Tree physiology/ theory part, 3rd grade, department of forestry/

instructed by Assist Prof. Dr. Sirwa Anwar Qadir

TREE PHYSIOLOGY DEFINITION:

- **Tree Physiology** is the study of **how** trees **grow** and **develop** in terms of genetics, biochemistry, cells, tissues, and organ functions.
- It also relates to a tree's **interaction** with environmental factors.

- Have you ever wondered **how trees begin**? You know it is from **seeds**, but what tells the seed to begin to grow? Then you have to wonder, how does the seed know the conditions are just right so the **embryo** will be able to grow into a seedling and then into a tree?

- **What parts** of a tree begin to **grow first**?

Germination

- Germination is defined as the **growth of an embryonic** tree contained within a seed.

- Seed germination depends on both **internal** and **external** conditions being just right to support seedling growth.

- Often this depends on:

1. The individual **seed variety**
2. **Ecological conditions** of a tree's natural habitat.

Ecological Factors Inducing Germination

- **Temperature: it** affects germination in three primary ways:

A. **Moisture**, for seeds to germinate, they need to imbibe water. For this to occur, sufficient moisture must be present. A warmer climate may increase evaporation and decrease moisture, which would negatively affect germination.

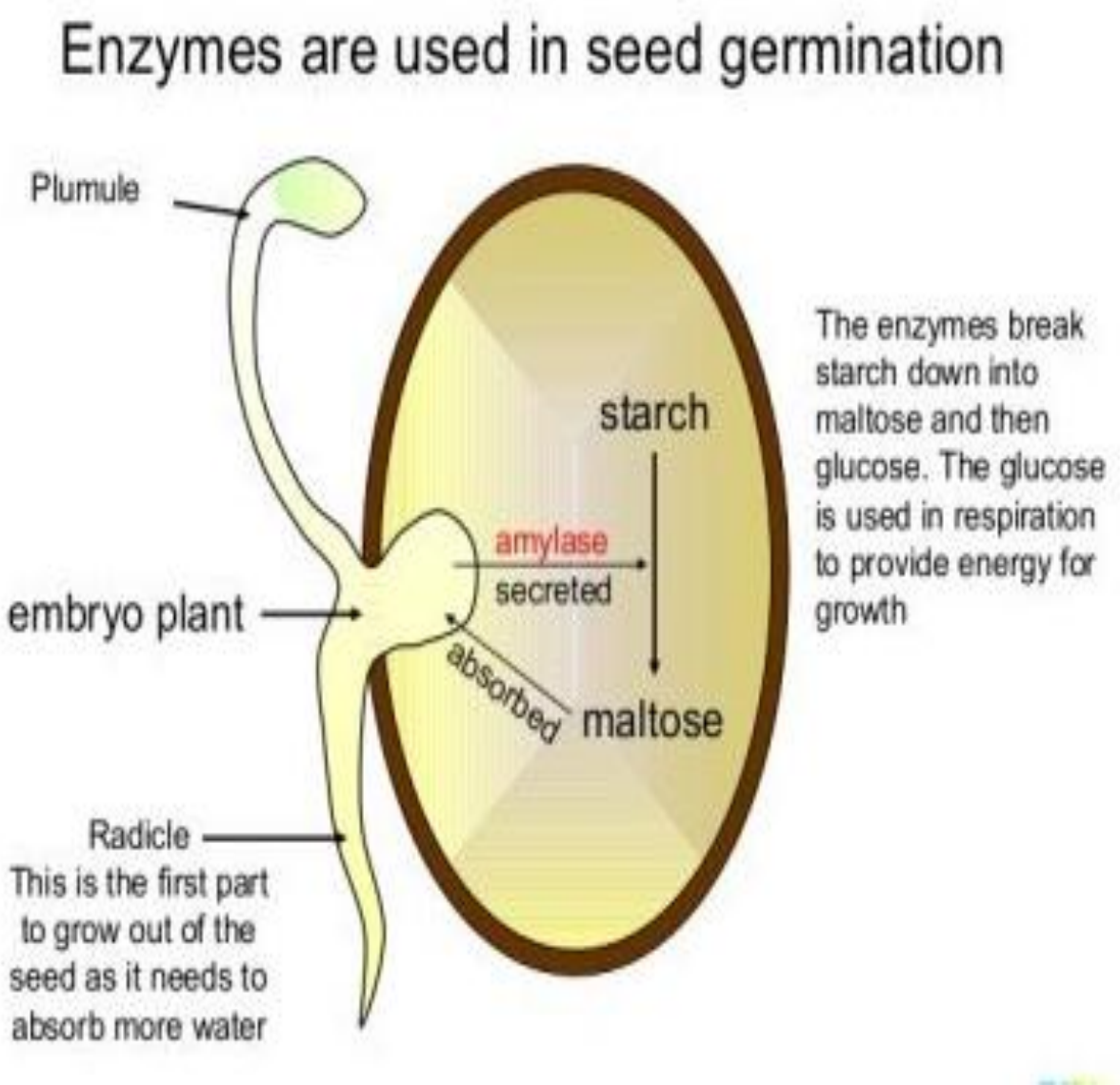
B. **Hormones**: Temperature affects the transcription of genes that control the production of plant hormones. Two different **hormones** regulate germination:

