

Gymnosperms: Naked-Seed Plants

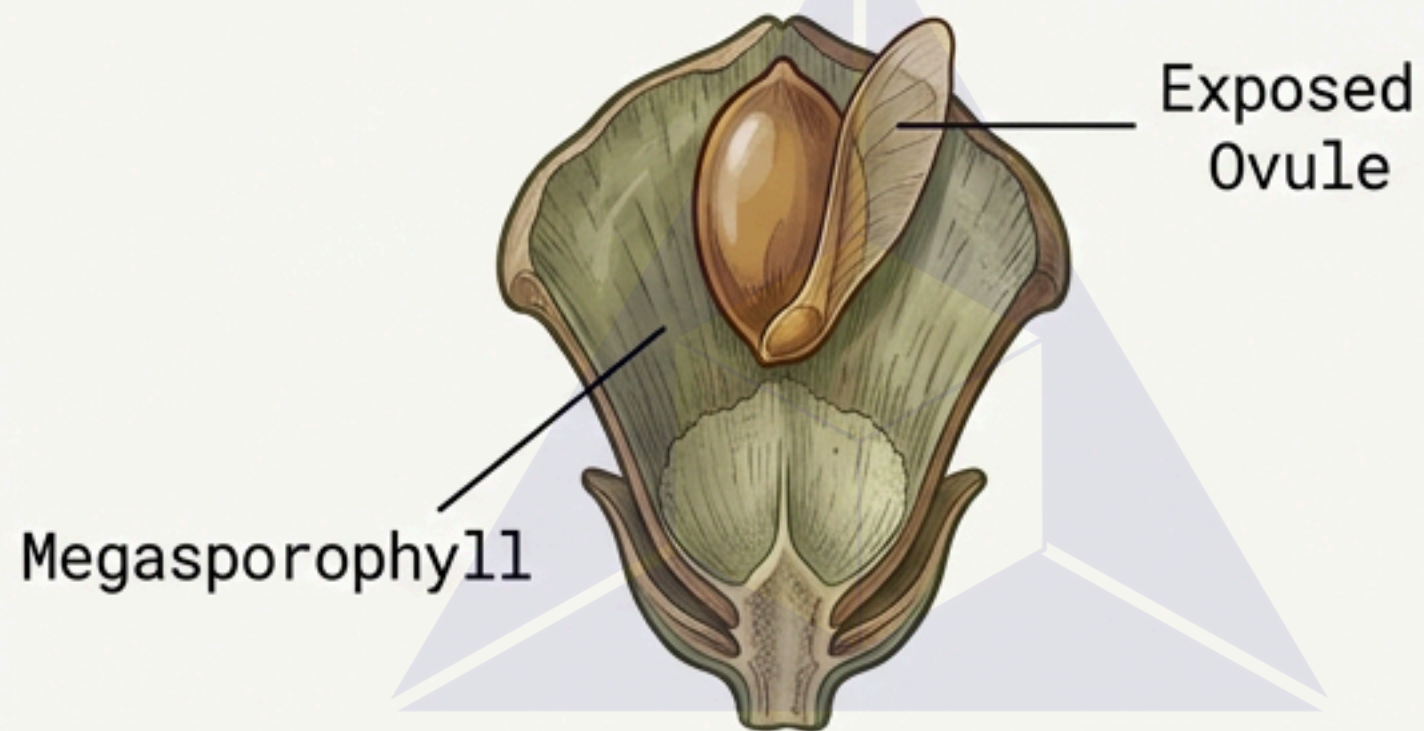
gymnos (naked) + sperma (seed)

Plants in which the ovules are not enclosed by any ovary wall and remain exposed, both before and after fertilisation.

Scale ranges from medium shrubs to towering giants, specifically including the giant redwood Sequoia, one of the tallest tree species on Earth.

