Causes of Seed Deterioration

- **Temperature**
  - Increases air's ability to suspend water
  - Enhances physiological speed of deterioration reactions

°C	g H_2O/kg air
0	3.9
10	7.6
20	14.8
30	26.4
40	41.4

"Rules of Thumb"

- Every 1% decrease in seed moisture content doubles seed storage life.
- Every 5°C decrease in storage temperature doubles seed storage life.
- Practical seed storage equation:

$$\% \text{ RH} + {}^{o}\text{C} \leq 45.5$$

Role of moisture and temperature on seed viability and storability

Seed moisture %	Effect on seed
35-80	Moisture content of developing seed. Seed not mature enough to harvest
18-40	Physiologically mature seed, High respiratory rate, susceptible to field deterioration, heating occurs if seed is bulked without proper ventillation.
13-18	Respiratory rate still high, mold and insects can be damaging and seed resistant to mechanical damage
10-13	Seed store well for 6-8 months in open storage in temperate climates.
8-10	Seed sufficiently dry for 1-3 years open storage in temperate climates. Very little insect activity.
4-8	Safe moisture for sealed storage
0-4	Extreme desiccation. Can be damaging to seed.
33-60	Seed germinates when they imbibe water to these levels.

Table 1. Maximum seed moisture content for seeds stored in sealed containers. The seed moisture percentage of stored seed should not be higher than the values given below (USDA Federal Seed Act, 1976).

Vegetable	Seed moisture (%)	Vegetable	Seed moisture (%)
Bean, common	7.0	Leek	6.5
Bean, Lima.	7.0	Lettuce	5.5
Beet	7.5	Muskmelon	6.0
Broccoli	5.0	Mustard	5.0
Brussels sprouts	5.0	Onion	6.5
Cabbage	5.0	Onion, Welsh	6.5
Carrot	7.0	Parsley	6.5
Cauliflower	5.0	Parsnip	6.0
Celeriac	7.0	Pea	7.0
Celery	7.0	Pepper	4.5
Chard, Swiss	7.5	Pumpkin	6.0
Chinese Cabbage	5.0	Radish	5.0
Chives	6.5	Rutabaga	5.0
Collards	5.0	Spinach	8.0
Corn, sweet	8.0	Squash	6.0
Cucumber	6.0	Tomato	5.5
Eggplant	6.0	Turnip	5.0
Kale	5.0	Watermelon	6.5
Kohlrabi	5.0	Unlisted	6.0

Define seed dormancy

- Seed Dormancy:
  - A protective condition that prevents the seed from germinating until all of the environmental factors required for optimum growth are present.

Seed dormancy

Dormant seed: a seed that does not germinate under optimal water ; oxygen and temperature conditions

Germination: Growth of embryo, breakage of seed coat, Water absorption and cell division in the embryo.

توقف موقت در رشد قابل مشاهده هر ساختار گیاهی که حاوی مریستم باشد

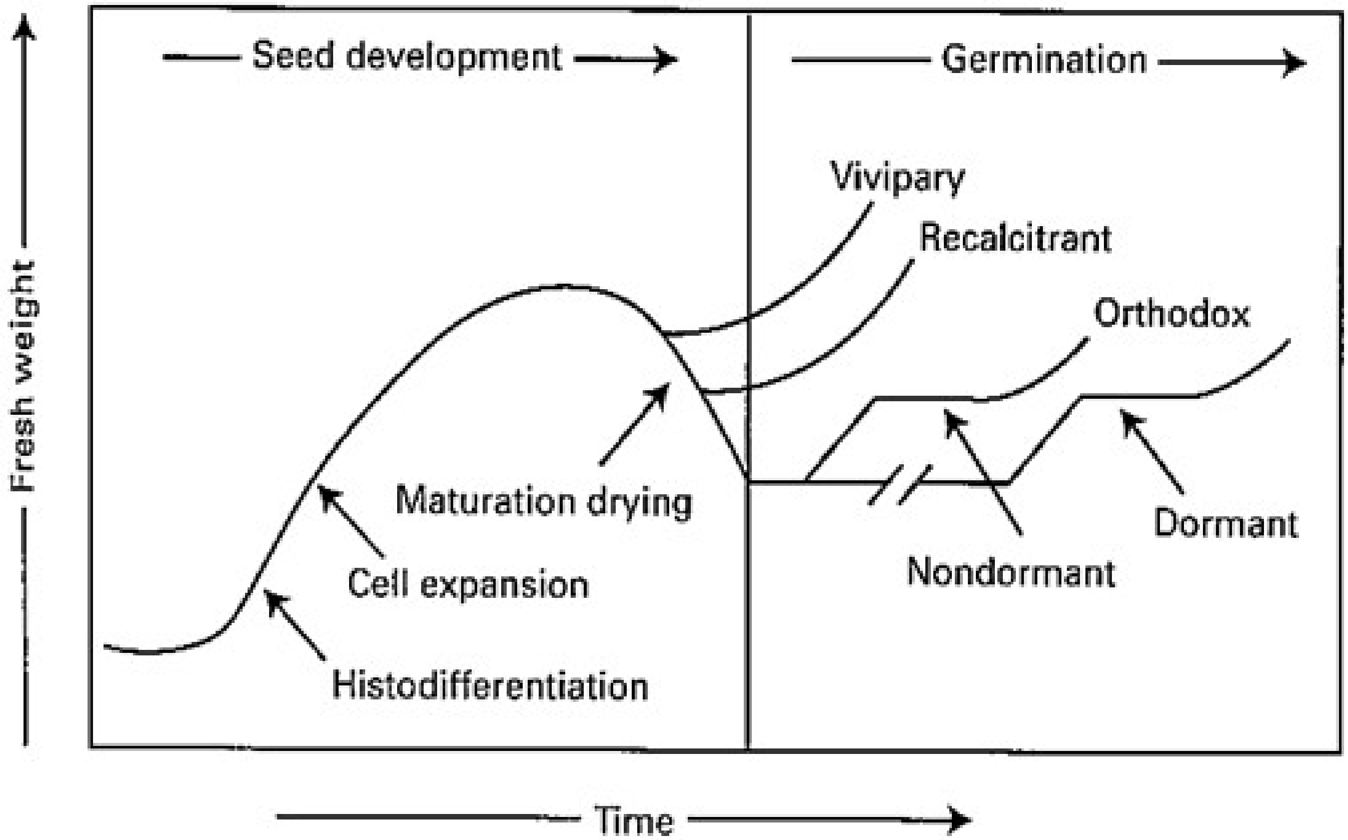


FIGURE 7–2 The transition from seed development to seed germination. Seeds may end seed development and display viviparous, recalcitrant, or orthodox seed behavior. Viviparous and recalcitrant seeds germinate before completing the maturation drying stage of development. Orthodox seeds continue to dry to about 10 percent moisture and can be either nondormant (sometimes termed *quiescent*) or dormant.

