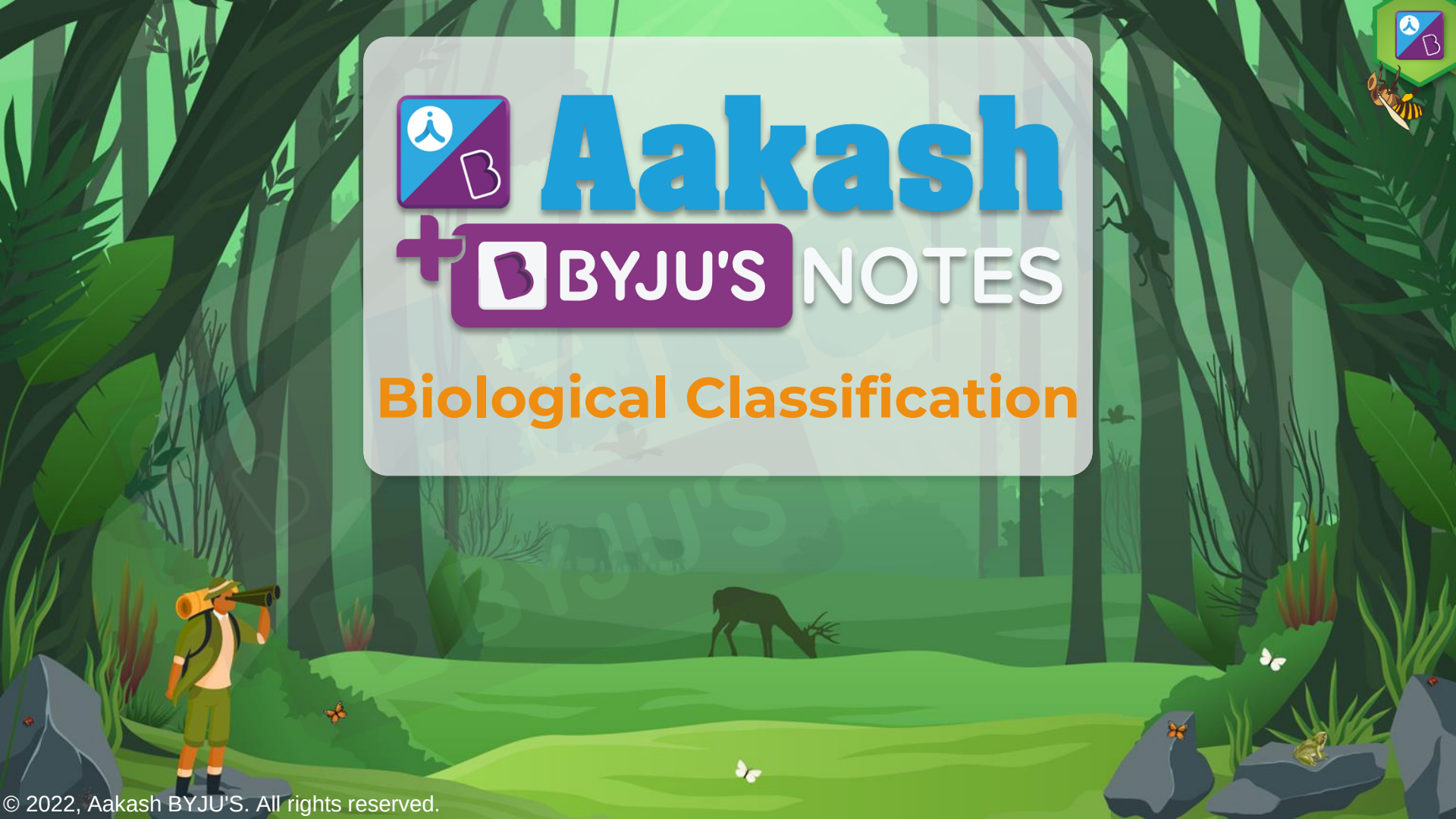


Key Takeaways

1. Aristotle Classification
2. Two Kingdom Classification
3. Five Kingdom Classification
4. Six Kingdom Classification
5. Kingdom Monera
   - Characteristics
   - Classification of bacteria
6. Kingdom Protista

Summary

8 Kingdom Fungi

Reproduction

Classification

9 Kingdom Plantae

10 Kingdom Animalia

11 Viruses

Viral infections

12 Viroids

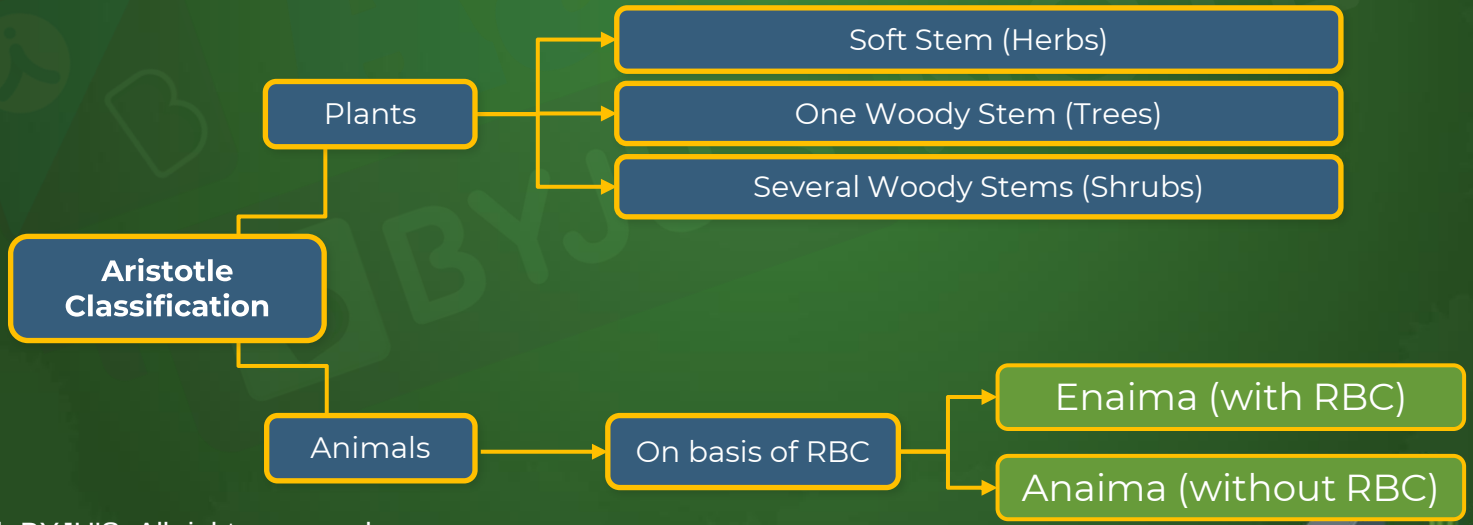
13 Prions

14 Lichen

Aristotle Classification

Aristotle

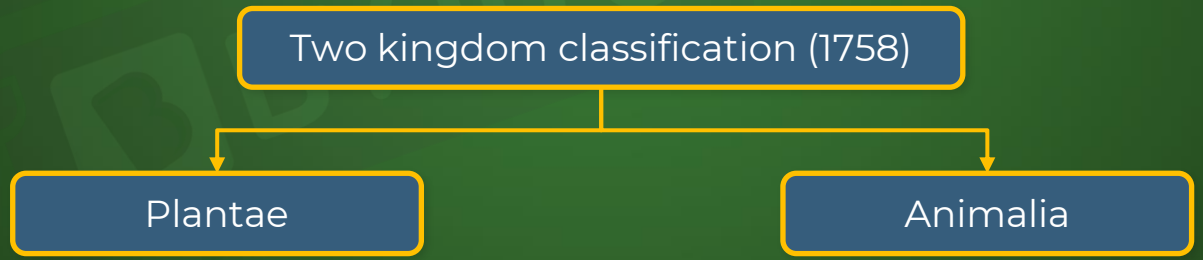
- Father of biology
- Earliest scientific classification, based on simple morphological characters
- Classified living things as, plants and animals
- Merit: First novel attempt of classification of living organisms
- Demerit: No evolutionary relationships consideration



Two Kingdom Classification

Carolus Linnaeus

- Father of systematic botany
- Gave two kingdom classification
- Wrote Species Plantarum and Systema Naturae
- Main basis of classification - Presence or absence of cell wall
- **Demerits:** Unable to differentiate between the following;
  - Unicellular and Multicellular
  - Prokaryotic and Eukaryotic
  - Photosynthesis and Non photosynthetic organisms



