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General Science

By Kinshuk Sir

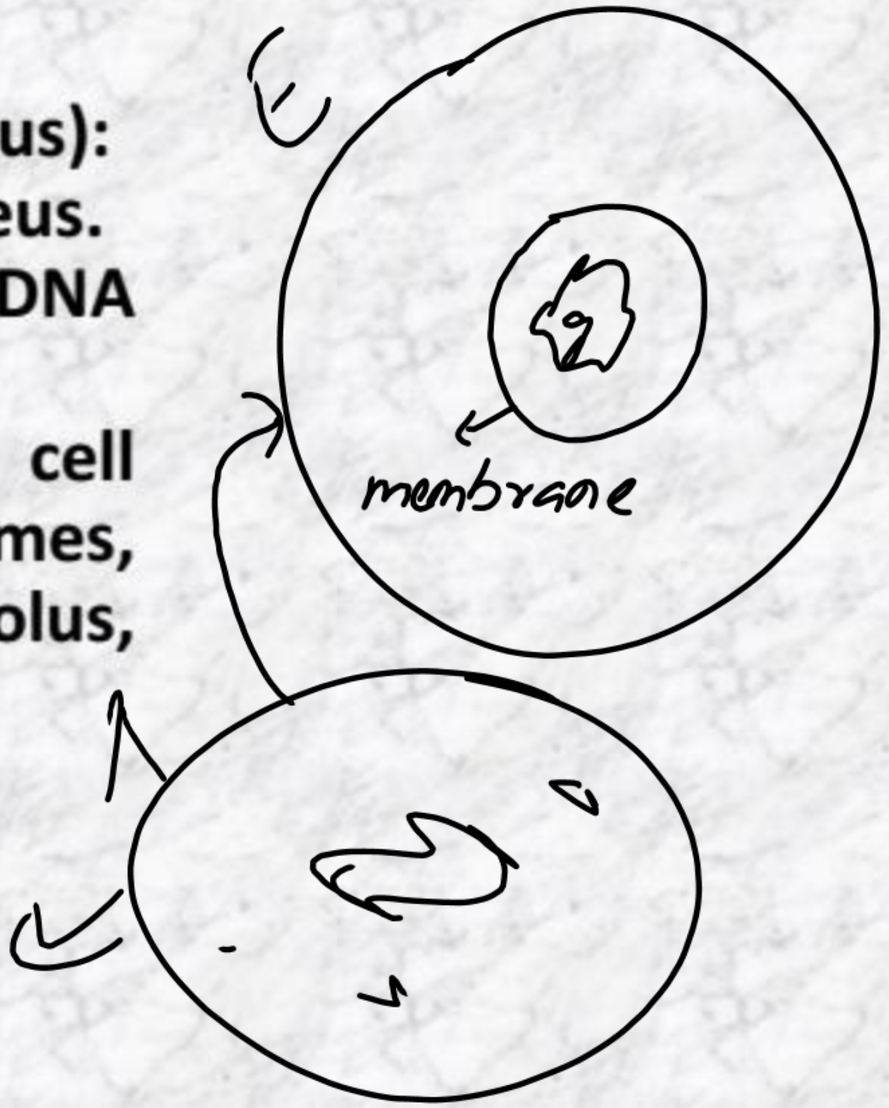
Classification of Cells

A. PROKARYOTIC AND EUKARYOTIC CELL

Prokaryotic cell (Gk. Pro-before; karyon-nucleus): These cells do not have a well-organized nucleus. The genetic material is a single molecule of DNA lying in the cytoplasm.

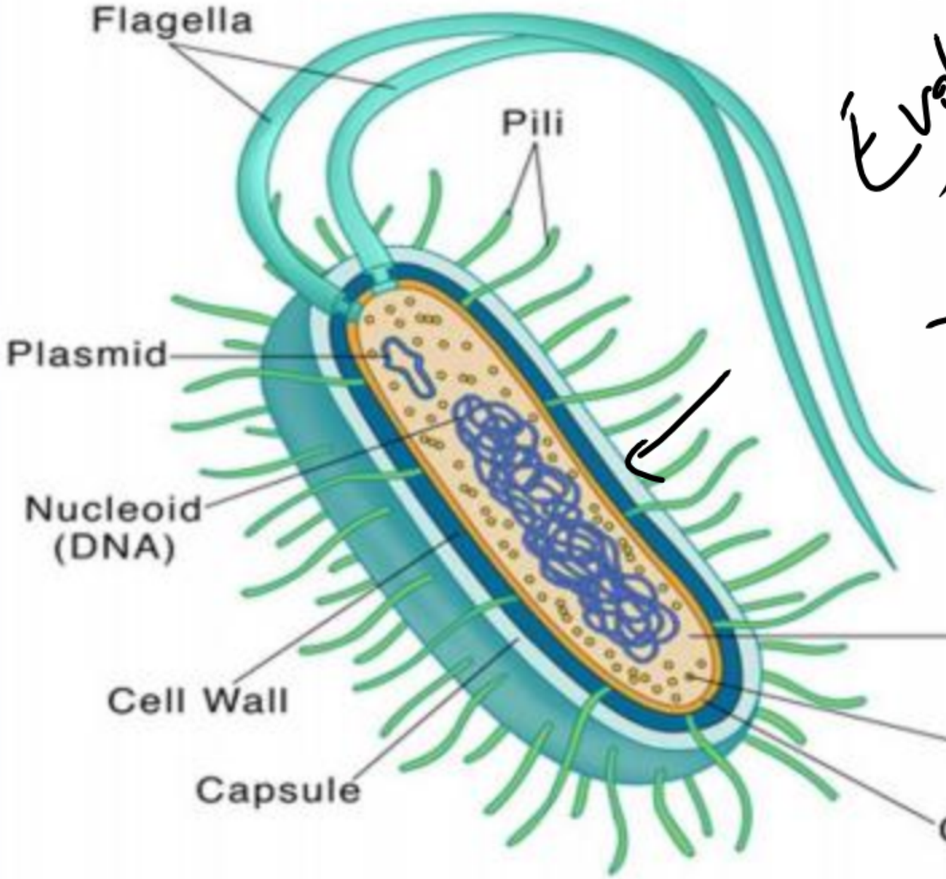
Not only is the nuclear membrane absent, cell organelles like mitochondria, lysosomes, endoplasmic reticulum, chloroplast, nucleolus, etc are also not present in prokaryotic cells.

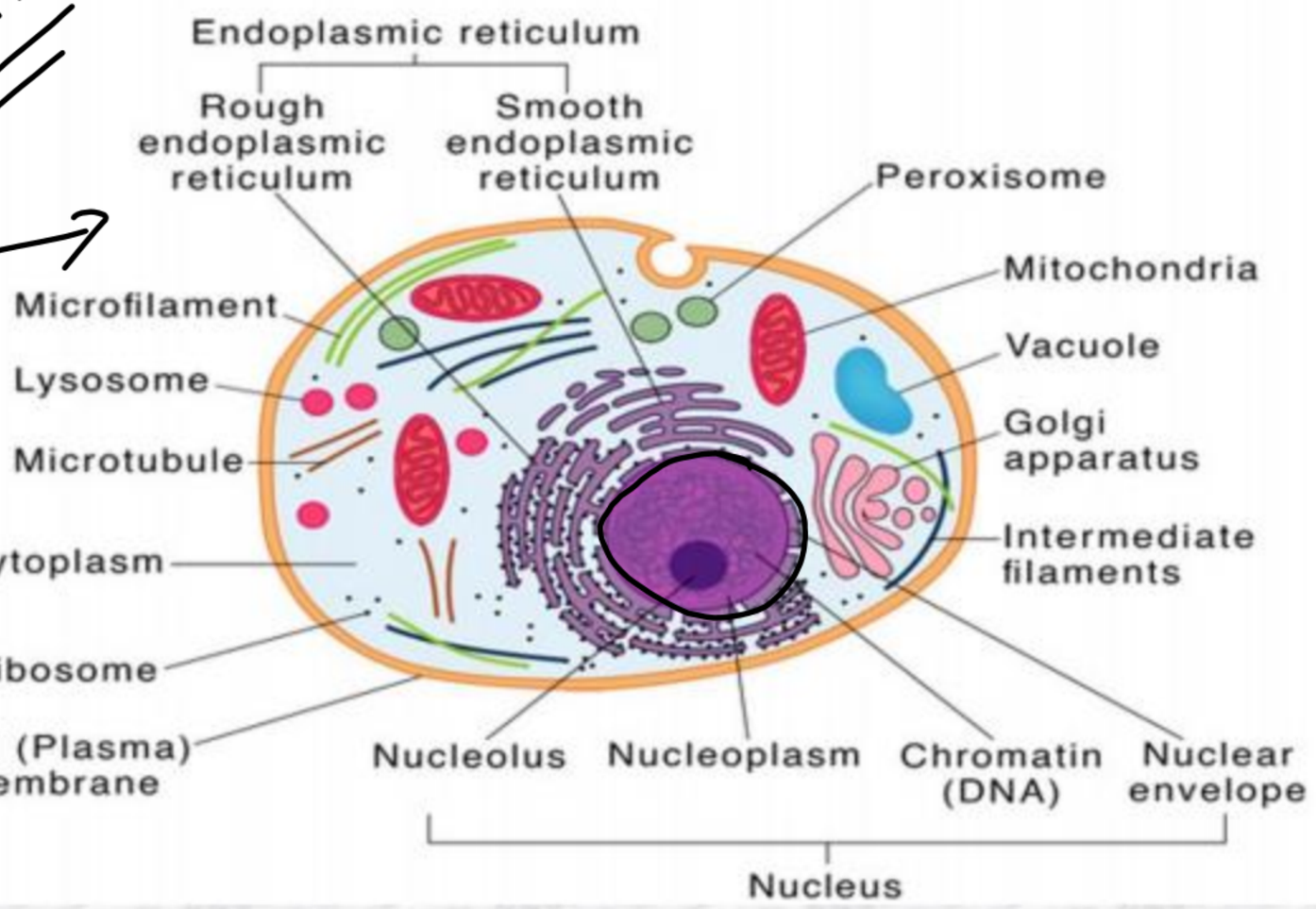
Examples: Bacteria and blue-green algae.



