

UPSC - CSE

Civil Services Examinations

Union Public Service Commission

General Studies

Paper 3 – Volume - 3

SCIENCE & TECH



<u>IAS</u>

G.S. PAPER - 3 VOLUME - 3

SCIENCE & TECH

S.No.	Chapter Name	Page No.
1.	Biology	1
	Organisms	
	 Hierarchy of Classification- Groups 	
	 5 Kingdom classification 	
	 Microorganisms 	
	 Animals 	
	• Cell	
	 Cell Structure and its components 	
	 Types of Cells 	
	 Plant and Animal Cells 	
	 Animal Cell 	
	 Nucleus 	
	o Cilia	
	o Shape	
	 Chloroplast 	
	Cytoplasm Factoria Patric I are	
	Endoplasmic ReticulumRibosomes	
	and the second s	
	MitochondriaVacuole	
	• Tissues	
	TissuesTypes of Tissues	
	 Animal Tissues 	
	• Life	
	Life processes	
	Nutrition	
	o Respiration	
	Breathing and Respiration	
	Transportation	
	 Human circulatory system 	
	 Transportation in plants 	
	Excretion	
	Reproduction	
	Control and Coordination	
	o In animals	
	Genetics	
	Human anatomy	
	 Muscular System 	
	 Skeletal System 	

Immunity & Immune SystemParts of immune system

o Disorders of the Immune System

	o Disease	
	 Causative Agent 	
	 Transmission 	
	o Affect on	
	o Details	
	 Diseases Caused By Bacteria 	
	 Diseases Caused By Viruses 	
	 Diseases Caused By Protozoans 	
	 Diseases Caused By Fungi 	
2.	Chemistry	71
	Matter	
	Atoms & molecules	
	 Chemical bonds 	
	Chemical Reactions	
	o Equilibrium	
	Acids and Bases	
	o Indicators	
	o Acids	
	o Bases	
	o Salts	
3.	Physics	84
	• Motion	
	Work and Energy	
	• Force	
	 Gravity 	
	 Mass 	
	 Weight 	
	Electricity	
	Magnetism	
	• Optics	
	• Sound	
4.	Space Technology	99
	• Fundamentals	
	Geo Imaging Satellite or GISAT	
	Space Pollution	
	Launch Vehicles	
	Propellants used in Space Vehicles	
	Space Organizations	
	Major international Space Missions	
5.	Biotechnology	120
•	Relevance	
	Genetic Engineering	
	DNA or deoxyribonucleic acid	
	Comparison of DNA and RNA	
	DNA sequencing	
	DNA Sequencing DNA Bar coding	
	 DNA bar coung DNA Fingerprinting or DNA typing, DNA profiling, genetic fingerprinting, 	
	genotyping, or identity testing	
	Gene Editing Environmental Biotochnology	
	 Environmental Biotechnology 	

Diseases

	•	Forest Biotechnology	
	•	Bioprocess/fermentation technology	
	•	Biotechnology in India	
	•	mRNA Technology	
6.	Nan	otechnology	139
	•	History of Nanotechnology	
	•	Generations of Nanotechnology	
	•	Types	
		Dry nanotechnology	
		 Wet nanotechnology 	
	•	Nanomaterial	
	•	Applications of Nanotechnology	
		Nanomedicine	
		 Semiconductors and Computing 	
		o Food	
		o Textiles	
		 Sustainable Energy 	
		 Environment 	
		 Transport 	
		o Space	
		 Carbon nanotubes 	
		o Graphene	
		 Quantum dots 	
		Nanobots (Nano + robot)	
		o Agriculture	
	•	Adverse Impacts of Nanotechnology	
	•	Nanotechnology in India	
	•	Government efforts towards this field	
7.	Com	nputer & Information Technology	151
	•	Information technology (IT)	
		 Information and Communication Technology 	
	•	Computing	
		 Super Computing 	
		 Indian Supercomputers 	
	•	Internet	
		o Types of Networks	
		 Internet Protocols 	
	•	Digital Communications	
	•	Mobile Technology	
		 Various generations of Digital Communication 	
		 IPTV (Internet Protocol television) 	
	•	Laser Technology	
		 Recent advances in Laser Technology field in India 	
		 Laser-Based Clad Technology 	
	•	Cloud Architecture	
		o Models	
		Cloud Computing	
	•	Internet of Things	
		Technologies involved	
		o Applications	
		 Measures taken by Indian Government 	