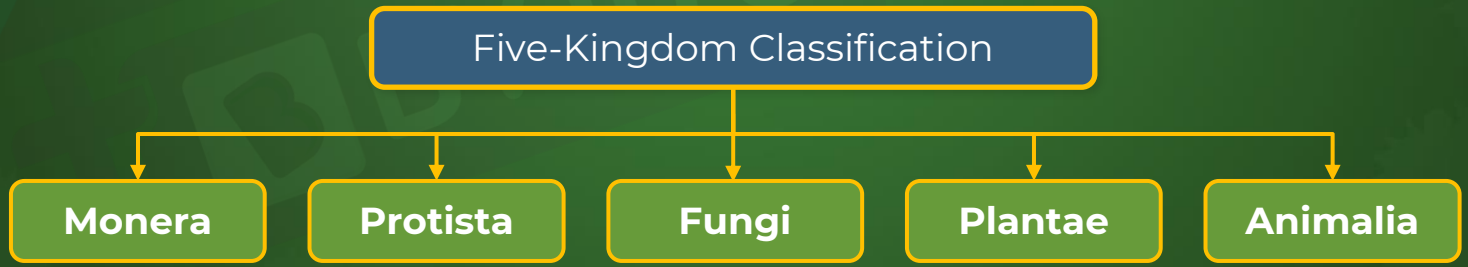
Five Kingdom Classification

Robert H. Whittaker

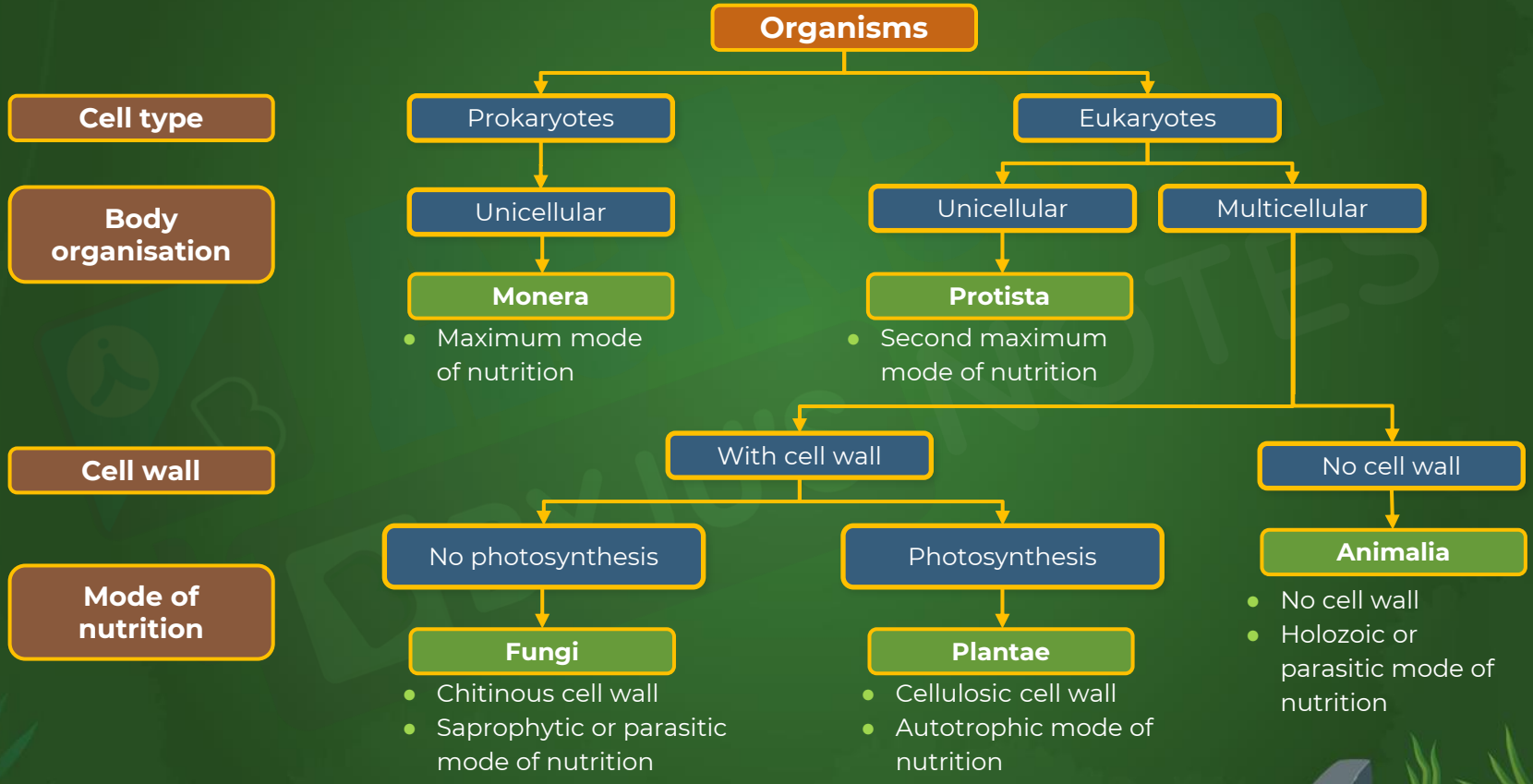
- Proposed **five kingdom classification in 1969**
- **Established Kingdom Fungi**
- Based on : Cell structure, Body organisation, Mode of nutrition, Reproduction and Phylogenetic relationship

Limitations

- Some unicellular algae (*Chlamydomonas*) are kept in Kingdom Protista, away from remaining algae placed in Kingdom Plantae.
- *Chlorella* and *Chlamydomonas* (autotrophic) placed with *Paramecium* and Amoeba (heterotrophic) in Kingdom Protista
- No place for lichens



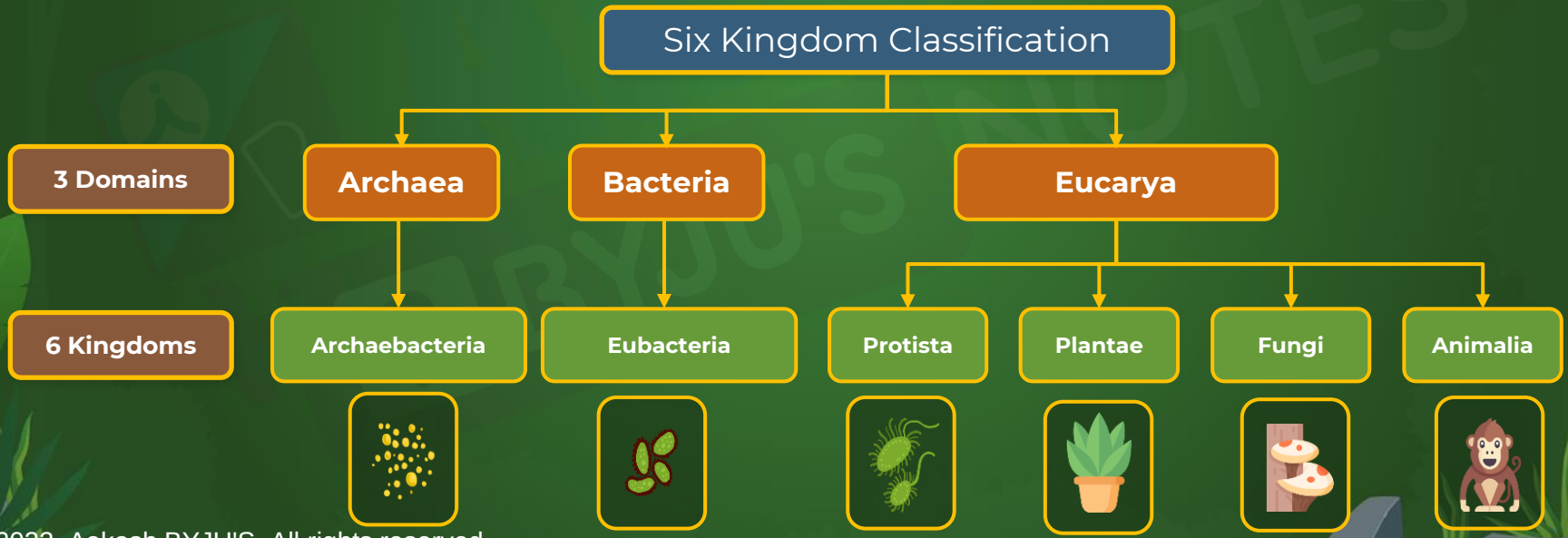
Five Kingdom Classification



Six Kingdom Classification

Carl Woese

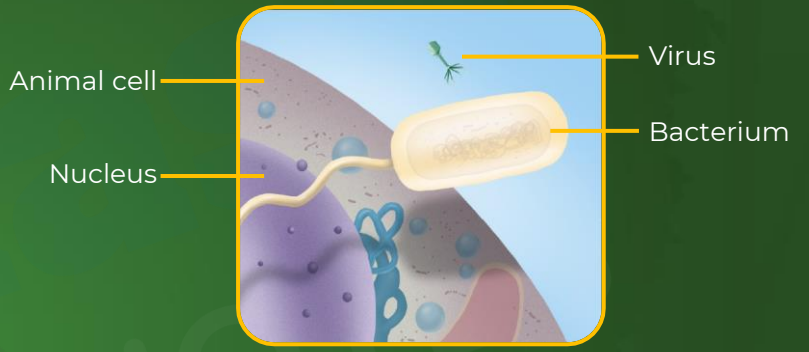
- Proposed **six kingdom** or **three domain classification** in 1990.
- The classification **is based on the sequence of 16S rRNA** which is supposed to be conserved and present across all kingdoms.