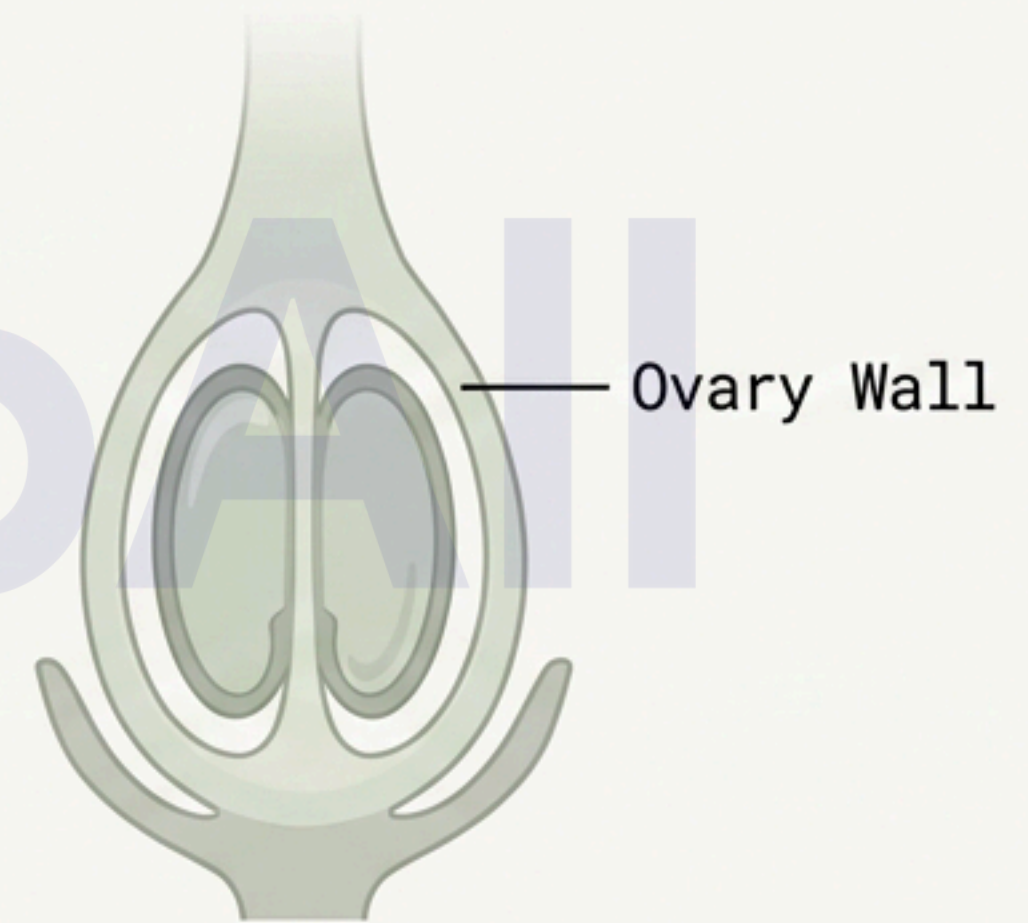
The Defining Trait: Exposed Ovules

The Gymnosperm



Seeds develop completely uncovered post-fertilization.