Prokaryotic Cells VS Eukaryotic Cells

Evolution





Classification of Cells

A. PROKARYOTIC AND EUKARYOTIC CELL

Eukaryotic cell (Gk. Eu-true; karyon-nucleus): DNA is enclosed in a nuclear membrane forming a nucleus.

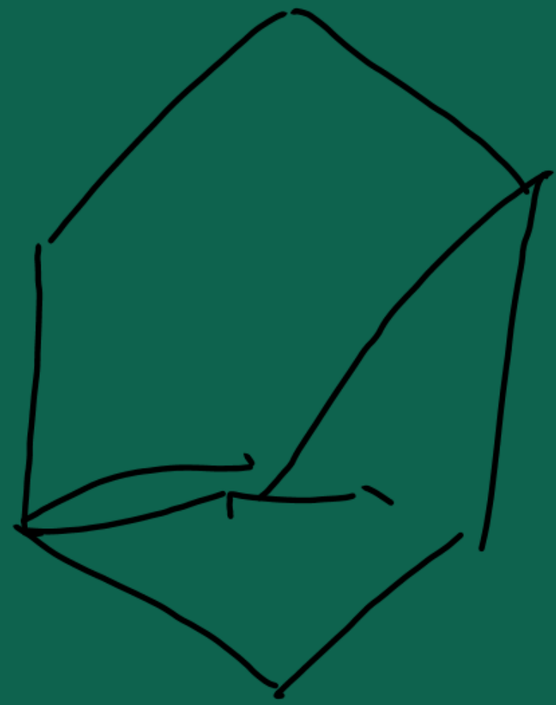
The genetic material is made of two or more DNA molecules, which are present as a network of chromatin fibres when the cell is not dividing.

Membrane-bound organelles, such as mitochondria, endoplasmic reticulum, lysosome, chloroplast, nucleolus, etc. are present within the cytoplasm.

Examples: Cells of plants, fungi, protozoa and animals.

Plant Cells & Animal Cells:

Feature	Plant cell	Animal cell
Size and Shape	Larger in size and rectangular in shape.	Smaller in size and oval in shape.
Cell wall	Cell wall is made up of cellulose.	Cell wall absent.
Vacuoles	Vacuoles are large. In a mature plant cell, usually a single large central vacuole is present.	Vacuoles are mostly absent or if present are small in size and scattered.
Golgi bodies	Golgi bodies are diffused in the plant cells and are called dictyosomes.	Golgi bodies are well-developed and present near nucleus.
Centrosome	Centrosome and centrioles are absent.	Centrosome and centrioles are present.
Plastids	Present	Absent
Storage of reserve food	Reserve food is stored in the form of starch or oil.	Reserve food is stored in the form of glycogen.