1. **Abscisic acid (ABA): promotes dormancy** and inhibits germination and
2. **gibberellins or gibrillic acid (GA): promotes germination** and release dormancy.

3. Enzymes: required to facilitate germination.

a. Enzymes **degrade endosperm** tissue and rupture the seed coat to imbibe water.

b. Seeds contain **stored food** in the cotyledons to provide energy for growth. **Amylase** breaks down **starch** to **maltose**, allowing for the formation of **ATP** (via glucose).
The **energy** produced in the embryo is used to facilitate germination.



Ecological Factors Inducing Germination

- **Water** is required for:

a. the swelling of the food reserves within the seed, which causes the **breaking of the seed coat**.

b. Activation **of hydrologic enzymes** (e.g.; amylase) which **break down** the stored food resources into metabolically **useful chemicals** that will begin the growth process.

Ecological Factors Inducing Germination

- **Oxygen** is used in **aerobic respiration**, the main source of the seedling's **energy** until it grows leaves.
- Oxygen is found in pore spaces **between the particles of soil**.
- Three cases observed due to the deficiency of oxygen:

1. If a seed is buried **too deeply** within the soil the seed can be **oxygen starved** and germination will be **delayed**.
2. If the soil is **waterlogged** the seed will also die from can be **oxygen starved**
3. **Root rot happen** if **too much water** occurs **after the germination** process has started.

Ecological Factors Inducing Germination

- **Light** or darkness can be an environmental trigger for germination and is a type of **physiological dormancy**.

- light in the **red wave** length usually **promotes** germination whereas blue light inhibits it.
- Most seeds are **not affected** by light or darkness,
- Many seeds, including species found in **forest** settings, will not germinate until an **opening in the canopy** allows sufficient light for growth of the seedling. Because:
- The **photochrome** inside the seeds reacts, causing the seed to break dormancy and sprout. Chemicals also, such as **nitrates** in the soil, can substitute for light in stimulating seeds to germinate so that some light requiring seeds will still germinate if covered with fertile soil.

Seed dispersal strategies

There are three main strategies for seed dispersal:

1. **Wind-driven seeds** such as on a **maple tree**.

2. **Seeds falling on the ground** beneath the trees such as a **nut tree.**

3. **carried away** by certain species of animals or birds such as a **crabapple** being eaten by a bird and the seeds are dropped some distance from the tree.

- **All seeds can germinate?**

- Some **viable** seeds **might not germinate.**

- Many seeds have developed a **dormancy** (or sleep) period.

Seed dormancy is a condition that **prevents** germination even under optimal environmental conditions.

- **Why would it benefit seeds to not all germinate when conditions are right?**
- In nature, staggering germination keeps some seedlings **safe from bad weather** or **herbivores** that might eat them.

- For seeds to come out of dormancy, we have to **break their physical or chemical** dormancy factors;

Types of dormancy

Physical dormancy (hard or thick seed coat):

This can be **broken** by:

1. **Soaking** the seed
2. **Scarifying** (scratching the surface) the seed.

Chemical dormancy (internal chemical or metabolic conditions):

- It includes the presence of certain **plant hormones**--notably, **abscisic acid,** which **inhibits germination**, and **gibberellin**, which ends seed dormancy.