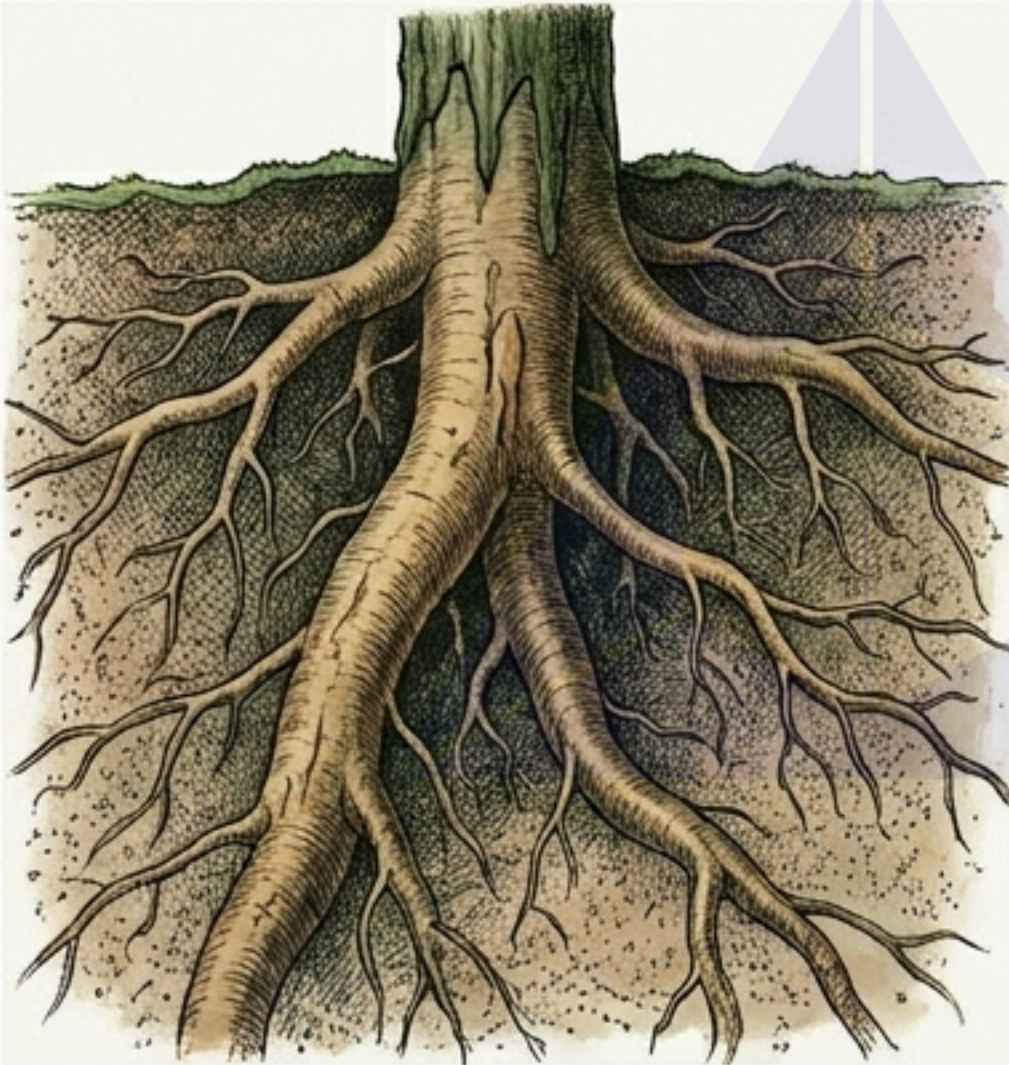
Contextual Contrast



Unlike flowering plants, gymnosperm seeds are directly exposed to the environment, completely lacking a protective fruit or ovary wall.

