Seed Germination

III MSc Botany

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Seed Germination Defined

Biology-online.org:

"…the process by which a dormant seed begins to sprout and grow into a seedling under the right growing conditions."

http://www.biology-online.org/dictionary/Germination

Seedbiology.de:

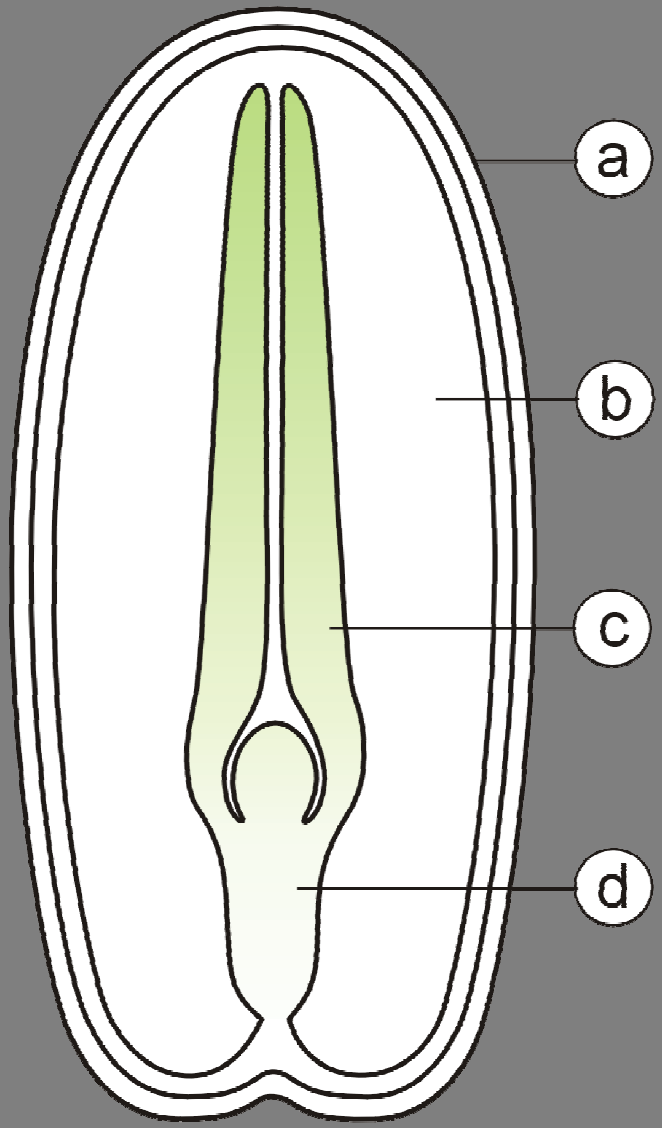
"…a complex physiological process triggered by imbibition of water after possible dormancy mechanisms have been released by appropriate triggers…rapid expansion growth of the embryo culminates in rupture of the covering layers and emergence of the radicle…considered completion of germination."

http://www.seedbiology.de/germination.asp

Dictionary.refere.nce.com:

ger*mi*nate [**jur**-*muh*-neyt]

1. To begin to grow or develop.
2. *Botany*.
   a. To develop into a plant or individual, as a seed, spore, or bulb.
   b. To put forth shoots; sprout; pullulate.
3. To come into existence; begin.