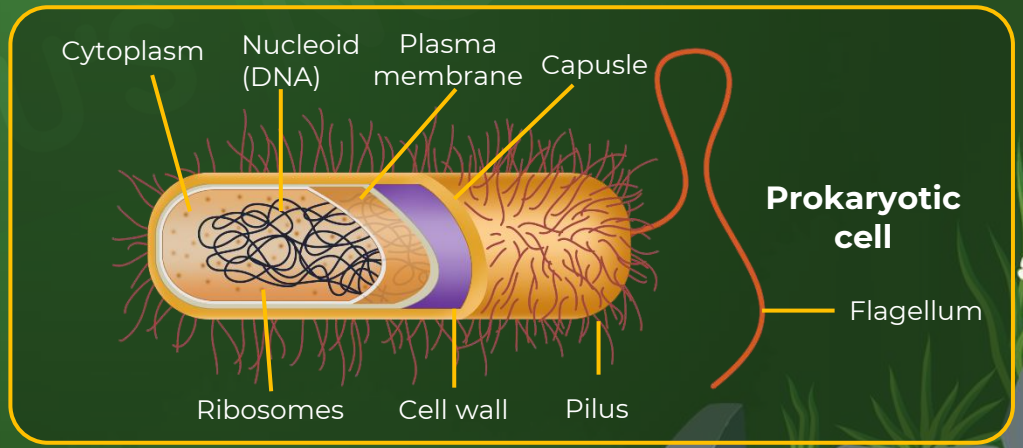
Kingdom Monera

Characteristics

- Prokaryotes (includes all bacteria)
- Ubiquitous
- Double-stranded circular DNA
- Membrane-bound cell organelles absent
- Rigid cell wall
- 70s ribosomes
- Maybe motile (flagella) or non-motile
- Nutrition - Heterotrophic (saprophytic/parasitic) or autotrophic



Cell size comparison



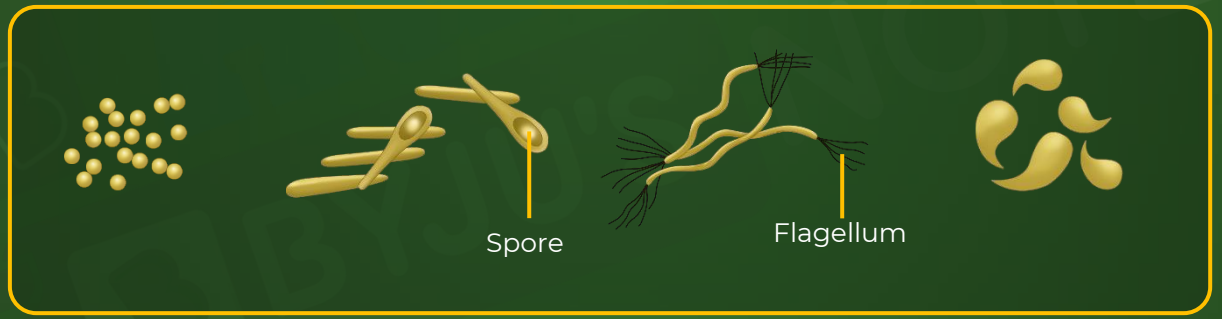
Prokaryotic cell

Kingdom Monera

Classification of bacteria

Based on their shape:

- Cocci
- Bacilli
- Spirilla
- Vibrio



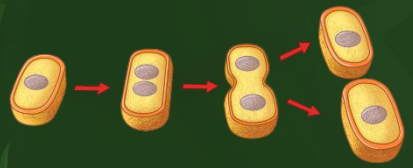
Kingdom Monera

Reproduction in bacteria

Asexual

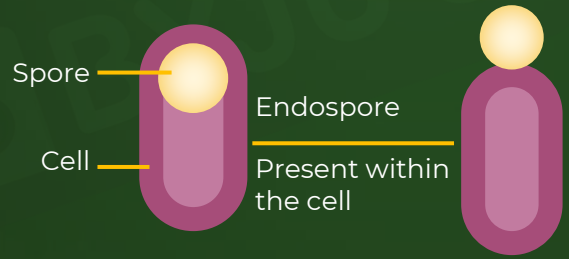
Binary fission

The process in which the **parent cell divides** into **two independent daughter cells.**



Sporulation

The process in which the parent cell produces spore/spores, each of which can develop into an **independent organism**.



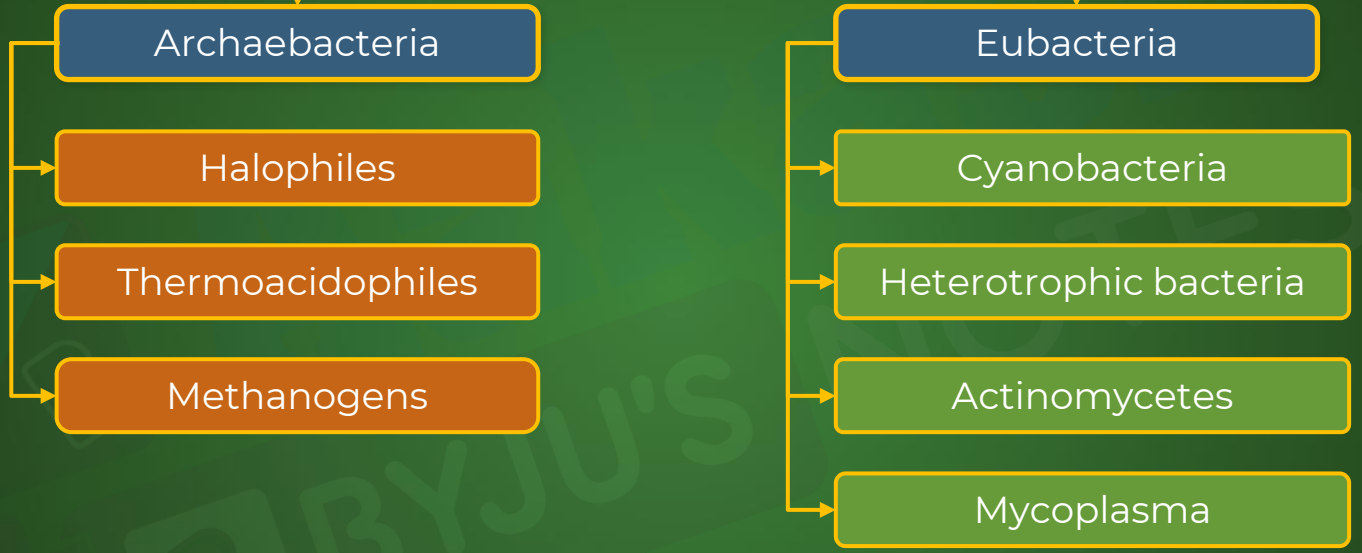
Spore formation (unfavourable conditions)

Sexual

Conjugation

It refers to the process by which one **bacterium transfers its genetic material to another bacterium through direct contact**.

Kingdom Monera



Kingdom Monera

Archaebacteria

- They are the most primitive group that occurs in extreme habitats.
- Their cell wall is made of pseudopeptidoglycan (pseudomurein).
- They are classified into three groups:

Halophiles

- They are found in extremely **saline environments**.
- They have been observed in The Great Salt Lake, U.S.A.
- E.g. : ***Halobacterium***

Thermoacidophiles

- They are found in environments having **high temperature and low pH**.
- They have been observed in Yellowstone Acid pool, U.S.
- E.g. : ***Sulfolobus***

Methanogens

- They are found in the **gut of ruminants**.
- They are responsible for the production of methane from dung.
- E.g.: ***Methanobacterium***

Kingdom Monera

Eubacteria

- They are also known as '**true bacteria**' and their cell wall is made of **peptidoglycan**.
- They can be of the following types depending on the mode of nutrition:

Cyanobacteria | **Chemosynthetic autotrophs** | **Heterotrophic bacteria** | **Actinomycetes** | **Mycoplasma**

- Also known as **blue-green algae**.
- **Photosynthetic autotrophs** that contain **chlorophyll a, phycocyanin and phycoerythrin**
- Show gliding and oscillatory movements and are **covered** by a **gelatinous sheath**
- Found in freshwater, marine or terrestrial regions
- E.g. : *Anabaena, Nostoc* (both are heterocysts as well)
- Three types:

Spirulina **(Unicellular)** | ***Microcystis*** **(Colonial)** | ***Nostoc*** **(Filamentous)**

Kingdom Monera

Eubacteria

Chemosynthetic autotrophs

- These bacteria oxidise inorganic substances such as nitrates, nitrites, and ammonia.
- Energy thus released is used for **ATP production**.

Heterotrophic bacteria

- Most abundant in nature
- Most of them are saprophytes
- Useful in:
  - **Curd formation** from milk
  - **Nitrogen fixation** in the roots of leguminous plants
  - Production of **antibiotics**
- Some are **pathogenic**
- Cause diseases in plants, animals, and humans (cholera, typhoid, etc.)

Kingdom Monera

Eubacteria

Actinomycetes

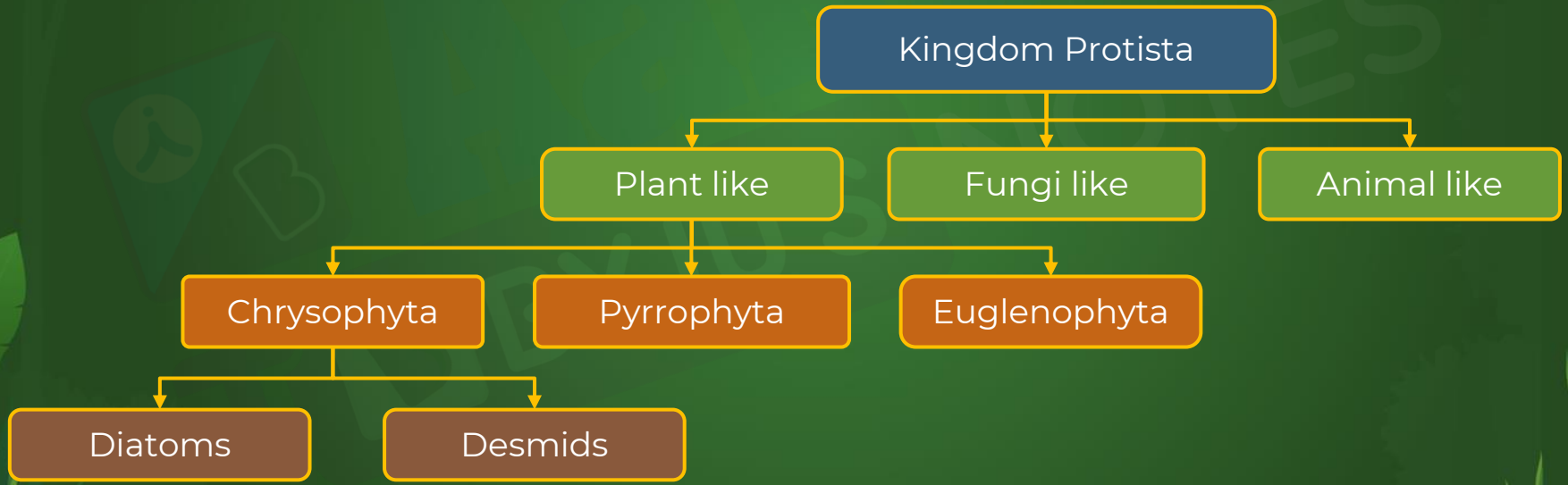
- **Mycelial bacteria** that help decompose organic materials (chitin)
- **Produce antibiotics**
- Commonly found in soil and aquatic regions (both freshwater and marine)
- E.g. : ***Streptomyces***

