Plant Kingdom

- Plants are **autotrophic** i.e. they do not rely on other organisms for food. Instead they build complex molecules from simple substances by the process of photosynthesis, using light energy.

Light & chlorophyll

carbon dioxide + water ---------- > glucose + oxygen

- Light energy is absorbed by the green pigment **chlorophyll** found in the **chloroplasts** of most plant cells. This energy is required to combine carbon dioxide and water.
- They also have a **cellulose** cell wall.

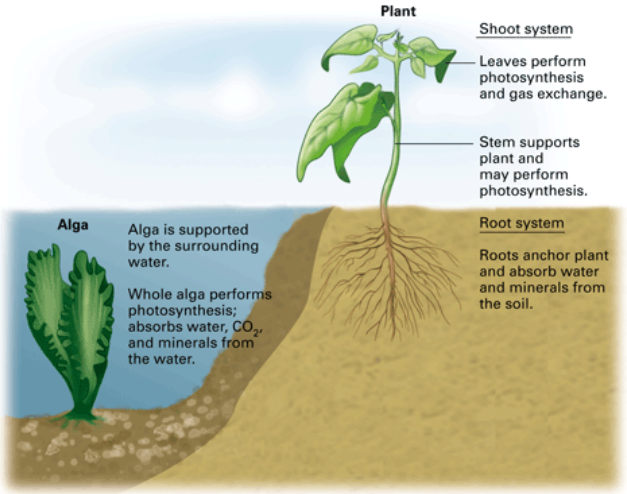
Plants have originally lived in water and eventually moved to land. There are advantages both in water and on land as summarized below:

	Water	**Land**
Sunlight	Less sunlight	More sunlight
Water	Readily available	Less available
Minerals	Readily available (in water)	Less available
Reproduction	Medium for spore/gamete transfer	No medium for sport / gamete transfer
Concentration CO_2	Less available	More available
Space	Less available	More available (Lack of colonisation by animals)

How have plants adapted to the challenges faced on land?

1) *Problem*: **UV radiation** causes mutations
   Solution: Presence of waxy cuticle and epidermis that absorb UV light

2) *Problem*: **Dessication** is caused due to exposure to air
   Solution: Presence of waxy cuticle and hair like structures to reduce loss of water



3) *Problem*: Lack of **Structural support** as water offers buoyancy

Solution: Presence of cellulose cell walls and lignin (wood) in xylem

4) *Problem*: During **reproduction** male gametes need water to reach female gametes.
Solution: Specialised *reproductive* structures that do not require water for gamete transfer.

Major milestones in plants evolution

1) **Growth occurring at shoot and root tips** allowing them to reach additional space and resources
2) Cells developed **lignin** that offered support enabling the plant to grow tall and upright exposing the leaves to the sun
3) **Vascular (transport) tissues** enabled plants to transport nutrients and water efficiently throughout the plant body
4) Leaves developed **pigments** that absorb UV radiation, a waterproof cuticle layer that reduces water loss and stomata (to allow gaseous exchange)
5) **A main plant body** that ensures that the new generation of plants can survive until conditions are favourable for growth.

Plant classification

Land plants can be characterized by:

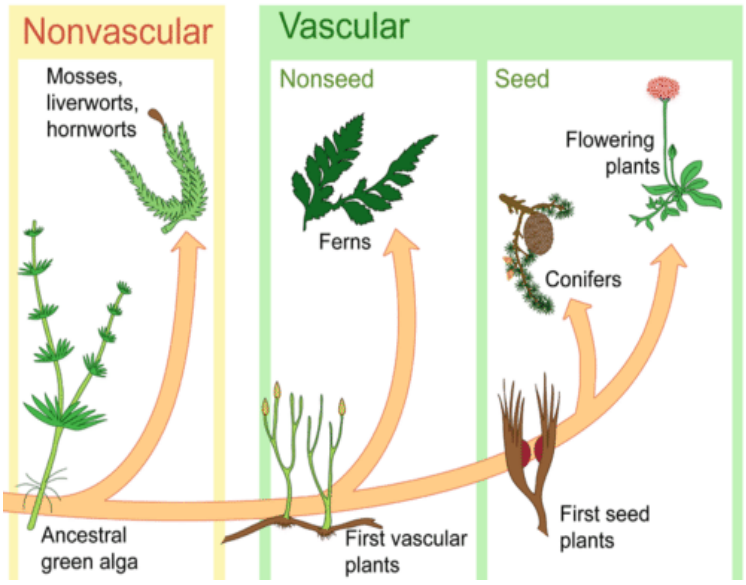
- ➔ the presence or absence of vascular tissue (xylem and phloem)
- ➔ the way they reproduce, with or without seeds.