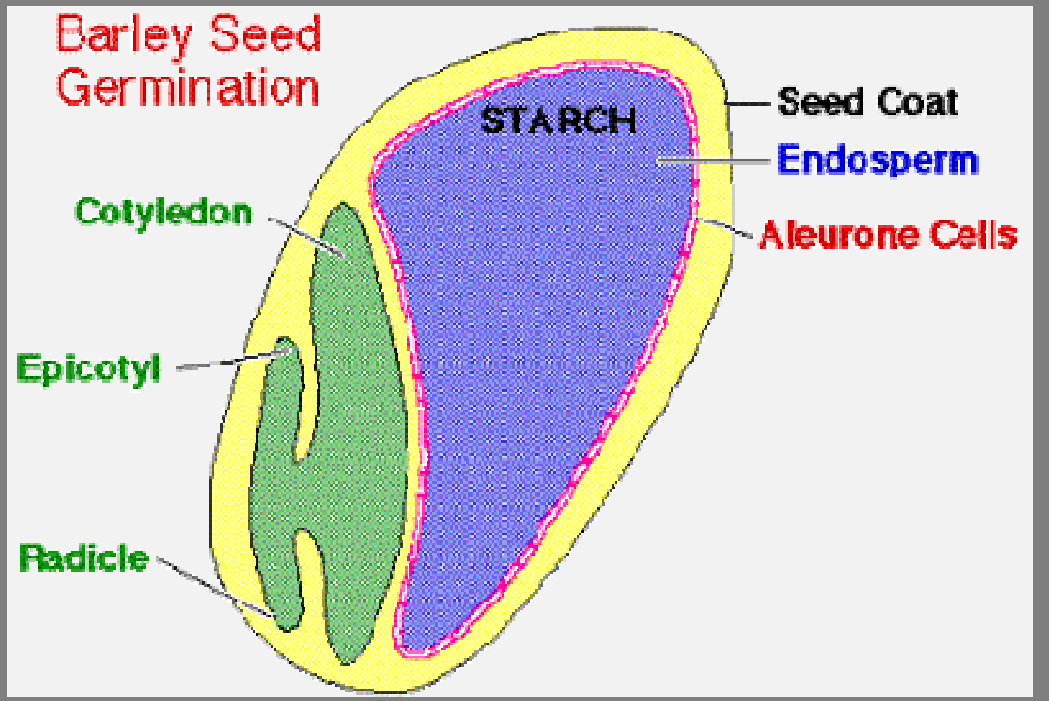


(a) seed coat, (b) endosperm, (c) cotyledon, (d) hypocotyl

Seed Anatomy

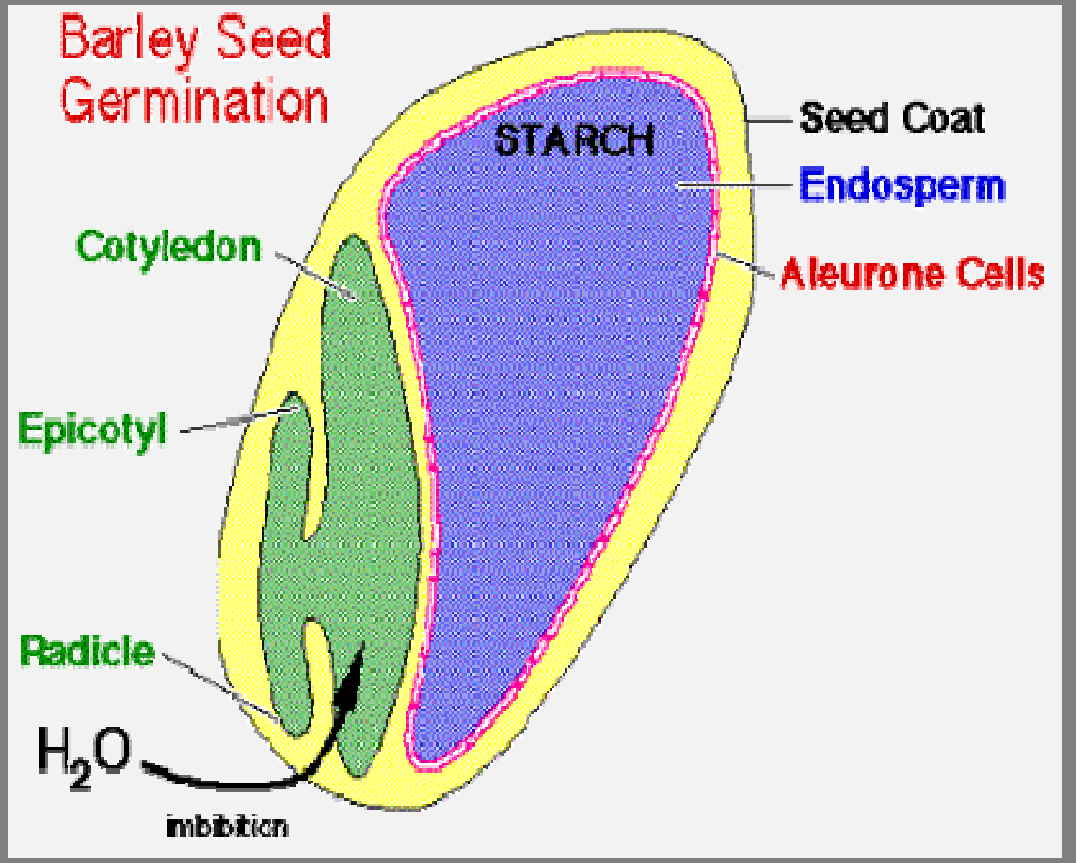
- Seed coat provides protection
- Endosperm = food (STARCH)
- Aleurone cells = store abundant protein