Mycoplasma

- Smallest living cells
- Also called **PPLO** (Pleuro Pneumonia Like Organisms)
- Lack cell wall and are non-motile
- Exhibit **pleomorphism** and can survive without oxygen
- Pathogenic to plants and animals

Kingdom Protista

- They are **single-celled**/colonial eukaryotes that evolved from **prokaryotes (endosymbiosis)**.
- They are primarily aquatic and use **cilia** and **flagella** for **locomotion**.
- Their reproduction is sexual and asexual.



Kingdom Protista

Chrysophyta

- Live in freshwater and marine environments
- Most are **photosynthetic**
- Float passively in water currents (**plankton**)
- They can be
  - diatoms
  - desmids

Diatoms

- **Chief producers** of the **ocean**
- Unicellular/colonial, and cell wall contains silica
- **Mostly non-motile** or show gliding movement
- Dead diatoms form **diatomaceous earth** (fossilised geological deposit of nearly pure diatoms frustules)
- Used in polishing, filtration of oils and syrups, toothpaste, metal polishes and facial scrubs

Desmids

- Also known as **golden algae**
- Unicellular and microscopic
- Have a golden hue due to pigment **fucoxanthin and oil droplets**
- Food reserve is oil droplets

Kingdom Protista

Pyrrophyta

- It consists of category of organisms called **dinoflagellates.**
- They are microscopic, unicellular and **biflagellate organisms.**
- Their cell walls have **stiff cellulose plates.**
- They are **mostly marine** and **photosynthetic.**
- They are yellow, green, brown, blue or red in appearance due to varying pigments.
- Toxins released are harmful to fishes.

Euglenophyta

- They consist of euglenoids among others.
- **Euglenoids** are unicellular, **biflagellate** and microscopic, **freshwater** organisms.
- They have **pellicle instead of a cell wall.**
- Mode of nutrition:
  - In the presence of sunlight, it carries out photosynthesis.
  - In the absence of sunlight, it has heterotrophic (holozoic) mode of nutrition.
  - Hence, it is a **link between plants and animals.**

Kingdom Protista

Fungi-like protists/ Slime moulds

Cellular slime moulds

- They are amoeba-like cells with no cell wall.
- They move and capture by **pseudopodia.**
- They remain grouped but as unfused cells.

Acellular slime moulds

- It forms plasmodium under suitable conditions.
  - **Plasmodium** is the type of body which is made up of wall less multinucleated protoplasmic mass.
- They do not have a cell wall and are **multinucleated**.
- They grow and spread over several feet and form spores during unfavourable conditions.

Kingdom Protista

Animal like protozoans

- **Unicellular** and mostly heterotrophs.
- They possess structures for movement.
- Mode of nutrition is holozoic or parasitic.
- They are of 4 types:

Amoeboid

- Live in freshwater, seawater or moist soil and show amoeboid movement (pseudopodia)
- Marine forms have silica shells on their surface
- Some may be parasites
- E.g. : **Amoeba, *Entamoeba histolytica***

Flagellated

- Free-living or parasitic
- Flagellated
- Marine and freshwater organisms
- May cause diseases such as sleeping sickness
- Example: ***Trypanosoma brucei***

Ciliated

- Aquatic
- Have a cavity that open to outside of cell surface
- Cilia help in feeding
- E.g. : ***Paramecium, Vorticella***

Sporozoans

- Parasites of animals
- Cause diseases
- Have an infectious spore-like stage
- May have more than one host
- E.g. : ***Plasmodium*** (malarial parasite)

Kingdom Fungi

Characteristics

- Kingdom Fungi, also known as **Mycota**, was introduced to the **Five Kingdom Classification** by **R.H. Whittaker**.
- Fungi are eukaryotic **decomposers**.
- The study of fungi is known as **mycology**.
- Except for **yeast**, all fungi are **multicellular** organisms.
- Their **cell wall** is made up of **chitin** and **polysaccharides**.
- Food is stored in the cell in the form of **glycogen** and **oil bodies**.

Habitat

- Fungi are **widely distributed**; they prefer **warm and humid environments**.
- Predominantly **terrestrial**, but are found in water, air and on animals and plants.

Dikaryophase

- Some fungi exist in a special condition called **dikaryon** where each cell has **2 nuclei (n+n)**.

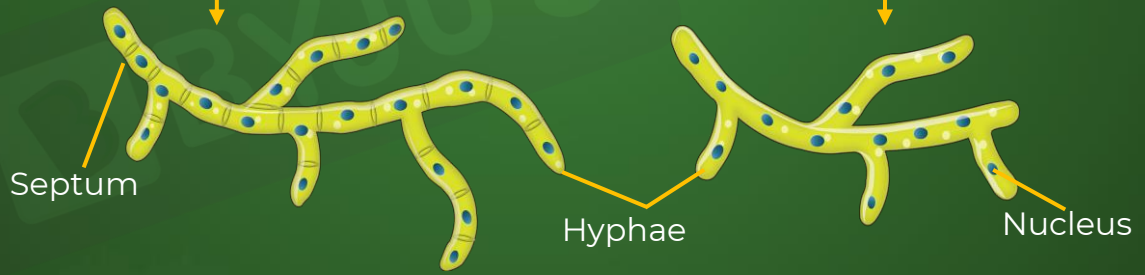
Kingdom Fungi

Structure of fungi

- Fungi have a filamentous body known as **hyphae.**
- The hyphae form a network known as the **mycelium**.
- The mycelium can be of two types:

Septate - Hyphae have cross-walls or septae

Aseptate - Hyphae contain a multinucleate continuous cytoplasm



Septate hyphae

Coenocytic hyphae

Kingdom Fungi

Mode of nutrition

- Fungi are **achlorophyllous** - they lack chlorophyll; hence they are heterotrophic.

Saprophytic

- Saprophytic fungi **grow on dead plant and animal matter.**
- They break down and recycle the soluble organic matter that they absorb from the dead substrates.

Parasitic

- These fungi grow on a **living host** and absorb nourishment from the host.
- In this process, they may harm and sometimes even kill the host.

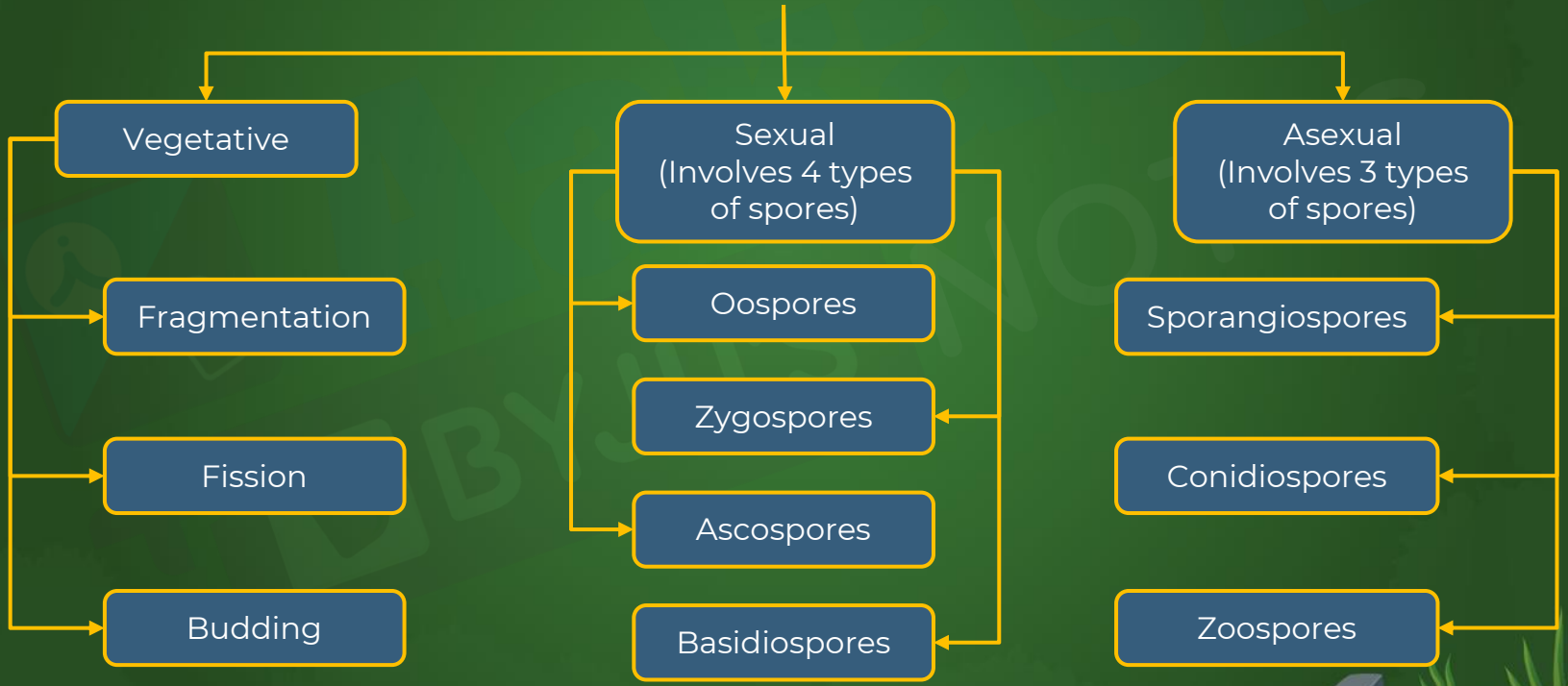
Symbiotic

- Fungi form a **symbiotic association** with organisms to derive nourishment.
- Example 1: **Lichen** - Association of **algae** with **fungi**.
- Example 2: **Mycorrhiza** - Association of **fungi** with roots of higher **plants**.

