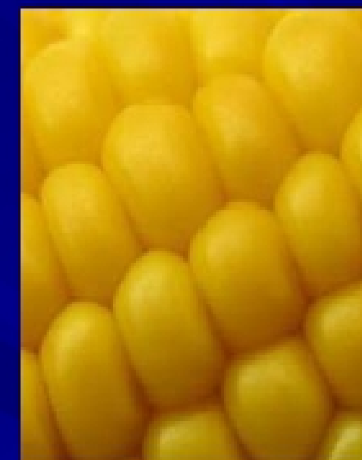
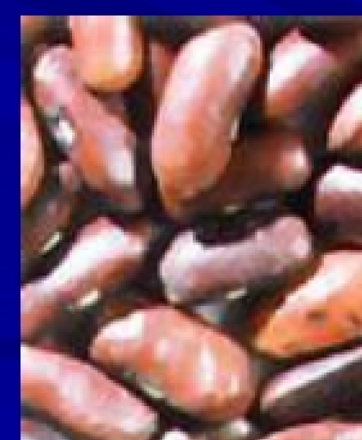

SEED

"A good seed in good soil yields abundant" -Manu script



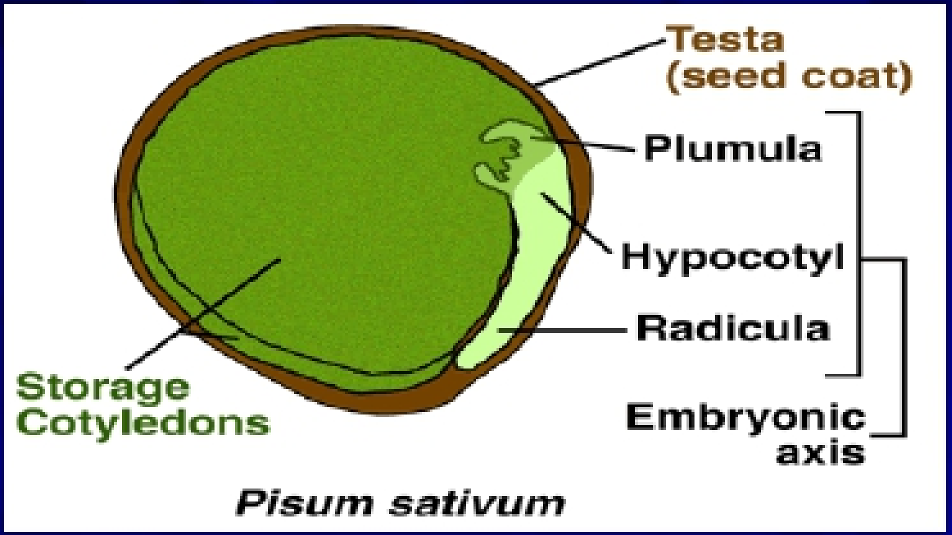


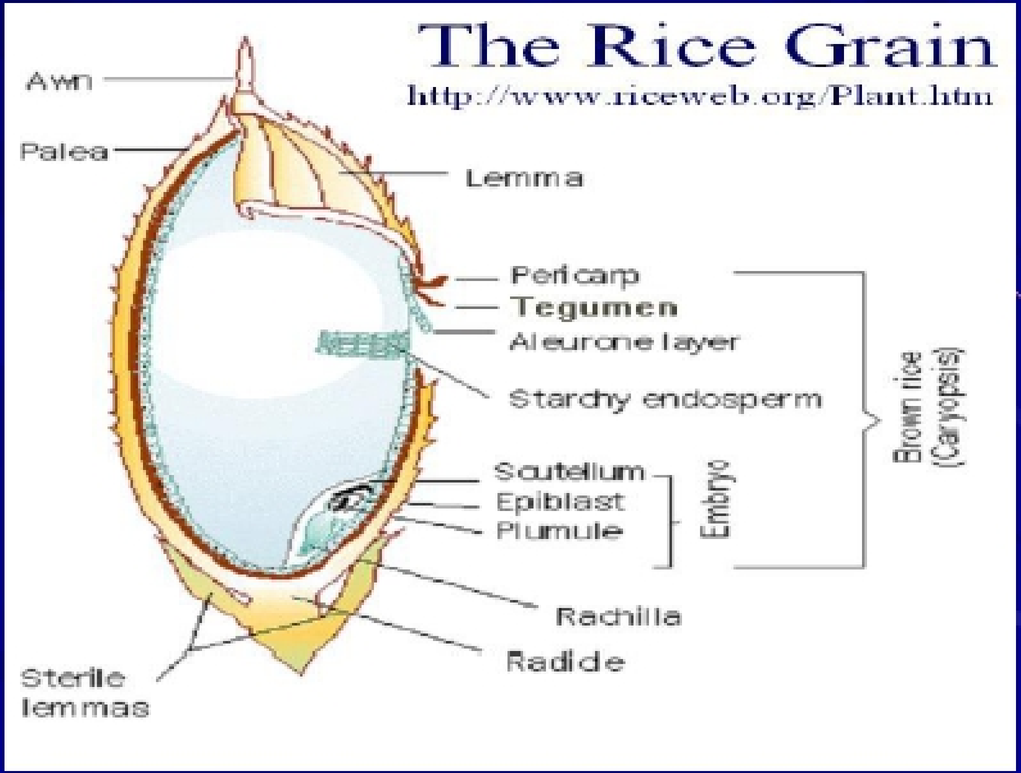



Seed

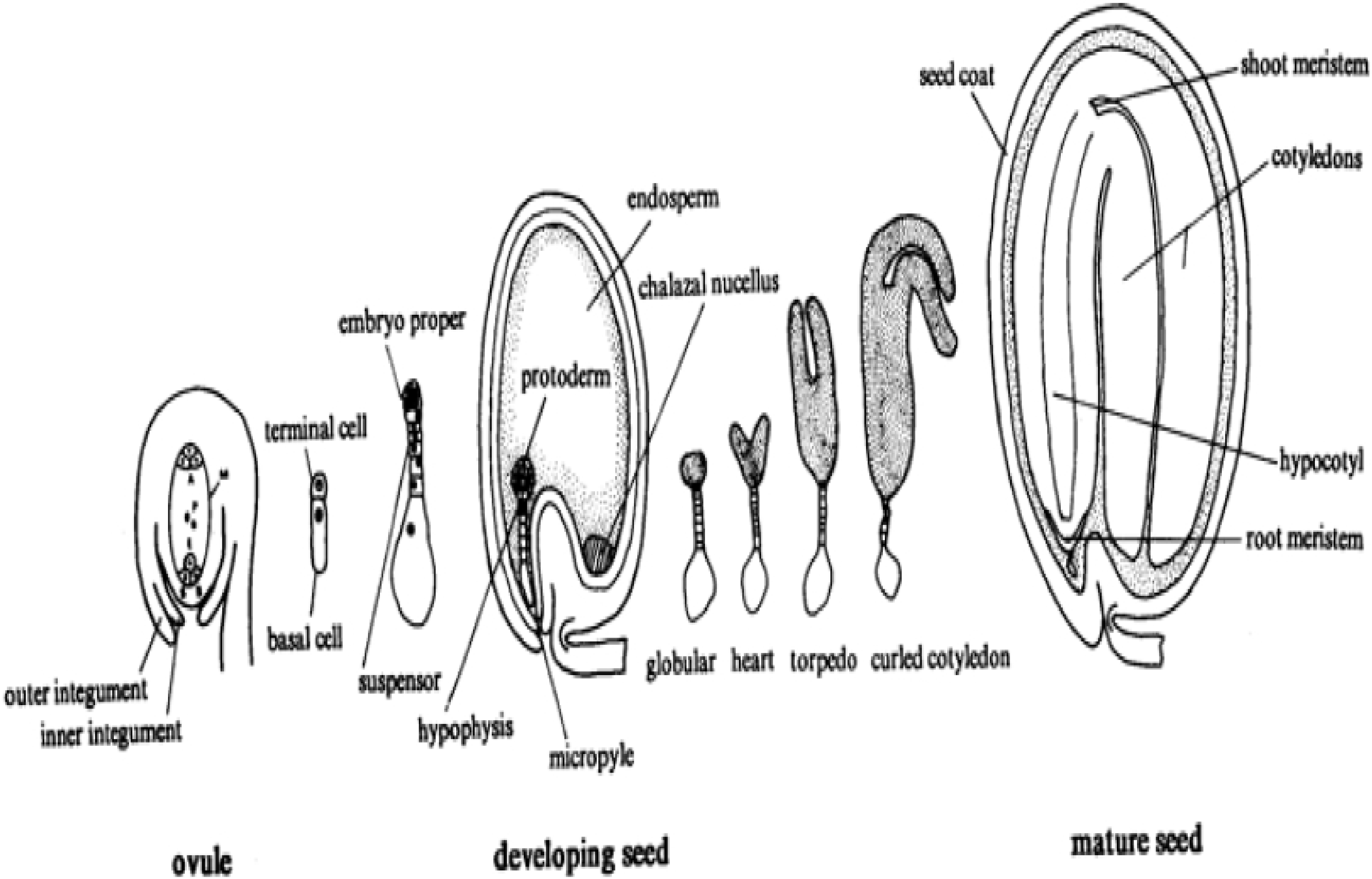
A seed is a fertilized mature ovule consists

- embryo
- storage reserves
- protective coverings





Therefore seeds possess plant’s life in miniature


seed coat
shoot meristem
cotyledons
endosperm
chalazal nucellus
embryo proper
protoderm
terminal cell
hypocotyl
root meristem
basal cell
globular
heart
torpedo
curled cotyledon
outer integument
inner integument
suspensor
hypophysis
micropyle
ovule
