Plant Growth Regulators

GROWTH

Growth

- Irreversible change in Mass, i.e. increase in size, volume and weight of any part of plant's body.
- It means quantitative increase in plant body.
- e.g. Cell division → Cell enlargement.

Development

- Irreversible change in state.
- It means the qualitative change in plant body.
- e.g. Seed → Seedling → Vegetative maturation → Flowering.

Growth is a continuous process
Development is phase to phase process.

- Plant's growth and development are under the control of two sets of internal factors.
- Nutritional factors such as the supply of carbohydrates, proteins, fats and others constitute the raw materials required for growth.
- Proper utilization of these raw materials is under the control of certain ***"chemical messengers"*** which can be classified into hormones and vitamins.

Hormone	Vitamin
1)The site of synthesis is different from the site of action. 2)Plant hormones are physiologically active.	1)Vitamins are used in the same part without being transported. 2)Vitamins by themselves are not physiologically active. They act as co-factor of enzyme.

- The term Hormone is derived from a Greek root '*hormao*' which means 'to stimulate' (Beylis and Starling, 1902).

- Thimann (1948) suggested using the term '**Phytohormone**' for Hormones of plant.

- Phytohormones are organic substances produced naturally by the plants which in minute/low concentration
  - ✓increase,
  - ✓decrease
  - ✓modify the growth and development.
- *Also termed as*
  - ✓growth hormones
  - ✓growth promoting substances
  - ✓growth substances
  - ✓growth regulators
  - ✓growth factors etc.

Phytohormones

Phytohormones are organic substances produced naturally by the plants which in minute/low concentration

- ✓increase,
- ✓Decrease,
- ✓modify the growth and development.