Kingdom Fungi

Reproduction

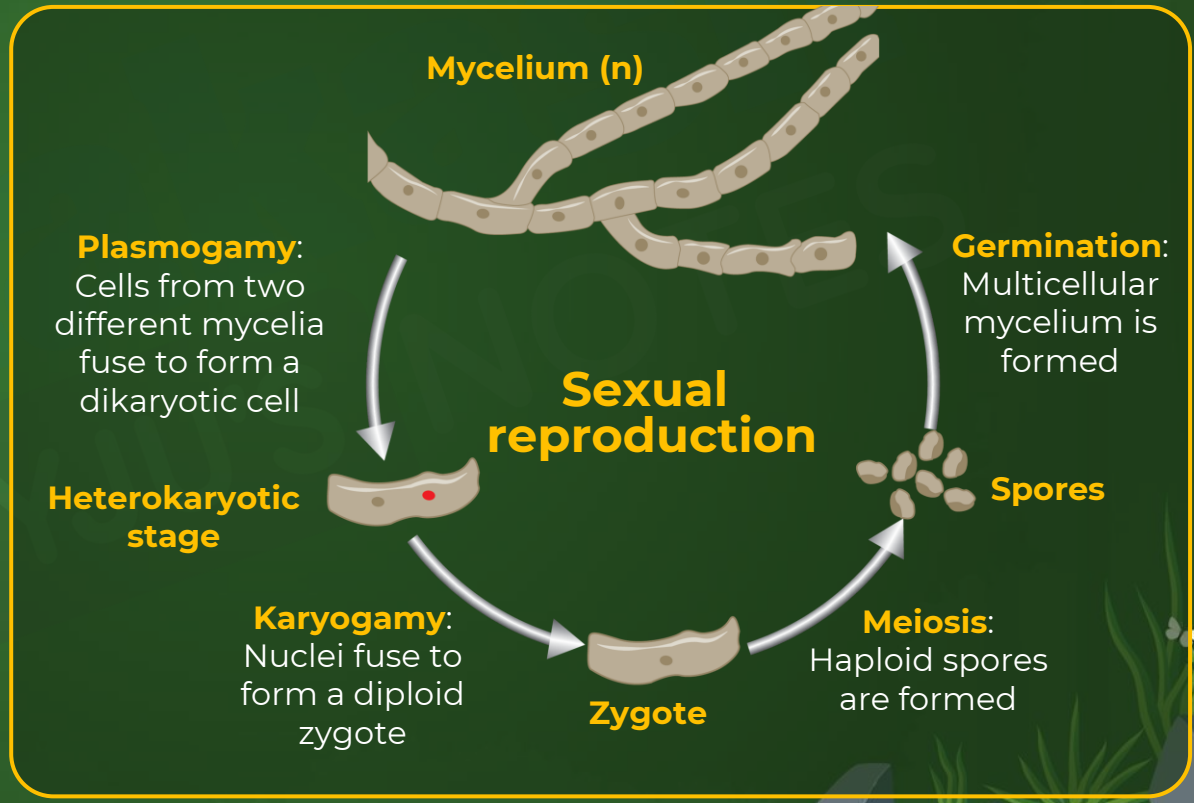
3 modes of reproduction:



Kingdom Fungi

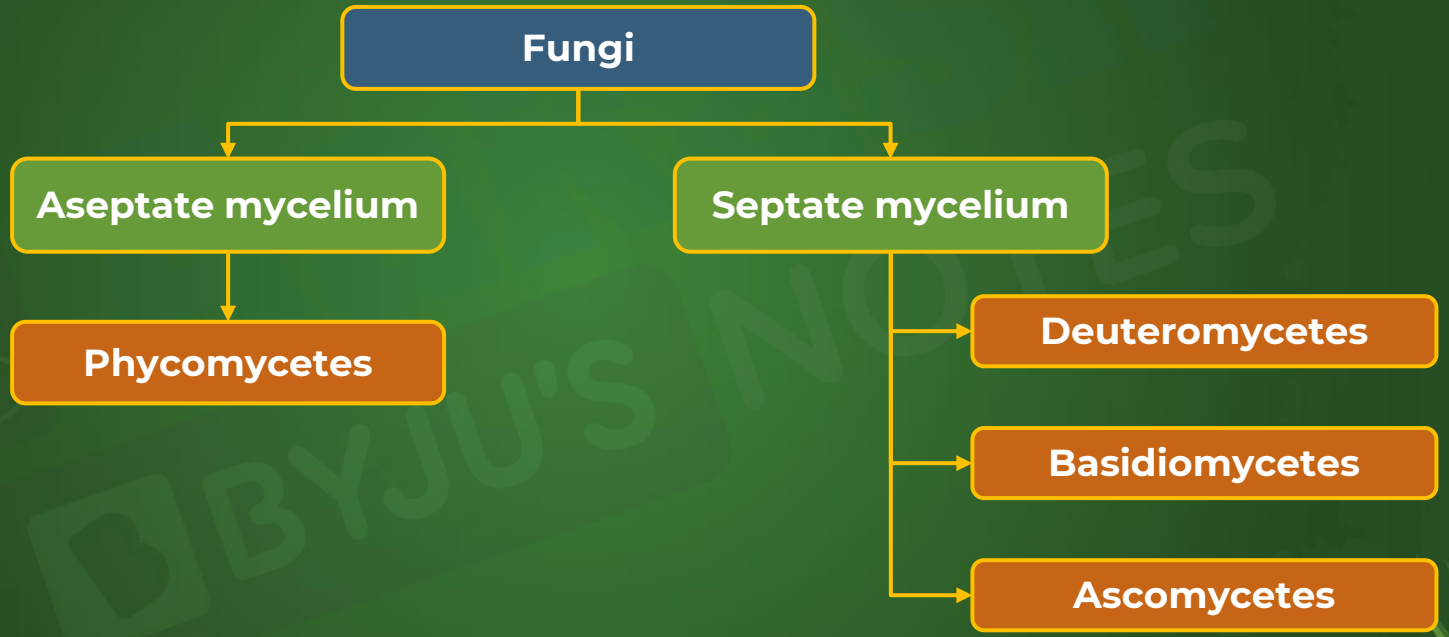
- During sexual reproduction, three types of gametic fusion are observed:
  - **Isogamy**: Fusion of gametes of similar size
  - **Anisogamy**: Fusion of **one big** and **one small** gamete
  - **Oogamy**: Fusion of a **large**, **non-motile female** gamete and a **small**, **motile male** gamete.

Sexual reproduction



Kingdom Fungi

Classification of fungi

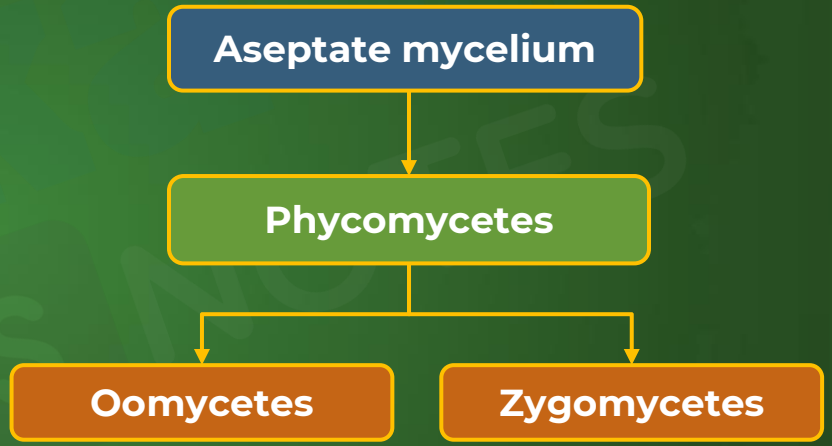


Classification of Fungi

Phycomycetes

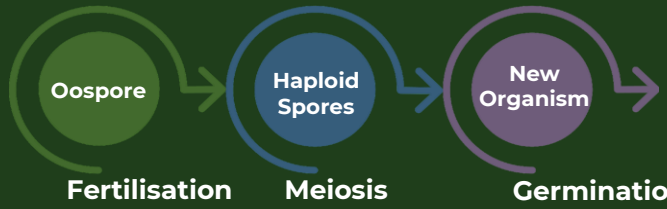
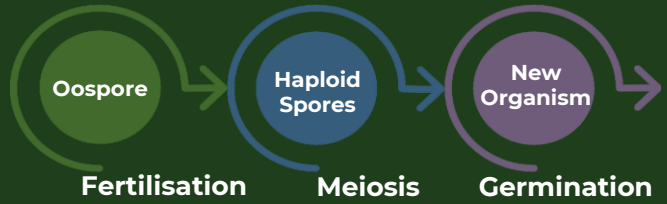
- They have **aseptate** or **coenocytic** mycelium.
- They can survive:
  - In aquatic
  - In moist decaying wood

  as **obligate parasites**.
- Reproduction
  - **Asexual** reproduction by **sporangiospores**
  - **Sexual** reproduction by **oospores**/**zygospores**