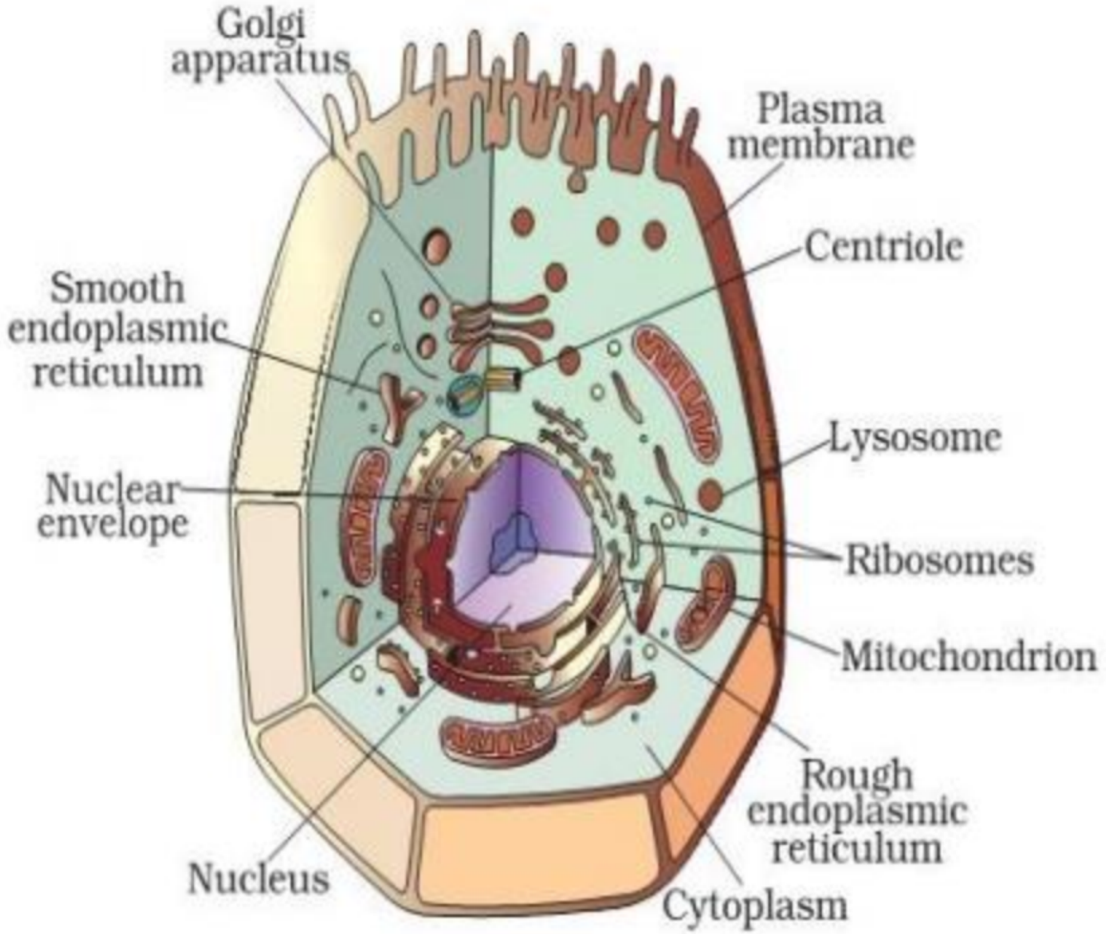


Fig. 5.5: *Animal cell*

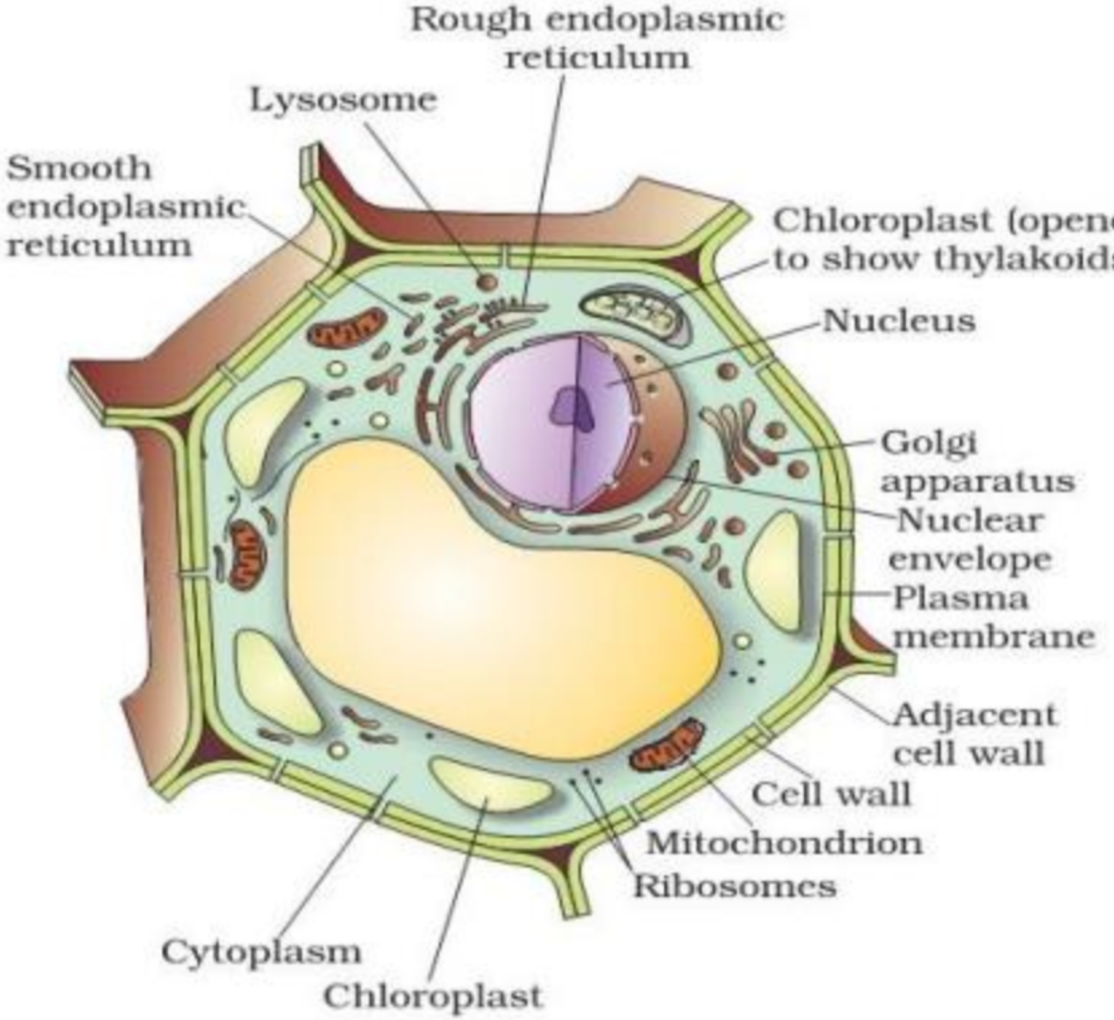