- To **break** chemical dormancy, you might have to:

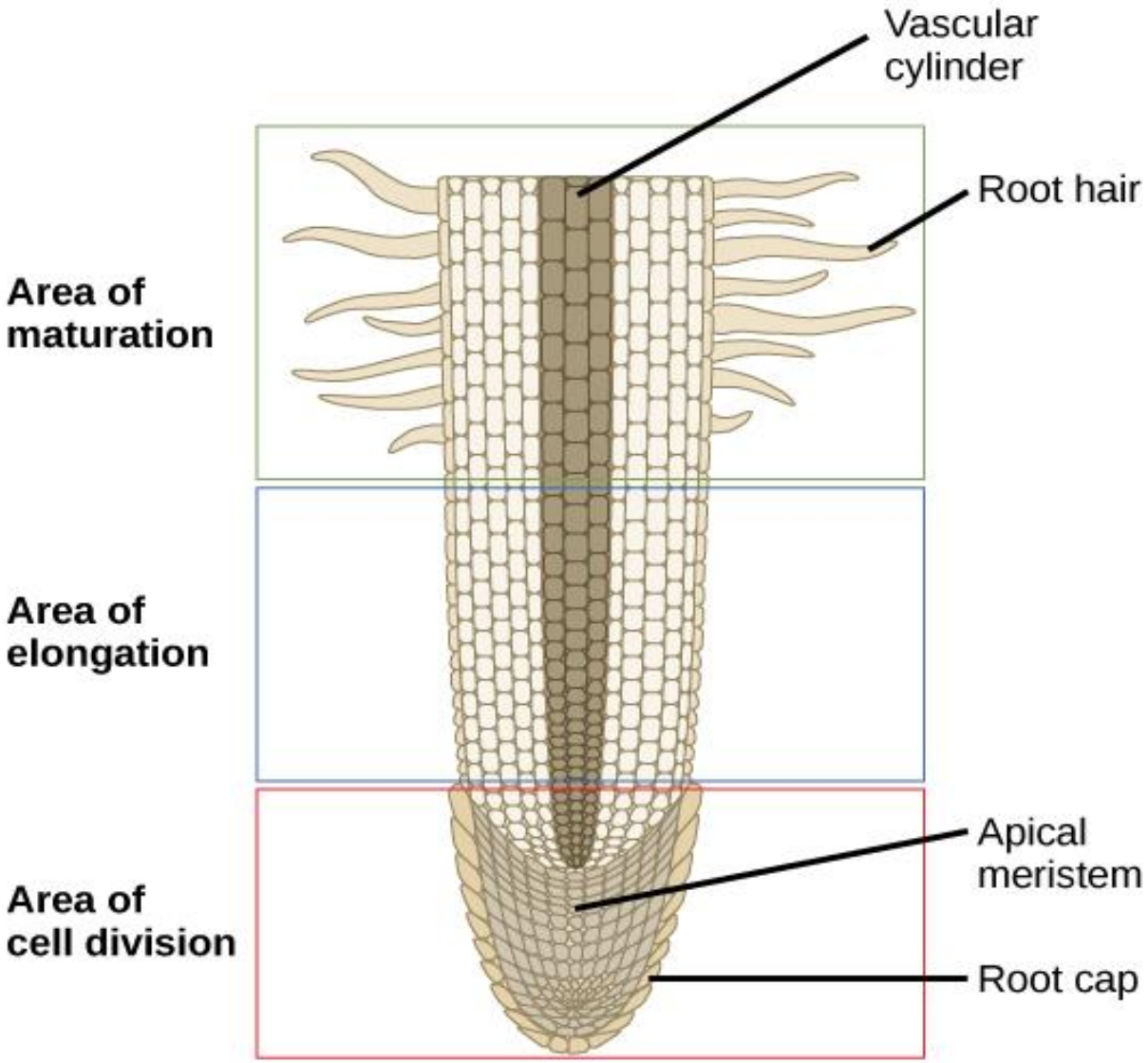
1. **leach** the seed
2. use **cold/moist stratification** (put the seeds in a plastic bag, then placed them inside a refrigerator for about a month)
3. **fire scarification**.

Radicle growth:

- First to emerge from the seed coat is the **primary root**, or **radicle** as it is called in the embryo.

- This radicle is composed of **one major root** that is thicker at its base and tapers toward the growing tip.