Vegetative Adaptations: Root Symbiosis

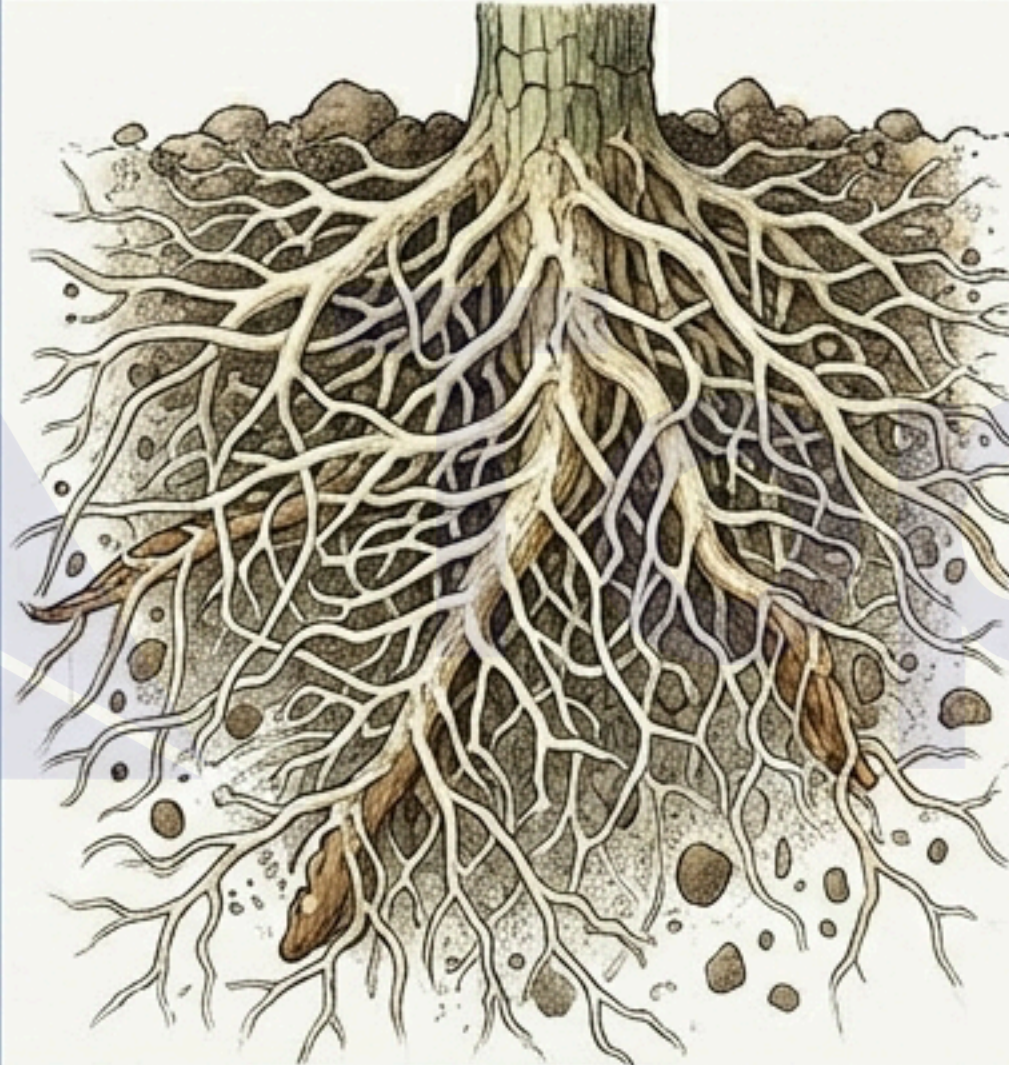
Tap Roots



The standard root architecture for the majority of gymnosperm genera, anchoring massive trees deeply into the soil.