Vivipary : No dormancy the seed continues growth.
Orthodox seeds: The seed enters dormancy, dehydrated seed-tolerance to water deficiency
Recalcitrant seeds: the seed enters dormancy but is not tolerant to water deficiency

Types of dormancy

-Non-dormant seeds

- Primary dormancy – gradual time dependant Release from dormancy – post ripening

- Secondary dormancy – seeds do not germinate under unfavorable environmental conditions

➢ Primary dormancy

1. Exogenous
- i. Physical
- ii. Mechanical
- iii. Chemical

2. Endogenous
- i. Morphological
  - a. Rudimentary
  - b. Linear
  - c. Undifferentiated
- ii. Physiological
  - a. Non- deep
  - b. Intermediate
  - c. Deep

3. Intermediate
- i. Morpho- physiological
  - a. Epicotyl
  - b. Double dormancy
- ii. Exo- endodormancy

➢ Secondary dormancy

1. Thermodormancy
2. Photodormancy
3. Skotodormancy

Baskin and Baskin, 2004

Seed dormancy
Types of dormancy

Exogenous- **Coat imposed dormancy**

- Mechanical dormancy: growth constraint.
- Physical dormancy: permeability to H_2O , O_2, inhibitors.
- Chemical dormancy: inhibitors in endosperm, seed coat.

Endogenous- **Embryo dormancy**

- Morphological dormancy: Under-developed embryo.
- Physiological dormancy : Physiological inhibition.

Dormancy classification

Nikolaeva (1977),
Baskin & Baskin (1998)

Black & Bewley (1980)

Coat imposed dormancy

Mechanical dormancy

Harsh seed coat inhibits germination .

Oleaceae

(Rosaceae)

(Juglandaceae)

Physical dormancy

✓ژنتیک

✓محیط

water permeability barrier

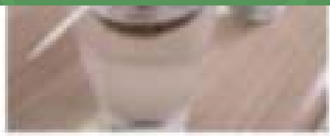
, Musaceae, Cannaceae .

Chemical dormancy

-ABA

-Phenols (coumarin, ferulic acid)

i. Physical dormancy



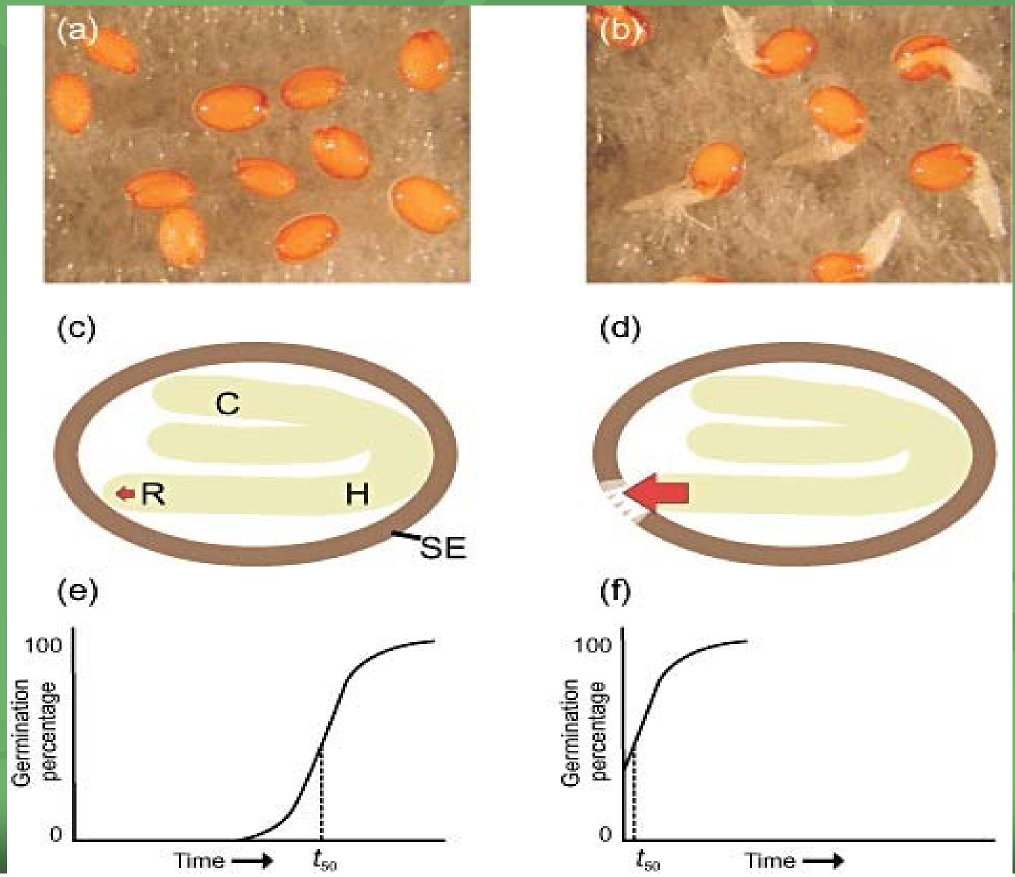
- Seeds coats are impermeable in water due to macrosclereid cells, mucilaginous outer cell layer or hardened endocarp.
- Depth of the puncture to the seed coat increased, so did the permeability of seed coat to water.
- Eg: Olive, Peach, Plum, Apricot, Cherry etc. (hardened endocarp), Walnut and Pecan nut (surrounding shell).