Based on this 3 main group are formed:

1) **Non-vascular seedless plants**: These are plants that lack vascular tissue and reproduce without seeds. Examples include mosses.

2) **Vascular seedless plants**: These are plants that have vascular tissue but reproduce without seeds. Examples include ferns.

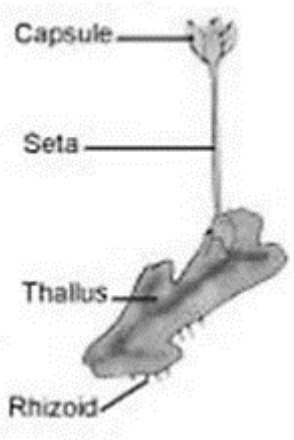
3) **Vascular seed plants**: These are plants that have vascular tissue and reproduce through seeds. Examples include gymnosperms and angiosperms.



Mosses

Features:

- They are **non-vascular seedless** plants
- They have a very simple structure called a **thallus**, which lacks proper roots, leaves, and stems
- They have hair-like structures called **rhizoids** on the lower surface absorb moisture.

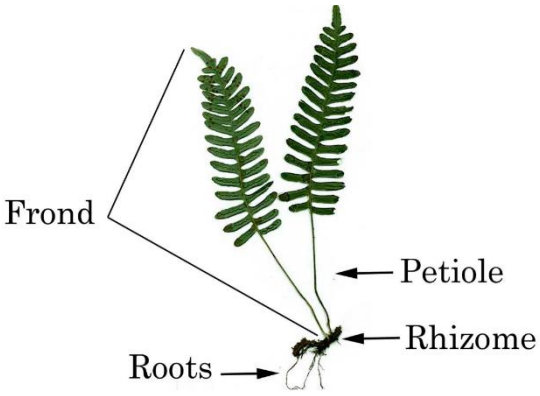


The absence of vascular tissue limits their size and spread, and they are heavily dependent on water for reproduction.

Ferns

Features:

- They are **vascular seedless plants**.
- They have **roots**, **stems**, and **leaves**.
- They have a **waxy layer** allows them to colonize drier areas



Vascular tissue allows ferns to attain **considerable sizes.** This led to their domination of land forming vast forests and providing food for the animals that were starting to move on land.

Reproduction still requires a damp environment and so ferns can't live in very dry places like deserts.

Spermatophytes

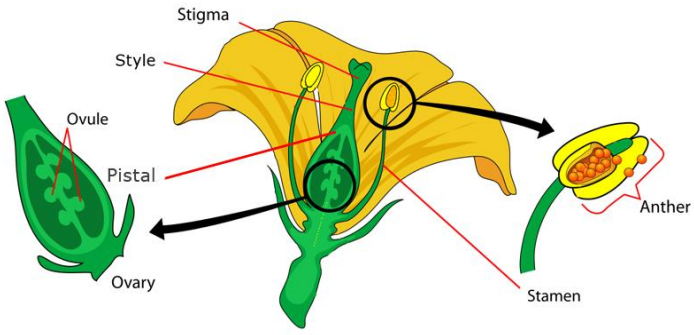
Features:

- They are **vascular seed plants**.
- They are able to conserve water and reproduce through seeds.

There are two types of spermatophytes:

1) **Gymnosperms:** These are plants whose seeds are formed in **cones** and are not enclosed in an ovary (fruit). They have needle-like leaves and a waxy cuticle. Examples include conifers.