Mycorrhiza

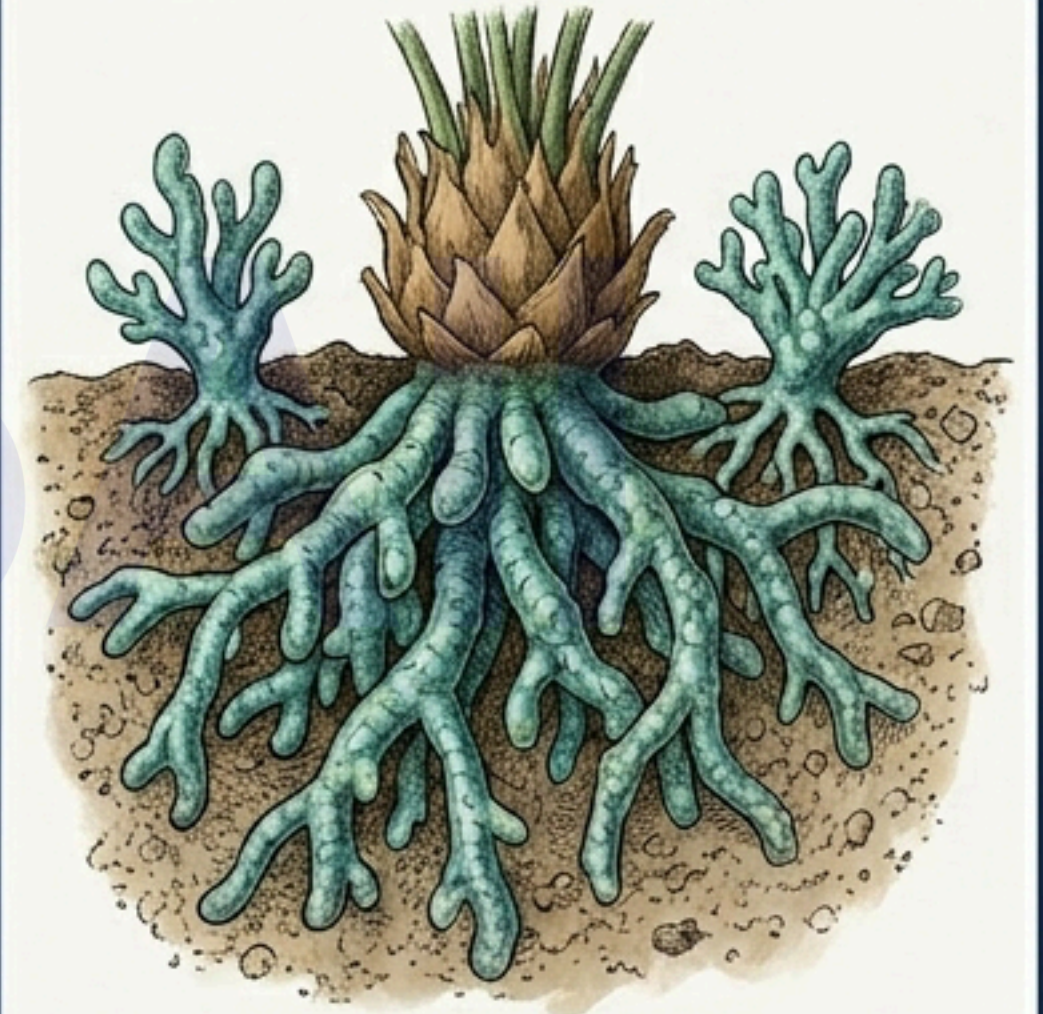
Pinus



A symbiotic association with fungi that drastically expands nutrient and water absorption capabilities.

Coralloid Roots

Cycas



Specialized roots harboring N_2 -fixing cyanobacteria, allowing the plant to thrive in nitrogen-poor soils.



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Structural Engineering: Stems & Leaves