	 Recent Advances 	
	Optical Fibre	
	 Components of an Optical Fibre cable 	
	 Optical Fibre Communication 	
	Wireless Technology	
	 Different kinds of Wireless Technologies 	
	 Bluetooth 	
	 WiFi (Wireless Fidelity) 	
	Recent Advances in India	
	○ Li-Fi (Light Fidelity)	
	Crypto Technology-Blockchain Technology	
	o Bitcoin	
	Artificial Intelligence	
	 Subsets under AI 	
	o Types of Al	
	 Applications of Al 	
	 Pros and Cons of Al 	
	 Government Initiatives 	
	• Robotics	
	 Applications 	
	Quantum Computing	
	 India and Quantum Computing 	
	3-D Printing or Additive Manufacturing	
	 3D Printing Technologies 	
	 Aspects of 3D printing 	
	3D Printing in India	
8.		181
8.	o 3D Printing in India	181
8.	3D Printing in IndiaNuclear Technology	181
8.	 3D Printing in India Nuclear Technology Nuclear energy 	181
8.	 3D Printing in India Nuclear Technology Nuclear energy Nuclear fission 	181
8.	 3D Printing in India Nuclear Technology Nuclear energy Nuclear fission Nuclear fusion 	181
8.	 3D Printing in India Nuclear Technology Nuclear energy Nuclear fission Nuclear fusion Nuclear fuel Production of Nuclear fuel Radiation 	181
8.	 3D Printing in India Nuclear Technology Nuclear energy Nuclear fission Nuclear fusion Nuclear fuel Production of Nuclear fuel 	181
8.	 3D Printing in India Nuclear Technology Nuclear energy Nuclear fission Nuclear fusion Nuclear fuel Production of Nuclear fuel Radiation Types Of Radiation need more content types Radioactivity 	181
8.	 3D Printing in India Nuclear Technology Nuclear energy Nuclear fission Nuclear fusion Nuclear fuel Production of Nuclear fuel Radiation Types Of Radiation need more content types 	181
8.	 3D Printing in India Nuclear Technology Nuclear energy Nuclear fission Nuclear fusion Nuclear fuel Production of Nuclear fuel Radiation Types Of Radiation need more content types Radioactivity Other types of Radioactivities Nuclear waste management 	181
8.	 3D Printing in India Nuclear Technology Nuclear energy Nuclear fission Nuclear fusion Nuclear fuel Production of Nuclear fuel Radiation Types Of Radiation need more content types Radioactivity Other types of Radioactivities 	181
8.	 3D Printing in India Nuclear Technology Nuclear energy Nuclear fission Nuclear fusion Nuclear fuel Production of Nuclear fuel Radiation Types Of Radiation need more content types Radioactivity Other types of Radioactivities Nuclear waste management 	181
8.	 3D Printing in India Nuclear Technology Nuclear energy Nuclear fission Nuclear fusion Nuclear fuel Production of Nuclear fuel Radiation Types Of Radiation need more content types Radioactivity Other types of Radioactivities Nuclear waste management Classification of Radioactive Waste Processes for management of radioactive waste Nuclear programmes in India 	181
8.	 3D Printing in India Nuclear Technology Nuclear energy Nuclear fission Nuclear fuei Production of Nuclear fuel Radiation Types Of Radiation need more content types Radioactivity Other types of Radioactivities Nuclear waste management Classification of Radioactive Waste Processes for management of radioactive waste Nuclear programmes in India India's Three Stage Nuclear Power Programme 	181
8.	 3D Printing in India Nuclear Technology Nuclear energy Nuclear fission Nuclear fusion Nuclear fuel Production of Nuclear fuel Radiation Types Of Radiation need more content types Radioactivity Other types of Radioactivities Nuclear waste management Classification of Radioactive Waste Processes for management of radioactive waste Nuclear programmes in India India's Three Stage Nuclear Power Programme Nuclear Reactors in India 	181
8.	 3D Printing in India Nuclear Technology Nuclear energy Nuclear fission Nuclear fuei Production of Nuclear fuel Radiation Types Of Radiation need more content types Radioactivity Other types of Radioactivities Nuclear waste management Classification of Radioactive Waste Processes for management of radioactive waste Nuclear programmes in India India's Three Stage Nuclear Power Programme 	181
8.	 3D Printing in India Nuclear Technology Nuclear energy Nuclear fission Nuclear fusion Nuclear fuel Production of Nuclear fuel Radiation Types Of Radiation need more content types Radioactivity Other types of Radioactivities Nuclear waste management Classification of Radioactive Waste Processes for management of radioactive waste Nuclear programmes in India India's Three Stage Nuclear Power Programme Nuclear Reactors in India List of Operational Nuclear Power plants List of under construction nuclear power plants 	181
8.	 3D Printing in India Nuclear Technology Nuclear energy Nuclear fission Nuclear fusion Nuclear fuel Production of Nuclear fuel Radiation Types Of Radiation need more content types Radioactivity Other types of Radioactivities Nuclear waste management Classification of Radioactive Waste Processes for management of radioactive waste Nuclear programmes in India India's Three Stage Nuclear Power Programme Nuclear Reactors in India List of Operational Nuclear Power plants List of India Construction nuclear power plants List of Planned Nuclear Power plants in India 	181
8.	 3D Printing in India Nuclear Technology Nuclear energy Nuclear fission Nuclear fusion Nuclear fuel Production of Nuclear fuel Radiation Types Of Radiation need more content types Radioactivity Other types of Radioactivities Nuclear waste management Classification of Radioactive Waste Processes for management of radioactive waste Nuclear programmes in India India's Three Stage Nuclear Power Programme Nuclear Reactors in India List of Operational Nuclear Power plants List of under construction nuclear power plants List of Planned Nuclear Power plants in India Organizations responsible for promotion of Nuclear Energy 	181
8.	 3D Printing in India Nuclear Technology Nuclear energy Nuclear fission Nuclear fusion Nuclear fuel Production of Nuclear fuel Radiation Types Of Radiation need more content types Radioactivity Other types of Radioactivities Nuclear waste management Classification of Radioactive Waste Processes for management of radioactive waste Nuclear programmes in India India's Three Stage Nuclear Power Programme Nuclear Reactors in India List of Operational Nuclear Power plants List of under construction nuclear power plants List of Planned Nuclear Power plants in India Organizations responsible for promotion of Nuclear Energy Research and Development wings of Department of Atomic Energy 	181
8.	 3D Printing in India Nuclear Technology Nuclear energy Nuclear fission Nuclear fusion Nuclear fuel Production of Nuclear fuel Radiation Types Of Radiation need more content types Radioactivity Other types of Radioactivities Nuclear waste management Classification of Radioactive Waste Processes for management of radioactive waste Nuclear programmes in India India's Three Stage Nuclear Power Programme Nuclear Reactors in India List of Operational Nuclear Power plants List of under construction nuclear power plants List of Planned Nuclear Power plants in India Organizations responsible for promotion of Nuclear Energy Research and Development wings of Department of Atomic Energy 	181
8.	 3D Printing in India Nuclear Technology Nuclear energy Nuclear fission Nuclear fusion Nuclear fuel Production of Nuclear fuel Radiation Types Of Radiation need more content types Radioactivity Other types of Radioactivities Nuclear waste management Classification of Radioactive Waste Processes for management of radioactive waste Nuclear programmes in India India's Three Stage Nuclear Power Programme Nuclear Reactors in India List of Operational Nuclear Power plants List of under construction nuclear power plants List of Planned Nuclear Power plants in India Organizations responsible for promotion of Nuclear Energy Research and Development wings of Department of Atomic Energy 	181