- Cotyledon → leaves
- Epicotyl → shoot
- Radicle → root



Process: Seed Germination

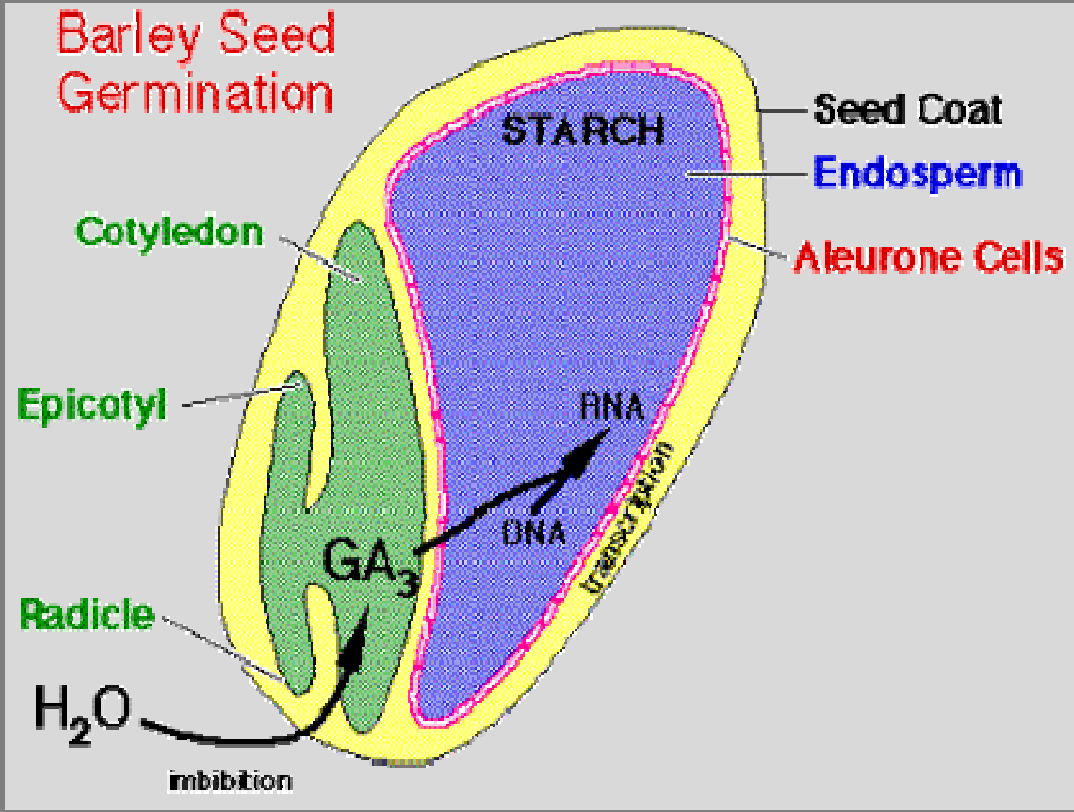
1. Imbibition
   - water uptake, softens inner tissues
   - causes swelling and seed coat rupture
   - more water uptake
   - Biochemical process begins