Unbranched



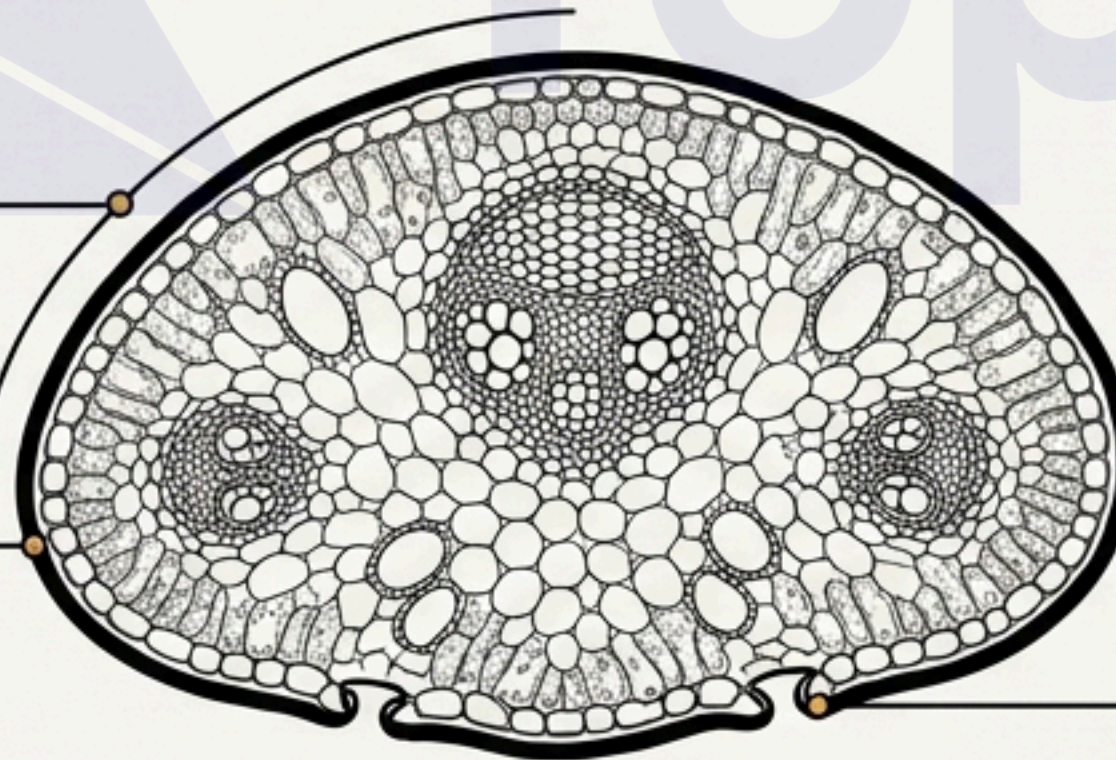
Branched



The Leaf Survival Kit

Needle-like Shape
Drastically reduces surface area to minimize exposure.

Thick Cuticle
A heavy waxy layer sealing in moisture.



Sunken Stomata
Pores recessed into the leaf surface to trap humid air and prevent water loss.

Field Note

In *Cycas*, distinct pinnate leaves persist for several years before shedding.

Reproductive Structures: Heterospory & Cones

Gymnosperms are **heterosporous**, producing **two distinct types** of **spores** within **sporangia** on **spirally** arranged **sporophylls** (cones/strobili).

Microsporangiate (Male Strobili)



- Bears microsporophylls and microsporangia.
- Produces microspores that develop into a highly reduced male gametophyte—the pollen grain.

Macrosporangiate (Female Strobili)



- Bears megasporophylls with ovules (megasporangia).
- The megaspore mother cell divides meiotically to form a multicellular female gametophyte.

Distribution Note: These cones can be borne on the same tree (monoecious, e.g., *Pinus*) or different trees (dioecious, e.g., *Cycas*).

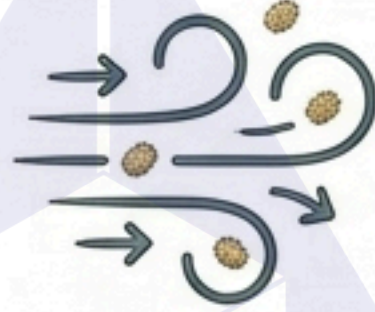
The Fertilization Pathway (Waterless Reproduction)

1. RELEASE



Pollen grains are released from the microsporangium.

2. TRANSPORT



Carried entirely by air currents (wind), eliminating the need for water transport.

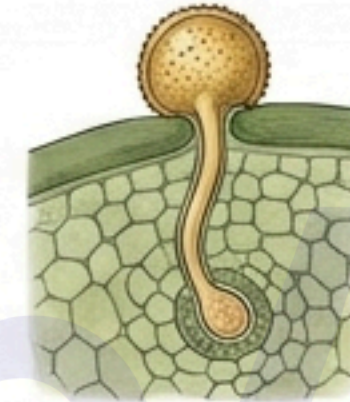
3. CONTACT



3. CONTACT

Pollen lands directly on the opening of the ovules borne on the megasporophylls.

5. DEVELOPMENT



4. POLLEN TUBE

A critical structure grows toward the archegonia in the ovules, discharging male gametes near its mouth.



Following fertilization, the zygote develops into an embryo, and the exposed ovules harden into naked seeds.

Botanical Dossier: Key Genera in the Wild

Plate 1



Cycas

Unbranched stem, persistent pinnate leaves, dioecious (separate male/female plants), coralloid roots.