-Barrier to gas exchange

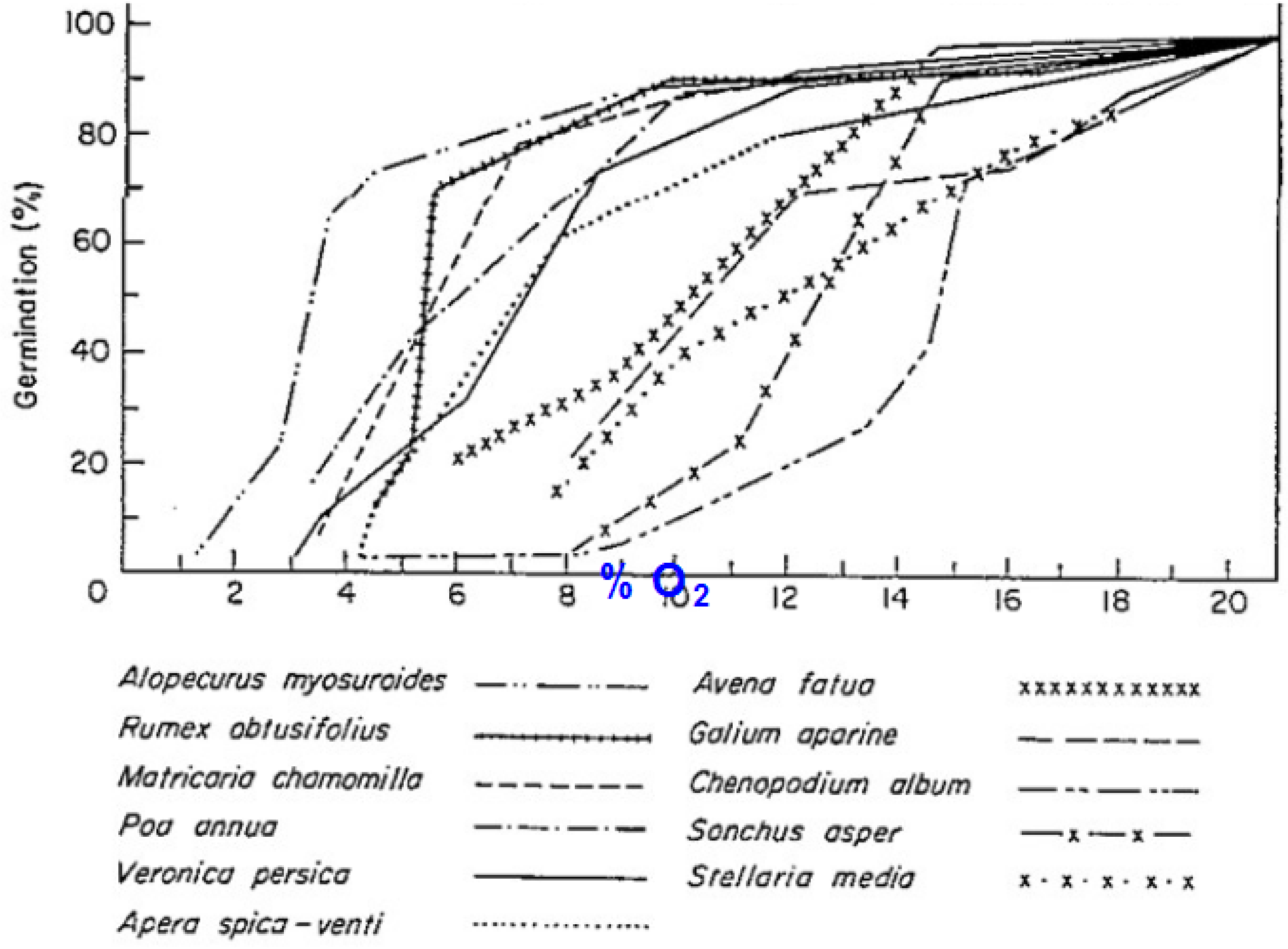
1. Seed coats are impermeable to oxygen the difusion coefficient of oxygen in water is very low, could be a limiting factor to germination

Excess water can inhibit germination

2. Seed coats contain phenolic compounds that fix oxygen molecules



% Effect of oxygen concentration on seed germination



ii. Mechanical dormancy

- Seed coats are too hard to allow the embryo to expand during germination.
- In nature coats are softened by environmental agents such as acids in guts, microorganism in warm, moist, forest fire, environment, etc.
- To overcome **horticultural** – scarify with sandpaper, hot water, acid, moist environment, fire and immature embryo.
- Eg. Stones of olive, Pits of stone fruits, Shells of walnut.

iii. Chemical dormancy

- Presence of chemical inhibitors in the outer covering of the seeds and fruits.
- In nature overcome by heavy rains, some soil inhibits the toxins such as ammonia given off.
- In **horticultural** leach with running water, change the water daily, excising embyro, chilling for a few days, use of hormone gibberellic acid .
- Eg. Citrus, Grapes, Apple, etc.

2. Endogenous dormancy

i. Morphological dormancy – Embryo is not fully developed at the time of ripening. Need additional embryo growth after the seed is separated from the plant. Eg. Datepalm

a. Rudimentary – about pro-embryo stage. May be inhibitors present .

b. Linear – at torpedo stage. Takes up about ½ of the seed cavity. May be inhibitors present.

c. Undifferentiated – rare at fruit crops.

✓ To overcome **horticultural** :

- Alternate warm and cool temperature.
- Hormone such as GA3.
- Exposure to cool temperature.
- Some tropical spp. required extended period at high temperature for full development of embryo. Eg. Date palm.

ii. Physiological dormancy

i. Non- deep

- Short term and disappear with storage last up to 1-6 months
- To overcome – dry storage, pre-chilling, light alternating , KNO3 and GA3.

ii. Intermediate

- The embryo itself is quiescent, not dormant and germinate if excised.
- To overcome – stratification and GA3 treatment response.

iii. Deep

- Control are within the embryo itself.
- To overcome stratification which required temperature, light, aeration, moisture, time, hormone interaction.

Physiological dormancy

Non-deep physiological dormancy

The dormancy can be broken by a short (days) exposure to either low or high temperatures, light or hormonal treatments **GA** -ا **CK**.

-The requirements is nullified gradually in storage

Intermediate/deep physiological dormancy

Seeds require 1-5 months of stratification to break dormancy

During stratification hormonal changes will occur in the embryo axis

تغییرات بیولوژیکی که به طور پیش رونده درون بذر در ضمن سرمادهی مرطوب صورت می گیرد "پس رسی" نامیده می شود. این تغییرات به رطوبت، تهویه، سرما و زمان نیاز دارد.

ii. Double dormancy

- Combination of two or more types of dormancy is known as double dormancy. It can be morpho-physiological or exo-endodormancy.
- Require chilling period for embryo, followed by warm period for root, then followed by cold period for shoot growth.

Secondary dormancy

- Imposition of new dormancy mechanism under unfavourable condition.
- The critical point is that this dormancy occurs AFTER the seeds has been separated from the plant. It is of three types:

i. Thermodormancy: high temperature induced dormancy. دما خفتگی

ii. Photodormancy: prolonged exposure of seeds to an excess light نور خفتگی

iii. Skotodormancy: required light for germination when they are imbibed in dark for extended period of time. تاریک خفتگی

- To overcome this dormancy it requires chilling, light or GA, etc.

Techniques for breaking seed dormancy

1. Scarification - mechanical abrasion

2. Stratification -. Chemical treatments

Treatment with concentrated sulfuric acid (15 min.)

3. Hot water or dry air

Germination, dormancy and Hormonal control

- Temperature – Cardinal temperatures for dormancy break and germination
- Water potential – At low water potential seeds will not germinate regardless of temperatures.
- Light – Stimulate germination of many species. Red light (Phytochrome response)
- GA required for seed germination. Induces Beta mananase and other cell wall hydrolyzing enzymes.
- Ethylene – stimulates germination.
- Nutrients – Most seeds do not require nutrients for germination except for nitrates. KNO_3 induces germination.

سیستم های آماده سازی بذر Seed Priming Systems

مفهوم این سیستم عبارت است از:

کنترل رطوبت بذر به گونه ای که فعالیت های متابولیکی قبل از جوانه زنی انجام شود ولی از رویيدن واقعی ریشه چه جلوگیری شود.

