdom Animalia > Phylum Chordata (has notochord) > Subphylum Vertebrata > Superclass Tetrapoda (bears four limbs) > Class Mammalia > Order Primate > Family Hominidae > Subfamily Ponginae > Genus *Homo*

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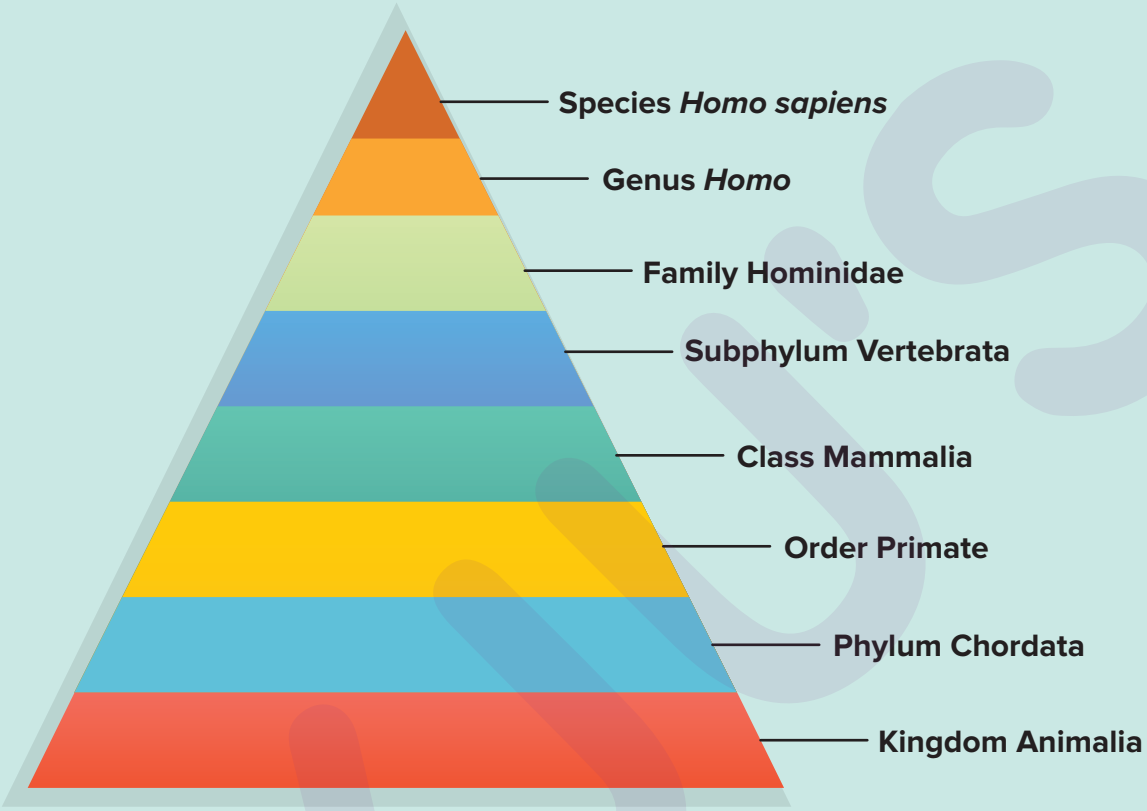
Species

- It is the lowest category of classification and forms the second word of a scientific name.
- Example: Taxonomic hierarchy of human beings



Benefits of taxonomy

- Helps in categorisation of organisms for ease of study.
- Compares similarities and dissimilarities between organisms.
- Shows evolutionary relationships.
- Same name is used for an organism worldwide.
- Gives knowledge of bioresources and their diversity.

Summary Sheet

Need for classification

- About 15,000 new organisms are discovered every year.
- Thousands of organisms are yet to be identified and described.
- It is impossible to study each and every individual.
- It is difficult to remember their names, characters, and uses.

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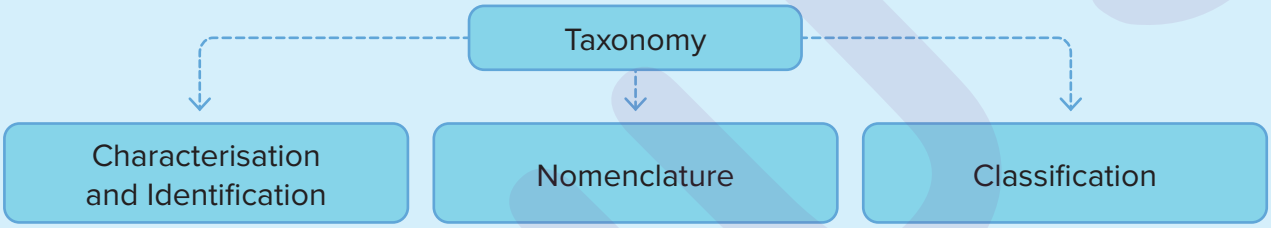
Systematics: It is the **study of diversity of organisms** and their comparative and evolutionary relationships.