9. Defence 197

- Regulatory Authorities
 - o Ministry of Defence
 - Department of Defence
 - o Defence Research and Development Organization
- Missile Defence System in India
 - Types of Military Missiles
 - Integrated Guided Missile Development Program
 - Ballistic Missile Defence System
 - o Ballistic Missiles of India
 - Agni Series
 - Prithvi Series
 - Submarine launched ballistic missiles (SLBM)
 - Anti-ballistic missiles
 - o Cruise missile
 - Other Missiles of India
- Air Defence Systems
- Unmanned Aerial Vehicles (Drones)
 - o Unmanned Aerial Vehicles developed in India
 - o Rustom
 - o Drone Rules 2021
 - Joint Agreement between India and US for developing Air-launched Unmanned Aerial Vehicle (ALUAV)
- Submarines
 - Nuclear powered submarines of the Indian Navy
 - India's Nuclear powered submarines
 - Diesel electric submarines
 - o Different Indian Submarines
- Aircraft carriers of the Indian Navy
- Light Combat Aircraft
 - o Aircrafts in IAF

10 Schemes and policies

- Department of Biotechnology
- Department of Electronics and Information Technology (DeitY)
- Department of Science and Technology
- National Science, Technology, and Innovation Policy
 - Department of Science and Technology

212



Biology



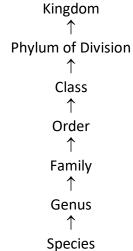
Organisms

- A living thing with an organized structure that can:
 - React to stimuli
 - Reproduce
 - o Grow
 - Adapt
 - Maintain homeostasis.
- Classified by taxonomy into groups:
 - O Multicellular animals, plants, and fungi or unicellular microorganisms
 - O Eg. protists, bacteria, and archaea.
- All organisms made of cells.

Classification of Organisms

Based on the number of cells	Based on the subcellular structure	
Single-celled: Bacteria, archaea, and protists	Eukaryotes: Having a well-defined nucleus with	
Multicellular: Animals and Plants	genetic material.	
	• Prokaryotes: Without nucleus but possess	
	genetic material in a nucleoid.	

Hierarchy of Classification- Groups





- **Hierarchy sequence of categories** in a **decreasing** or **increasing order** from kingdom to species and vice versa.
- Kingdom (highest rank) followed by division, class, order, family, genus and species (lowest rank).
 - 1. Species:



 Group of population similar in form, shape and reproductive features so that fertile sibling can be produced.

2. Genus:

- A group of similar species.
- Genera having only one species monotypic.
- Genera having more than one species polytypic.
- Eg. Lion & tiger are quite similar species placed under genus Panthera.

3. Family:

- Collection of similar genera.
- Separated from genera by reproductive and vegetative features.
- Eg. cats and leopard family Felidae.

4. Order:

- One or more than one similar families constitute order.
- Eg. Family Felidae are included in the order Carnivora.

5. Class:

- One or more than one order makes a class.
- Eg. Class Mammalia includes all mammals bats, rodents, kangaroos, whales, great apes and man.

6. Phylum:

- Collection of similar classes.
- **Eg.** Phylum chordata of animals has class Mammalia along with birds, reptiles and amphibians.