2) **Angiosperms**: These are **flowering plants** whose seeds are formed within the ovaries of flowers, which develop into **fruits** that aid seed dispersal. They are the most diverse and successful group of land plants, making up approximately 90% of all living plant species. They are divided into **monocots** and **dicots**.



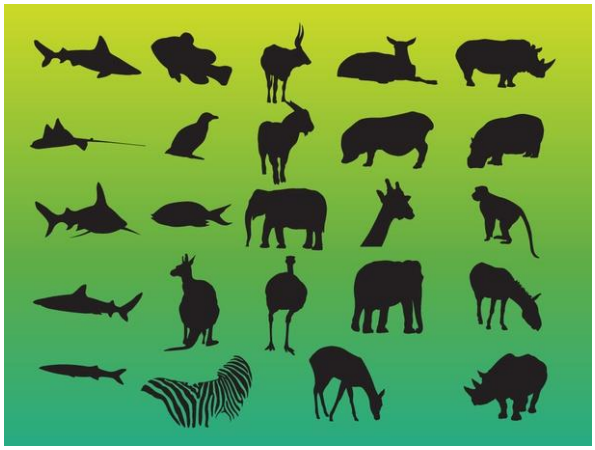
Animal Kingdom

As more and more plants starting living on land, this prompted aquatic animals to also move on land due to the availability of food. Similar to plants, animals also had several problems to solve on moving from water to land as summarized below:

Problem	Solution
Drying out due to exposure to air	Skin adapted to withstand drying, such as a **waterproof outer layer** of skin or scales
Extracting oxygen from air rather than water	Evolution of **lungs** that can extract oxygen from air
Support body weight and prevent collapse under gravity	Development of either an **internal (endoskeleton**) or **external (exoskeleton**) skeleton
Detection and response to changes in environment	Evolution of a highly efficient **nervous system**
Regulation of **body temperature**	Development of various mechanisms to regulate body temperature, such as **sweating, panting, and shivering**
Reproduction not dependent on availability of free water	Evolution of methods of reproduction that are not dependent on water, such as **internal fertilization** and development of **shelled eggs**
Ensuring the **survival of offspring**	Development of various strategies to ensure survival of offspring, such as **parental care, nesting behaviors, and complex social structures**

Animals show a greater variety as they move around and encounter different habitats. As a result, animals have developed specialized adaptations that allow them to take advantage of these diverse eating opportunities. For example:

- some predators have developed **specialized hunting techniques** to capture prey in different habitats
- some parasites have evolved **complex life cycles** that enable them to survive in different hosts.



Additionally, many animals have evolved specialized digestive systems that allow them to extract nutrients from a wide range of food sources. This ability to adapt to different habitats and food sources has allowed animals to thrive in a wide variety of environments and has contributed to the remarkable diversity of life on Earth.

Arthropods

Arthropods are a group of invertebrate animals that include **insects, spiders, crustaceans**, and others.

Arthropods were the **first animals** to successfully colonize land.

Characteristics that made arthropods successful on land include:

- **Body segments and jointed legs** that facilitate mobility on dry land.
- A **waterproof exoskeleton** that prevents water loss and protects against predators.
- An **advanced sensory system** that allows them to detect and respond to environmental cues.

Primitive arthropods and their co-evolution with seed plants:

- Primitive arthropods, particularly insects, **co-evolved** with seed plants, giving rise to a diversified terrestrial vegetation.
- Insects facilitated **pollination** and consequently the evolution of angiosperms (flowering plants).
- This co-evolutionary relationship between insects and plants led to the development of **complex ecosystems** on land.