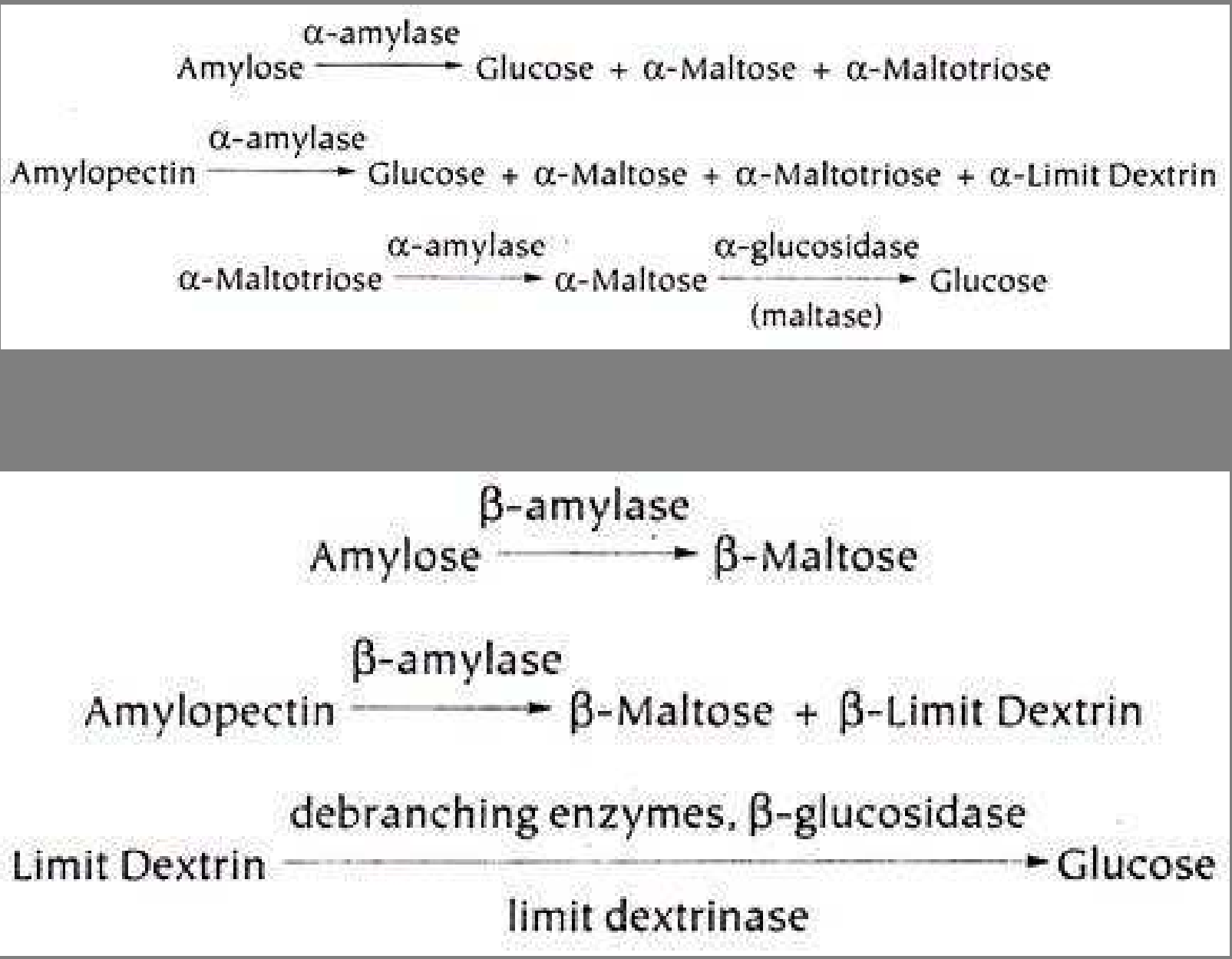


Process: Seed Germination

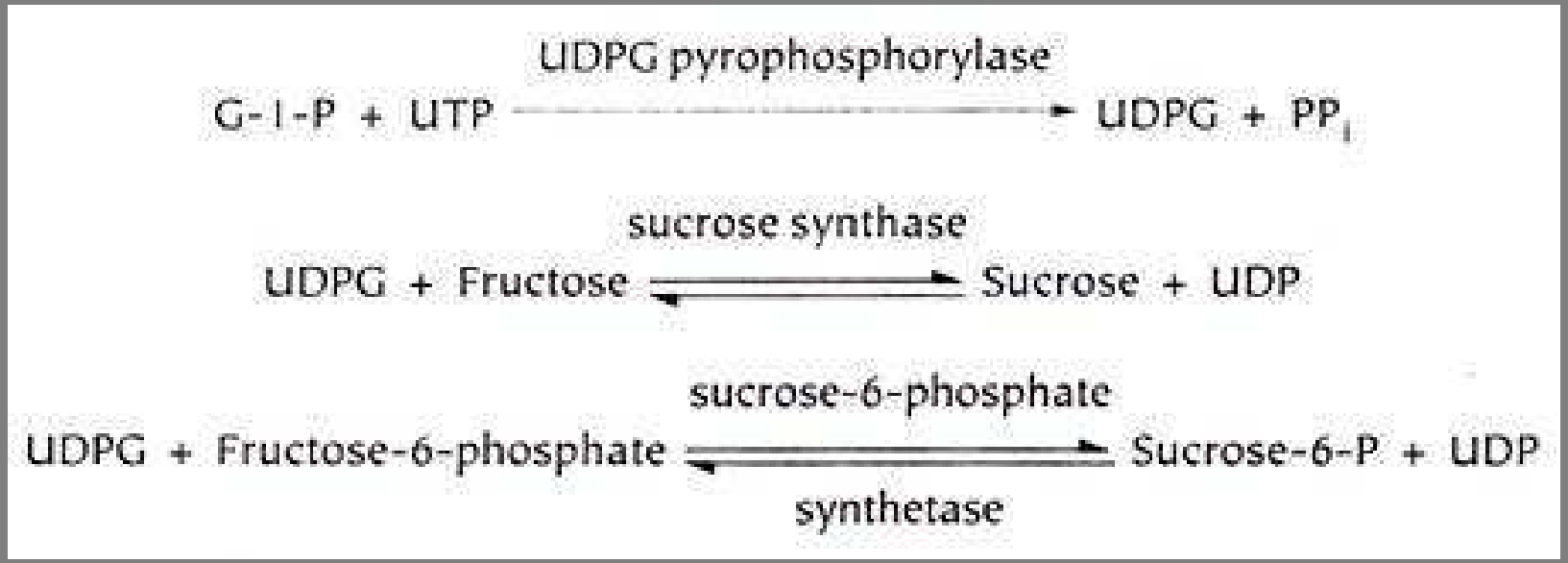
1. Imbibition
   - water uptake, softens inner tissues
   - causes swelling and seed coat rupture
   - more water uptake

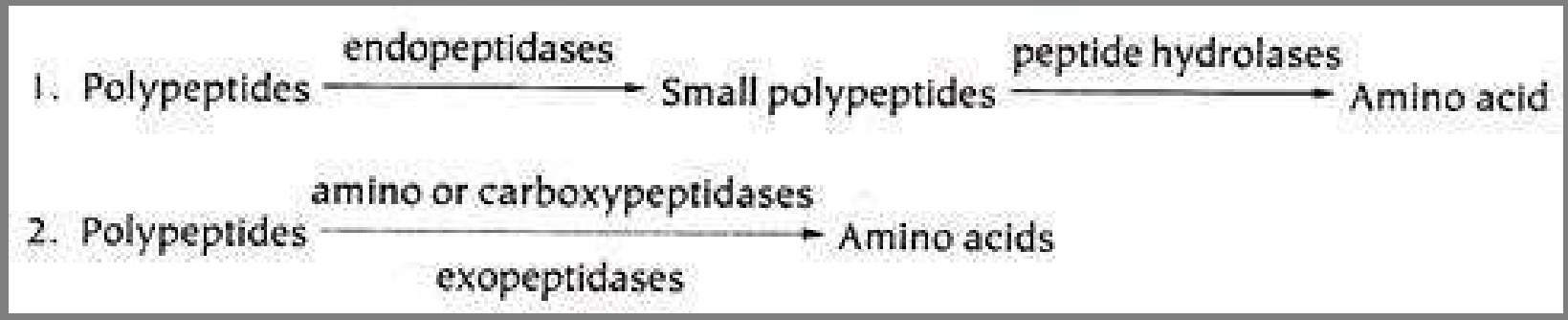
2. Gibberelic Acid
   - Plant hormone (similar to steroids)
   - Dissolved & distributed by water




α-amylase
Amylose → Glucose + α-Maltose + α-Maltotriose
α-amylase
Amylopectin → Glucose + α-Maltose + α-Maltotriose + α-Limit Dextrin
α-amylase
α-Maltotriose → α-Maltose
α-glucosidase
(maltase)
Glucose
β-amylase
Amylose → β-Maltose
β-amylase
Amylopectin → β-Maltose + β-Limit Dextrin
debranching enzymes, β-glucosidase
Limit Dextrin → Glucose
limit dextrinase


starch phosphorylase
Amylose + Amylopectin + P_i
Glucose-1-P + Limit Dextrin


UDPG pyrophosphorylase
G-1-P + UTP
UDPG + PP_i
sucrose synthase
UDPG + Fructose
Sucrose + UDP
sucrose-6-phosphate
UDPG + Fructose-6-phosphate
Sucrose-6-P + UDP
synthetase

