Abscisic acid (ABA)

is one of the most important plant growth inhibitor rather than stimulatory hormone. ABA accumulates rapidly in plants in response to environmental stresses, such as drought, cold, or high salinity, and plays important roles in the adaptation and survival of these stresses.

Discovery

Scientists in the United States in (1965) isolated an inhibitor from cotton fruits and named it ‘abscisin II’. At almost the same time another group named it "dormin" associated with bud & Seed Dormancy and organ abscission. The structure of abscisin II was determined in 1965 and dormin was subsequently shown to be chemically identical to abscisin II. This compound was renamed **abscisic acid.**

Sites of synthesis:

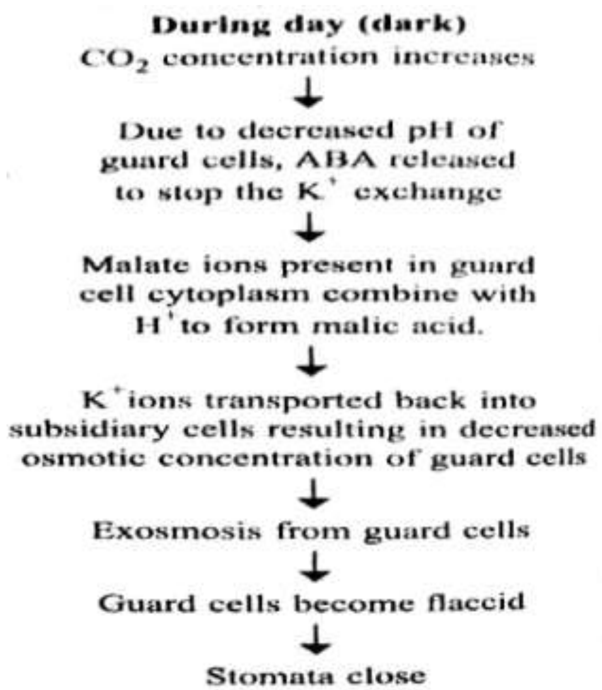
ABA is synthesized from mevalonic acid either directly or from the breakdown of carotenoid pigments in roots and mature leaves, particularly in response to water stresses. Seeds are also rich in ABA which may be imported from the leaves.

Transport:

ABA is exported from roots in the xylem and from leaves in the phloem. There is some evidence that ABA may circulate to the roots in the phloem and then return to the shoots in the xylem.

Physiological Role

1. Stomatal regulation: The most significant and best known effect of abscisic acid is its control of stomatal closing in water stress or drought plants. It inhibits K+ uptake by guard cells. It results reduction of osmotically active solutes so that the guard cells become flaccid and stomata get closed.



2. ABA inhibits shoot growth (but has less effect on, or may promote, root growth). This may represent a response to water stress.

3. Enhancing organ abscission, senescence and Chlorophyll degradation.

4. Seed and bud dormancy: ABA acts as growth inhibitor and induces bud dormancy in a variety of plants. In general, it acts as an inhibitory chemical compound that affects bud growth, and seed and bud dormancy. ABA counteracts the effect of gibberellin on α-amylase synthesis in germinating cereal grains. Seeds will germinate when ABA is removed or inactivated. Exogenous supply of ABA inhibits germination of most non-dormant seeds. As soon as it is removed by washing the seeds, the germination can take place which may be due to- inhibition of enzymes involved in germination process.

5. Role in water stress: Abscisic acid plays an important role in plants during water stress and drought conditions. It increases the tolerance of plants to different kinds of stress and is, therefore, called ‘stress hormone’.

Ethylene

Ethylene gas (CH2==CH2), the structurally simplest plant growth hormone. Ethylene is the only plant growth regulator that occurs in the form of a gas. Like abscisic acid, ethylene is usually considered as inhibitory hormone.

The Triple Response:

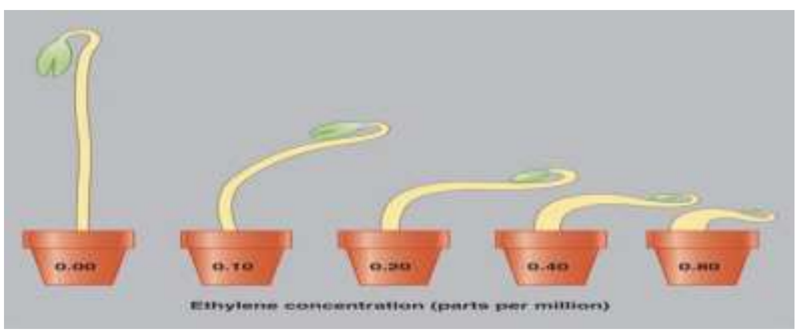
Exposure of seedlings to ethylene in the dark produces a characteristic ‘triple response’:

i. A slowing of stem elongation

ii. A thickening of the stem

iii. Curvature causing horizontal growing - Decrease in ethylene, back to normal growth.

Prolonged exposure leads to leaf senescence and abscission.



Ethylene biosynthesis

In general, meristematic regions are the most active in ethylene biosynthesis. However, ethylene production also increases during leaf abscission and flower senescence, as well as during fruit ripening. Any type of wounding can induce ethylene biosynthesis, as can physiological stresses such as flooding, disease, and temperature or drought stress. The amino acid methionine is the precursor of ethylene, and ACC (1-aminocyclopropane-1-carboxylic acid) serves as an intermediate in the conversion of methionine to ethylene.

Physiological role:

1. **Acceleration of senescence and abscission:** Ethylene promotes/ accelerates senescence and abscission of plant parts. It accelerates senescence of leaves, flowers and fruits as endogenous ethylene increases during senescence which reduces or degrades chlorophyll content. Ethylene appears to be the primary regulator of the abscission process. The *target cells*, located in the abscission zone, synthesize cellulose and other polysaccharide-degrading enzymes, and secrete them into the cell wall via secretory vesicles derived from the Golgi. The action of these enzymes leads to cell wall loosening, cell separation, and abscission.

2. **Fruit Ripening:** All fruits that ripen in response to ethylene exhibit a characteristic respiratory rise before the ripening phase called a **climacteric**. Climacteric fruits generate large amount of ethylene and show a marked increase in respiration as ripening proceeds. This increase in respiration is called **climacteric** and fruits that show this are known as **climacteric fruits.** In contrast, fruits do not exhibit the respiration and ethylene production rise and are called **nonclimacteric** fruits.

3. **The ethylene cause epinasty:** Exposure of plants or plant parts to ethylene causes drooping of leaves and flowers, a phenomenon known as epinasty. Epinastic curvature results from unequal (or asymmetric) growth on the upper and lower sides of petioles or peduncles. The upper (adaxial) side grows at a faster rate than the lower (abaxial) side resulting in a downward curvature of the organ**.**

4. **Growth inhibition and morphogenetic effect:** Ethylene inhibits the elongation growth of stems in most dicots by affecting cell growth and shape but it enhances lateral expansion. These effects of ethylene are common to growing shoots of most dicots, forming part of the triple response.

5. Ethylene Induces the Formation of Roots and Root Hairs.