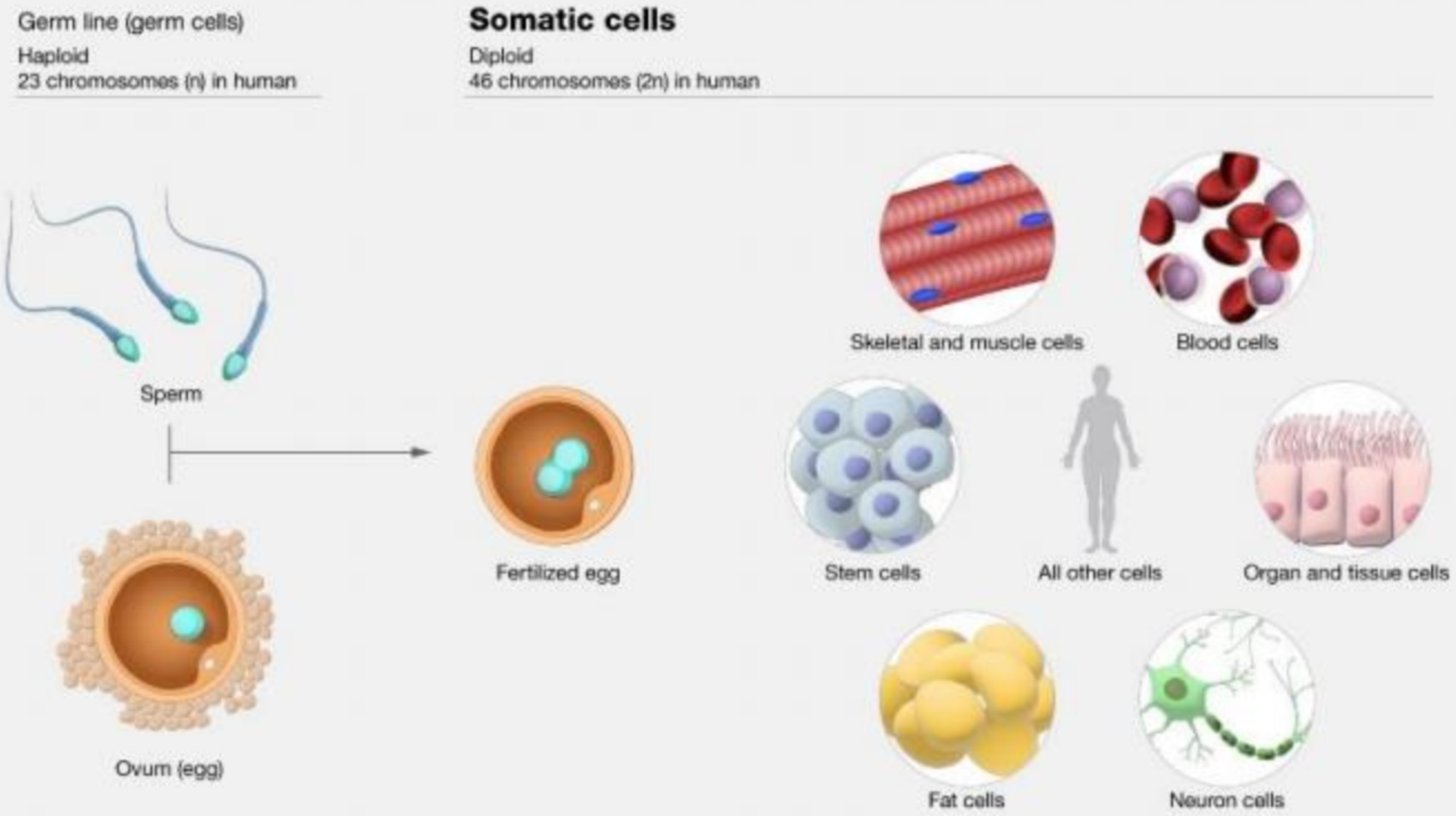
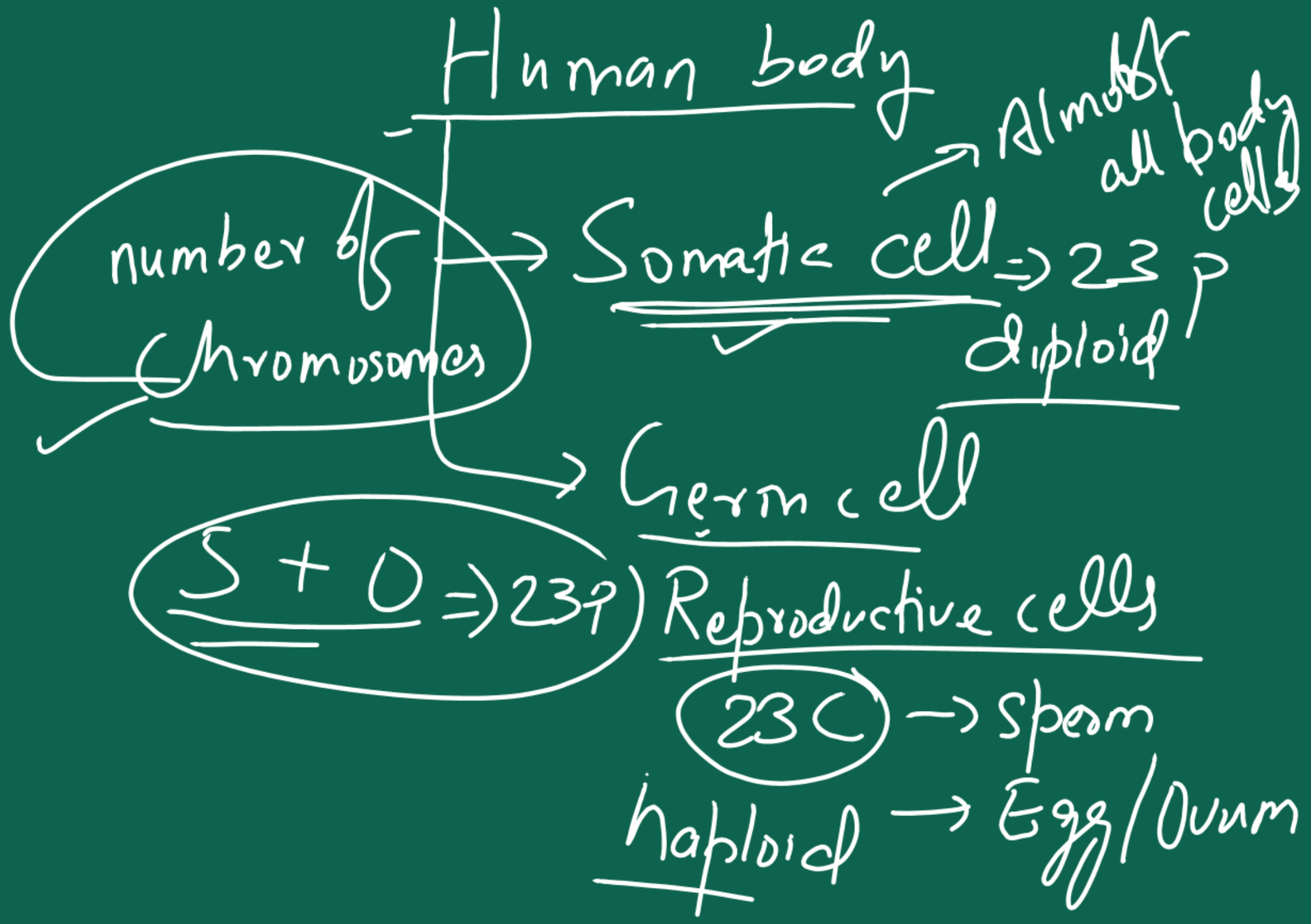
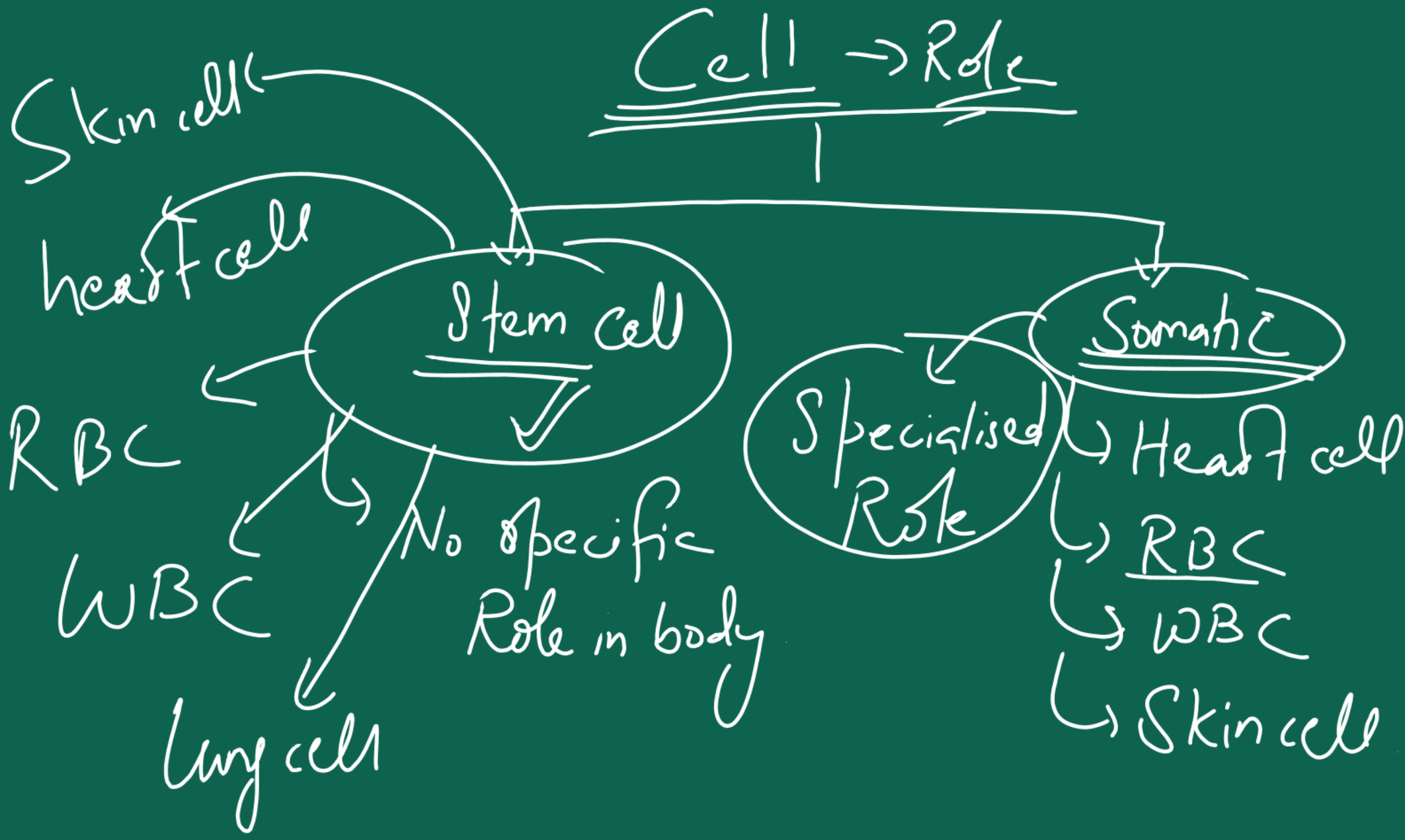