پرایمنیگ بذر بخصوص برای افزایش سرعت جوانه زنی و یکنواختی جوانه زنی کاربرد دارد. در سال ۱۶۰۰، اولیور دیسیریس ترفند ماهرانه خیس کردن دانه‌های گندم و جو برای چند روز در آب و کود دامی و بعداً خشک کردن در سایه قبل از کشت کردن بذرها را تشریح و بیان کرد که بذرهای خیس شده سریع سبز می شود و از "خطر خوراک توسط آفت‌های خاکی" جلوگیری می‌شود.

روش‌های مختلفی از پرایمینگ بذر وجود دارد که هر یک به هدف خاصی انجام می‌شود و شامل هیدرو پرایمینگ، اسموپرایمینگ، هالوپرایمینگ، ترموپرایمینگ، پرایمینگ ماتریکس مواد جامد و بیوپرایمینگ میباشد که هریک به هدف خاصی به کار می‌رود

[1]- hydropriming
[2]- Osmopriming
[3]- Halopriming
[4]- Thermopriming
[5]- Solid Matrix Priming
[6]Biopriming

فرآیند خیس کردن بذرها در آب و مجدداً خشک کردن آن‌ها قبل از کامل شدن جوانه زنی آنها را هیدروپرایمینگ گویند.

اسموپرایمینگ فرآیند فروبردن بذرها در محلول اسمزی با پتانسیل آب پایین می باشد که جهت کنترل کردن میزان جذب آب، مورد استفاده قرار می گیرد. از جمله ترکیب هایی که پتانسیل پایین اسمزی ایجاد می کند، پلی اتیلن گلایکول، مانیتول ، فسفات پتاسیم و دیگر املاح می باشد.

هالو پرایمینک به صورت خیساندن بذور درغلظت های متفاوتی از نمک های معدنی (کلروسدیم، فسفات پتاسیم و غیره) تعریف می شود . این نوع پرایمینگ مخصوصاً زمانی استفاده می شود که بذور در خاک های شور کاشته می شود.

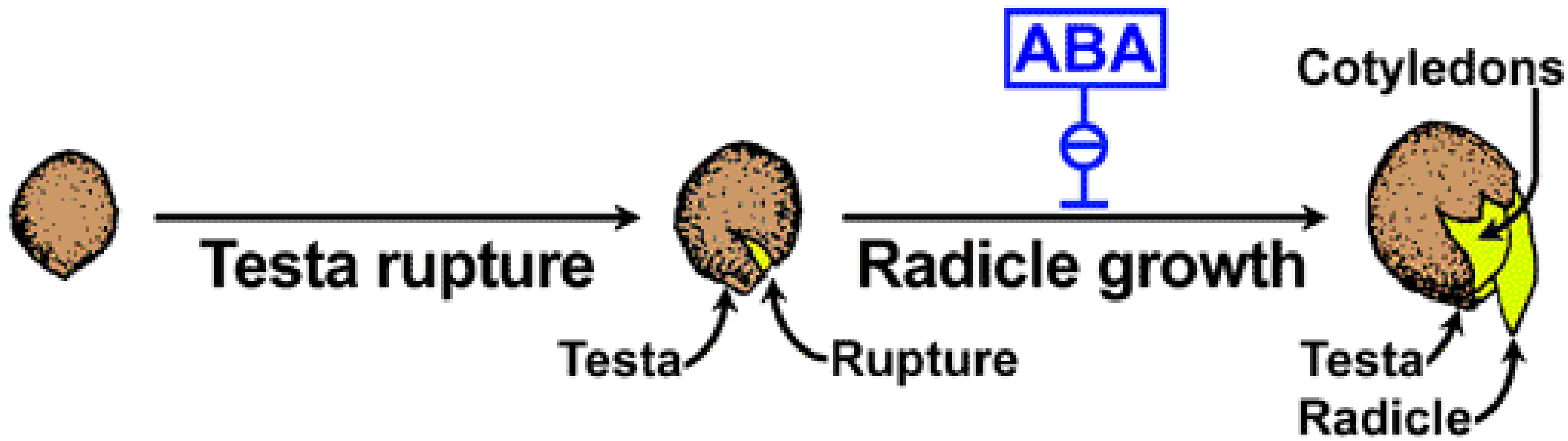
روش دیگر پرایمینگ، استفاده از بسترهای جامد با پتانسیل ماتریک پایین است. این فرآیند ماتری پرایمینگ نامیده می شود. حلالیت جزیی در آب، توانایی بالای نگهداری آب، نسبت بالای سطح به حجم، غیرسمی بودن برای دانه ها و توانایی چسبیدن به سطح دانه برخی خصوصیات حاملین با پتانسیل ماتریک پایین هستند. ورمیکولیت و پیت ماس موادطبیعی پردازش شده دارای این خصوصیات هستند

- **seeds travel**
  - seeds stick to socks
  - stick to animal fur
  - seeds blow in the wind
- **seeds to grow need:**

- **Viability**
- **Favor environment**
  - Soil
  - Water
  - Sunlight
- **Remove Dormancy**

  After ripening process

1-Activation **2-Digestion** **3-Seedling growth**



Finch-Savage and Leubner-Metzger (2006) - Seed dormancy and the control of germination
Tansley Review, New Phytologist, © Blackwell Science, http://www.newphytologist.org

Phase I (imbibition)- Water uptake is a physical process driven by .water potential gradient between the seed and its environment

افزایش سریع رطوبت بذر، نرم شدن پوشش بذر، مرطوب شدن پروتوپلاسم، تورم بذر، هم بذر زنده و هم غیرزنده

افزایش ۸۰ تا ۱۲۰درصدی وزن خشک بذر

دوره ایستایی

افزایش ۱۷۰ تا ۱۸۰درصدی وزن خشک بذر- رشد دانهال

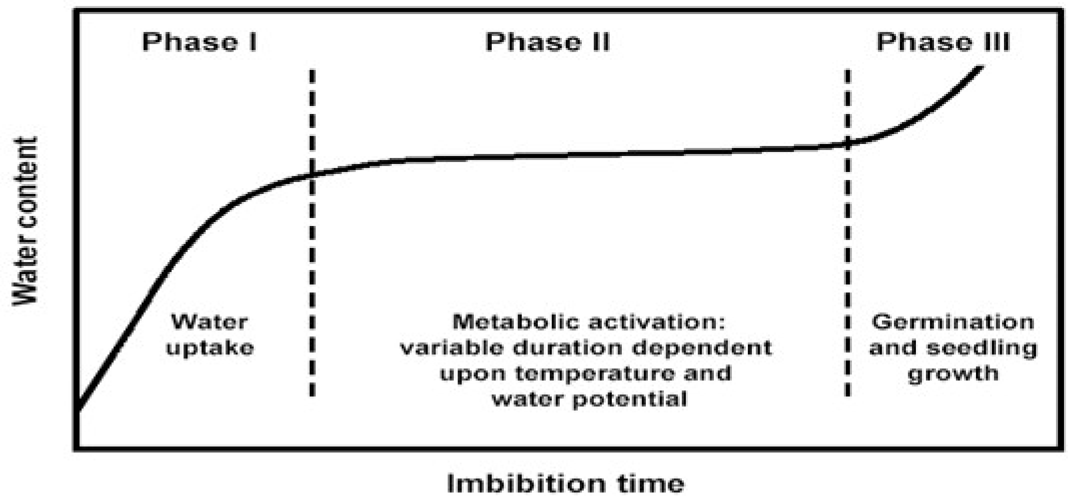


Figure 13.1. Triphasic pattern of water uptake during seed imbibition. Respiration rate follows a similar pattern.