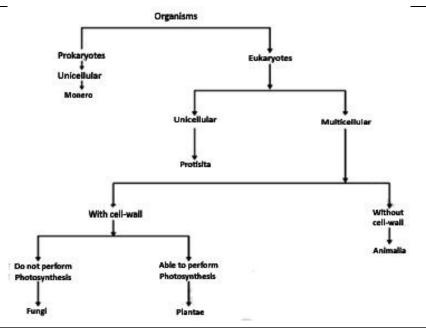
7. Kingdom:

- Top most taxonomic category.
- Eg. all animals are included in Kingdom Animalia.

Taxon

Unit that denotes grouping of organisms based on observable features.

5 Kingdom classification

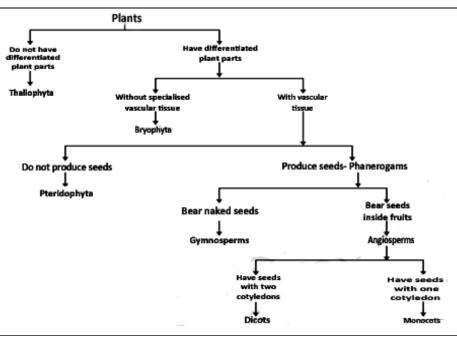






Comparison of Five Kingdom					
Criteria	Monera	Protista	Fungi	Plantae	Animalia
Cell Type	Prokaryotic	Eukaryotic	Eukaryotic	Eukaryotic	Eukaryotic
Leval of	Unicellular	Unicellular	Multicellular	Tissue/organ	Tissue organ/
organisation			and		organ system
			unicellular		
Cell wall	Present (made up	Present in some	Present	Present (made	Absent
	of peptidoglycan	(made up of	(made up of	up of cellulose)	
	and	cellulose, absent	chitin or		
	mucopeptides)	in other)	cellulose)		
Nutrition	Autotrophic	Autotrophic	Hetetrophic,	Autrophic	Heterotrophic
	(Phototrophic,	photosynthetic	Parastic or	(photosynthetic)	(holozoic)
	Chemoautrophic)	Hetetrophic	saprophytic		
	Hetetrophic				
	parastic and				
	saprophytic)				
Motility	Motile or non-	Motile or non-	Non-motile	Mostly Non-	Mostly motile
	motile	motile		motile	
Organisms	Archaebacteria,	Chrysophytes,	Yeast,	Algae,	Sponges,
	Eubacteria,	Dinoflagellates,	Mushrooms,	Bryophytes,	Invertebrates
	Cyanbacteria,	Euglanoids,	and molds	Pteridophytes,	and
	Actinomycetes	Slime molds,	$\triangle A$	Gymnosperm	vertebrates
	and mycoplasma	Amoeba,	- O V 1	and Angiosperm	
		Plasmodium,			
		Trypanosoma,	5h the	Loppe	r in vo
		Paramecium			

Plantae Kingdom





1. Thallophyta

- Unique features:
 - Plants that do not have well-differentiated body design.
 - o Commonly called algae.
 - o Predominantly aquatic.
 - o Eg. Spirogyra, Ulothrix, Cladophora, Ulva and Chara.
- Reproduction: No specialised reproduction process

2. Bryophyta

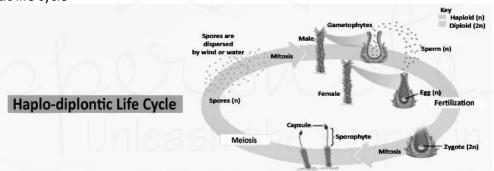
Bryophyta

- Amphibians of plant kingdom
- Grow in terrestrial environment but depend on water for reproduction
- Grow in moist & shady areas
- Responsible for plant succession on bare rocks
- Habitat: Arid forests, rainforests, apart from the alpine habitats
- Grow on rocks, soil, tree trunks, bones, rotting wood etc.

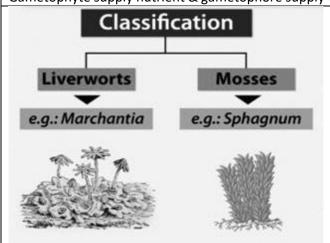


Unique Bryophyta

- Length: Few millimetre to 1 m
- Partially differentiated body, lacking true roots, leaves & stem
- Root-like structure called rhizoid present, body is more thallus-like & haploid
- Spore producing, non-vascular plants
- Exhibit haplo-diplontic life cycle



- Reproduction: Sex organs are multicellular. Antheridium is the male sex organ while archegonium is the female sex organ → Antheridium produces antherozoids with 2 flagella & archegonium produces single
 - (i) Antherozoid released in water come in contact with archegonium
 - (ii) Male & female gametes fuse to form zygote which remains in archegonium for some time.
 - (iii) Mitosis of zygote forms embryonic sporopyte that is covered & proteced by calyptra
- (iv) Meiosis occurs in sporophyte to produce haploid spores which germinate to produce gametophyte Gametophyte supply nutrient & gametophore supply water & minerals to embryo



Importance

- Have the ability to initiate soil formation in barren lands as they survive on bare rocks.
- Maintain soil moisture & replenism nutrients in fores tvegetation
- Peat mosses act as biofuel & are economically useful



• Used as packing material for shipment of living material as they can retain water.