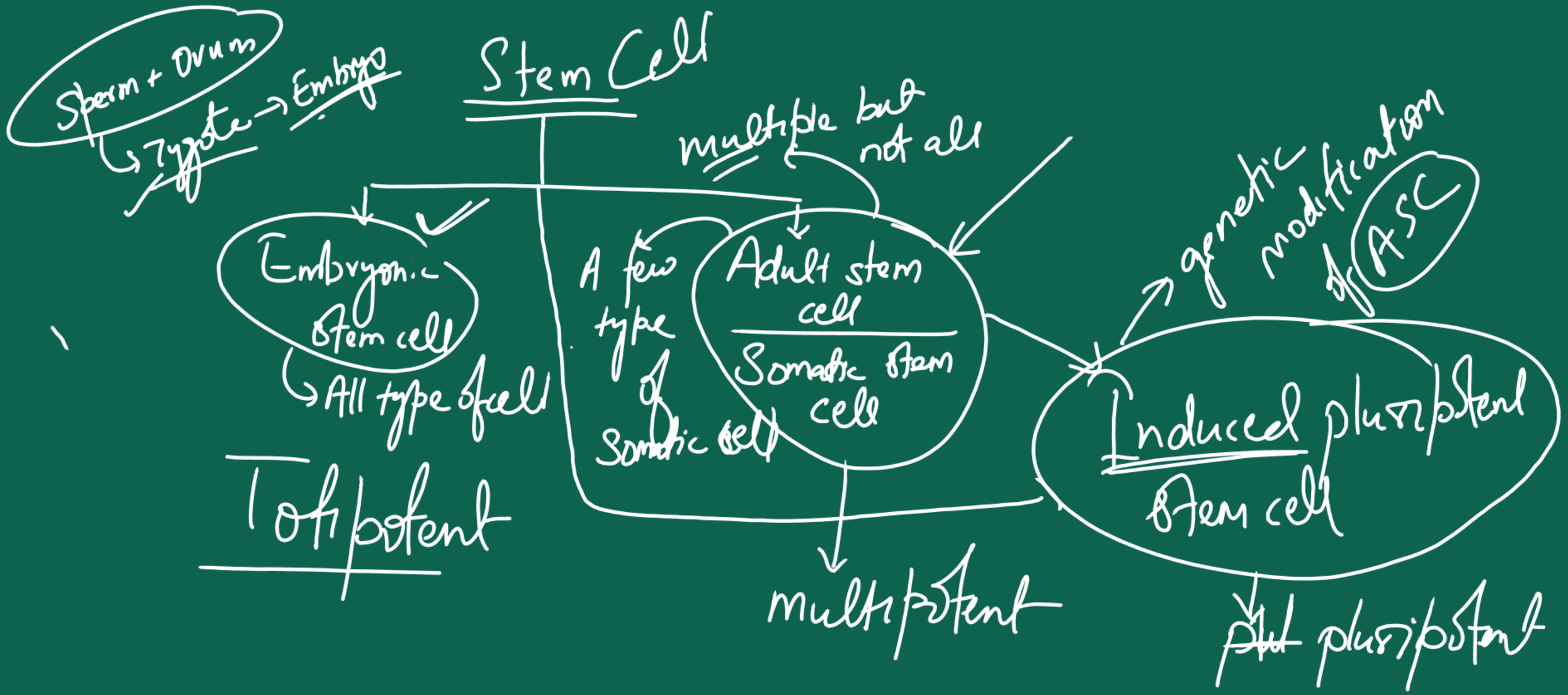
Fig. 5.6: *Plant cell*

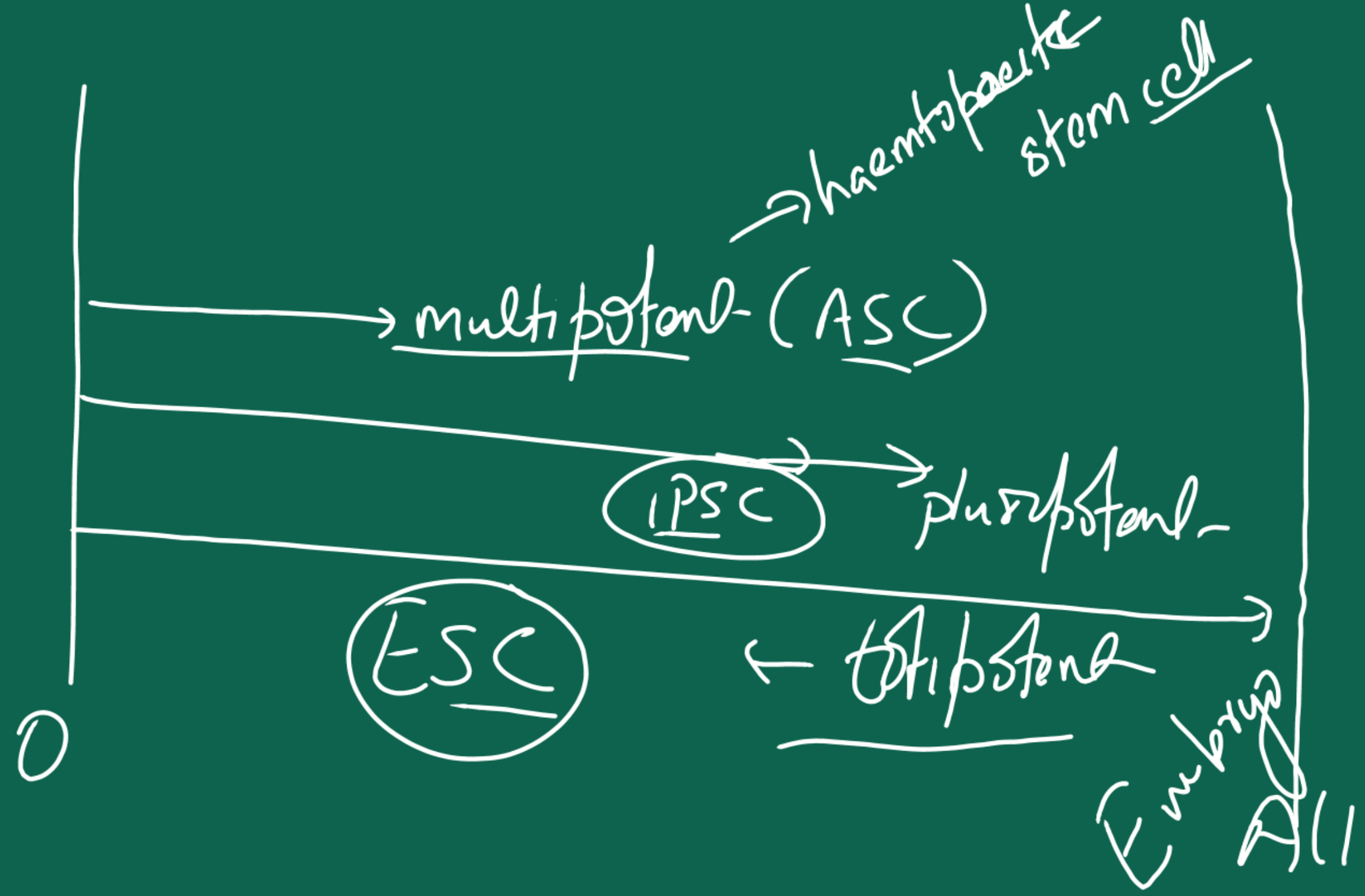
Germ Cells & Somatic Cell




Human body
number of Chromosomes
Somatic cell
Almost all body cells
23 P
diploid
Germ cell
S + O ⇒ 23 P
Reproductive cells
23 C → Sperm
haploid → Egg/Ovum


Cell → Role
Skin cell
Heart cell
Stem cell
RBC
WBC
Lung cell
No specific Role in body
Specialised Role
Somatic
Heart cell
RBC
WBC
Skin cell


Sperm + Ovum
↳ Zygote → Embryo
Stem Cell
multiple but not all
Embryonic Stem cell
↳ All type of cell
Totipotent
A few type of Somatic cell
Adult stem cell
Somatic Stem cell
Multipotent
genetic modification of ASC
Induced pluripotent Stem cell
Pluripotent


haemtopoietic stem cell
multipotent (ASC)
IPSC
pluripotent
ESC
totipotent
0
Embryo
Dell

Classification of Cells

- **Difference Between Somatic Cells and Germ Cells**
- **Somatic Cells: Somatic cells are any cells in a multicellular organism that are not involved in the production of gametes.**
- **Germ Cells: Germ cells are the cells that create reproductive cells or gametes.**
- **Types**
- **Somatic Cells: Various types of somatic cells are arranged into different types of tissues in the body of multicellular organisms, performing specific functions.**
- **Germ Cells: Germ cells produce male and female gametes.**

Classification of Cells

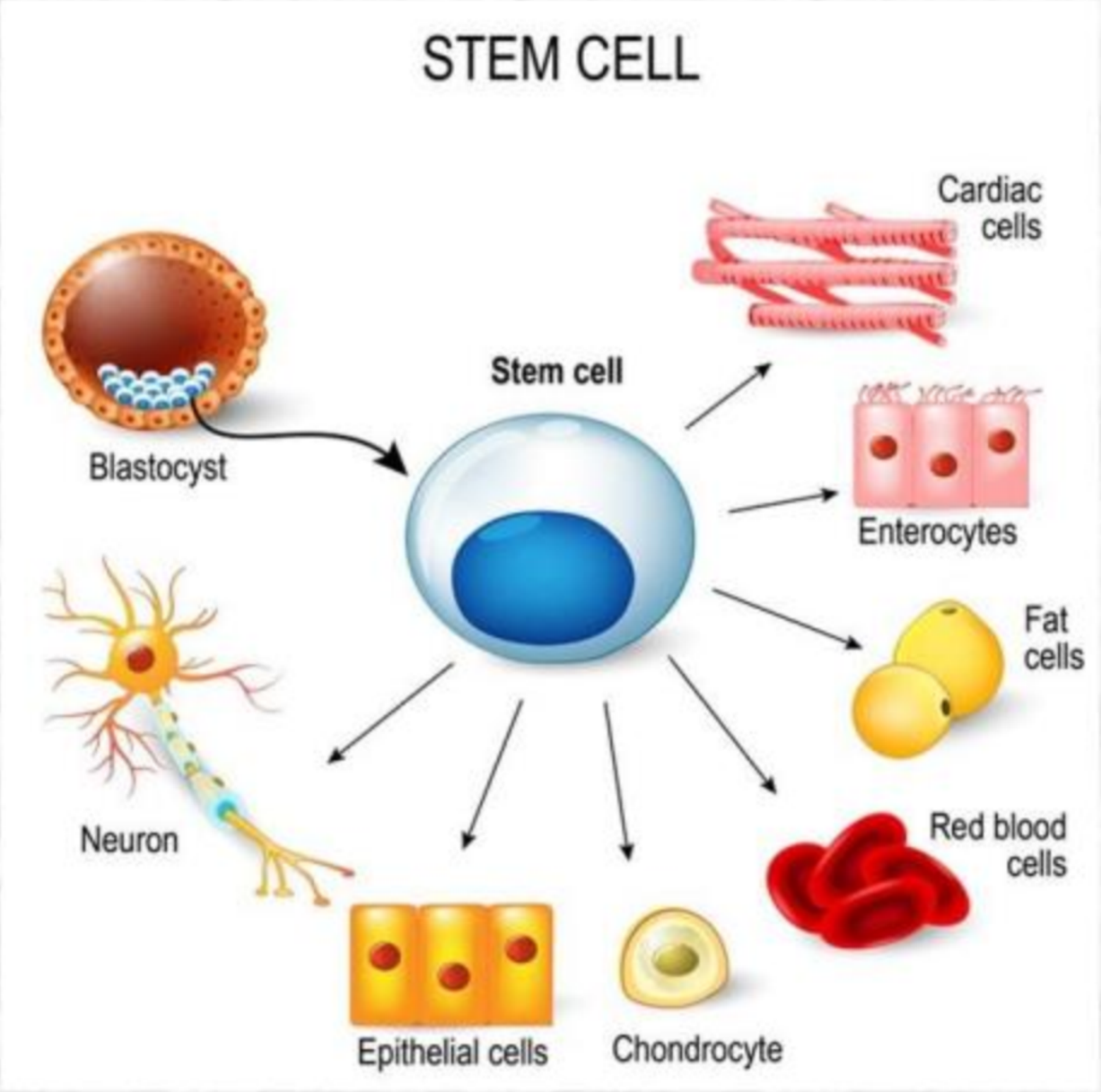
- **Difference Between Somatic Cells and Germ Cells**
- **Amount**
- **Somatic Cells: Majority of the body cells in multicellular organisms are somatic cells.**
- **Germ Cells: Germ cells are very few in number.**
- **Functions**
- **Somatic Cells: Somatic cells perform various functions in the body.**
- **Germ Cells: Germ cells produce gametes, which participate in sexual reproduction.**