Phase II (lag phase)- Seed water reaches a plateau level and remains constant. Metabolic processes are activated. Duration depends on .Temp

Phase III (Embryo growth)- Point of no return, seed absorbs large quantities of water. Sensitive to dehydration. Embryo growth and .radicle emergence

فعالیت آنزیم ها چند ساعت پس از آبگیری بذر آغاز می شود (سنتز یا دوباره فعال شدن آنزیم ها). تولید مواد شیمیایی ساده و انتقال به نقاط رشد محور رویان

نمو دانهال در نتیجه تقسیم سلولی در نقاط رشد.
با شروع رشد در محور رویانی وزن تر و خشک دانهال افزایش می یابد
کاهش ماده ذخیره ای
افزایش تنفس
افزایش جذب آب

Stages leading to cell division

Mitchondria reconstituted

Respiration
Initially anaerobic
Later aerobic

Soluble sugars

ATP

RNA activated

Polysomes

Protein synthesis (0.5h)

Enzymes (proteins)

DNA synthesis (45h)

Mitosis (70h)

www.rbgsyd.nsw.gov.au/ data/assets/image/ 81026/

Germination: The breaking of dormancy

The growth of the embryo and its penetration of the seed coat

Break down of barriers
Abrasion of seed coat
Decomposition of seed coat Cracking of seed coat (fire)

Change in physical state - rehydration

Destruction and dilution of inhibitors
Light, temperature, water

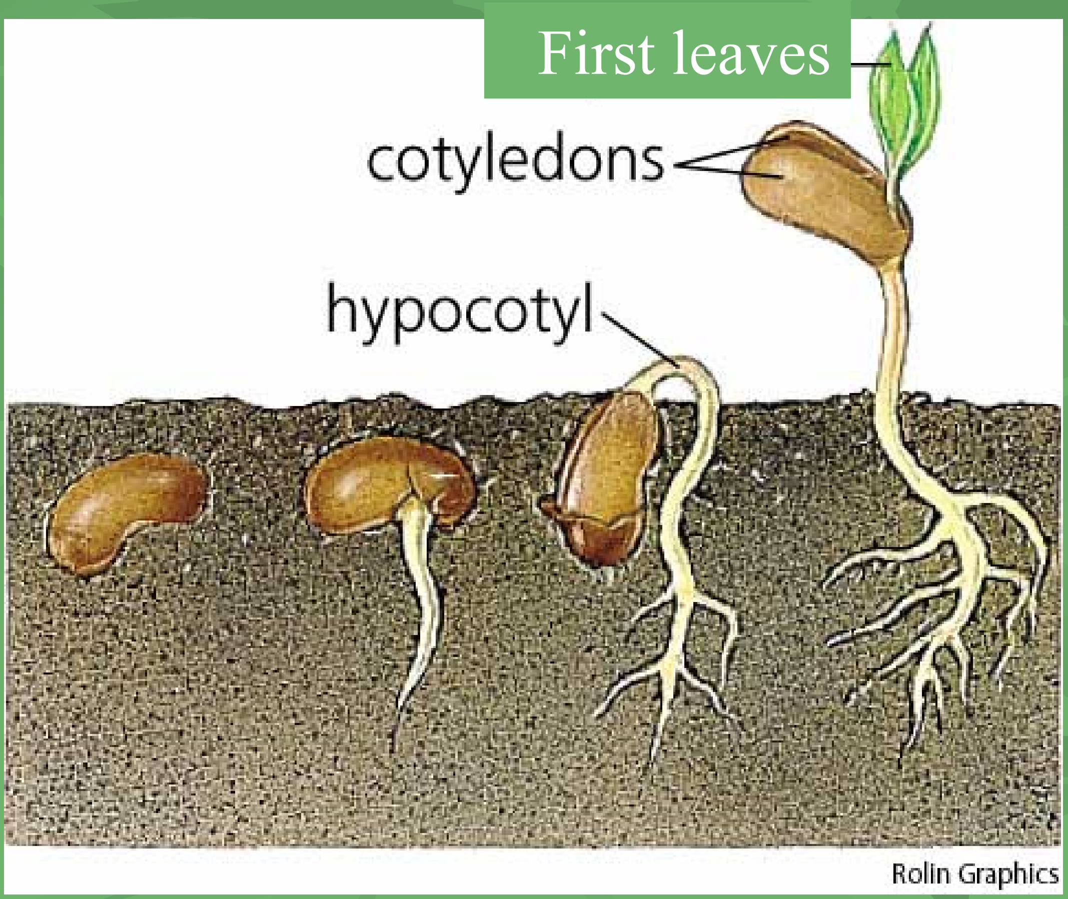
Production of **growth promoters**

GERMINATION

What is germination?

Steps:

1. Seed coat breaks
2. Radicle becomes ROOT
3. Hypocotyl and epicotyl become the STEM
4. First leaves grow = PHOTOSYNTHESIS



Germination

The emergence and development from the seed embryo of those structures which seed indicate the ability to produce a normal plant.