- **Early root growth** is one of the functions of the **apical meristem** located near the **tip** of the root.



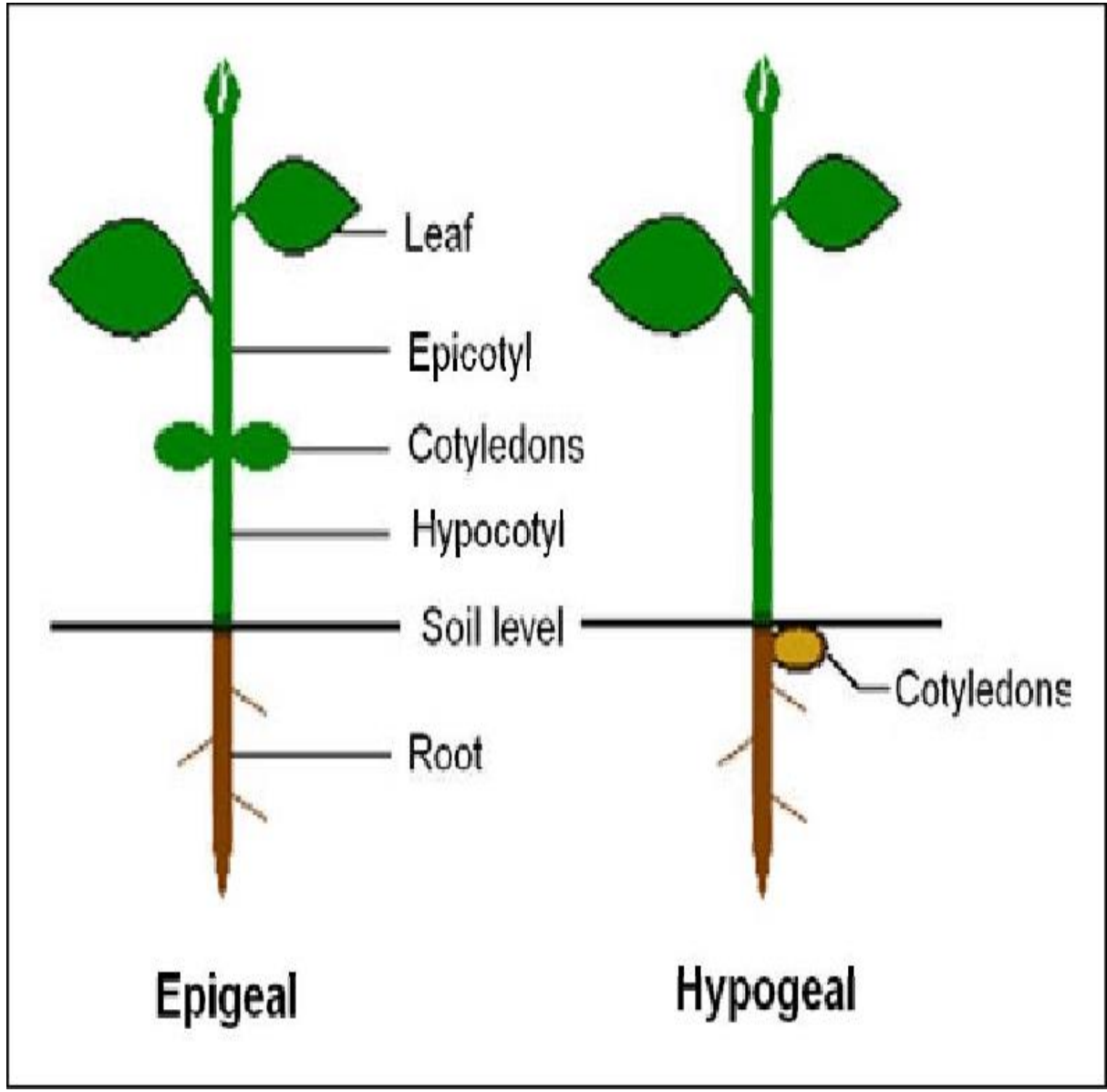
Plumule growth:

- The plumule is the part of a seed embryo develops into the **shoot bearing the first** true leaves of a plant.

- Plumule growth does not occur until the cotyledons (the **first leaf or one of the first pair** developed by the embryo.