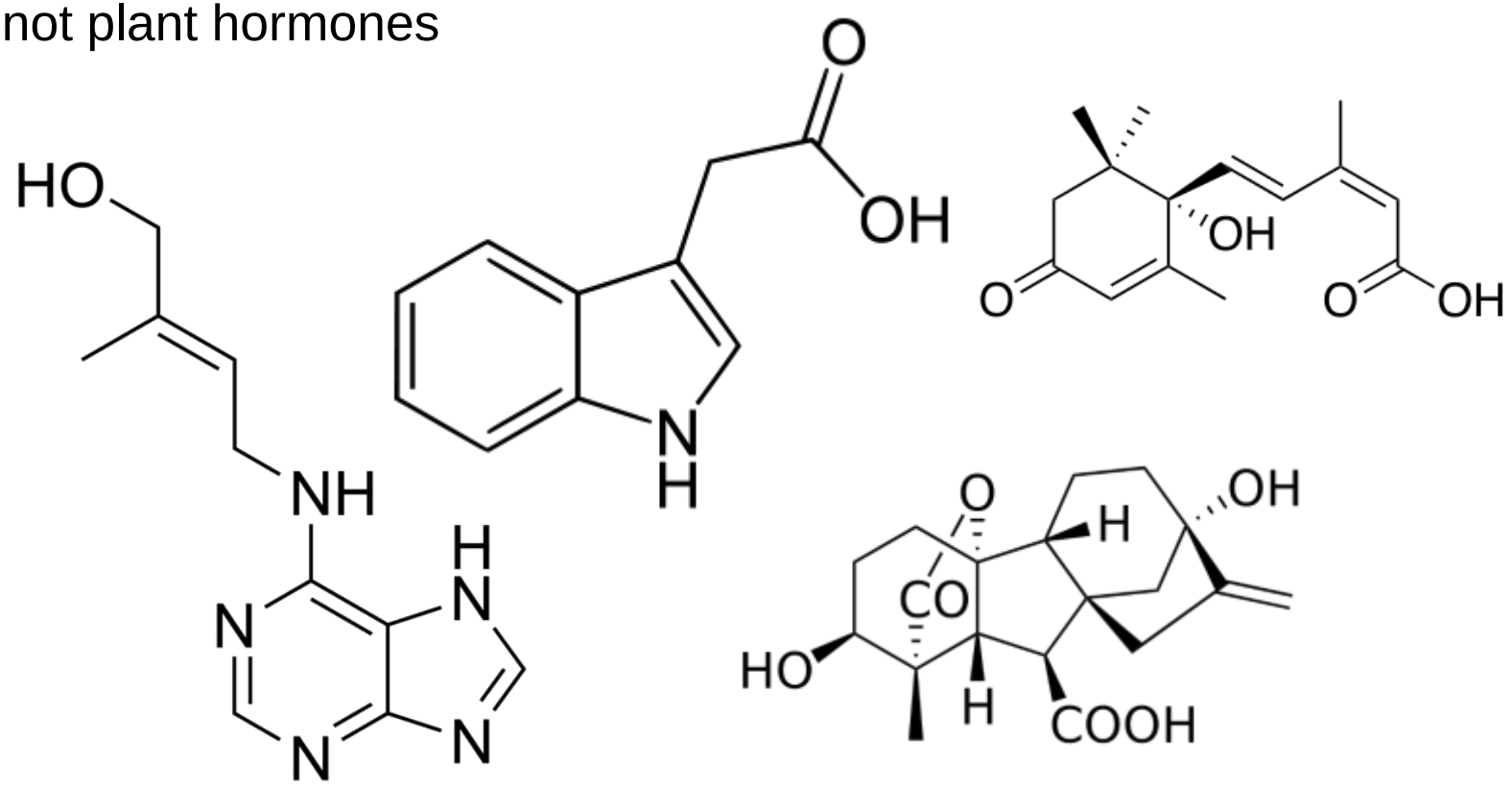
Other names

1) Plant growth hormones
2) Plant growth promoting substances
3) Plant growth regulators

Plant Growth Regulators

Plant Growth regulators (PGR) refers to natural or synthetic substances influence the growth and development.

- All plant hormone are plant growth regulators but,
- All plant growth regulator are not plant hormones



Classification of PGR's

On the Basis of Origin

Natural hormone

Produced by some tissues in the plant. Also called Endogenous hormones. e.g. IAA.