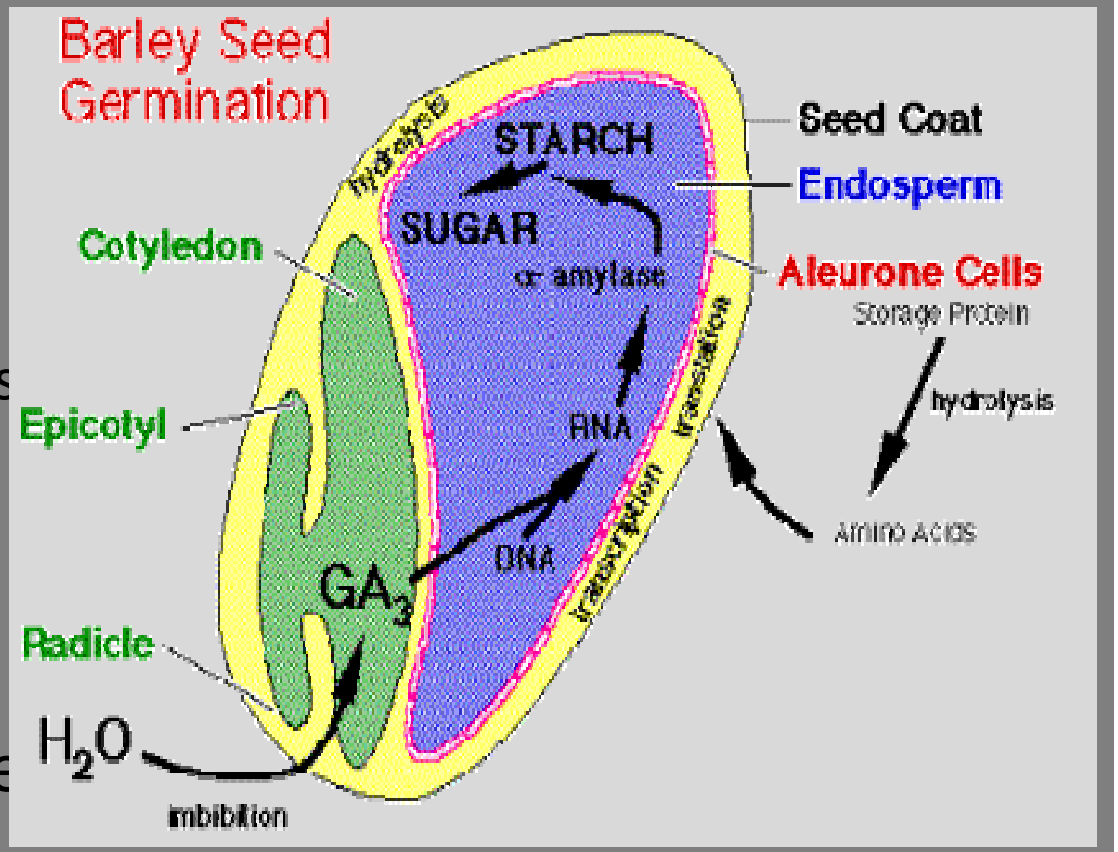

1. Polypeptides
endopeptidases
Small polypeptides
peptide hydrolases
Amino acid
2. Polypeptides
amino or carboxypeptidases
exopeptidases
Amino acids

