Classification System in Biology

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⇒ Important Terms Related to classification/ Taxonomy:

① Nomenclature:- It is the process of giving scientific names to the organisms.

② Classification:- It is the process of grouping animals and plants into convenient categories on the basis of certain observable traits.

③ Identification:- It is the determination of correct position of an organism in the classification.

④ Taxonomy:- It is the study of the process of classification.

⑤ Systematic:- This includes the identification, nomenclature and classification of organisms based on various parameters.

⇒ History of classification:-

① Hippocrates:- classified animals into various groups like insects, fishes and birds, ..etc.

② Aristole:- father of zoology/ Biology.

③ Theophrastus:- father of Botany.

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(4) Carrolus Linnaeus - father of Taxonomy.
Book — Genera plantarum and species (1753).

Role of Nomenclature

(1) In binomial nomenclature each scientific name has two components —

(i) Generic name (Genus)
(ii) specific name / epithet (Species).

(2) Generic name :— Capital letter.
Specific name :— small letter.

(3) Both Generic & specific names - Sberately underlined or given in Italic to show their Latin origin.

(4) Generic name — usually a noun.
Specific name — usually an adjective.

(5) Specific name of the organism is generally followed by the name of the person.
If the specific name is given in the honour of a male → name ends with 'i'
for female - name ends with 'ae'.

(6) Tautonym:- It is the binomial name in which the name of genus and species are the same.

(7) Julian Huxley:- Introduced the term new - systematics.

(8) Whittaker (1969):- Introduced 5-kingdoms classification.

Species:- According to the biological concept of the species they can be defined as group of natural population of animals and plants, whose members can be interbreed among themselves and reproductively isolated from other such groups.

↳ Basic unit of biological classification.

↳ 1.2 million animal species.

↳ 0.5 million plants species.

↳ classification parameters — morphology, biochemical metabolic reactions and genetic evolution.

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⇒ History And Types of classification

① Artificial system of classification :-

↳ All taxonomists from Aristole to Linnaeus, classified Organisms on the basis of-
- (i) External observable (morphological).
- (ii) floral structure
- (iii) Root modification
- (iv) Leaf venation
- (v) Phylogenetic relationship
- (vi) Habit and Habitats.

② Natural system classification :-

↳ uses more number of character.
↳ Based on natural affinities using homology and comparative study.
↳ Bentham - Hooker - used this classification for angiosperms (seed producing plants).

③ Numerical Taxonomy (Phenetics) or Quantitative taxonomy :-

↳ uses numerical methods for evaluating the similarities and differences b/w the species
↳ This ceses max^m number of character.
↳ This system uses computer analysis.
↳ Adansonian system of classification.

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(4) Phylogenetic classification (cladistics):-

↳ Based upon evolutionary relationship and also uses morphological characters origin and evolution.
↳ family tree ⟶ cladogram.
↳ Proposed by Hutchinson.
↳ A. Engler and K. Prantl published 'phylogenetic system of classification' in plants.

(5) Karyotaxonomy:-

↳ classification based on chromosome number, structure of chromosome, size, and shape of chromosomes and the behavior of chromosomes during meiosis.

(6) Chemotaxonomy:-

↳ Based on chemical products, particularly secondary metabolism.

(7) Experimental taxonomy:-

↳ Relationship is determined by the genetics and breeding experiments.

(8) Biochemical taxonomy:-

↳ based on biochemistry of various chemicals like harmones and pharmones, etc.

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(9) New systematics :-

↳ covers systematic studies considering evolutionary relationship and other parameters like molecular biology, cytology, genetics, biochemistry, etc.

* Plants classification :→ International code of Botanical Nomenclature (ICBN).

* Animals classification :→ International code of zoological Nomenclature (ICZN).

Basic concepts of Taxonomic Hierarchy :-
There are seven basic categories of Hierarchy :-

1. Kingdom
2. phylum (in animal) / division (in plants)
3. Class
4. Order
5. family
6. Genus
7. Species

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(1) Species:-

↳ lowest category in basic taxonomic hierarchy.