developing seed
mature seed

SEED — Fertilized Ripened Ovule

↓

three parts

- Protective tissue → Seed coat
- Nutritive tissue → Endosperm or Cotyledons
- Potential part → Embryo

1.Seed coat

- **Tegmen** (inner thin layer)
- **Testa** (outer thick layer)

2.Endosperm/Cotyledons

Reserve foods

Nucleic acids, CH_2O, Protein, Fat and Minerals

Support the growth in early stages

3.EMBRYO

Potential part

Embryonic Axis (EA)

Upper part of EA ⟶ **Plumule** ⟶ **Shoot**

Lower part of EA ⟶ **Radicle** ⟶ **Root**

CHEMICAL COMPOSITION OF SEED

1. Carbohydrate -- Starch (Amylose and Amylopectin)

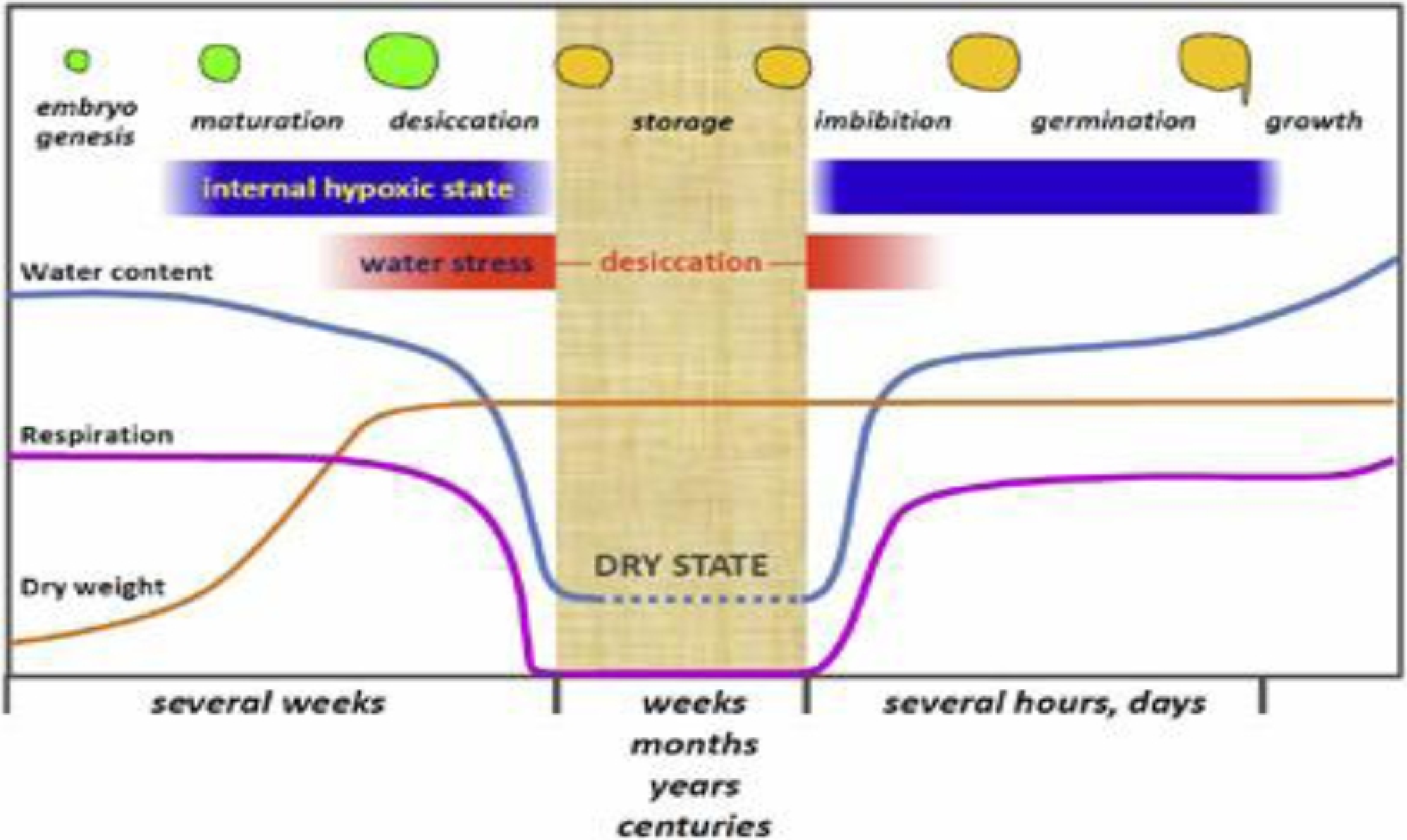
2. Proteins -- Polymers of Amino acids – Peptide bonds