Conditions Necessary for Germination

- **Water**
- **Air**
- **Temperature**
- **Light**

Modes of Germination

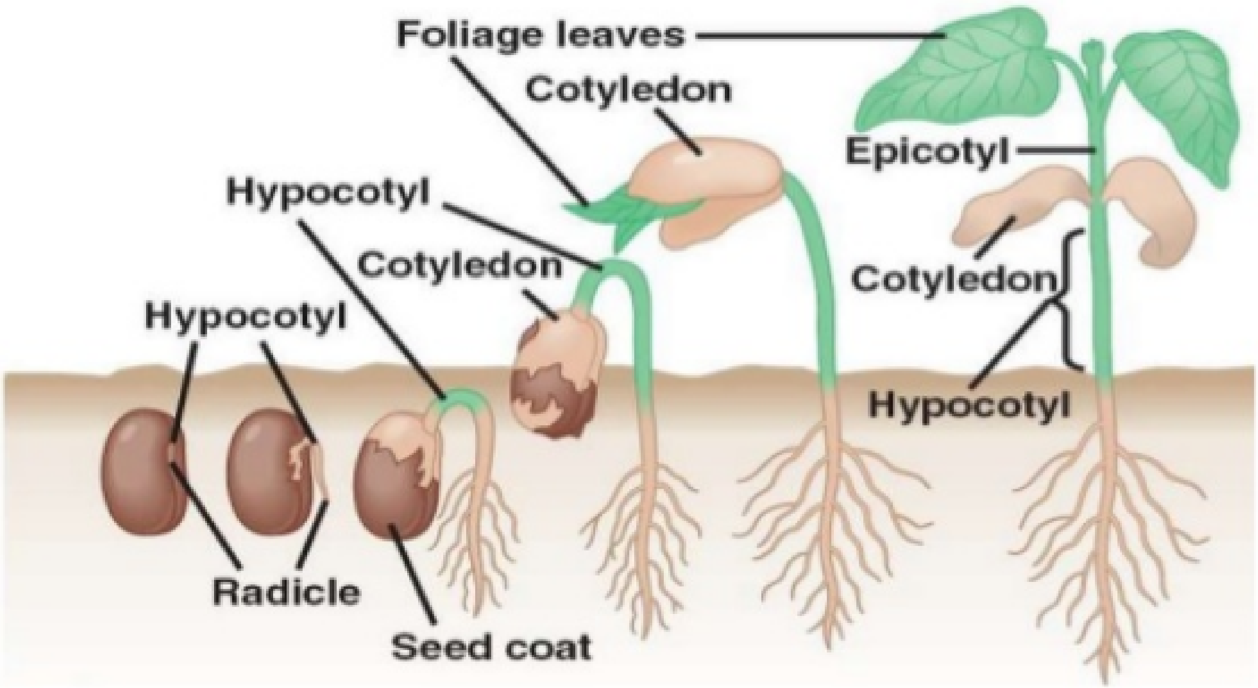
Seeds present two modes of germination based on the behavior of the cotyledons or storage organs.

- **Epigeal Germination**
- **Hypogeal Germination**

برون خاکی
رشد طولی زیرلپه
گیلاس

1.Epigeal Germination

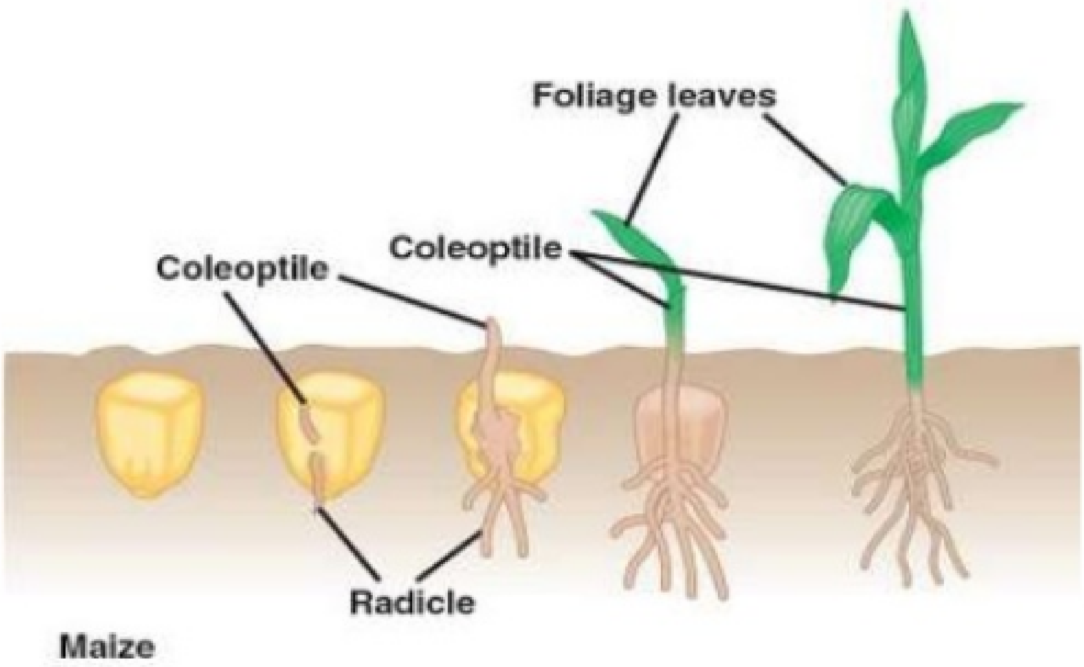
The cotyledons come out above the soil surface and generally turn green and act as first foliage leaves. This type of germination present in groundnut, bean, cotton, sunflower and cotton seeds.