Process: Seed Germination

2. Gibberelic Acid
   - Arrives at aleurone cells
   - Activates certain genes

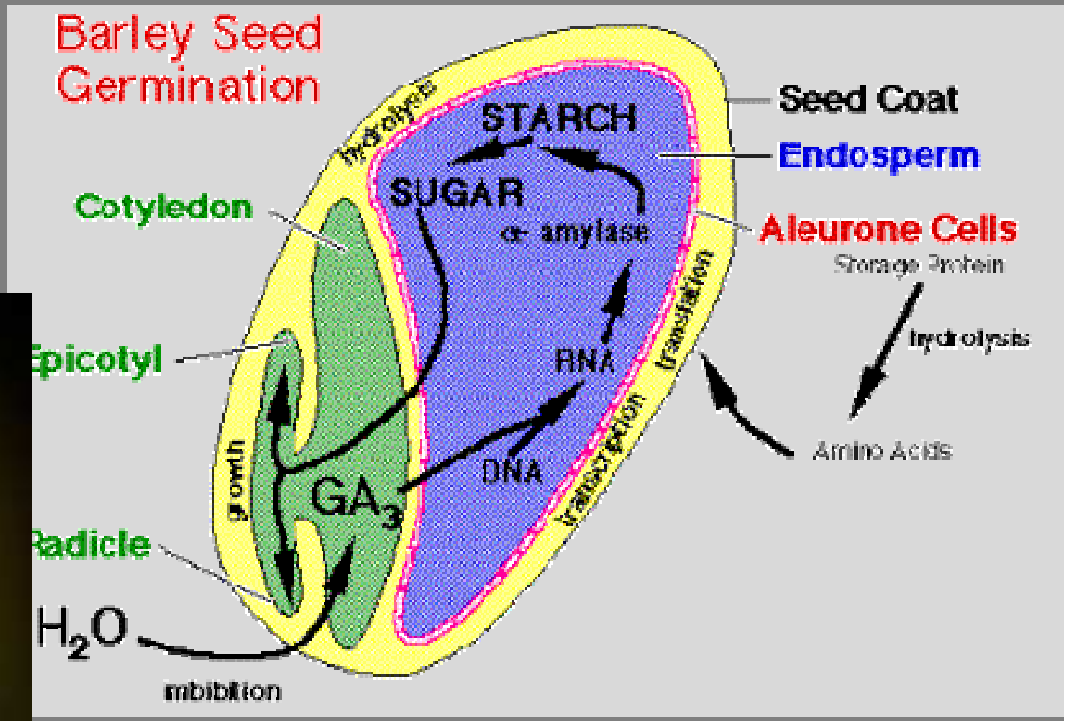
3. Transcription→ Transportation→ Translation → amylase

4. Amylase accelerates hydrolysis of starch



Process: Seed Germination

5. Hydrated starch moves to the cotyledon and radicle to initiate growth



Various events take place in a process of seed germination

a) The hydrophilic colloid present in the seed coat absorbs water.

b) The seed swells up due to imbibitions of water by the inner tissue.

c) The seed coat ruptures under the pressure of the swelling seed.

d) The cell wall and protoplasm of the inner cells are hydrated.

e) The hormone gibberellin is activated.

f) De-novo synthesis of the enzyme alpha-amylase takes place, which converts storage starch into soluble sugar.

g) Increase in osmotic potential causes greater absorption of water.

h) The soluble sugar is assimilated by the growing embryo.

i) The emergence of radical takes place and thus the seed germination is take place.

Process: Seed Germination

http://www.buzzle.com/articles/steps-of-seed-germination.html

http://bonnieplants.com/library/bonnie-herb-and-vegetable-plant-food-now-available-for-home-gardens/seed-germinating/

http://www.rollitup.org/cfl-fluorescent-lighting/492395-best-way-germinate-feminized-ordered.html

Three fundamental conditions must exist before germination can occur.

(1) The embryo must be alive, called seed viability.

(2) Any dormancy requirements that prevent germination must be overcome.

(3) The proper environmental conditions must exist for germination.

Seed vigor is a measure of the quality of seed, and involves the viability of the seed, the germination percentage, germination rate and the strength of the seedlings produced.

Seed Coat Affects Germination

- Strawberries/raspberries need to be consumed
- Water
  - Common glasswort needs to be pounded by surf
- Temperature
  - Kentucky coffee needs to be frozen
  - Blazing stars need to be burned

Other Factors Affecting Germination

- Water
- Oxygen
- Light/darkness
  - Forest seeds will not open until hole in canopy

References

- Wikipedia: http://en.wikipedia.org/wiki/Germination
- Champlin Website: http://web1.uct.usm.maine.edu/~champlin/Courses%20F'09/Handouts/seed%20germination.htm
- Plant Science and Landscape Architecture, UMD: http://www.psla.umd.edu/faculty/Coleman/Seed%20Germination.pdf