Synthetic hormone

Produced artificially and similar to natural hormone in physiological activity. Also called Exogenous hormones. e.g. 2,4- D, NAA etc.

Postulated hormone

Also produced spontaneously in the plant body, but their structure and function is not discovered clearly. e.g. Florigen, Vernalin.

Classification of PGR’s

On the Basis of Nature of Function

Growth promotors (Increase growth of plants)

Auxins

Gibberellins

Cytokinins

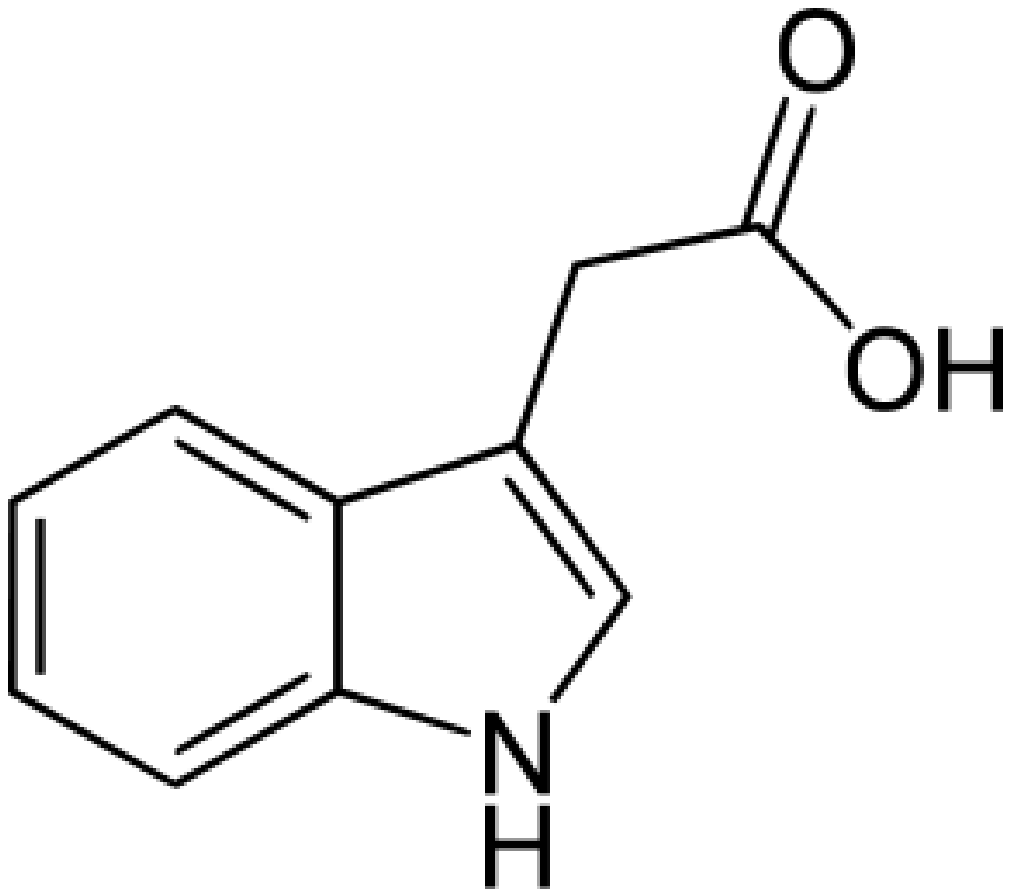
Growth Inhibitors (Retard growth of plants)