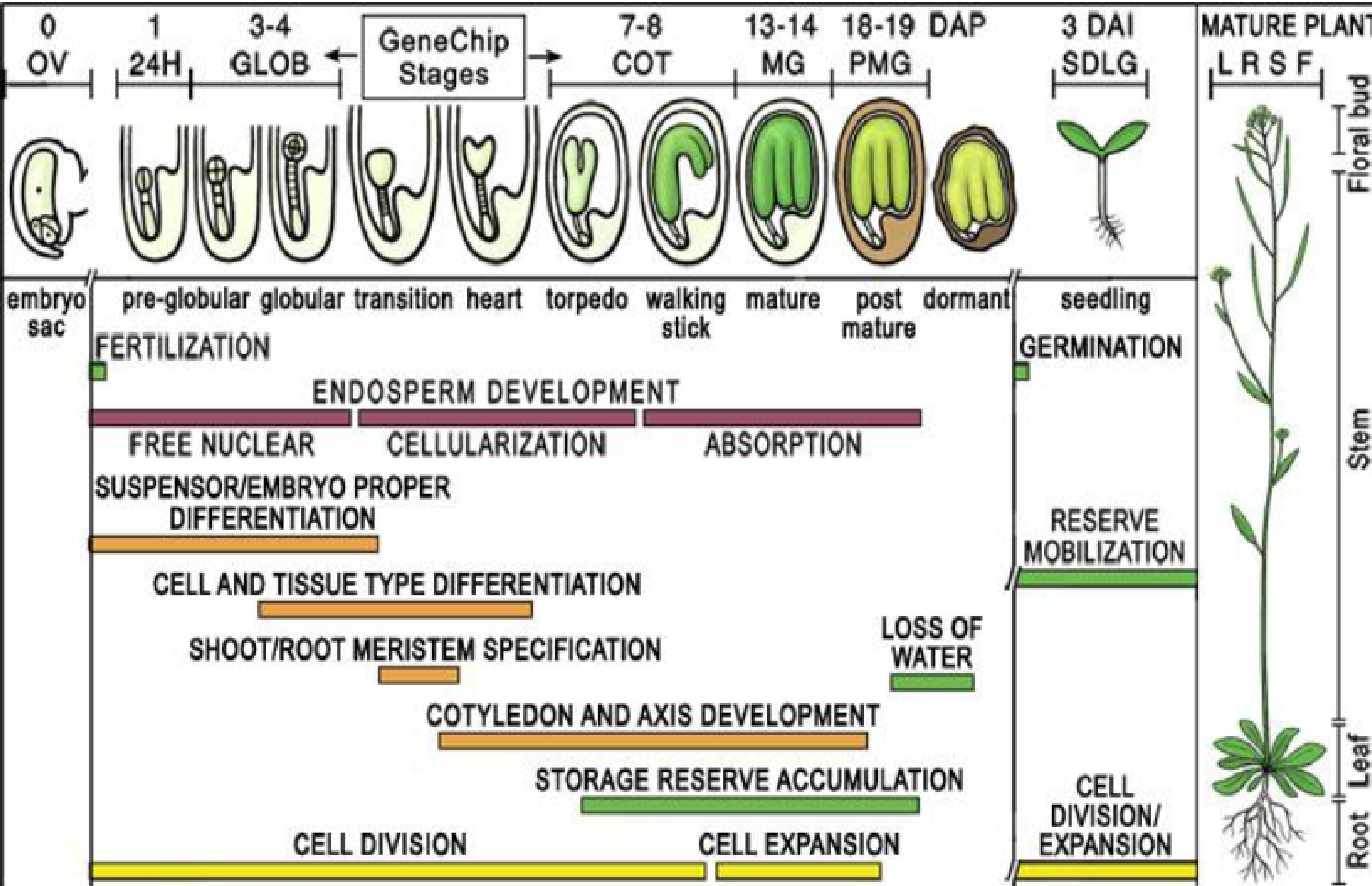
3. Lipids – Fats and Oils – Esters of Fatty acids and Alcohol