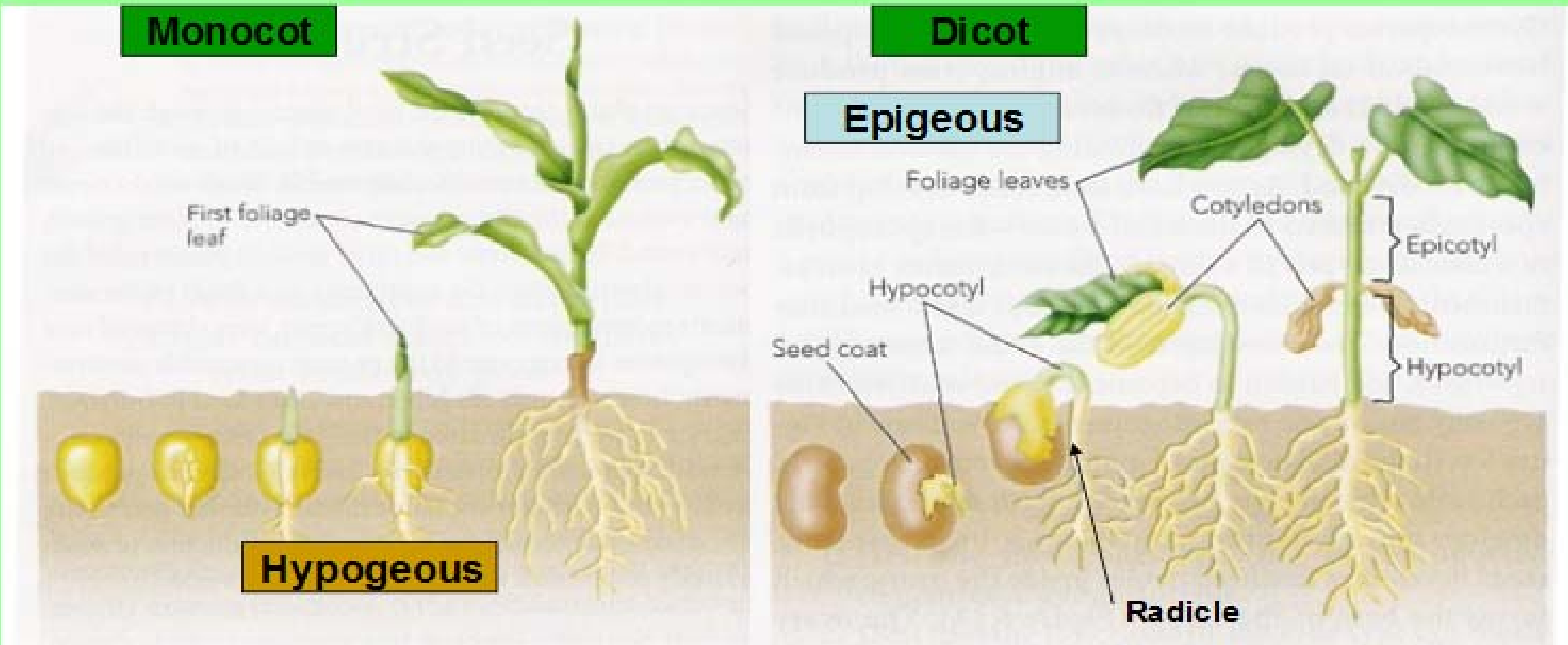
درون خاکی
رشد کم زیرلپه
هلو

1.Hypogeal Germination

The cotyledons do not come above the soil surface. This type of germination is found in wheat, barley, maize and pea.