ABA

Ethylene

Auxins

Indole-3-acetic acid (IAA) is the main auxin in most plants.



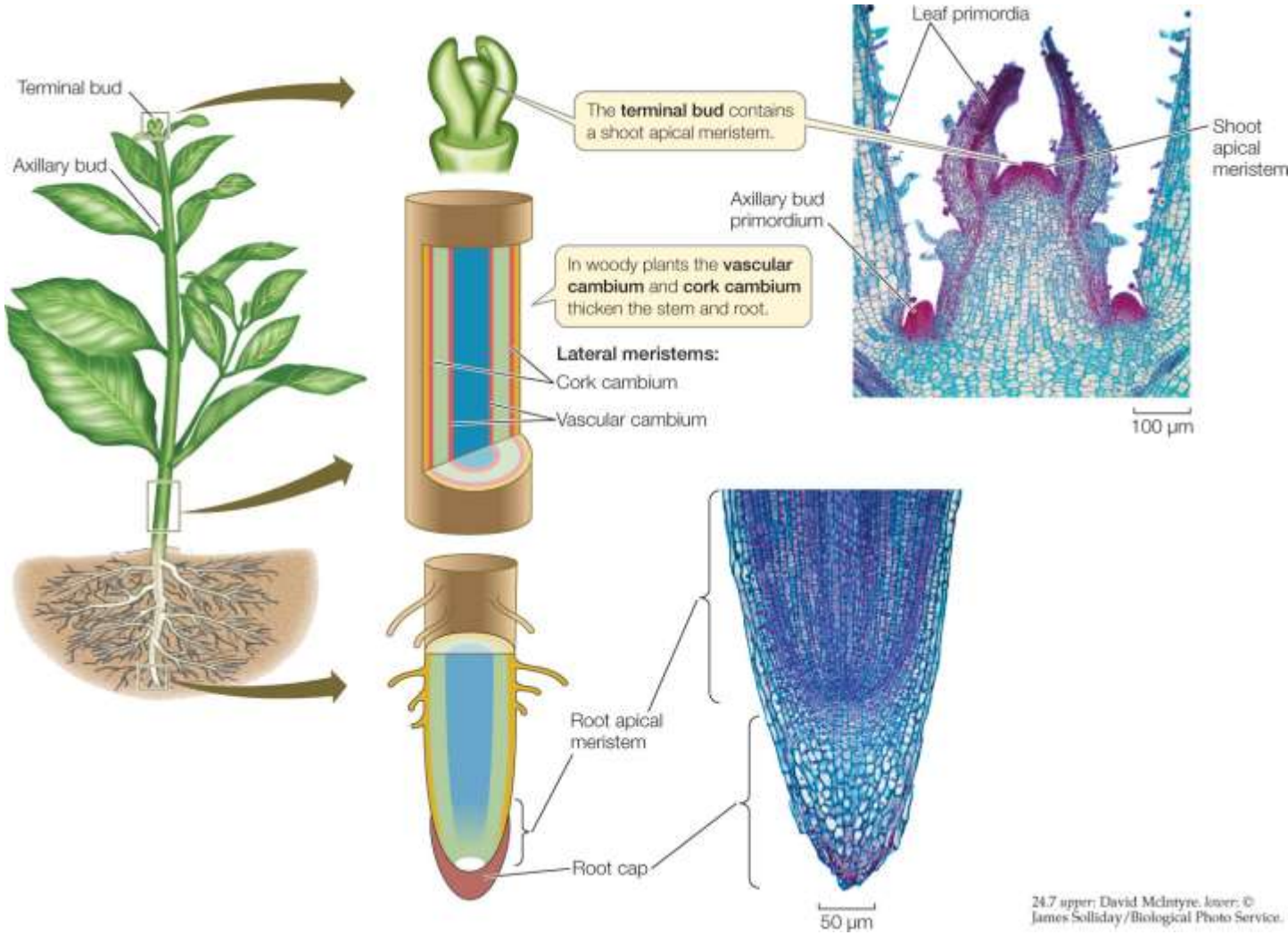
Auxins

Sites of biosynthesis

synthesized from tryptophan or indole primarily in leaf primordia, young leaves and root tips.

Transport

IAA transport is cell to cell. Transport to the root probably also involves the phloem.



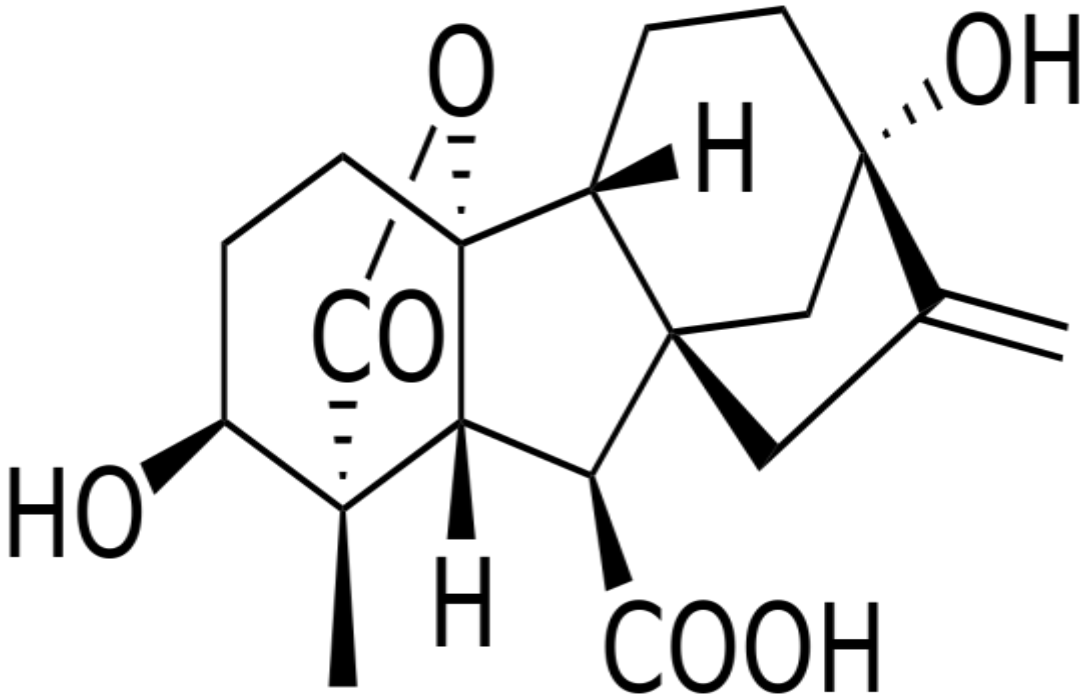
Functions of Auxins

The following are some of the responses that auxin is known to cause.

1) Stimulates cell elongation
2) Stimulates cell division
3) Stimulates differentiation of phloem and xylem
4) Stimulates root initiation on stem cuttings and lateral root development in tissue culture
5) The auxin supply from the apical bud suppresses growth of lateral buds
6) Delays leaf senescence
7) Promotes flowering

Gibberellins

- The gibberellins(GAs) are a family of compounds.
- While the most widely available compound is GA3 or gibberellic acid, which is a fungal product.
- The most important GA in plants is GA1.



Gibberellins

Sites of biosynthesis

GAs are synthesized from mevalonic acid in young tissues of the shoot and developing seed.