Stem Cell and Somatic Cell

- Stem cells are unspecialized cells with self-renewal capacity. They can divide through mitosis limitlessly to replenish other cell types of multicellular organisms throughout their life.
- After stem cell division, each newly produced cell can either remain as a stem cell or differentiate to form any other cell type with more defined functions, such as muscle cell, blood cell, or neural cell.

- There are mainly two types of stem cells: embryonic stem cells, which are derived from embryos, and somatic or adult stem cells, which are undifferentiated cells residing in a tissue or organ along with other differentiated cells (somatic cells).

The major difference between embryonic and somatic stem cells is that embryonic stem cells have the potential to differentiate into all cell types of the body, as they are pluripotent stem cells (cells that are able to differentiate into three primary germ cell layers of the early embryo and, thus, into any cell type of the body); whereas, it is believed that somatic stem cells can differentiate only into different cell types present in the tissue of their origin.



Plant and Animal Kingdom

- R.H. Whittaker (1969) proposed a Five Kingdom Classification.
- The kingdoms defined by him were named Monera, Protista, Fungi, Plantae and Animalia.
- The main criteria for classification used by him include cell structure, body organisation, mode of nutrition, reproduction and phylogenetic relationships

TABLE 2.1 Characteristics of the Five Kingdoms

Characters	Five Kingdoms				
	Monera	**Protista**	**Fungi**	**Plantae**	**Animalia**
Cell type	Prokaryotic	Eukaryotic	Eukaryotic	Eukaryotic	Eukaryotic
Cell wall	Noncellulosic (Polysaccharide + amino acid)	Present in some	Present with chitin	Present (cellulose)	Absent
Nuclear membrane	Absent	Present	Present	Present	Present
Body organisation	Cellular	Cellular	Multiceullar/ loose tissue	Tissue/ organ	Tissue/organ/ organ system
Mode of nutrition	Autotrophic (chemosynthetic and photosynthetic) and Heterotrophic (saprophytic/parasitic)	Autotrophic (Photosynthetic) and Heterotrophic	Heterotrophic (Saprophytic/ Parasitic)	Autotrophic (Photosynthetic)	Heterotrophic (Holozoic/ Saprophytic etc.)

Plant and Animal Kingdom

- **KINGDOM MONERA**
- **Bacteria are the sole members of the Kingdom Monera.**
- **They are the most abundant micro-organisms.**
- **Bacteria occur almost everywhere. Hundreds of bacteria are present in a handful of soil.**
- **They also live in extreme habitats such as hot springs, deserts, snow and deep oceans where very few other life forms can survive.**
- **Many of them live in or on other organisms as parasites.**

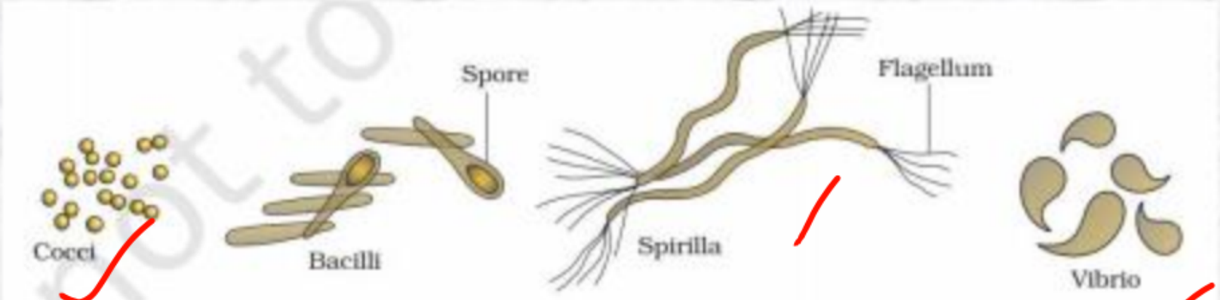


Figure 2.1 Bacteria of different shapes

KINGDOM PROTISTA

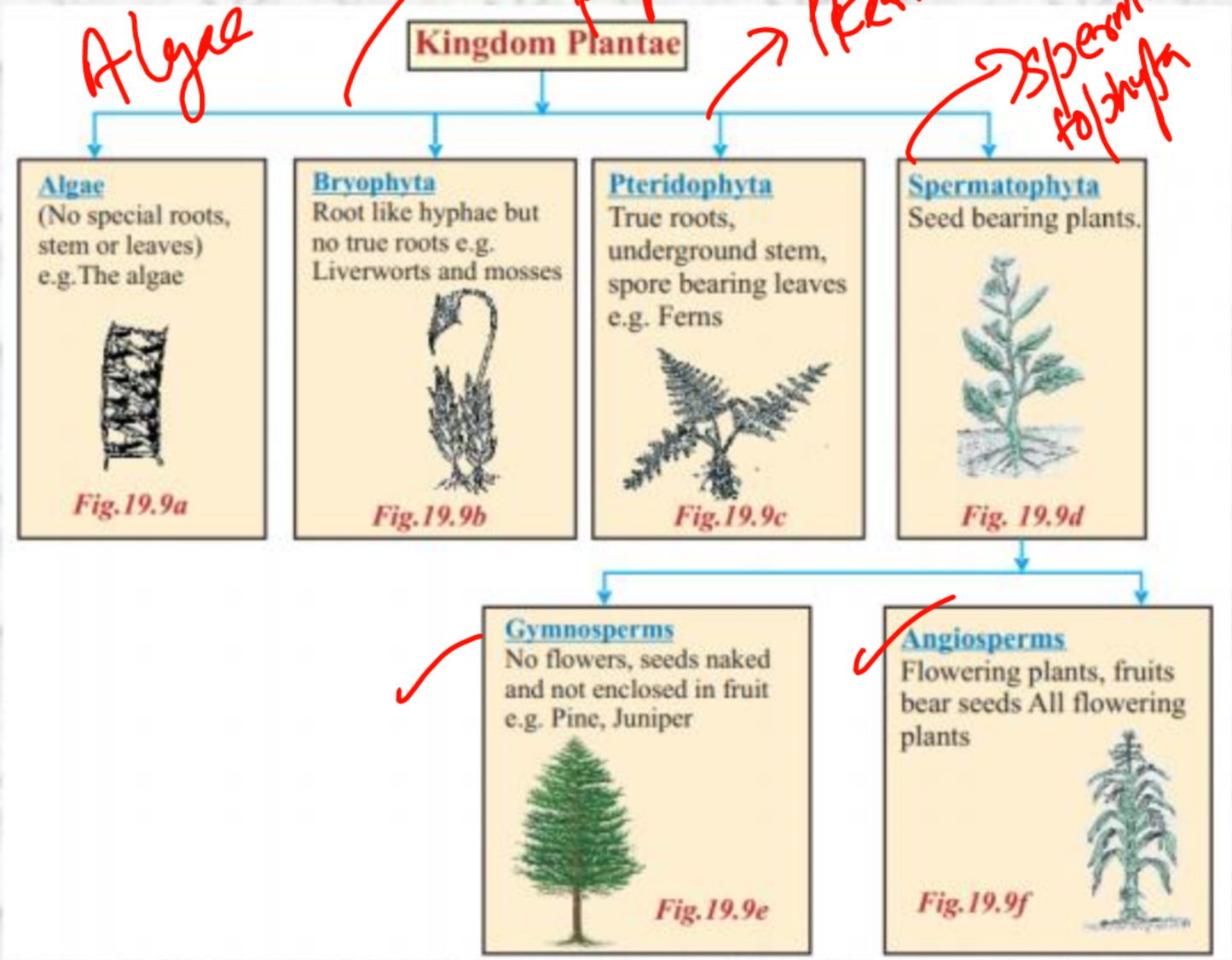
- All single-celled eukaryotes are placed under Protista, but the boundaries of this kingdom are not well defined.
- What may be 'a photosynthetic protistan' to one biologist may be 'a plant' to another.
- Members of Protista are primarily aquatic.
- This kingdom forms a link with the others dealing with plants, animals and fungi.
- Being eukaryotes, the protistan cell body contains a well defined nucleus and other membrane-bound organelles.
- Some have flagella or cilia. Protists reproduce asexually and sexually by a process involving cell fusion and zygote formation.