↳ Maxm common characteristics with other species under the same genus.

↳ In genus Panthera, there are several species.

(2) Genus:-

↳ Group of a closely related species.

↳ The taxon genus has more common characteristics with other genera than the higher rank.

(3) family:-

↳ Group of closely related genera, and has less common characteristics than species or genus rank.

(4) Order:-

↳ A higher taxon and is the assemblage of families having similar characteristics.

(5) Class:-

↳ Group of related order.

↳ The lizards, birds and cattle belog to class Reptilia.

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(6) Phylum :- The classes with similar features are grouped into phylum share very few common characteristics with other phyla.

↳ Common characteristics :- Phylum chordata are dorsal tubular nervous system Notochord, Annelida, Arthropoda and Mollusca, etc.

(7) Kingdom :- The phyla are grouped into still broader categories called kingdom.

Eg- of Taxonomy of humans.

Common Name	-	Human
Biological Name	-	Homo spapiens
phylum	-	Chordate
class	-	Mammalia
order	-	Primates.
family	-	Hominidae.
Genus	-	Homo

⇒ Concept of classification :-

↳ Great diversity in structure
↳ cellularity
↳ Habitat
↳ Mode of nutrition of different organisms.

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① Cellularity

↳ An organism cab be unicellular or multicellular.

↳ Number of cells decide the structure, metabolic functions and other parameters of organisms

⇒ Difference b/w unicellular or Multicellular. org.

Characteristics	unicellular org.	Multicellular org.
① cell number	single cell	Many cells
② function	All functions performed by single cell.	Different cell different function-
③ Division of Labor	Not performed	cell specified to perform diff. functions.
④ Reproduction	Involves the same single cells	Germ cells take part in Reproduction.
⑤ Life span	short	Long.

② Ultra structure

↳ On the basis of internal structure of cell of an organism, cells can be divided into prokaryotes & Eukaryotes.

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⇒ Differences b/w Prokaryote & Eukaryote.

Prokaryote	Eukaryote
(1) Circular DNA in cytosol.	(1) Linear DNA in nucleus.
(2) No organelles.	(2) Several membrane bound organelles.
(3) Nucleoid (not memb.)	(3) Nucleus (membrane bound).
(4) Single chromosome.	(4) several chromosome.
(5) Plasma membrane without Receptors.	(5) Plasma membrane with receptors.
(6) Chemically complex cell wall.	(6) Chemically simple cell wall.
(7) DNA transcription and RNA translation occurs simultaneously.	(7) DNA transcription in nucleus & RNA translation in ~~cytot~~. Cytosol.
(8) flagellum (If present) simple, built from two proteins.	(8) Flagellum (If present) complex, built from microtubules.
(9) May have pili and fimbriae.	(9) May have cilia.
(10) Haploid genome (only one copy of each gene).	(10) Diploid genome (more than one copy of each gene).
(11) May have plasmids (DNA outside chromosome)	(11) plasmid DNA not common.
(12) Compact genome (little repetitive DNA)	(12) usually large amounts of non-coding & repetitive DNA.
(13) May have a glycocalyx cover.	(13) Glycocalyx only if no cell wall.
(14) Small Ribosomes.	(14) Large ribosomes in cytosol/nucleus Small ribosomes in organelles.

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Prokaryotes	Eukaryotes
(15) No histones in chromosomes.	(15) DNA wound around histones.
(16) Lacks cytoskeleton.	(16) Cytoskeleton.
(17) Mycolaginous capsule.	(17) No mycolaginous capsule.
(18) Cell size range (0.5–100) mm.	(18) Cell size 10–150 mm.
(19) Asexual reproduction.	(19) Sexual reproduction.

(3) Energy and carbon utilization

↳ On the basis of energy & carbon utilization, the organisms are divided into three types —

① Autotrophes.
② Heterotrophs.
③ Lithotrophes.