Classification of Fungi

Phycomycetes

Type of gametic fusion	Isogamous Or Anisogamous	Isogamous or Anisogamous
Process of Sexual reproduction		
Examples	*Phytophthora infestans* *Albugo candida*	*Rhizopus (bread mould)* *Mucor*

Classification of Fungi

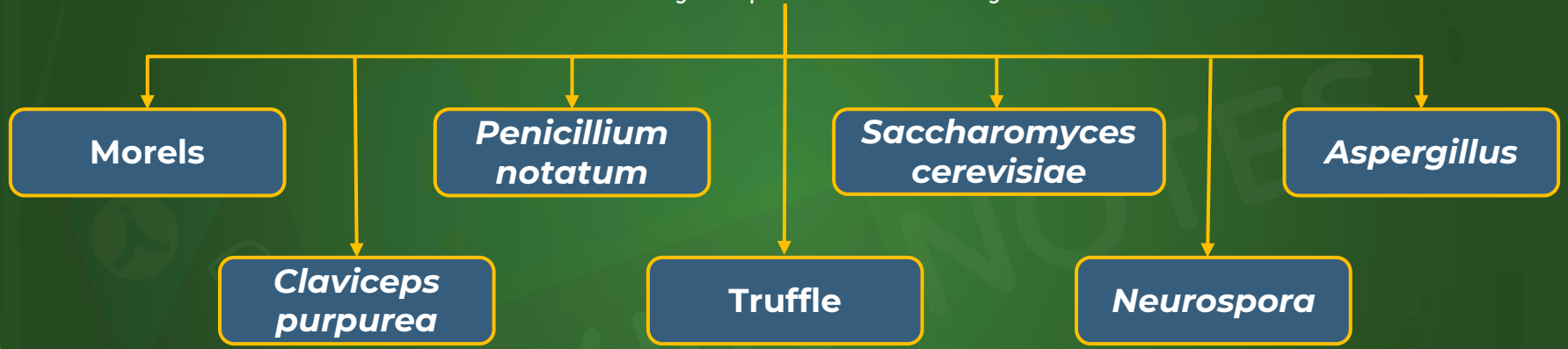
Ascomycetes

01	Characteristics	• Commonly called ‘sac fungi’ • Saprophytic, decomposers, parasitic, or coprophilous (growing on dung) • Rarely unicellular (yeast) mostly multicellular (Penicillium) • Septate, branched mycelia
02	Reproduction	• Vegetative by budding • Asexual by conidiophores • Sexual by ascospores produced in sac like asci
03	Sexual Reproduction	Ascocarp (fruiting body) → Ascus → 8 Ascospores

Classification of Fungi

Ascomycetes

Economically important ascomycetes



- ***Aspergillus, Claviceps and Neurospora*** are used extensively in **biochemical and genetic work**.
- **Morels and truffles are edible** and used in **delicacies**.
- Penicillium and Saccharomyces can be **saprophytic, decomposers, parasitic, or coprophilous**.

Classification of Fungi

Basidiomycetes

01	Characteristics	• Commonly called ‘club fungi’ • Grow in soil, on logs and tree stumps • Parasitic (rusts and smuts)
02	Reproduction	• Vegetative by fragmentation • Asexual spores are generally not found
03	Sexual Reproduction	• Sex organs absent • Sexual reproduction is by somatogamy • Fusion of somatic or vegetative cells result in formation of basidium Basidiocarp (fruiting body) → Basidia → Basidiospores

Classification of Fungi

Ascomycetes

Basidiomycetes

- Mushroom

- Bracket fungi

- Puffballs

Classification of Fungi

Some important members of Basidiomycetes

- Cause **smuts**.
- Ears of cereals turn into black powder.
- Seen in **wheat**, **corn** and ***Sorghum***

Corn smut

- Cause **rust disease**
- **Parasitic**
- Completes life cycle in two hosts - **wheat** and **barberry**
- Forms four types of spores:
  - Infecting wheat: Urediniospores, Teliospores, Basidiospores
  - Infecting barberry: Aeciospore

Puccinia

Classification of Fungi

Deuteromycetes

01	Characteristics	• Also called as ‘fungi imperfecti’. • Mycelia are septate and branched. • Saprophytic or parasitic mode of nutrition. • Help in mineral cycling.
02	Reproduction	• Vegetative reproduction. • Asexual reproduction by conidia. • Sexual reproduction not reported.

Examples

- *Alternaria*
- *Trichoderma*
- *Colletotrichum*

Kingdom Plantae

Characteristics of Kingdom Plantae:

- **Autotrophic**
- **Eukaryotic**
- Cell wall made up of **cellulose**
- **Starch** as reserve food material
- Some show partial heterotrophic nutrition:
  - **Insectivorous (Venus Fly trap)**.
  - Parasitic (***Cuscuta***).

Cuscuta

Venus fly trap

Kingdom Plantae

- Life cycle shows alternation of generation
  - **Diploid sporophytic** phase
  - **Haploid gametophytic** phase

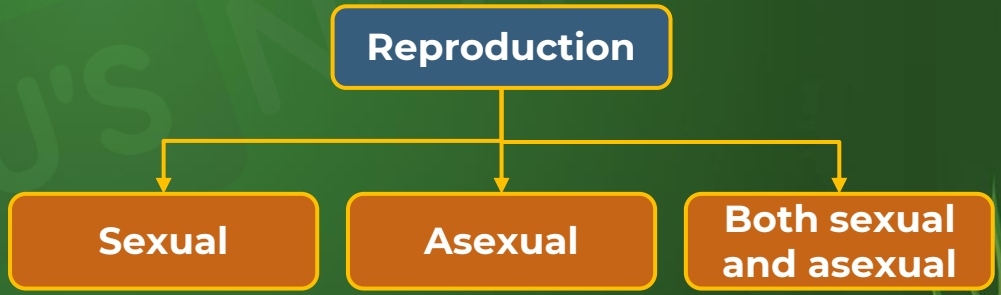
Kingdom Animalia

General characteristics

- Kingdom Animalia consists of several phyla of **eukaryotic** organisms.
- The cells lack a **cell wall**.
- They show tissue/organ/organ system level of organisation.
- A definite growth pattern can be seen.
- Complex sensory and neuromotor mechanisms can be seen in higher organisms.
- Most members of the kingdom show locomotion.

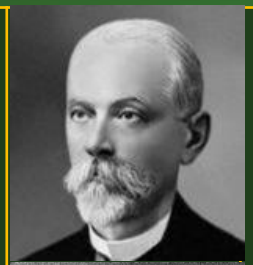
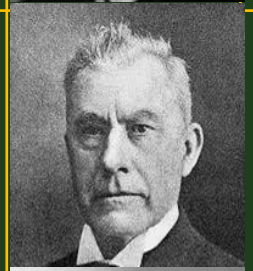
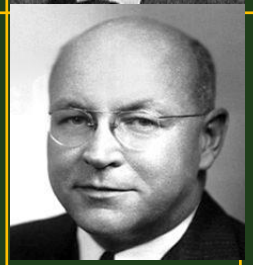
Mode of nutrition

- Heterotrophic
  - Holozoic (by ingestion)
- The food consumed is stored in the form of **glycogen** or **fat**.



Viruses

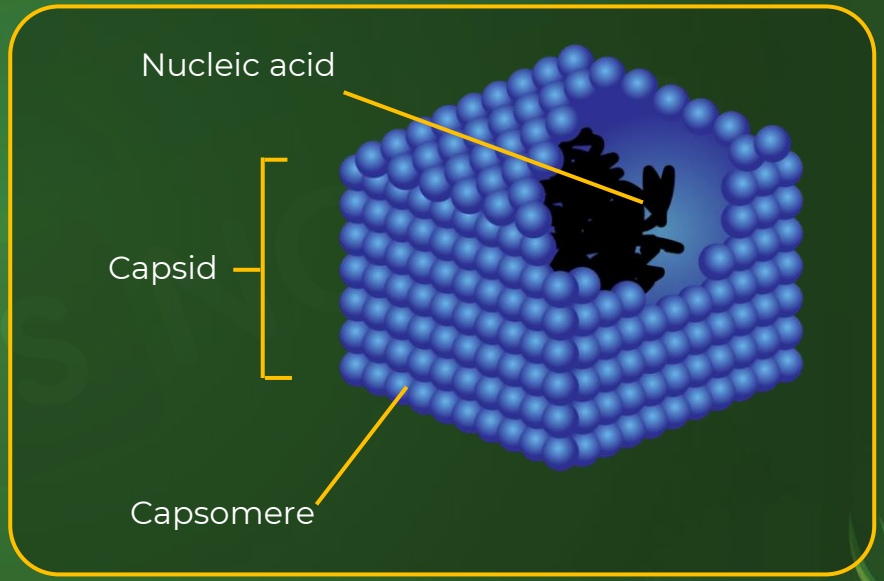
Discovery

Dmitri Ivanovsky		• **Coined** the term '**virus**' (venom) • Worked on **Tobacco Mosaic Virus** • Found that **virus** was **smaller than bacteria** as they passed through bacteria proof filters
M.W. Beijerinck		• Demonstrated that **extract from infected tobacco plants caused disease in healthy plants** • Called the extract 'C***ontagium vivum fluidum***' (infectious living fluid)
W.M. Stanley		• **Crystallised Tobacco Mosaic Virus** (TMV) • Crystals mostly consisted of proteins

Viruses

Structure

- They contain infectious genetic material (either **DNA** or **RNA**, never both)
- The infectious material is covered by a **protein coat** called **capsid**.
- Capsid is made of subunits called **capsomeres**.
  - Capsomeres are arranged in helical or polyhedral geometric forms.