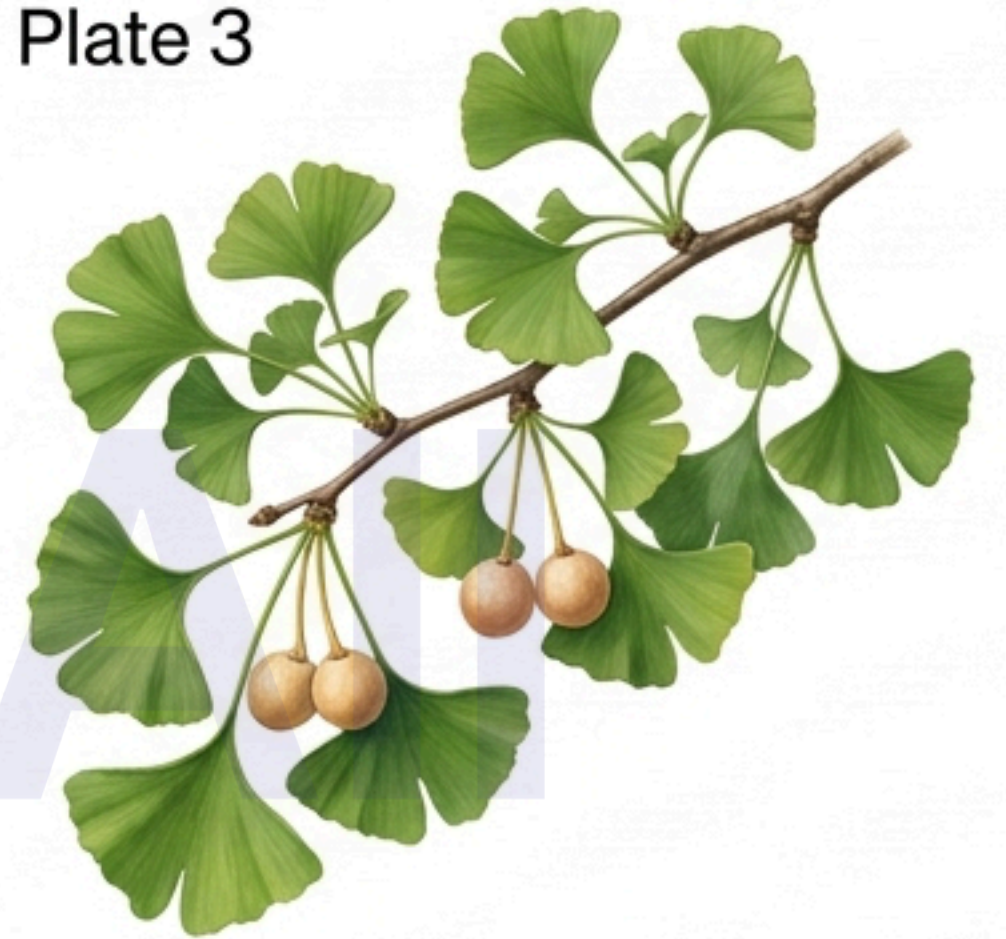
Plate 2



Pinus

Branched stem, needle-like leaves, monoecious (both cones on one plant), mycorrhizal fungal roots.

Plate 3



Ginkgo

Distinctive fan-shaped leaves, unique evolutionary relic showcasing distinct dwarf and long shoots, and exposed seeds.

Evolutionary Synthesis: The Shift in Dependence

The End of Free-Living Gametophytes.

Unlike bryophytes and pteridophytes, male and female gametophytes in gymnosperms do not have an independent, free-living existence. They are entirely retained within the sporangia on the dominant sporophyte.

Bryophytes & Pteridophytes

- Gametophyte has **independent** existence.
- **Water** often required for fertilization.

Gymnosperms

- Gametophyte is **physically dependent** on the sporophyte (retained in cones).
- **Wind** and **pollen tubes** completely replace the need for water.



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