— Carbon Sources :—

(i) Autotrophs :— CO_2 sole.
(ii) Heterotrophs :— Reduced, performed, organic molecules from other organisms.

— Energy Sources :—

(i) Phototrophs :— Light.
(ii) Chemotrophs :— Oxidation of organic or inorganic compounds.

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Hydrogen and Electron Sources:-

(i) Lithotrophs :- Reduced inorganic molecules.

(ii) Organotrophs :- Organic Molecules.

* Producers :- Plants
* Consumers :- Animals
* Decomposers :- fungus, insects, etc.

Role :- The role of a decomposer is to decompose or break down dead matter in the environment. Plants make their own food by photosythesis and also produce food for other consumers. Without producers an ecosystem could not sustain itself.

* Herbivores :- eat only producers.
* Carnivores :- eat only other consumers.
* Omnivores :- eat both producers & consumers.

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(4) Ammonia Excretion

↳ Animals can also divided on the basis of their excretory material which is related to their habitat and body metabolism.

↳ There is no pathway for nitrogen excretion in plants.

↳ The mayor excretory material in animal is nitrogen.

↳ On the basis of excretion animals can be divided into three-types.↵

(i) Ammonotelic animals:— excrete amino nitrogen as ammonia. eg- aquatic species, bony fishes ..etc.

(ii) Ureotelic animals:— excrete amino nitrogen in the form of urea.
eg- most terrestrial animals.

(iii) Uricotelic animals:— excrete amino nitrogen as uric acid.
eg- birds, reptiles ..etc.

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⇒ Classification based on ammonia excretion:-

waste	Advantage	Disadvantage	Habitat	Excreted by
① Ammonia	Produced with little water.	Toxic in conc? Require a lot water for excretion.	water	Marine & fresh water Invertebrates bony fish, amphibians.
② Urea	Less toxic than ammonia Require less water for excretion.	Require little more energy to produce it.	Land, sea	Turtles, mammals, Adult amphibians.
③ uric acid	very little water is Required for excretion.	Require considerable energy to produce it.	land	Reptiles, birds, Insects.

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(5) Habitat :- Aquatic and Terrestrial animals.

⇒ Differences b/w aquatic & Terrestrial animals-

Aquatic animals	Terrestrial Animals
(1) Lives in water ~~on land~~	(1) Lives on Land.
(2) Respire through gills & their skin.	(2) Respire through lungs or traches.
(3) Streamline bodies, fins, webbed feet and air bladder.	(3) legs, waterproof skin, feathers, covered eggs, kidneys.
(4) Skin is slimy, slippery and soft.	(4) Skin is leathery, hard and spiny.

= Terrestrial plants :- Plants grow on land.
eg - trees, smaller plants like sugarcane, rice, cotton, .. etc.

= Aquatic plants :- underwater plants.
↳ These have narrow leaves without any stomata.
↳ They breathe through water and clean it. eg - tape grass, pond weed, etc.

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Molecular basis of classification of organisms :-

Carl Woese et al. classified organisms into three domain and six kingdoms on the basis of sequence of ribosomal RNA genes.

3- Domain And 6- Kingdoms

* I- Domain Bacteria

① Kingdom Eubacteria :- unicellular and prokaryotic with peptidoglycan. eg- bacteria.

* II- Domain Archea

② Kingdom Archea :- unicellular & prokaryotic without peptidoglycan. eg- Aeropyrum pernix.

* III- Domain Eukarya.

③ Kingdom protista :- unicellular / multicellular an eukaryotic. eg- protozoa.

④ Kingdom fungi :- unicellular / multicellular, eukaryotic and decomposers., eg- fungus.

⑤ Kingdom plantae :- Multicellular, eukaryotic and Autotrophic. eg- flowering plants.

⑥ Kingdom Animalia :- Multicellular, eukaryotic, and heterotrophic. eg- Vertebrate, insects. etc

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Model Organisms

A model organisms is a species that have been widely studied usually because it is easy to maintain and bread in a laboratory and has particular experimental advantages.