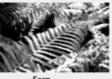


3. Pteridophyta

Pteridophyta

- Family of ferns & horsetails
- Called cryptogams as they don't bear flowers & seeds.
- First group of terrestrial vascular plants.
- Found in damp and shady places.
- Ferns are grown as ornamental plants.

Horsetail



Unique Featuers

- Length: Mostly short but few grow tall upto few metres.
- Plant body is differentiated into true roots, leaves & steams.





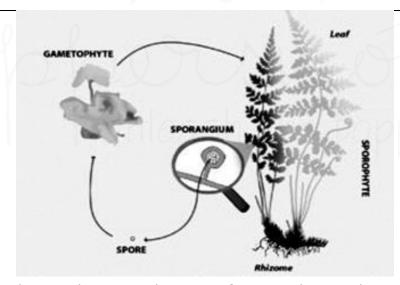
Sellaginella (microphylls)

Ferns (megaphylls)

- Leaves can be small (microphylls) or large (megaphylls)
- Sporangia bear leaf-like appendages sporophyll
- Sporophylls form compact structure called cones or strobili in som plants.
- Reproduction: Show true alternation of generation.



Cone of Equistem



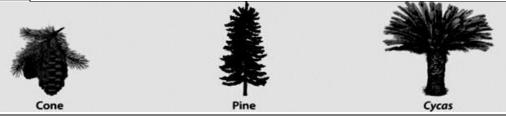
- Dominant sporophyte produce spores by meiosis & gametophyte produces gametes by mitosis.
- Sporangia produce spores in the spore mother cells that germinate to give gametophytes.
- Gametophytes are free-living, multicellular, photosynthetic Prothallus
- Male sex organ anteridia produce antherozoids & female sex organ is archegonia.
- Reproduction procedure.
 - o Antherozoids are released in water and come in contact with archegonia.
 - Gametes fuse in the archegonium to produce zygote
 - Zygote produces sporophyte after division.
- Spores: Homosporous or heterosporous
- In heterosporous plants, microspore & megaspore give rise to male & female gametephyte respectively.



4. Gymnosperms

Gymnosprem:

- Consist of pines & deodar
- Gymno-naked: sperma seed
- Plants with naked seeds that do not bear flower & fruits
- Seeds are visible as cones & develop on surface of reproductive structure.



Unique Features

- Wind is the major source of pollination.
- Leangth: Medium to large tree & few are shrubs
- Vascular & Complete differentiation into leaves, steam & roots
- Leaves: Needle-like with thick cuticle & sunken stomata.

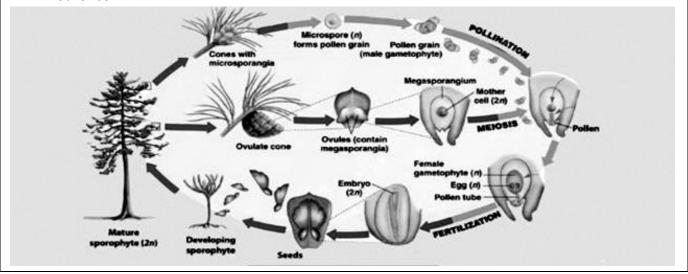


Roots

- Taproot system
- Some from mycorrhiza (e.g. pinus)
- Some form specialized roots called coralloids roots (e.g. Cycas)

Reproduction:

- Male & female cones can be same (e.g. Pinus) or different (e.g.: cycas) plants.
- Heterosporous plants that produce haploid microspores & megaspores.
- Male cones: Contain microsporophyll, few of which develop into pollen grains & rest degenerate.
- Female Cones: Several megasporophyll cluster to form female cone.
- Female cone bears ovule with megasporangium & give rise to haploid megaspores & a megaspore mother cell.







5. Angiosperms

Angiosperms

- The family of flowering platns.
- Vascular fauna dominating across the globe.
- Called phanerogams due to the presence of flowers
- Seeds (ovules) are enclosed inside hollow ovary (which forms the fruit)



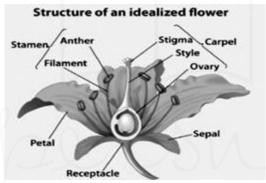
Unique Features

- Well differentiated plant body with fully developed root & shoot system.
- Survive in various habitats.
- Length: Microscopic Wolfia to > 100 m tall Eucalphytus
- Vast diversity including woody trees, shrubs & herbs.
- Leaves, steam & roots are adapted as per habitat