4. Seed mineral – Phytin (Phytic acid) – P, Ca, Mg and K

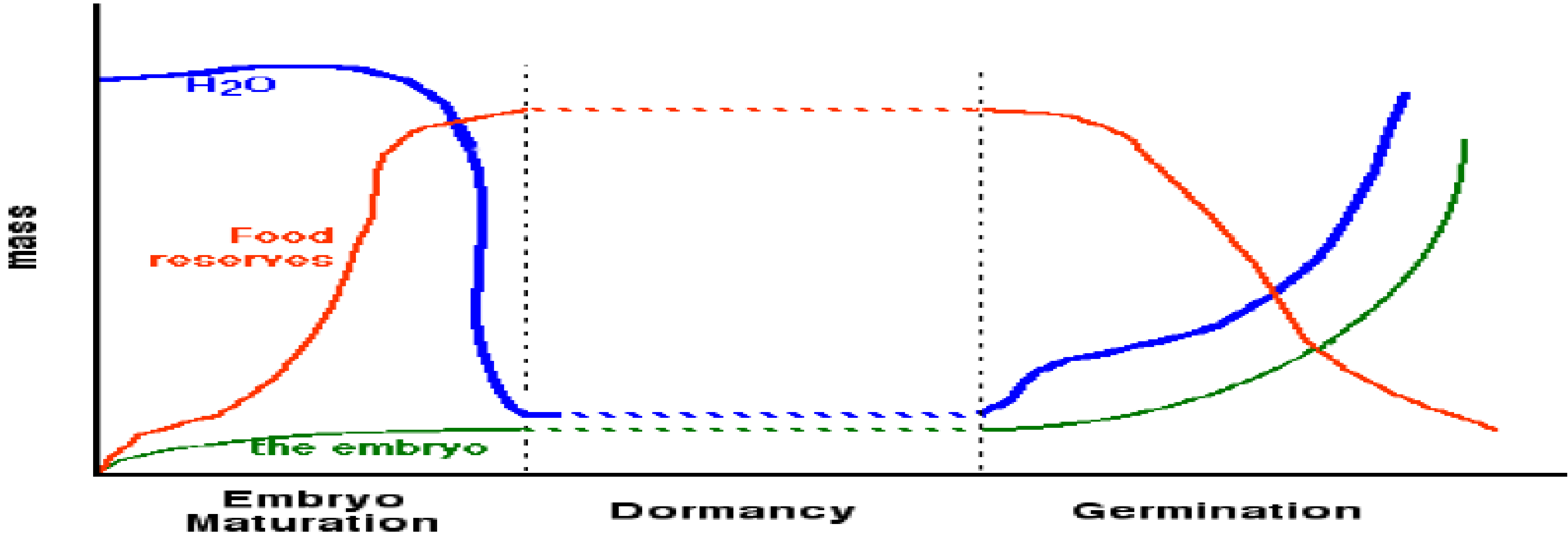
5. Nucleic acids

Seed Development





0
OV
1
24H
3-4
GLOB
GeneChip Stages
7-8
COT
13-14
MG
18-19
PMG
DAP
3 DAI
SDLG
MATURE PLANT
L R S F
Floral bud
Stem
Leaf
Root
embryo sac
pre-globular
globular
transition
heart
torpedo
walking stick
mature
post mature
dormant
seedling
FERTILIZATION
GERMINATION
ENDOSPERM DEVELOPMENT
FREE NUCLEAR
CELLULARIZATION
ABSORPTION
SUSPENSOR/EMBRYO PROPER DIFFERENTIATION
RESERVE MOBILIZATION
CELL AND TISSUE TYPE DIFFERENTIATION
LOSS OF WATER
SHOOT/ROOT MERISTEM SPECIFICATION
COTYLEDON AND AXIS DEVELOPMENT
STORAGE RESERVE ACCUMULATION
CELL DIVISION/ EXPANSION
CELL DIVISION
CELL EXPANSION



mass
H_2O
Food reserves
the embryo
Embryo Maturation
Dormancy
Germination

GERMINATION

Sequential series of events resulting in the transformation of an embryo in to a seedling

SEQUENCE OF EVENTS

Seed in favorable environment

↓

Absorption of water (IMBIBITION)

↓

Swelling of seed

↓

GA secretion

GA – involves synthesis of hydrolytic enzymes or activate the enzymes

↓

Act on food reserves

↓

Breakdown of food reserves

↓

Energy release

↓

Embryo growth

Embryo growth

↓

Splitting of seed coat

↓

Emergence of radicle and plumule

Emergence of radicle and plumule

radical comes out first and grows downward

↓

plumule comes out and grows upward

↓

continued growth of this seedling, plumule comes out of the soil

↓

exposed to light and develops its own photosynthetic apparatus.

THREE PHASES OF GERMINATION

I Phase -- Imbibition

II Phase -- 1. Respiration

2. Enzyme activity

III Phase -- Growth supported by leaf PS

FOUR EVENTS OF GERMINATION

1. IMBIBITION or HYDRATION

2. ENZYME ACTIVATION

3. HYDROLYSIS OF FOOD RESERVES

4. SEEDLING GROWTH

1. IMBIBITION or HYDRATION

More permeable to O2 and water

less resistant to outward growth of embryo.

2. ENZYME ACTIVATION

Rapid increase in respiration rate of embryo

Sucrose respiratory substrate provided by endosperm

GA – involves synthesis of hydrolytic enzymes or activate the enzymes

3. HYDROLYSIS OF FOOD RESERVES

Nucleic acids, CH_2O, Protein, Fat and Minerals

Building blocks for the development of embryo

Energy for the biosynthetic process

Nucleic acids for control of protein synthesis

Embryonic development

Growth depends upon stored food

1. Carbohydrate breakdown
2. Nucleic acids
3. Lipids
4. Protein breakdown
5. Inorganic materials

1. During germination and early seedling growth,- CHO

stored food reserves of the endosperm—chiefly starch and protein—
are broken down by a variety of hydrolytic enzymes,

Solubilized sugars, amino acids, and other products to the growing embryo

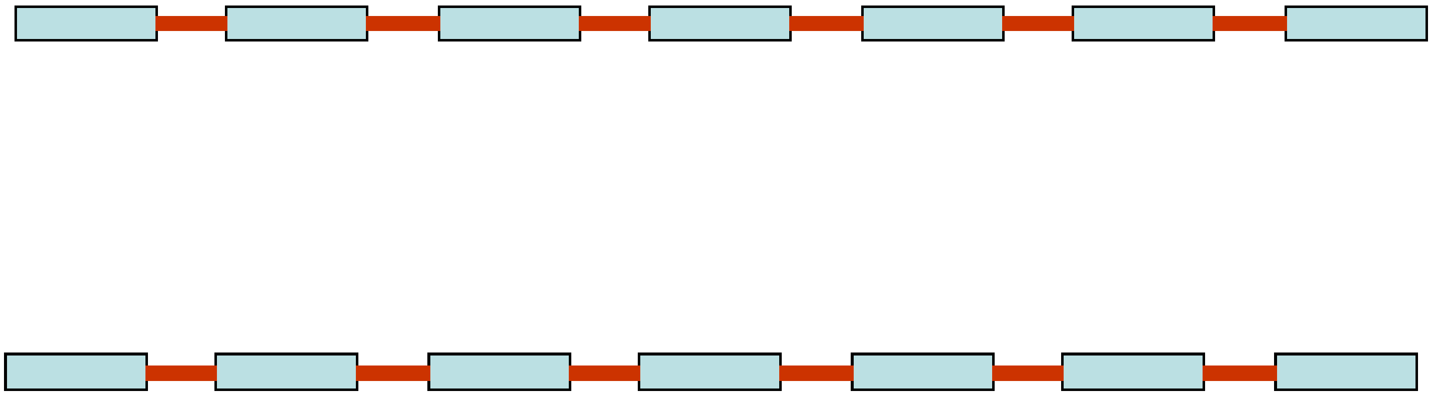
The two enzymes responsible for starch degradation are α- and β-amylase

α-Amylase hydrolyzes starch chains internally to produce oligosaccharides consisting of α-1,4-linked glucose residues

β-Amylase degrades these oligosaccharides from the ends to produce maltose, a disaccharide