It is uncertain whether synthesis also occurs in roots

Transport

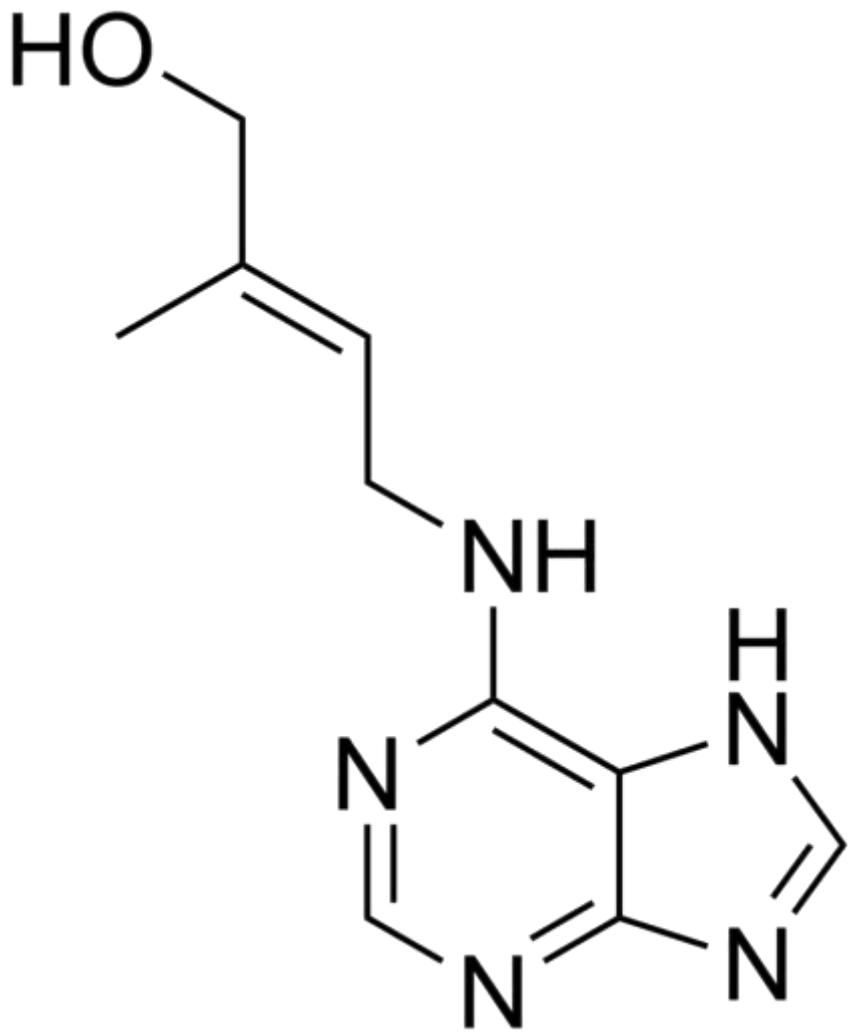
GAs are probably transported in the phloem and xylem.

Functions of Gibberellins

1) Stimulate stem elongation by stimulating cell division and elongation.
2) Stimulates bolting/flowering in response to long days.
3) Breaks seed dormancy in some plants which require stratification or light to induce germination.
4) Stimulates enzyme production (a-amylase) in germinating cereal grains for mobilization of seed reserves.
5) Can cause parthenocarpic (seedless) fruit development.
6) Can delay senescence in leaves and citrus fruits.

Cytokinins

The most common cytokinin base in plants is zeatin.



Cytokinins

Sites of biosynthesis

CK biosynthesis is through the biochemical modification of adenine.

It occurs in root tips and developing seeds.

Transport

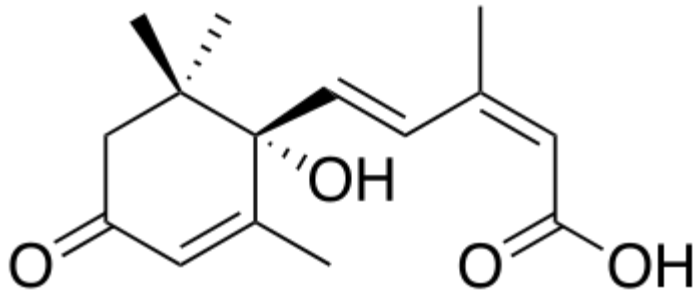
CK transport is via the xylem from roots to shoots.

Functions of Cytokinins

The response will vary depending on the type of cytokinin and plant species.

1) Stimulates cell division.
2) Stimulates morphogenesis (shoot initiation/bud formation) in tissue culture.
3) Stimulates the growth of lateral buds-release of apical dominance.
4) Stimulates leaf expansion resulting from cell enlargement.
5) May enhance stomatal opening in some species.