- **Epigeal germination** is a type of germination whereby the seed leaves or the cotyledons are brought **above the soil** along with the shoot during germination.

- **Hypogeal germination** is a type of germination whereby the seed leaves or the cotyledons **remain below the soil** surface during germination.



Seedling growth:

- **After** the **embryonic seedling emerges** from the seed coat and starts growing roots and leaves, the embryonic seedling's **food reserves** are quickly **exhausted**.

- At this point **photosynthesis** provides the energy needed for continuing growth and the seedling now requires a continuous **supply of water**, **nutrients**, and **light**.

- Most tree species grow a **taproot** from the seed until moisture is reached and the seedling can then focus on **spreading structural** roots, absorbing water and nutrients, and letting the leaves manufacture food.

Vegetative Reproduction

- Besides seeds, trees can be propagated with the assistance of mankind.

1. Cultivars are created by **grafting** **a bud** or **stem** of the parent tree onto a **seedling rootstock** of the species.

2. **Clones** are created by **encouraging roots to develop** on **cuttings** of the parent tree.

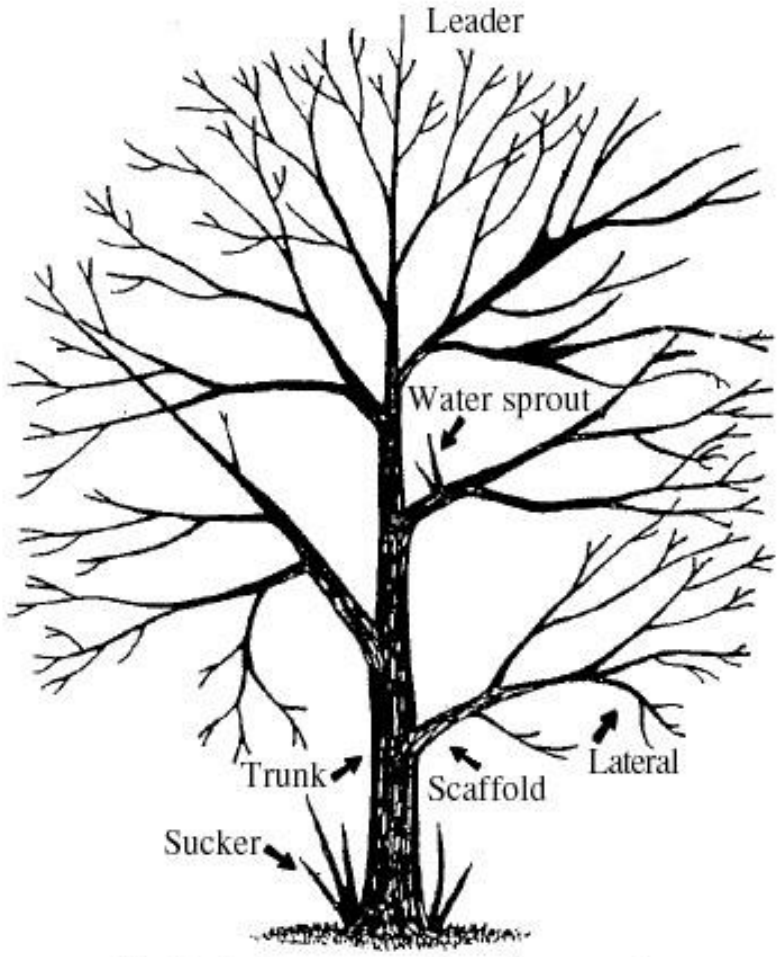
3. **Vegetative layering: branches** or **stems** come in **contact with the soil**, the cambium tissue sometimes will form roots.

4. **Tissue culture** is an **invention** of modern science to extract **cells** of desirable trees and grow these cells into **trees** within laboratory conditions. Trees from this process are genetically identical to the parent.

Vegetative Reproduction

5. Sprouts and **suckers** start with dormant buds that "come alive" to form **new shoots** off the parent trees.

- **Sprouts** are shoots from **stumps** of a tree.
- **Suckers** are shoots that originate from buds on the root systems.
- Both sprouts and suckers have the **potential t grow into new full size trees genetically identical to the parent**.
- **Often times**, sprouts and suckers will not grow until the **parent tree dies or becomes very sick**.



Typical above-ground tree framework