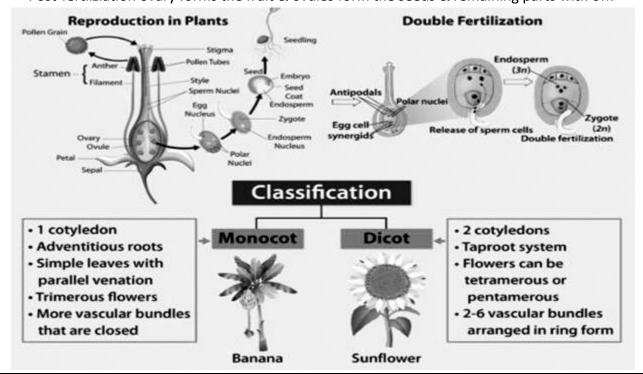


Reproduction:

Flower is the reproductive structure can be unisexual or bisexual



- Alternation of genetation haploid gametophyte alternates with the diploid sporophyte.
- Double fertilization is characteristic to Angiosperms Syngamy & triple fusion.
- Post-fertilziation ovary forms the fruit & ovules form the seeds & remaining parts with off.



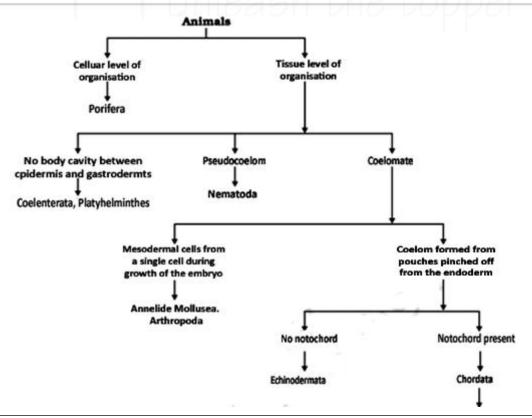


Vascular and Nonvascular Plants

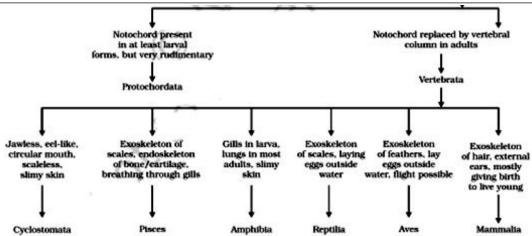
	Vascular Plants	Non - Vascular Plants
Definition	 Possess vascular system to conduct 	 Lack vascular systems
	food and water throughout the plant	
Diversity	Higher	• Low
Vascular System	• Present	• Absent
True stem, Roots &	• Yes	No; a stem and leaf-like
Leaves		structures and rhizoids, instead
		of true structures.
Plant Strength	Xylem tissues contain lignified tissues	 No water conducting tissues
	 provide support and rigidity to the 	 Tender and shorter than
	plant.	vascular plants
Reproduction	Sporophytes	 Gametophytes
Examples	 Ferns, conifers, and flowering plants. 	 Bryophytes, including
		liverworts, mosses, and
		hornworts.
Drought Resistance	Almost all are drought resistant	Susceptible to drought.
		Associated with swamps

Sporophytes	Gametophytes
Use the process of meiosis Use the process of mitosis	
Results - formation of spores Results - production of gametes	
Diploid plants Haploid plants	
Have two sets of chromosomes Have a single set of chromosomes	
Reproduce asexually Reproduce sexaully	

Animalia:







1. Porifera

- Non mobile animals attached to some solid support.
- Holes or pores all over the body.
- A canal system circulating water throughout body to bring in food and O2.
- Mainly found in marine habitats.
- Commonly k/a sponges

2. Coelenterata

- Animals living in water.
- **Diploblastic**: body is made up of two layers of cells.
- Some live in colonies while others have a solitary life
- Eg. span (Hydra) jellyfish .

3. Platyhelminthes

- Triploblastic: 3 layers of cells from which different tissues can be made.
- Some degree of tissues formation.
- Either free living or parasitic.
- Eg. Planarians, liver flukes.

4. Nematode

- Bilaterally symmetrical and triploblastic.
- Body is cylindrical rather than flattened.
- Tissues, but no real organs,
- A sort of **body cavity** or a **pseudocoelom**, is **present**.
- K/a parasitic worms causing diseases, such as worms causing elephantiasis (filarial worms) or worms in the intestines (roundworm or pinworms).

5. Annelida

- Have true body cavity.
- Allows true organs to be packaged in body structure.
- Extensive organ differentiation.
- Eg- Earthworms, leeches.

6. Arthropods

- Open circulatory system and so the blood does not flow in well defined blood vessels.
- Have joint legs.
- Eg- prawns, butterflies, houseflies, spiders, scorpions and crabs.



7. Mollusca

- Have an open circulatory system and kidney like organs for excretion.
- Little segmentation.
- A foot is used for moving around.
- Eg- snails, and mussels, octopus.

8. Echinodermate

- Spiny skinned organisms.
- Exclusively free living marine animals.
- Have a water driven tube system that they use for moving around.
- Have hard calcium carbonate structure that they use as skeleton.
- Eg- starfish, sea cucumber.

9. Protochordats

- Marine animals.
- Eg. balanoglossus, hardemania and amphioxus.