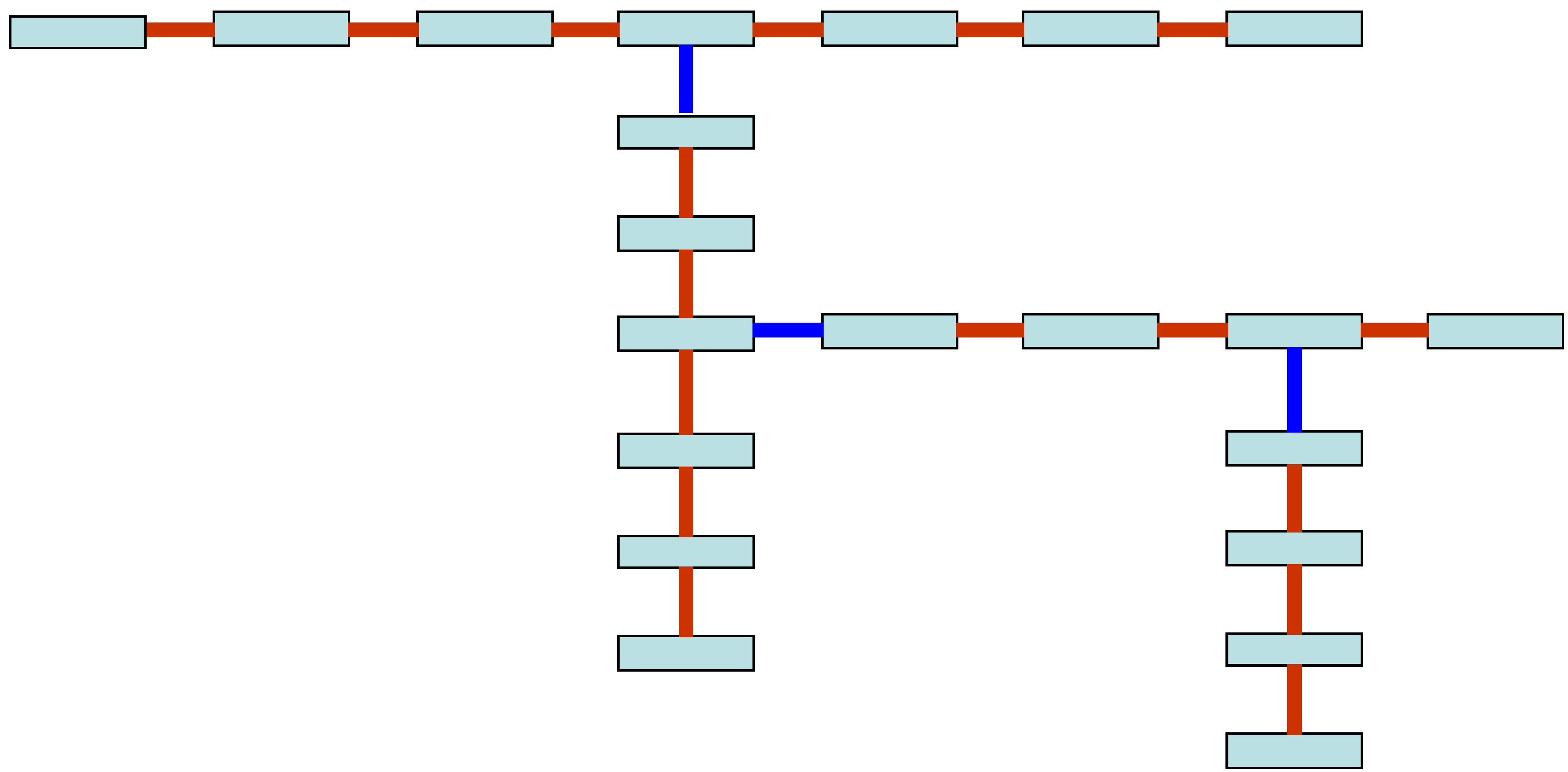
Maltase then converts maltose to glucose