Viruses

Characteristics

- They are **obligate intracellular parasites** and cause diseases in the host.
- Viruses are neither living nor non-living.

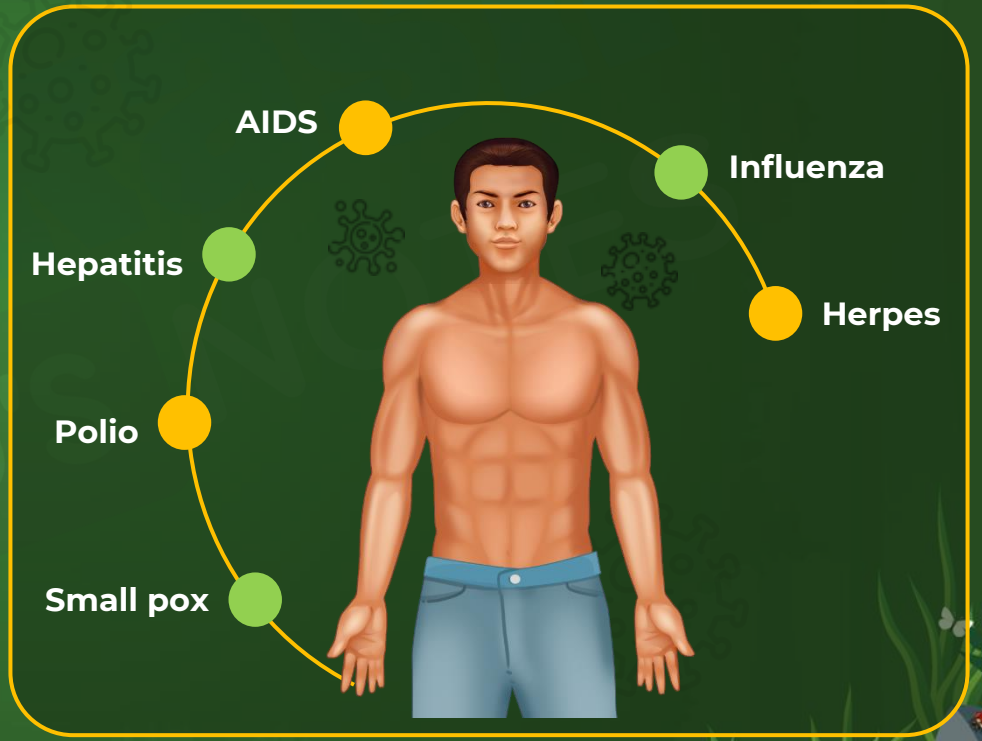
Living properties	Non-living properties
Contains genetic material (DNA or RNA)	Acellular
Surrounded by protein coat	Obligate parasites
Undergoes mutation	Inert crystalline structure
Reproduces in living host	Lacks enzyme system

Viral Infections

Tobacco mosaic disease in plants

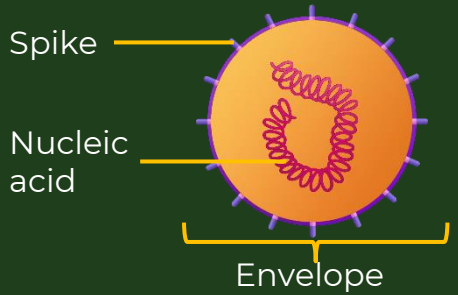
- Caused by the **Tobacco Mosaic Virus**.
- Symptoms in plants include:
  - Leaf curling
  - Leaf rolling
  - Mosaic formation
  - Yellowing and vein clearing
  - Dwarfing

Viral infections in humans



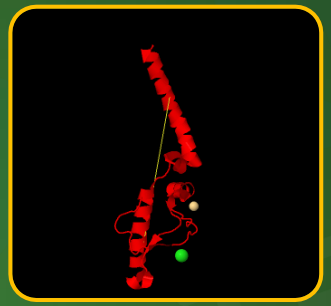
Viroids

- Discovered by **T.O Diener in 1971**
- Consists of **free RNA** of low molecular weight
- Cause disease like the **potato spindle tuber disease**

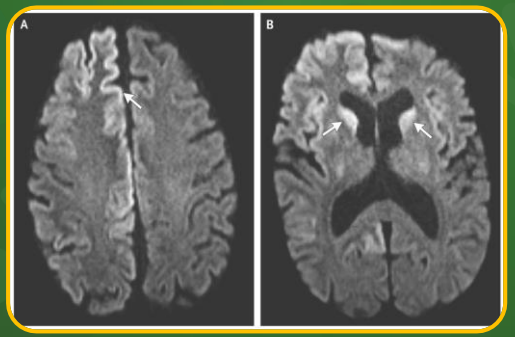
Viroids	Virus
Lacks protein coat	Has protein coat
Genetic material is RNA	Genetic material can be DNA or RNA
Smaller	Larger
Viroids Structure 	Virus structure 

Prions

- Prions are **abnormally folded proteins**
- Similar in size to virus
- Cause **neurodegenerative diseases**
- Highly infectious (untreatable and fatal)



Scrapie
infected sheep



Creutzfeldt Jacob Disease
(CJD) in humans:
Degenerative brain disorder

Bovine Spongiform
Encephalopathy (BSE)
or Mad Cow Disease

Lichen

- Lichen is the **symbiotic** association between **algae (phycobiont)** or **Cyanobacteria (cyanobiont)** and **fungi (mycobiont)**.

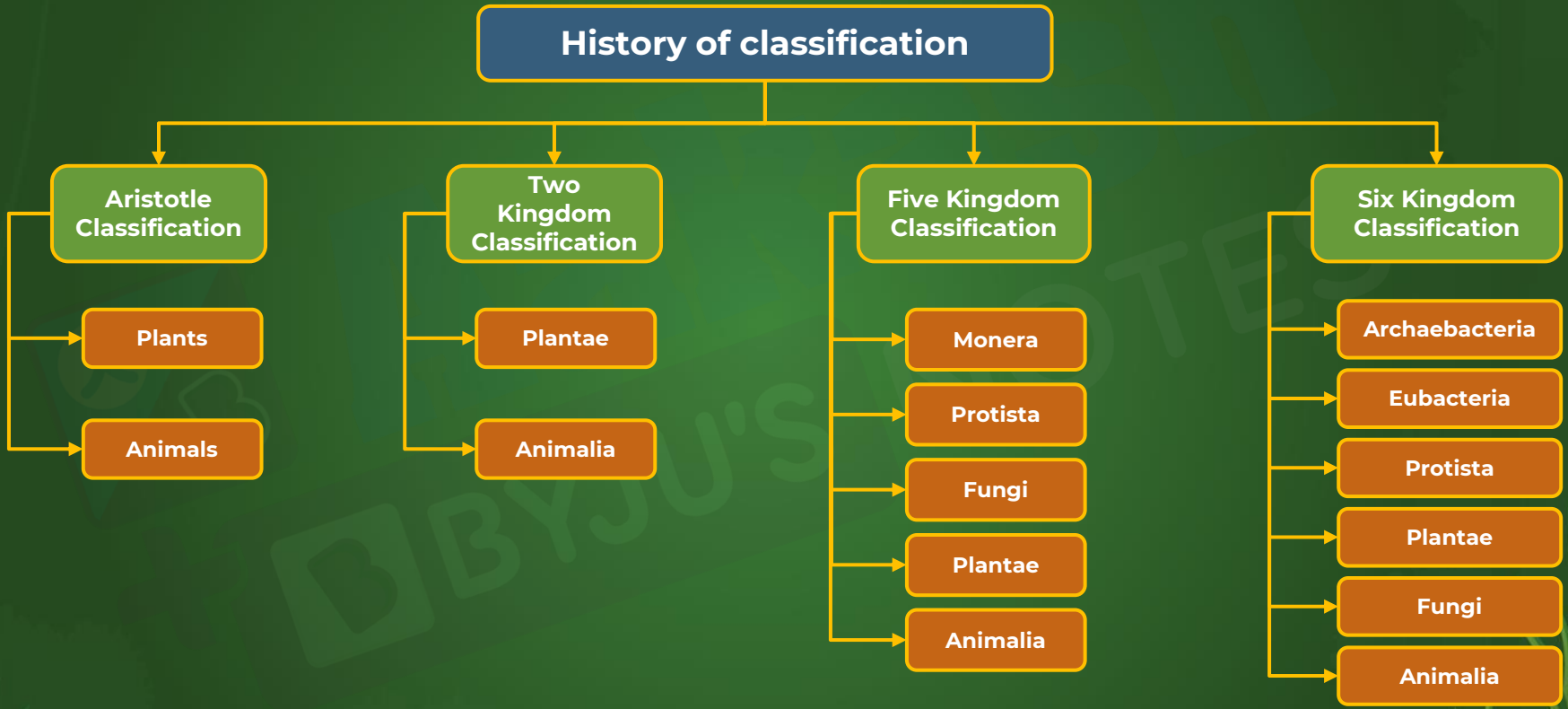
MYCOBIONT (fungus) HETEROTROPHIC + **CYANOBIONT (Cyanobacteria) or PHYCOBIONT (green algae) AUTOTROPHIC** → **LICHEN (symbiosis)**

Provides nutrition

Absorbs water, minerals and provides shelter

- Lichen are early colonizers of barren land
- It is also used in making Litmus indicators.
- They are also **bioindicators** of air pollution (sensitive to SO_2).