10. Vertebratia

- Have a true vertebral column & internal skeleton.
- Bilaterally symmetrical
- Triploblastic
- Coelomic and segmented
- Complex differentiation of body tissues and organs.
- All chordates possess the following features:
 - o have a notochord
 - have a dorsal nerve cord
 - Triploblastic
 - Paired gill pouches
 - Coelomate.
- Grouped into six classes:

A. Cyclostomes

- Jawless vertebrates.
- Have an elongated eel-like body, circular mouth, slimy skin
- Scaleless.
- Ectoparasites or borers of other vertebrates.
- Eg. Petromyzon (Lamprey) and Myxine (Hagfish)

B. Pisces

- Exclusively aquatic animals.
- Skin is covered with scales/ plates.
- Obtain oxygen dissolved in water by using gills.
- Body is streamlined, and a muscular tail for movement. T
- Cold-blooded
- Hearts have only two chambers.
- Lay eggs.
- Eg. sharks, tuna or rohu



C. Amphibia

- No scales
- Have mucus glands in the skin,
- 3 chambered heart.
- Respiration through either gills or lungs.
- Lay eggs.
- Found both in water and on land.
- Eg. Frogs, toads and salamanders

D. Reptilia

- Cold-blooded
- Have scales and breathe through lungs.
- Most have a three-chambered heart
- Exception: crocodiles- 4 heart chambers.
- Lay eggs with tough coverings.
- **Do not need** to **lay** their **eggs** in **water**, unlike amphibians.
- Eg. Snakes, turtles, lizards and crocodiles

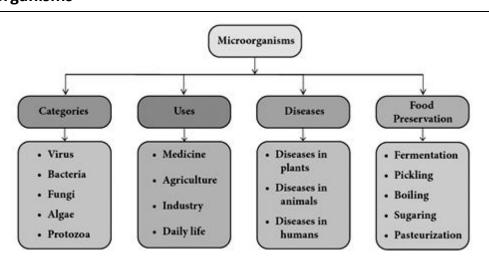
E. Aves

- Warm-blooded animals
- 4-chambered heart.
- Lay eggs.
- An outside covering of feathers; 2 forelimbs modified for flight.
- Breathe through lungs.
- Eg. All birds

F. Mammalia

- Warm-blooded animals with four-chambered hearts.
- Have mammary glands for production of milk.
- Skin has hairs& sweat and oil glands.
- Produce live young ones.
- Few like platypus and echidna lay egg
- Kangaroos give birth to very poorly developed young ones.
- Eg. human, monkeys, whale etc

Microorganisms







- Very small in size & cannot be seen with naked eye.
- Can be seen only with the help of a microscope.
- aka microbes.
- Microbiology- Branch of science dealing with study of microorganisms.
- Found in: air, water (ponds, lakes, rivers and oceans), soil and even inside our bodies.
- 5 categories.

Virus	A tiny particle made up of genetic material and protein.
	Intermediate between living and non living things.
	Intracellular obligatory parasites.
	Virology- study of viruses.
	10,000 times smaller than bacteria.
	Can be rod shaped, spherical or of other shapes.
	Contains a core DNA or RNA.
	Core surrounded with a protein coat
	Protein coat is sometimes covered by an envelope of proteins, lipids, and
	carbohydrates.
	Causes diseases to plants, animals and human beings.
Bacteria	Single-celled prokaryotes(cells without nuclei).
	Considered 1st living organisms on earth.
	Grouped under the kingdom Monera.
	Bacteriology- study of bacteria.
05	Size - 1μm to 5μm(micrometer).
	2 types based on respiration :
	 Aerobic bacteria (requires oxygen),
	Anaerobic bacteria (does not require oxygen).
	An outer covering k/a cell wall.
	Other cell organelles (mitochondria, golgi body, endoplasmic reticulum etc.,) are
	absent.
	Eg: E.coli, Bacillus anthracis, Vibrio cholera etc.
Fungi	Eukaryotic organisms that lack chlorophyll.
	Grow in dark environments.
	Either unicellular (like Yeast) or multicellular (like Penicillium).
	Found in all kinds of habitats.
	Included under kingdom Fungi.
	Mycology- study of fungi.
	Some are macroscopic (Eg. Mushroom).
	Around 70,000 species of fungi in the world.
Algae	Very simple plants like eukaryotic organisms.
	Found in moist habitats.
	Rich in chlorophyll
	Seen as thin film on surface of lakes and ponds.
	o aka 'grass of water'.



	Autotrophic and produce their own food(with help of chloroplast).	
	Algology/ phycology- study of algae.	
	• Size - 1 micron to 50 meter.	
	Eg: Chlamydomonas, Volvox, Ulothrix, Fristschiella etc.	
Protozoa	Single celled eukaryote.	
	Included under the kingdom Protista.	
	Protozoology- Study of protozoa.	
	Found in ponds, ocean, in moist soil, and in the cells and tissues of plants and	
	animals - causing diseases.	
	• Range - 2 to 200 microns.	
	Eg : Paramecium, Euglena, Amoeba, Plasmodium etc.	

Animals

- Any eukaryotic multicellular organism of kingdom Animalia.
- Heterotrophic, motile & with specialized sensory organs,
 - o Lacking a cell wall & growing from a blastula during embryonic development.