Taxonomy: It is the branch of science that deals with the study of **principles and procedures of biological classification.**

Cladistics: It is the classification of organisms according to the **historical order** in which the **evolutionary branches arose**.

Neosystematics: It is a concept of systematics that considers a species to be the product of evolution.



Nomenclature

Nomenclature is the process of naming a particular organism, such that it is known by the same name all over the world.

Trinomial nomenclature

Trinomial nomenclature uses three words in a name to recognise the genus, species, and subspecies.

Polynomial nomenclature

Polynomial nomenclature is a system that involves more than two names to define an organism.

Monomial nomenclature

Monomial nomenclature is the type of nomenclature in which one word is used to name organisms.

Binomial nomenclature

Binomial nomenclature uses two terms for each name to denote the generic name and the specific epithet of an organism. This system was given by **Carolus Linnaeus.**

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International Code of Botanical Nomenclature (ICBN) for naming plants

(ICBN)

(ICZN)

International Code of Zoological Nomenclature (ICZN) for naming animals

There are **5 different organisations** for naming different organisms

(ICVN)

International Code of Viral Nomenclature (ICVN) for naming viruses

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(IC Bac N)

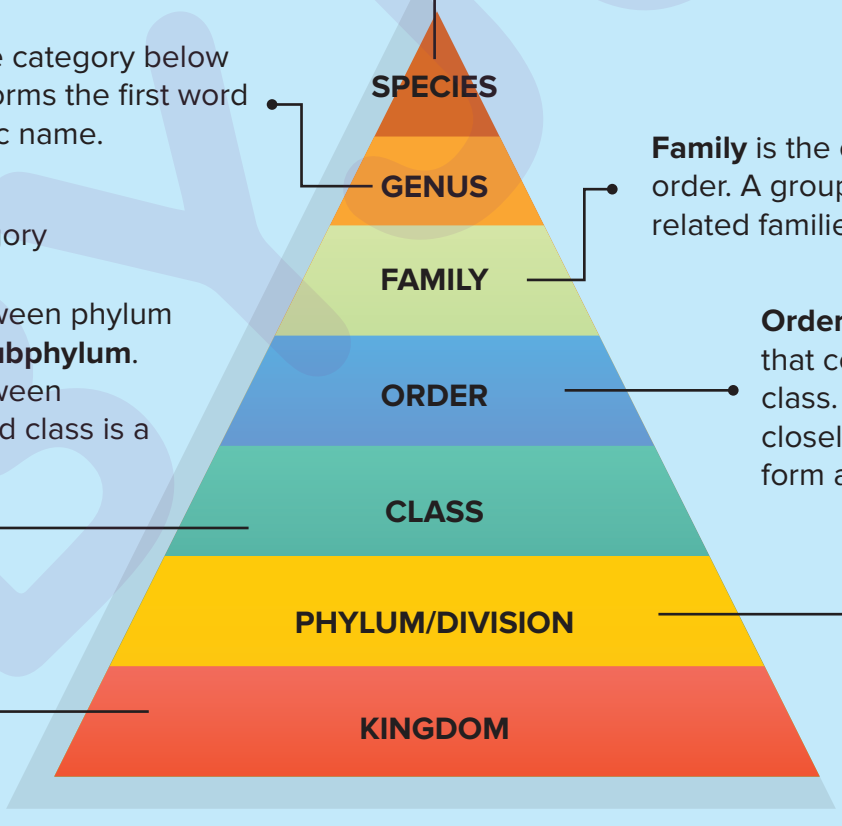
International Code of Bacteriological Nomenclature (IC Bac N) for naming bacteria

Taxonomic Categories

It is also known as the **Linnaean Hierarchy** as it was first proposed by Linnaeus.

Species is the lowest category of classification and forms the second word of a scientific name.

Genus is the category below family and forms the first word of a scientific name.



Family is the category below order. A group of closely related families form an order.

Class is the category below phylum.

- Category between phylum and class is **subphylum**.
- Category between subphylum and class is a **superclass**.

Order is the category that comes below class. A group of closely related orders form a class.

Kingdom is the highest category of classification in which certain common fundamental characters are used as the basis of classification.

A **phylum** is a category below kingdom, where classification is based on common features. Phylum is known as division in kingdom Plantae.

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