AMYLOSE



Glucose units joined by α 1,4 Linkage

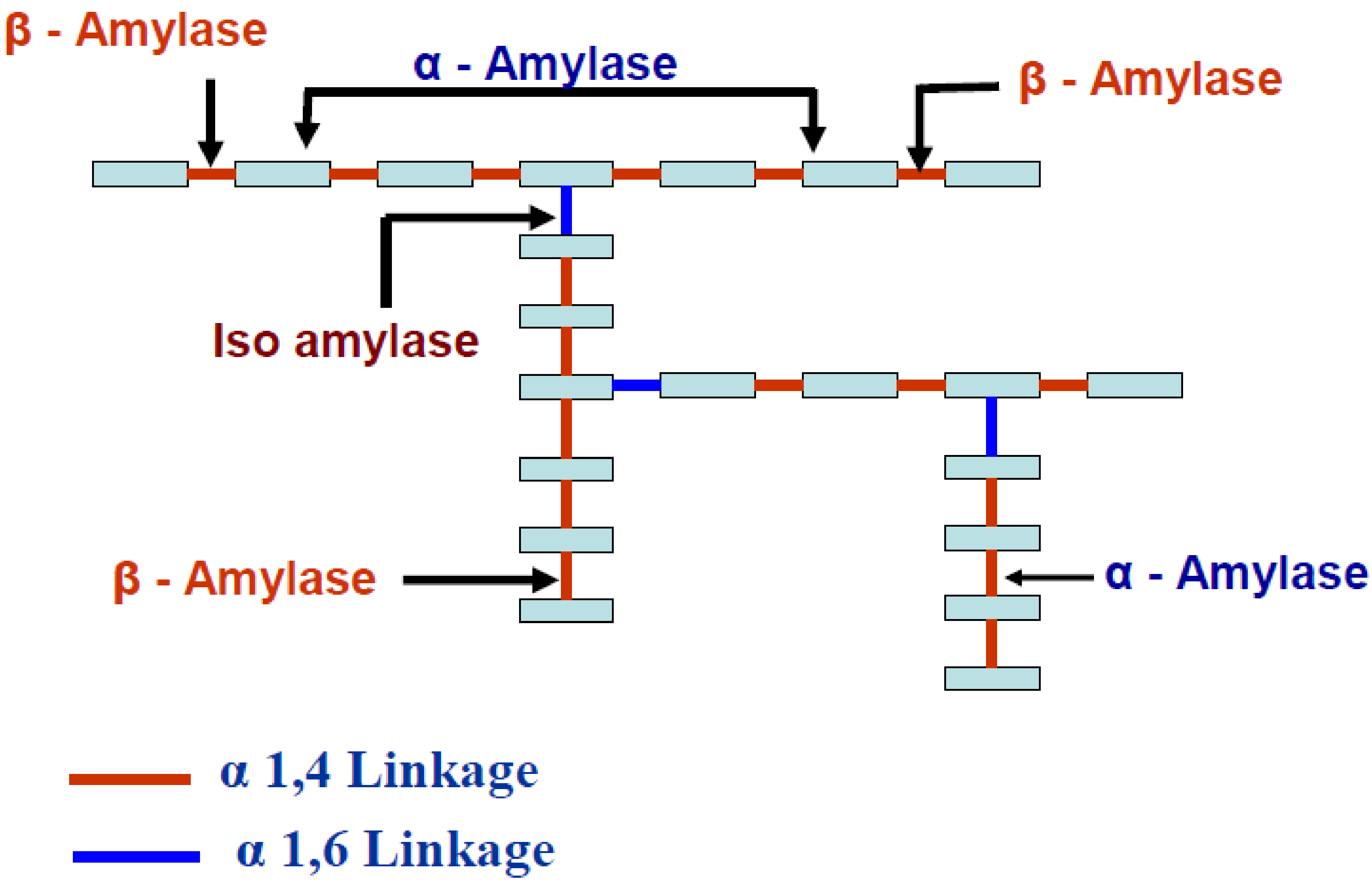
AMYLOPECTIN



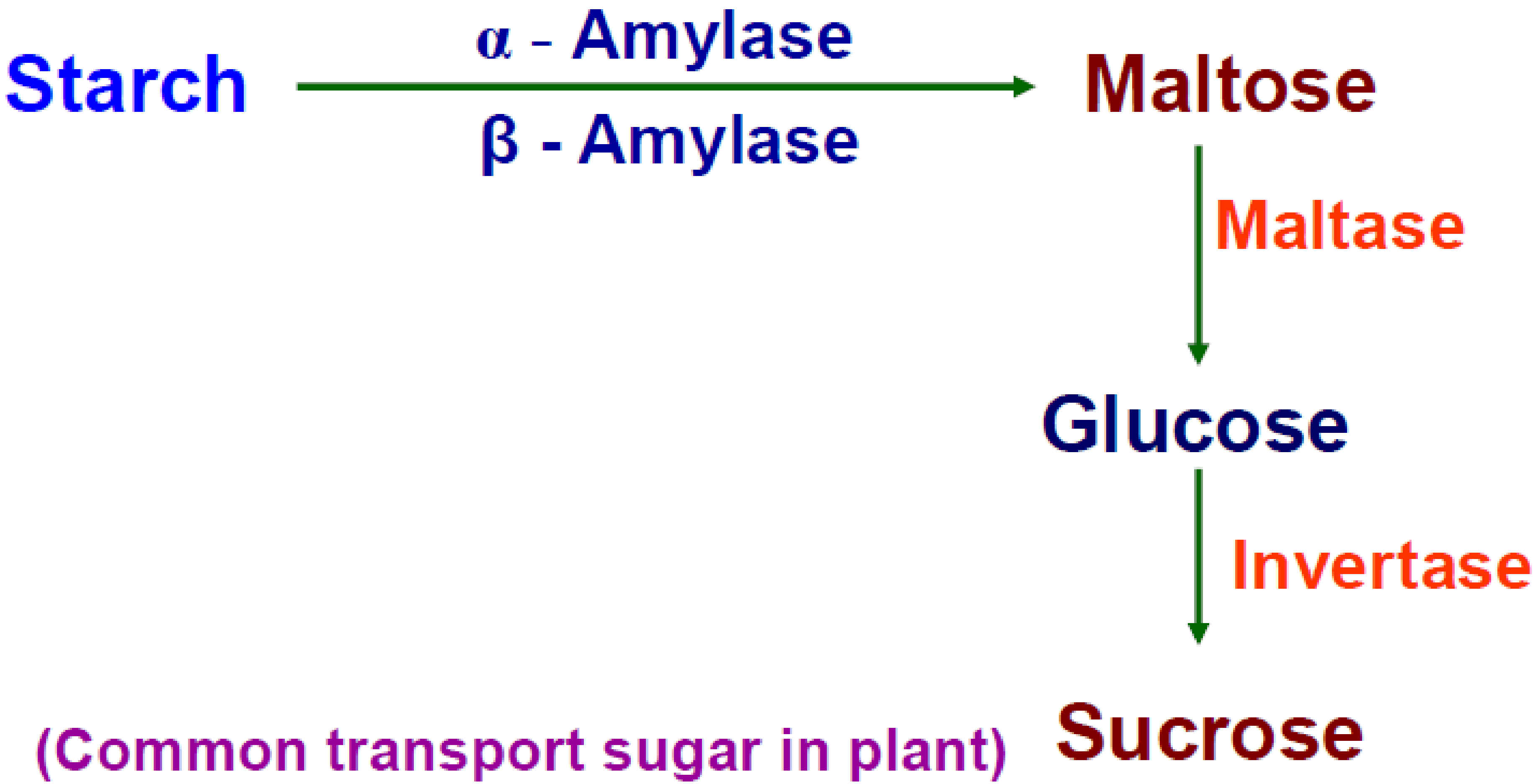
α 1,4 Linkage

α 1,6 Linkage

ENZYME ACTION ON STARCH



CARBOHYDRATE BREAKDOWN



Changes in components are as follows

2. Nucleic acids

during imbibition,

↓

rapid decrease of DNA and RNA content in the endosperm

↓

simultaneous increase in the embryonic axis due to their transportation

↓

High concentration of RNA in the embryonic axis precedes cell division

↓

Due to more cell division, DNA content is increased.

3. Lipids

Plants like castor bean, peanut etc., store large amount of neutral lipids or fats as reserve food in their seeds