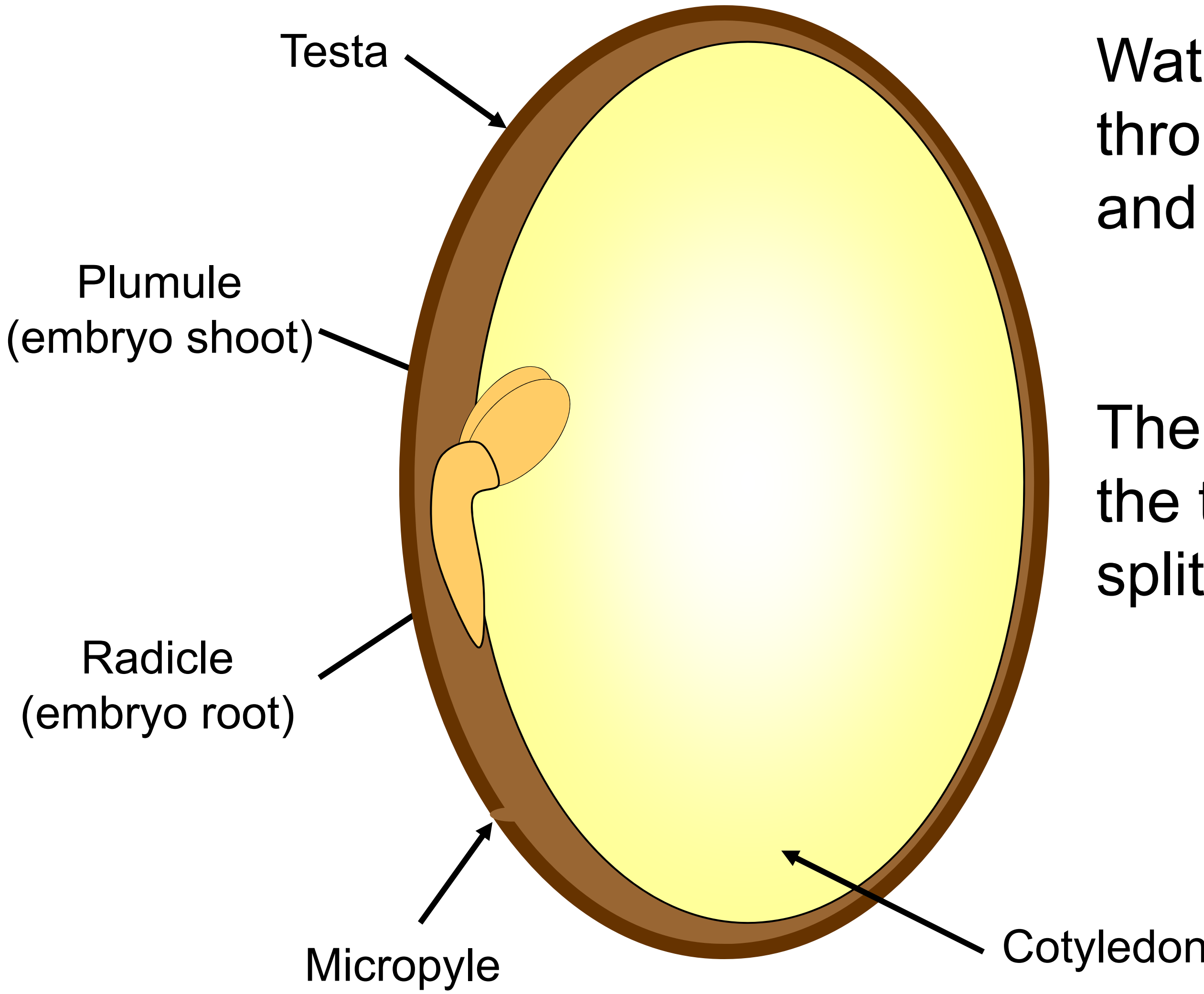


Seed Germination



Germination

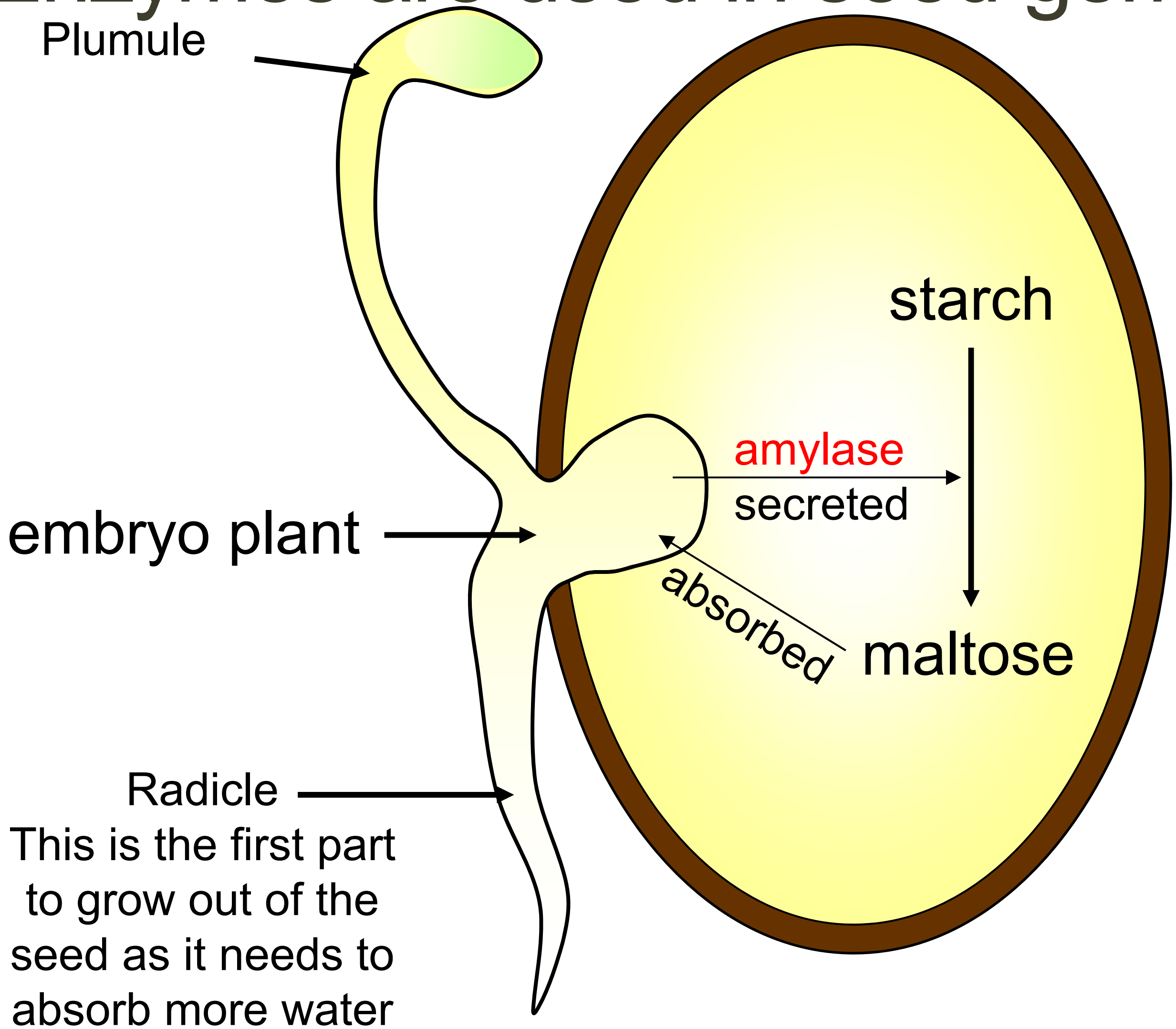
The seed contains the embryo plant and cotyledons (starch stores)



Water enters the seed through the micropyle and activates enzymes.

The water also softens the testa to allow it to split.

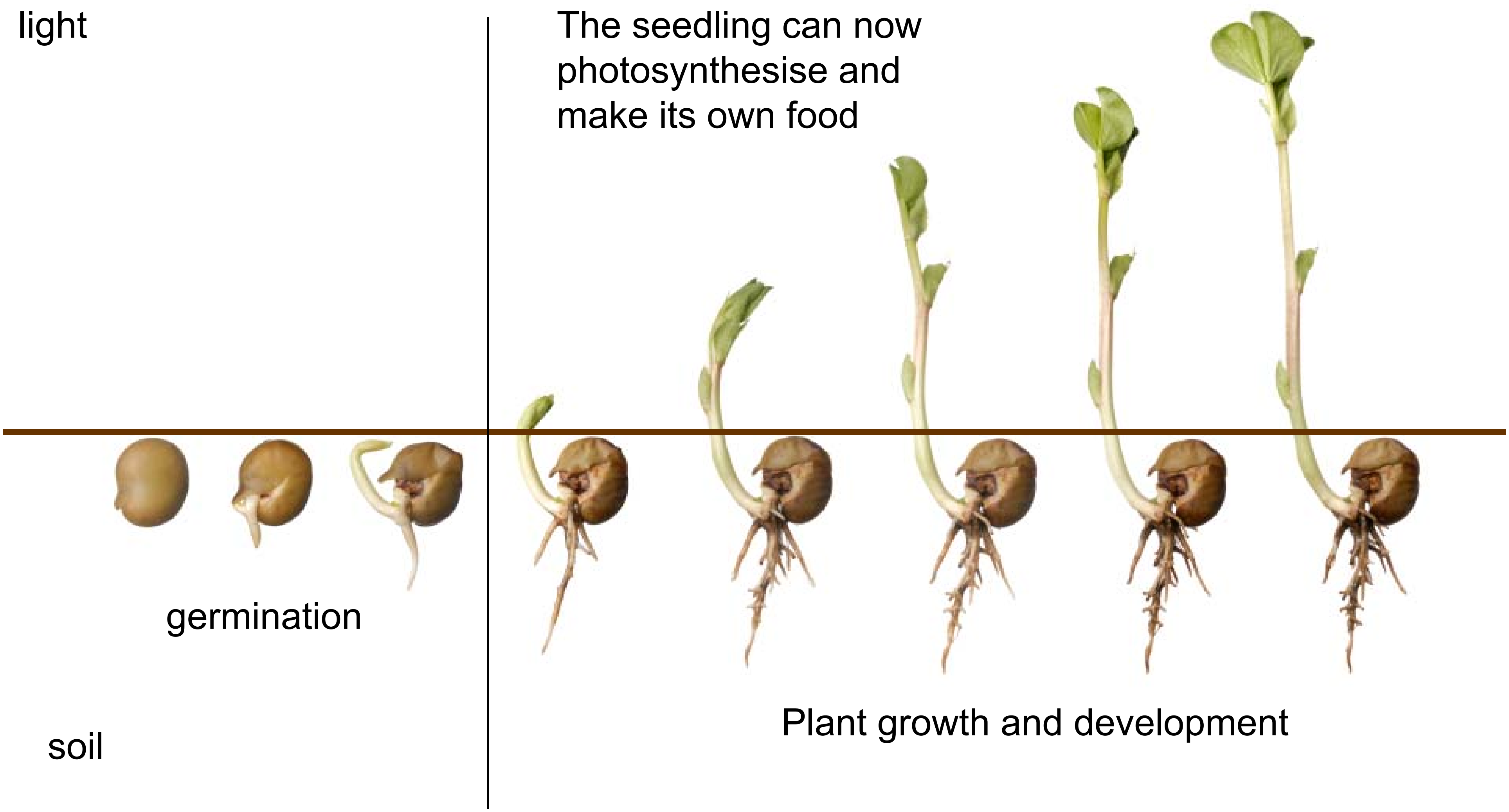
Enzymes are used in seed germination



This is the first part to grow out of the seed as it needs to absorb more water

The enzymes break starch down into maltose and then glucose. The glucose is used in respiration to provide energy for growth

Whilst germinating the plant uses food stores in the cotyledon to provide energy for growth



Transplanting Seedlings

- Seedlings are the small plants.
- Transplant when first true leaves appear
- Held by the true leaves rather than the stems to prevent stem bruising which will kill the plant.

Seed Culture

- Direct planting
- Transplanting

بذرکاری دست پاش

بذرکاری خطی

بذر کاری کپه ای

Hardening Off

- The reducing of humidity and water to make the environment more like the outside.

- Pelletized seeds



- Seed tapes