Characteristics

Multicellular	 Body composed of several cells performing specific functions. Cells organized into various animal tissues, Eg: Epithelial tissues, connective tissues, etc. 	
Eukaryotic	 Contain a membrane-bound nucleus. Nucleus -organelle containing chromosomes that bear genes. Other organelles suspended in the cytoplasm of an animal cell, Eg. Golgi apparatus, endoplasmic reticulum, lysosomes, and peroxisomes, 	
Heterotrophic	Depend on other organisms for food.	
Motile	 Capacity to move at will. by muscles and locomotory structures (e.g. arms, legs, wings, fins, tails, etc.) 	
Specialized sensory organs:	 Eg: eyes, ears, nose, skin, and tongue. Vital in recognizing and responding to stimuli in environment. Contains common and specialized receptors. 	
Reproduce sexually	 Produce a haploid sperm cell (a male sex cell) & a haploid ovum (a female sex cell) Unite at fertilization to form a diploid zygote. Capable of asexual reproduction. Eg: some cnidarians produce a genetic clone by budding. 	
Aerobic Respiration	 Inhale oxygen and release carbon dioxide . Oxygen important to cell respiration for synthesis of energy. 	



Cell

- Simplest and most basic unit of life.
- **Discovered:** Robert Hooke (1665)
- All living things made up of cells- structural, functional, and biological unit of life.
- Has the ability to duplicate itself on its own.
- aka "building blocks of life."

Cell Structure and its components

Cell Organelles







Plasma / Cell	Outermost covering of the cell		
Membrane	Separates contents of cell from its external environment.		
	A selectively permeable membrane as it allows entry and exit of some		
	materials in and out of the cell.		
Cell Wall	ONLY in plants		
	Outside the plasma membrane.		
	Mainly composed of cellulose.		
	Cellulose: A complex substance - provides structural strength to plants.		
Cytoplasm	Jelly-like substance present between cell membrane & nucleus.		
	Fluid content inside plasma membrane.		
	• Contains many specialised cell organelles (mitochondria, golgi bodies,		
	ribosomes, etc)		
Nucleus	• Contains chromosomes that contain information for inheritance of features		
	from parents to next generation in form of DNA		
	Plays a central role in cellular reproduction.		
	Nuclear membrane- a double-layered covering on nucleus.		
	O Allows transfer of material from inside nucleus to its outside, i.e., to		
	cytoplasm.		
Nucleolus	Ribosome synthesis site regulating cellular activity and reproduction.		
Gene	Unit of inheritance in living organisms.		
Protoplasm	Entire content of a living cell [cytoplasm + nucleus].		
	aka living substance of the cell.		
Chromosomes	Rod-shaped structures		
	Visible only when the cell is about to divide.		
	• Contain information for inheritance of features from parents to next		
	generation in the form of DNA (deoxyribo nucleic acid)		
	Composed of DNA and Protein.		
DNA molecules	Contains information necessary for constructing and organising cells.		
	Functional segments of DNA - genes.		
Vacuoles	Empty structure in cytoplasm		
	Act as storage sacs for solid or liquid contents.		
	Common in plant cells.		



	Smaller in animal cells.
	Substances stored- amino acids, sugars, various organic acids and some
	proteins.
Endoplasmic	A large network of membrane-bound tubes and sheets.
Reticulum	• 2 types :
回答回	Rough endoplasmic reticulum [RER]
	 Has ribosomes attached to its surface.
	 Ribosomes - sites of protein manufacture.
	2. Smooth endoplasmic reticulum
	Helps in the manufacture of fat molecules, or lipids, important for cell
	function.
	O Some of these proteins and lipids help in building the cell membrane
	k/a membrane biogenesis.
	• Serve as channels for transport of materials between various regions of
	cytoplasm or between the cytoplasm and the nucleus.
	• Also functions as a cytoplasmic framework providing a surface for some
	biochemical activities of cells.
Golgi Apparatus/	A system of membrane-bound vesicles arranged parallel to each other in
Complex	stacks called cisterns.
	Packages and dispatches material synthesised near ER to various targets inside
	and outside the cell.
	Stores, modifies and packages products in vesicles.
	Involved in the formation of lysosomes.
	Membrane-bound sacs filled with digestive enzymes.
	Kind of waste disposal system of the cell.
	O Help to keep the cell clean by digesting any foreign material as well as
	worn-out cell organelles.
Mitochondria	Aka powerhouse of the cell.
	Energy required for various chemical activities is released by mitochondria in
	the form of ATP (Adenosine Triphosphate) molecules.
	• 2 membranes:
	Outer membrane- porous
	o Inner membrane - deeply folded.
	■ Folds create a large surface area for ATP-generating chemical
	reactions.
ATP	aka energy currency of the cell.
	Body uses energy stored in ATP for making new chemical compounds and for
	mechanical work.
Ribosomes	Site of protein synthesis.
	Polyribosomes or Polysomes: Several ribosomes may attach to a single mRNA
	and form a chain.
	Prokaryotes- ribosomes are associated with the plasma membrane of the cell.