During germination

↓

fats are hydrolyzed into fatty acids

↓

glycerol by lipase enzyme

↓

Fatty acids converted into acetyl – CoA by the process, β - oxidation

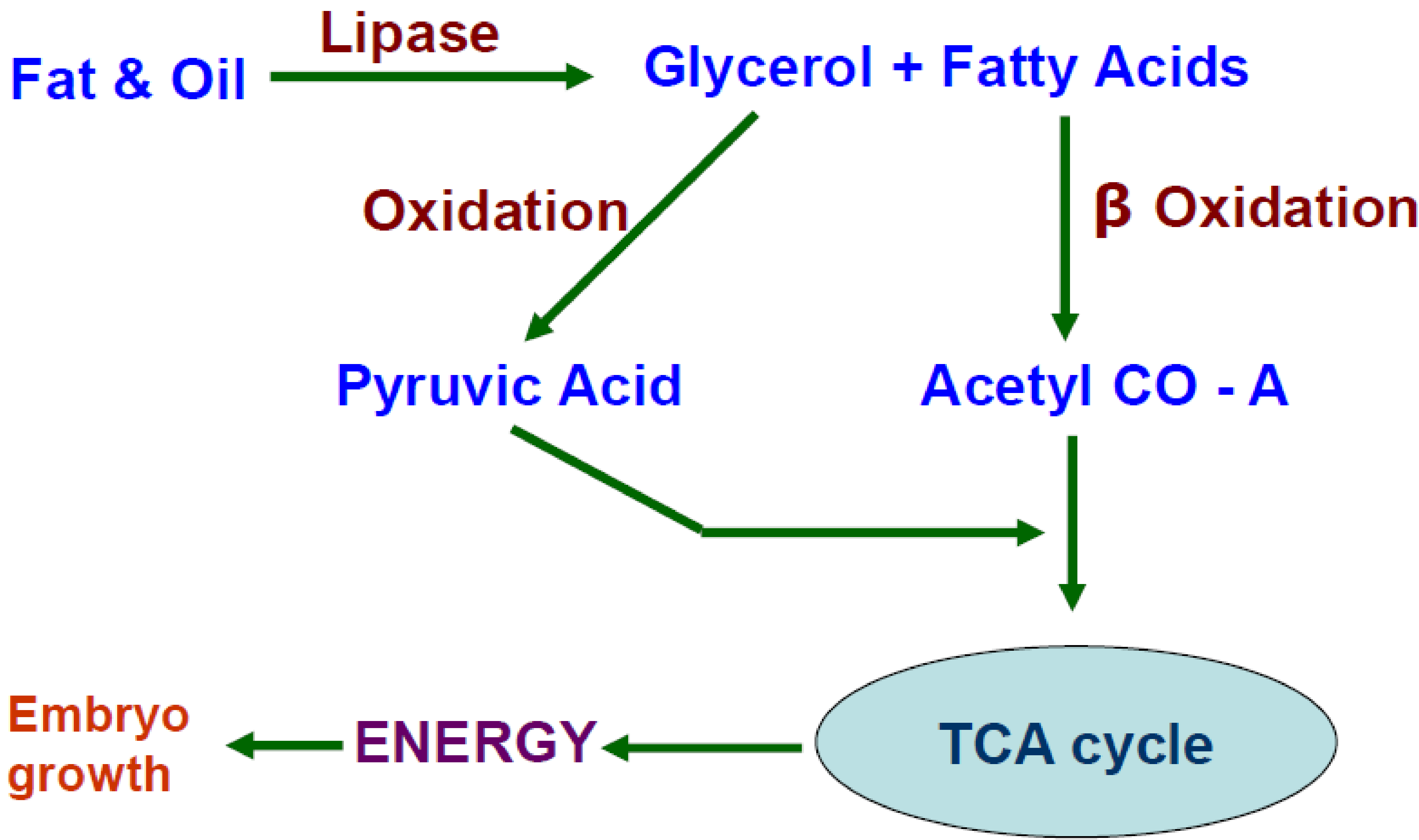
↓

acetyl CoA is further converted into sucrose via glyoxylate cycle

↓

transported to the growing embryonic axis.

LIPIDS BREAKDOWN



4. Proteins

Some plants store proteins as reserve food in their seeds in the form of aleurone grains.

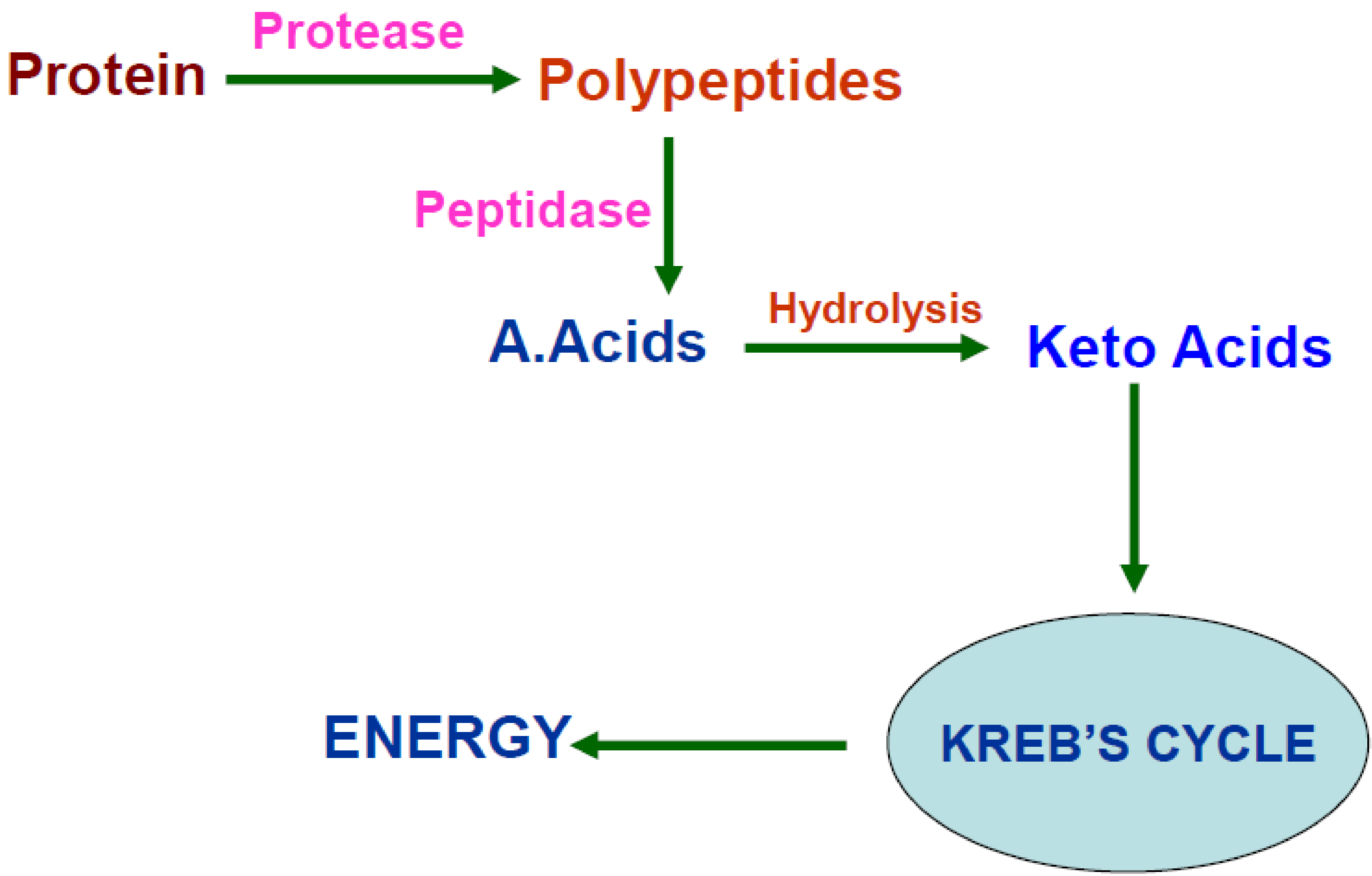
Proteins are hydrolyzed into amino acids by peptidase enzyme

amino acids may either provide energy by oxidation after deamination (removal of amino group)

or

may be utilized in the synthesis of new proteins.