⇒ Property of model organisms:—

1. Easy to grow and maintain in a restricted space.
2. Short generation time.
3. well understand growth & development.
4. Easy to provide necessary nutrients for growth.
5. closely resemble other organisms.

⇒ Different types of Modal Organisms:—

(1) Genetic model organisms.

(i) Good candidate for genetic analysis.

(ii) Breed in large number, short generation time.

eg - Drosophila.

(2) Experimental model organisms

(i) Good candidate for research in developmental biology.

(ii) produce robust embroys that can be easily manipulated & studied.

eg - frog.

(3) Genomic model organisms.

(i) Good candidate for genome research.

(ii) Easy to manage genomes. eg - Small genomes size or limited number of repeats. Geome is similar to human.

eg - Rat.

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① Mammalian models:—

↳ Mouse (Mus musculus).
↳ Rat (Rattus norvegicus).

② Non-mammalian models:—

↳ Bacterium (Escherichia coli).
↳ Baker's yeast (saccharomyces cerevisiae).
↳ Nematode (Caenorhabditis elegans).
↳ fruit fly. (Drosophila melanogaster).
↳ zebra fish (Danio rerio).

③ plant model:—

↳ Arabidopsis thaliana.

① E. coli

↳ It is used to studying fundamental aspects of biochemistry, and molecular biology.

↳ Most of our present concepts of molecular biology — DNA, genetic code, gene expression and protein synthesis come from the study of E. coli.

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⇒ Some reasons to make E.coli model organism are:—

(i) It is a single-celled organism so it is simple to study.
(ii) Life cycle is short.
(iii) Easily grown
(iv) Easily genetically manipulated.

(2) Mouse (Mus - musculus)

↳ The mouse has developed into the premier mammalian model system for genetic research.
↳ Its close genetic and physiological similarities to humans.
↳ Its geome can be manipulated and analyzed.

⇒ Reasons:—

(i) These are small, maintained easily and have a short life span.
(ii) All new drugs, treatments are tried on mice.
(iii) Their genetics, biological characters resemble humans.

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(3) fruit fly (Drosophila Melanogaster):-

↳ It is a ~~versd~~ versatile model organism.
↳ Used in biomedical research.

⇒ Reason or technical advantages :-

(i) Relationship b/w humans genes and fruit fly genes is close.
(ii) 75% of genes that cause human diseases are found in fruit fly.
(iii) Short life span. (8-14) days.
(iv) Inexpensive to maintain.
(v) Simple diet needing some carbohydrates and some proteins.
(vi) Easy to manipulate gene in fruit fly.

(4) Yeast (saccharomyces cerevisiae):-

↳ Simplest eukaryotic organisms.
↳ Many essential cellular processes are the same in yeast & humans.
↳ Used to study basic molecular processes in humans.

⇒ Reasons :-

(i) Easy to manipulate in the lab.
(ii) Cell division is similar way to our cells.
(iii) 20% of gene causing diseases are found in yeast.

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(iv) Many drugs are tested on yeast which have functional equivalent of mutated human genes to reverse the disease.

(5) Nematode (Caenorhabditis Elegans) :-

↳ Approx 1mm in length and transparent

⇒ Reasons :-

(i) Easily grow in labs on nutrient medium.
(ii) produces over thousand eggs per day.
(iii) Worm is transparent so its cells can be easily studied.
(iv) Easy to study nervous system of human.
(v) Genes can be easily mutated.
(vi) Many genes have functional counterparts in human so diseases can be easily studied.

(6) A. thaliana (Arabidopsis thaliana) :-

↳ It is small flowering plant that is widely used as a model organism in plant biology.
↳ Arabidopsis is a member of the mustard family.

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Mb → Megabase.

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⇒ Reasons:-

(i) It has a small geome (114.5 Mb / 125 Mb total).
(ii) Short life span — 6-weeks.
(iii) Easily cultivated.
(iv) Mutation can be easily produced in this plant.