Summary



Summary

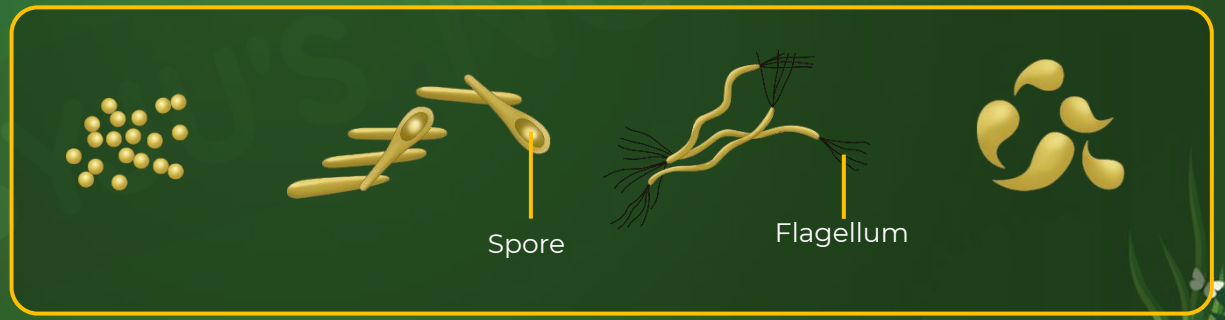
Kingdom Monera

Characteristics of Kingdom Monera

- Double-stranded circular DNA
- Membrane-bound cell organelles absent
- Rigid cell wall
- 70S ribosomes
- Chromatophores (containing pigment)
- Maybe motile (flagella) or non-motile
- Nutrition - Heterotrophic (saprophytic/parasitic) or Autotrophic

Classification of bacteria (based on shape)

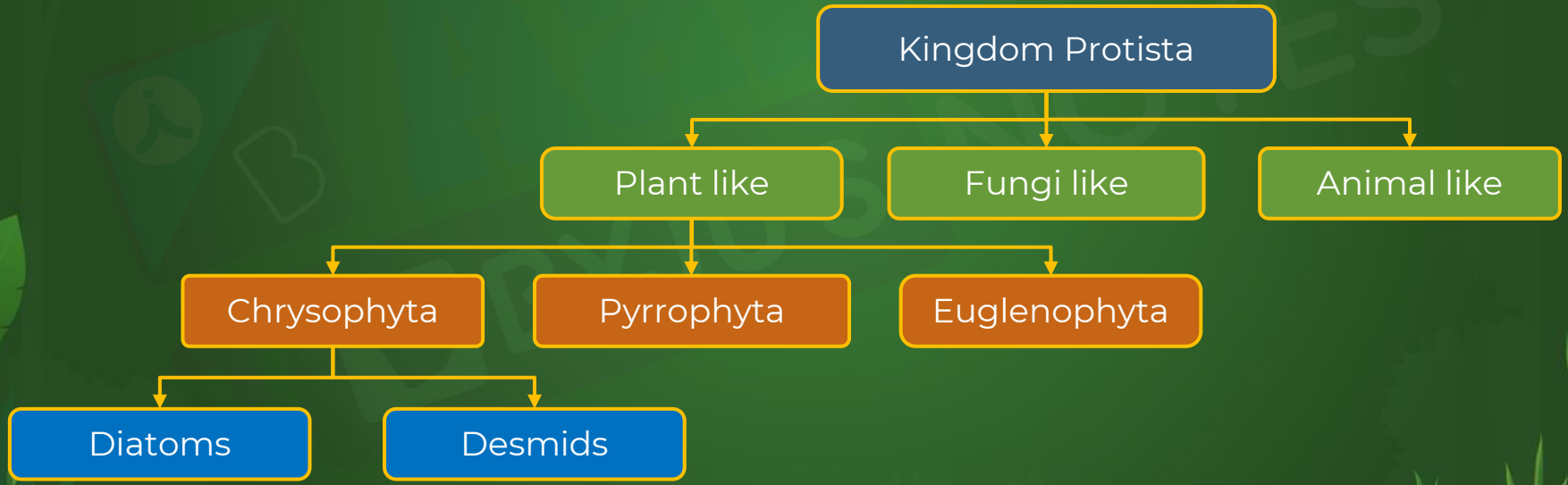
- Cocci
- Bacilli
- Spirilla
- Vibrio



Summary

Kingdom Protista

- They are single-celled/colonial eukaryotes that evolved from prokaryotes (endosymbiosis).
- They are primarily aquatic and use cilia and flagella for locomotion.
- Their reproduction is sexual and asexual.



Summary

Kingdom Fungi

Modes of nutrition

- Fungi are **achlorophyllous** - they lack **chlorophyll**; hence they are **heterotrophic**.

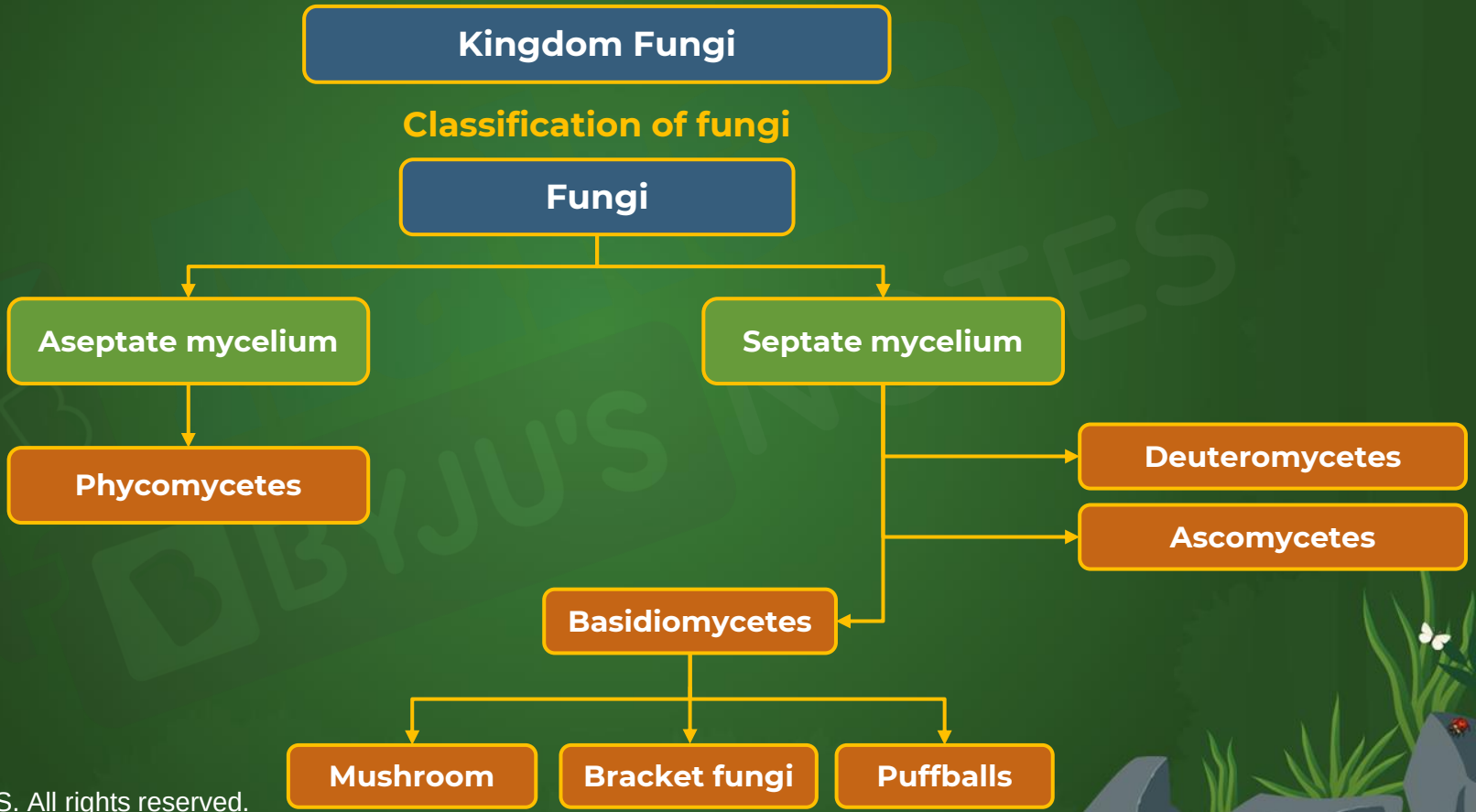
- Saprophytic
- Parasitic
- Symbiotic

Modes of reproduction

3 modes of reproduction:

- Vegetative
- **Sexual** (Involves 4 types of spores)
- **Asexual** (Involves 3 types of spores)

Summary



Summary

Viruses

Scientists with major contribution in discovery of viruses.

- **Dmitri Ivanovsky**
- **M.W. Beijerinck**
- **W.M. Stanley**

Structure

- Viruses contain either **DNA or RNA**, never both.
- The infectious material is covered by a protein coat called **capsid**.