PROTEIN BREAKDOWN



5. Inorganic materials

A number of inorganic materials

such as phosphate, calcium, magnesium and potassium are also stored in seeds in the form of phytin

These stored materials are liberated during germination due to the activity of various phosphatases including phytase

PHYTIN BREAKDOWN

Phytin

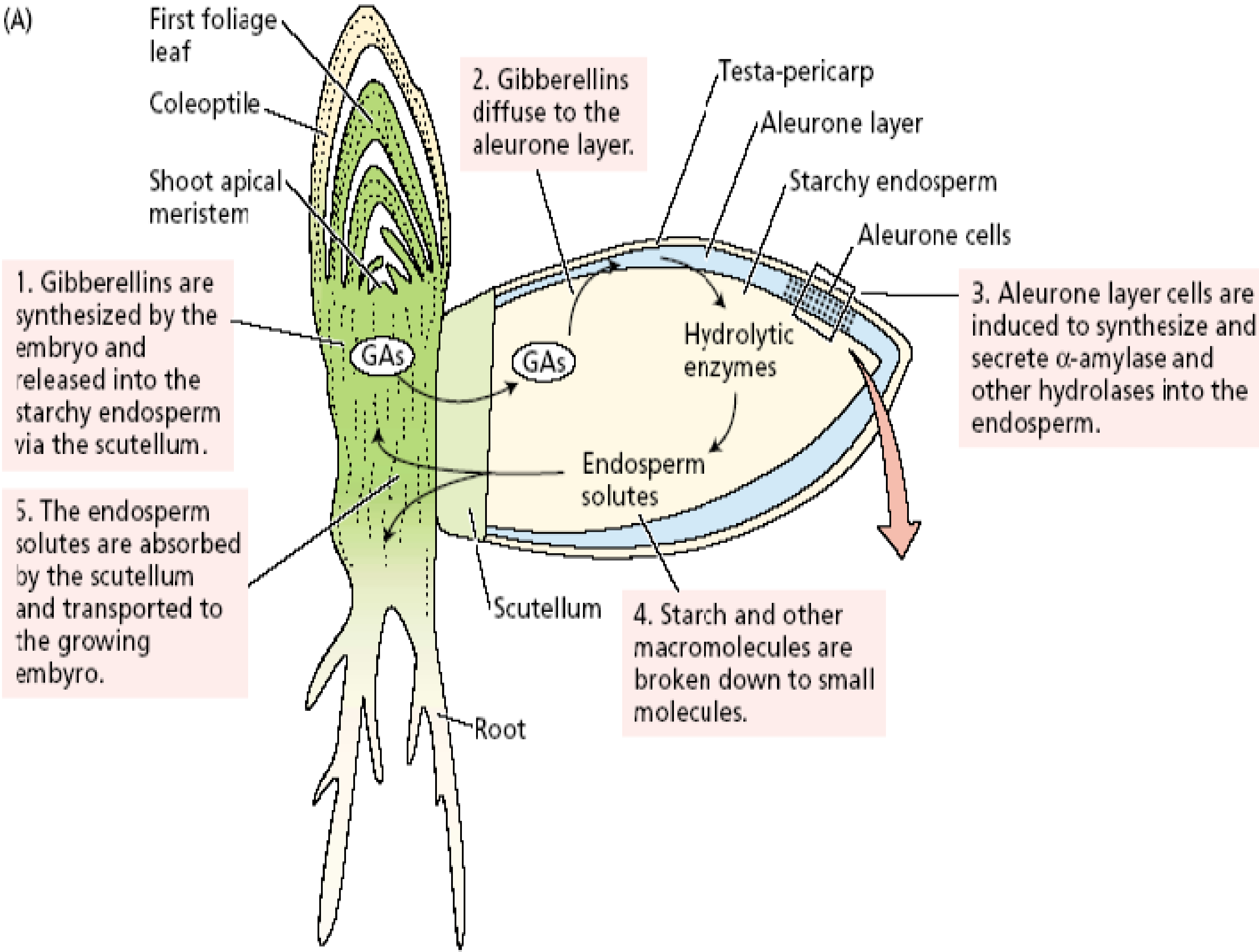
↓ PHYTASE

P, Ca, Mg and K

α-Amylase is secreted into the starchy endosperm of cereal seeds by both the scutellum and the aleurone layer

The sole function of the aleurone layer of the seeds of graminaceous monocots (e.g., barley, wheat,rice, rye, and oats) appears to be the synthesis and release of hydrolytic enzymes.

After completing this function, aleurone cells undergo programmed cell death.


(A)
First foliage leaf
Coleoptile
Shoot apical meristem
1. Gibberellins are synthesized by the embryo and released into the starchy endosperm via the scutellum.
GAs
2. Gibberellins diffuse to the aleurone layer.
GAs
Testa-pericarp
Aleurone layer
Starchy endosperm
Aleurone cells
Hydrolytic enzymes
3. Aleurone layer cells are induced to synthesize and secrete α-amylase and other hydrolases into the endosperm.
Endosperm solutes
5. The endosperm solutes are absorbed by the scutellum and transported to the growing embyro.
Scutellum
4. Starch and other macromolecules are broken down to small molecules.
Root

DORMANCY OF SEEDS

All the viable seeds have capacity to germinate if placed under suitable conditions necessary for germination

some seeds fail to germinate sometimes even if placed under the condition favourable for germination.

This may be due to some internal factors or due to specific requirement for some environmental factors

During this period, the growth of the seed remains suspended and they are said to be in rest stage or dormant stage and this phenomenon is called as dormancy of seeds

Factors causing dormancy of seeds

Seed coats impermeable to water- leguminaceae, solanaceae, malvaceae

Seeds coats impermeable to oxygen - cocklebur and many grasses

Immaturity of the Embryo - orchids

Germination Inhibitors- coumarin, ferulic acid, abscissic acid

Chilling or low temperature requirement- apple, rose, peach

6. Light sensitive seeds

In many species, the germination of the seeds is affected by light resulting in seed dormancy. Such light sensitive seeds are called *photo blastic*

Seeds of lettuce, tomato and tobacco are positively photo blastic and germinate only after they have been exposed to light

On the other hand, the seeds of certain plants are negatively photo blastic and their germination is inhibited by light.

Advantages of dormancy

In temperature zones, the dormancy of seeds helps the plants to tide over the severe colds which may be injurious for their vegetative and reproductive growth.

In tropical regions, the dormancy of seeds resulting from their impermeable seed coats ensures good chances of survival.

Dormancy of seeds in many cereals is of utmost importance to mankind. If these seeds germinate immediately after harvest in the field, they will become useless to man for consumption as food.


Thank You