Abscisic Acid



Abscisic acid

Sites of biosynthesis

ABA is synthesized from mevalonic acid in roots and mature leaves, particularly in response to water stress.

Seeds are also rich in ABA which may be imported from the leaves.

Transport

ABA is exported from roots in the xylem.

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

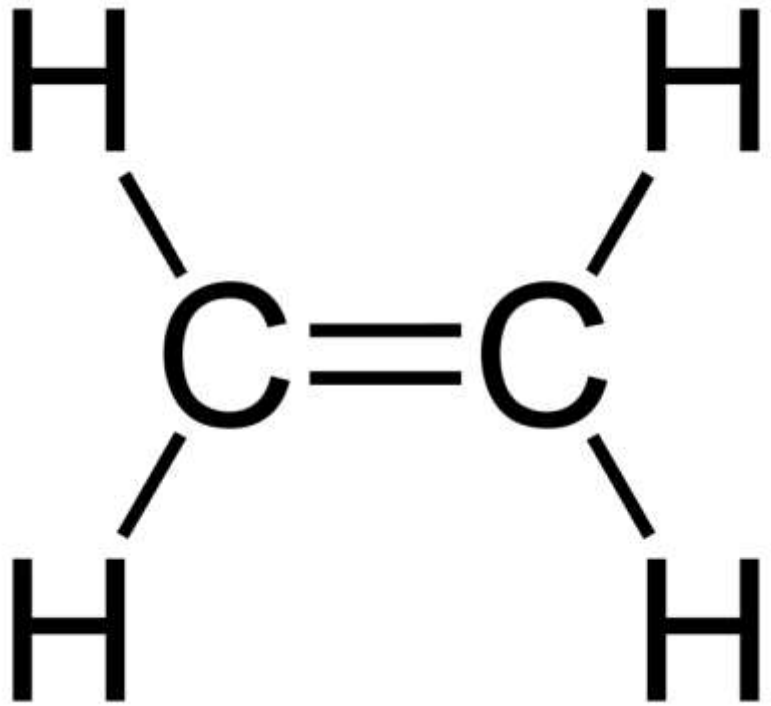
Functions of Abscisic Acid

The following are some of the physiological responses known to be associated with abscisic acid.

1) Stimulates the closure of stomata
2) water stress brings about an increase in ABA synthesis.
3) Inhibits shoot growth but will not have as much affect on roots.
4) Induces seeds to synthesize storage proteins.
5) Has some effect on induction and maintenance of dormancy.

Ethylene

The gas ethylene (C2H4) is synthesized from methionine in many tissues in response to stress.



Ethylene

Sites of biosynthesis

- Ethylene is synthesized by most tissues in response to stress.
- In particular, it is synthesized in tissues undergoing senescence or ripening.