KINGDOM FUNGI

- The fungi constitute a unique kingdom of heterotrophic organisms.
- They show a great diversity in morphology and habitat
- Fungi are cosmopolitan and occur in air, water, soil and on animals and plants.
- They prefer to grow in warm and humid places
- Most fungi are heterotrophic and absorb soluble organic matter from dead substrates and hence are called saprophytes.
- Those that depend on living plants and animals are called parasites.
- They can also live as symbionts – in association with algae as lichens and with roots of higher plants as mycorrhiza.

KINGDOM PLANTAE

- Kingdom Plantae includes all eukaryotic chlorophyll-containing organisms commonly called plants.
- A few members are partially heterotrophic such as the insectivorous plants or parasites.
- Bladderwort and Venus fly trap are examples of insectivorous plants and Cuscuta is a parasite.
- The plant cells have an eukaryotic structure with prominent chloroplasts and cell wall mainly made of cellulose.



Insectivorous Plants

- What are insectivorous plants?
- Special Characteristics
- Why do they eat insects?
- Medicinal Values of insectivorous plants

Insectivorous plants

- Insectivorous plants, also known as carnivorous plants,
- They are a group of plants that have developed unique adaptations to capture and digest insects and other small organisms as a source of nutrients.
- **These plants typically grow in environments where the soil is nutrient-poor**
- They have evolved to supplement their nutritional needs by deriving nutrients from insects.

Insectivorous plants

- They secrete enzymes, such as proteases and phosphatases, to break down the captured insects and release the essential nutrients, including nitrogen and phosphorus.
- Insectivorous plants are found in diverse habitats worldwide, **including bogs, swamps, marshes, and other wetland areas.**
- Some species also grow in nutrient-poor soils, **such as sandy or rocky environments**.
- Examples of insectivorous plants include **pitcher plants, Venus flytrap, sundews, and bladderworts**.

Insectivorous plants

- Insectivorous plants have evolved to be carnivorous despite having normal roots and photosynthetic leaves

because they typically inhabit **nutrient-poor environments where they face limitations in**

- obtaining essential nutrients, particularly nitrogen
- and phosphorus.

Insectivorous plants – Medicinal Value

- Digestive Aid: Some insectivorous plants, such as sundews (Drosera species), have been traditionally used to support digestion.
- They are believed to have digestive-enhancing properties and have been used as herbal remedies for digestive disorders, such as indigestion, stomach ulcers, and gastritis

Insectivorous plants – Medicinal Value

- Utricularia is beneficial for **treating wounds, treating coughs, and curing urinary diseases.**
- **Medicinal tea** is brewed using the dried leaves of Utricularia.

Insectivorous plants – Medicinal Value

- **Anti-cancer Potential:** Some studies have explored the potential anti-cancer properties of compounds derived from insectivorous plants.
- For example, extracts from sundews and pitcher plants have shown cytotoxic effects on cancer cells in vitro.

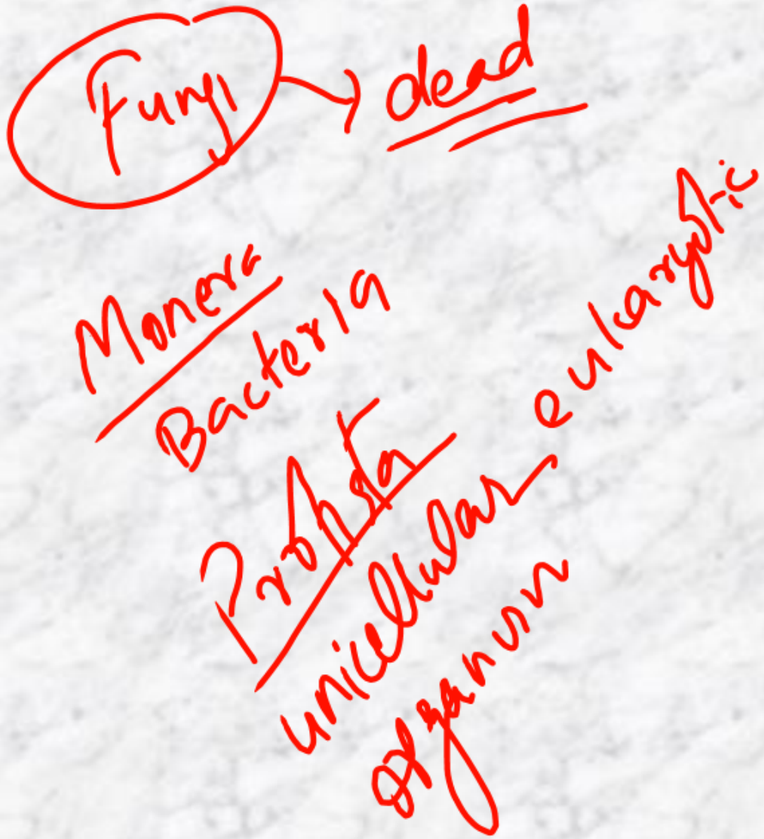
Insectivorous plants

- **Antioxidant Activity:** Insectivorous plants contain compounds with antioxidant properties, such as phenolic compounds and flavonoids.

- **Antimicrobial and Antifungal Activity**: Insectivorous plants produce a variety of secondary metabolites that may possess antimicrobial and antifungal properties.
- Such as pitcher plants (Nepenthes species) and sundews, exhibit inhibitory effects against certain bacteria and fungi.

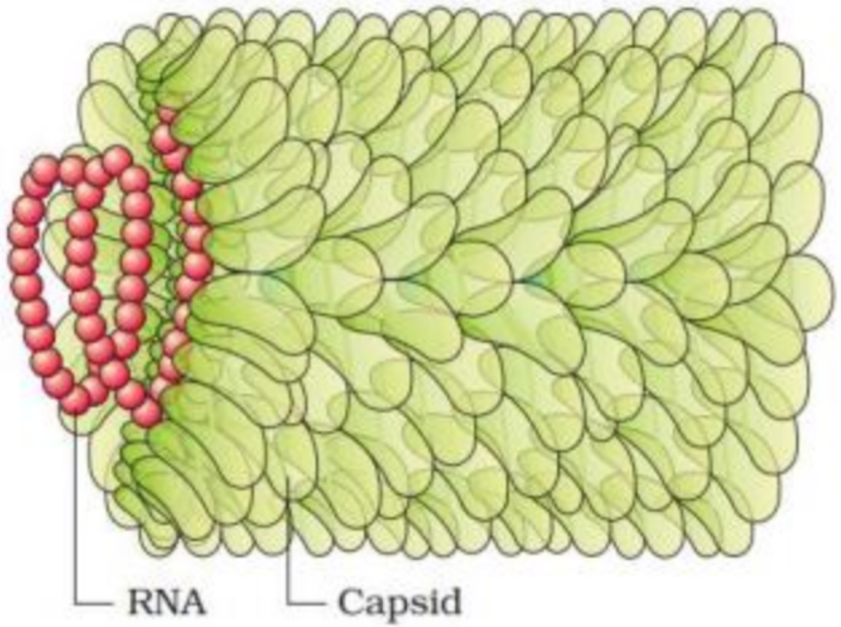
KINGDOM ANIMALIA

- This kingdom is characterised by heterotrophic eukaryotic organisms that are multicellular and their cells lack cell walls.
- They directly or indirectly depend on plants for food.
- They digest their food in an internal cavity and store food reserves as glycogen or fat.
- Their mode of nutrition is holozoic – by ingestion of food.
- They follow a definite growth pattern and grow into adults that have a definite shape and size.
- Higher forms show elaborate sensory and neuromotor mechanism. Most of them are capable of locomotion.
- The sexual reproduction is by copulation of male and female followed by embryological development.