Amphibians

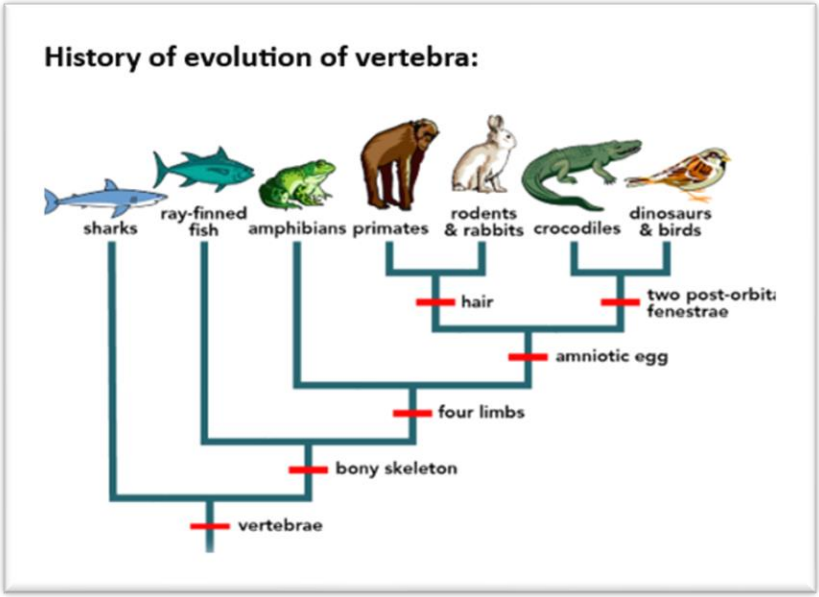
Amphibians **evolved from fish** and were the **first vertebrates** to colonize land.

- They have **primitive lungs** supplemented by gaseous exchange through a moist, scaleless skin.
- They have limbs and a **strong endoskeleton** to support their body on land.
- Amphibians **need a watery medium for external fertilization** and egg laying.

Reptiles

Reptiles are the **first truly successful** land vertebrates.

- They have **dry, scaly, waterproof skin** that prevents water loss.
- They have **strong limbs** that support their body on land.
- Reptiles reproduce through **internal fertilization** and lay **shelled eggs** on land.



Mammals

Mammals are a class of animals found in a wide range of habitats around the world and have diversified into a vast array of forms and sizes, from tiny shrews to massive whales. They have evolved from reptiles and their main characteristics include:

- they are **endothermic** (able to regulate their body temperature internally)
- body covered with **hair**
- **mammary glands** that produce milk
- **external ears**
- **diaphragm** separating the thorax from the abdomen
- give **birth to live young**.

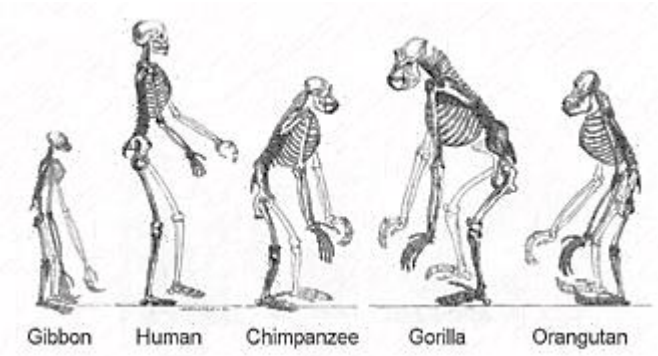
<u>There are three different reproductive methods in mammals:</u>

1) **Monotremes** are the most primitive mammals and have retained the reptilian **egg-laying method**.

2) **Marsupials** give birth to live **underdeveloped young** whose development is completed in the marsupial.

3) **Placentals** give birth to live young that have been nourished before birth in the mother's uterus through a **placenta.**

Human evolution



Humans and primates are not directly related, but both descend from a **common ancestral animal.**

- Human evolution culminated in the appearance of ***Homo sapiens*** and was characterized by changes in
    - **Posture** (becoming fully erect on two legs)
    - **Cranial capacity** (with brain size increasing)
    - Facial angle (becoming flatter and reaching a vertical face).
- Human evolution was **not a linear process**, but was characterized by a whole series of inter-linked (branching) lines of different ancestors and descendants.
- These various ancestors and descendants appeared because of **various available niches** and disappeared because of competition and/or interbreeding with ancestors of modern humans.