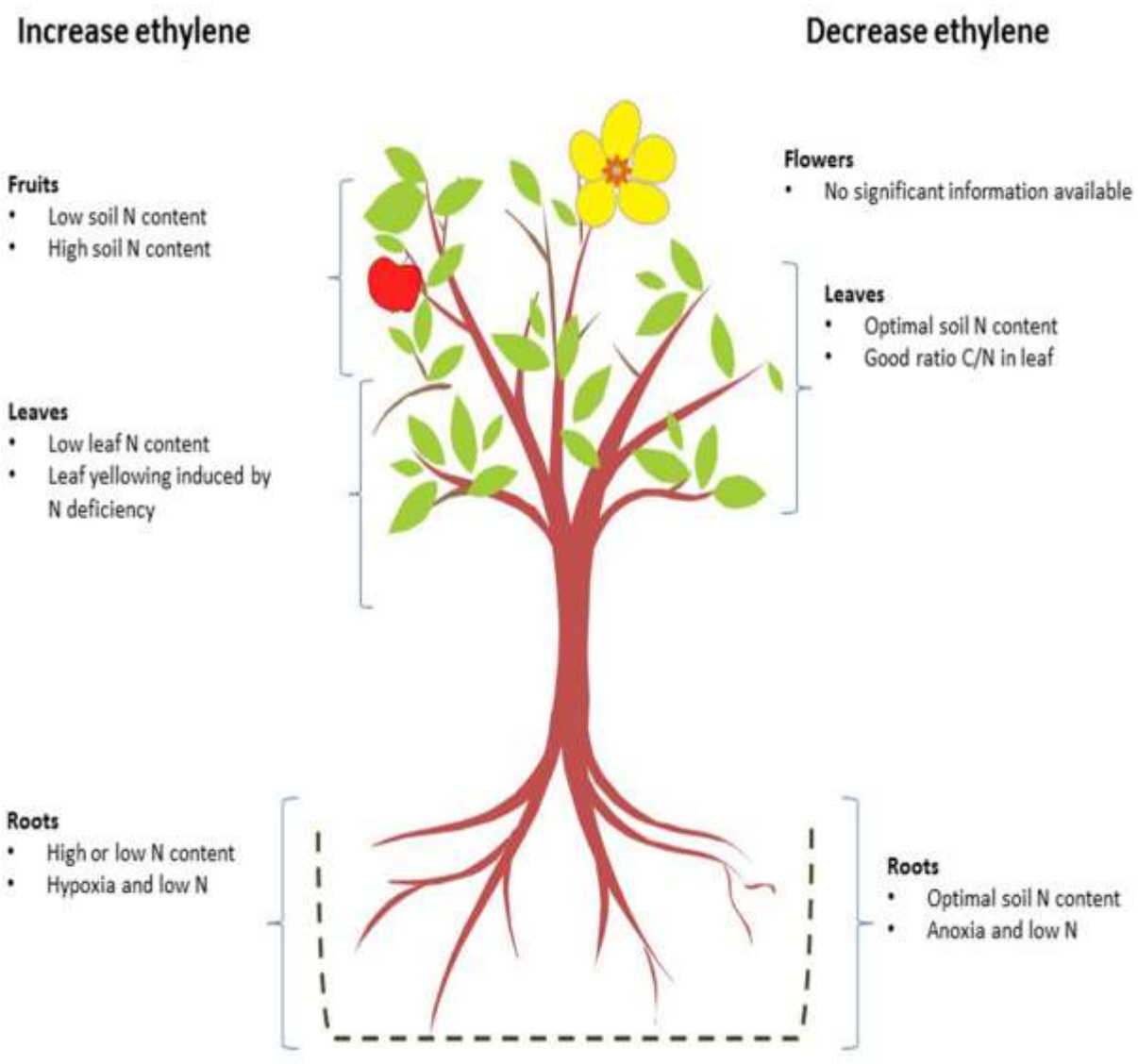
Transport

Being a gas, ethylene moves by diffusion from its site of synthesis.

Functions of Ethylene

Ethylene is known to affect the following plant processes.

1) Stimulates the release of dormancy.
2) May have a role in adventitious root formation.
3) Stimulates leaf and fruit abscission.
4) Stimulates flower opening.
5) Stimulates flower and leaf senescence.



(Khan, et al., 2015)

Practical applications of PGR's in Agriculture

Auxins

Propagation

The auxins stimulate root development in propagation through stem cuttings by inducing root initials that differentiate from cells of the young secondary phloem, cambium, and pith tissue.

Prevention of fruit drop

Foliar application of prevent fruit drop

Auxins

Herbicidal action

- 2,4-D and picloram(4-amino-3,5,6-trichloropicolinic acid) are two auxin-type herbicides
- At low concentration bring about growth responses in plants similar to IAA.
- At higher concentrations they are herbicidal.
- 2,4-D is commonly used to control broadleaf weeds in grasses.

Gibberellins

Increasing fruit size

GA is used extensively on seedless grape varieties to increase the size and quality of the fruit.

Increasing yield in sugarcane

Increase inter-nodal distance

Ethylene

Promoting fruit abscission

Ethephon may be applied approximately 10 days before anticipated harvest to reduce the fruit removal force to allow mechanical harvesting of the crop without tree injury.

Ethylene

Promoting fruit ripening

The ripening process in mature fruit can be accelerated by **ethephon** application.

In tomato, **ethephon** is used to accelerate ripening and concentrate maturity of the fruit for mechanical harvesting.

Other growth retardants

Controlling rank growth in cotton

Mepiquat chloride(1,1,dimethylpiperidinium chloride) applied at the time of flowering can reduce growth by 20~30%.

Other growth retardants

Lodging control in cereals

- Stem lodging is one of the most serious problems in wheat, when this crop is grown under the conditions of high fertility in Europe.
- The ability to use nitrogen to increase yield is limited by its adverse effect on stem growth.
- Chlormequat chloride and be used to reduce stem height and increase stem diameter.