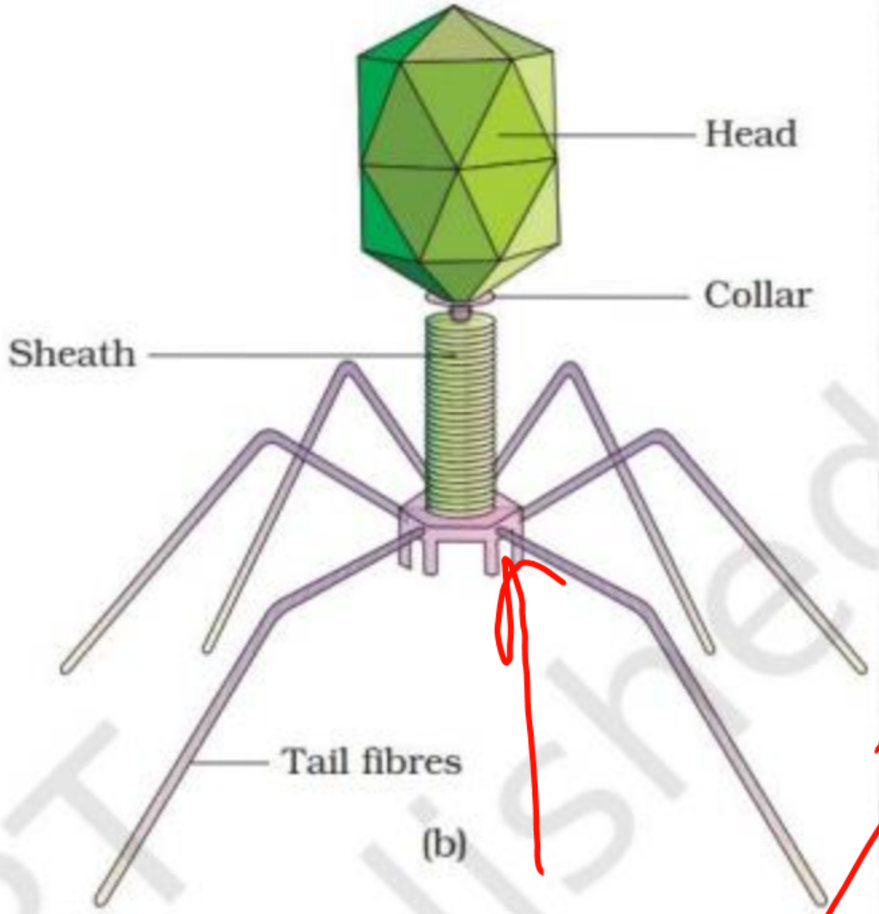


VIRUSES, VIROIDS, PRIONS AND LICHENS

- Viruses did not find a place in classification since they are not considered truly 'living', if we understand living as those organisms that have a cell structure.
- The viruses are non-cellular organisms that are characterised by having an inert crystalline structure outside the living cell
- Once they infect a cell they take over the machinery of the host cell to replicate themselves, killing the host.
- Virus means venom or poisonous fluid



(a)



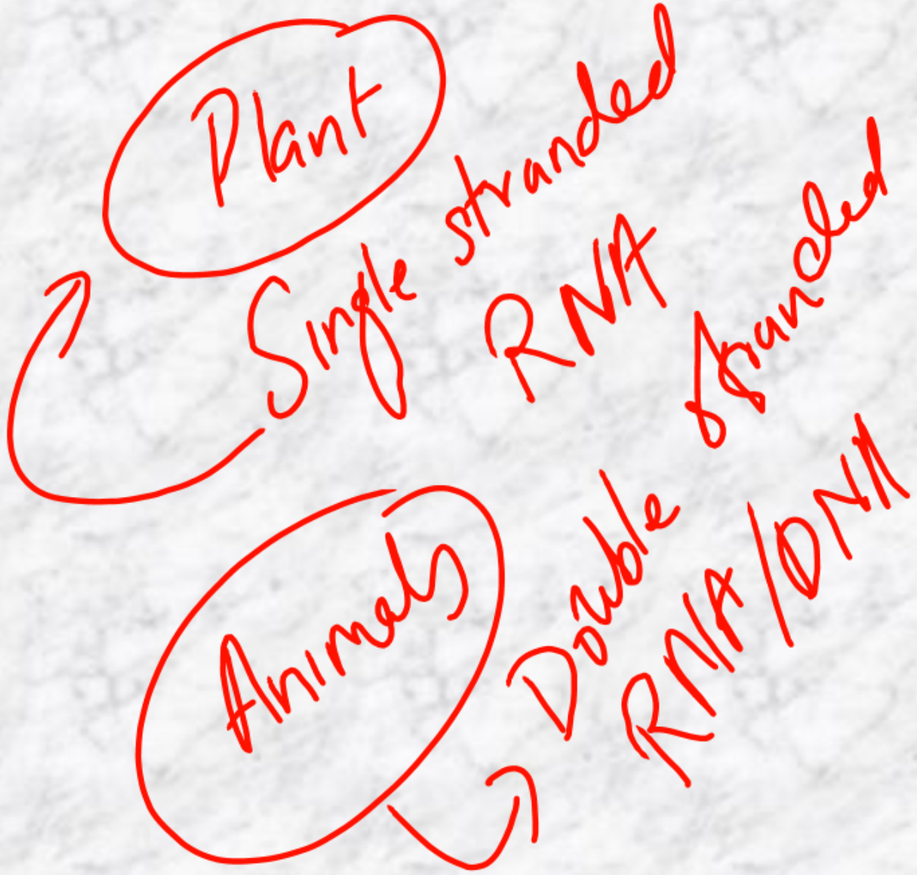
(b)

Figure 2.6 (a) Tobacco Mosaic Virus (TMV) (b) Bacteriophage

→ Virus found in Bacteria

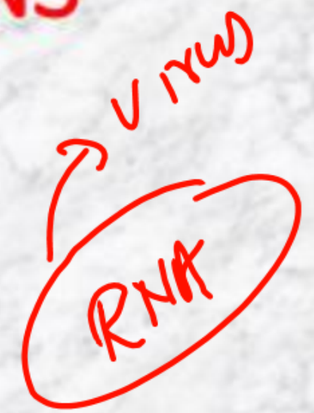
VIRUSES, VIROIDS, PRIONS AND LICHENS

- In addition to proteins, viruses also contain genetic material, that could be either RNA or DNA.
- No virus contains both RNA and DNA. A virus is a nucleoprotein and the genetic material is infectious.
- In general, viruses that infect plants have single stranded RNA and viruses that infect animals have either single or double stranded RNA or double stranded DNA.
- Bacterial viruses or bacteriophages (viruses that infect the bacteria) are usually double stranded DNA viruses



VIRUSES, VIROIDS, PRIONS AND LICHENS

- **Viroids :**
- **In 1971, T.O. Diener discovered a new infectious agent that was smaller than viruses and caused potato spindle tuber disease.**
- **It was found to be a free RNA; it lacked the protein coat that is found in viruses, hence the name viroid.**
- **The RNA of the viroid was of low molecular weight.**
- **Prions :**
- **In modern medicine certain infectious neurological diseases were found to be transmitted by an agent consisting of abnormally folded protein.**
- **The agent was similar in size to viruses. These agents were called prions.**
- **The most notable diseases caused by prions are bovine spongiform encephalopathy (BSE) commonly called mad cow disease in cattle and its analogous variant Cr–Jacob disease (CJD) in humans.**



VIRUSES, VIROIDS, PRIONS AND LICHENS

- **Lichens :**
- **Lichens are symbiotic associations i.e. mutually useful associations, between algae and fungi.**
- **The algal component is known as phycobiont and fungal component as mycobiont, which are autotrophic and heterotrophic, respectively.**
- **Algae prepare food for fungi and fungi provide shelter and absorb mineral nutrients and water for its partner.**
- **So close is their association that if one saw a lichen in nature one would never imagine that they had two different organisms within them.**
- **Lichens are very good pollution indicators – they do not grow in polluted areas.**

Algae + Fungi

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