

Plant Hormones

Plant hormones :

- Are chemical messengers;
- influence cell division, enlargement and differentiation;
- unlike for animals, are not synthesized by specific organs;
- effects (of different hormones) often overlap;
- often diminish or amplify the effects of other hormones;
- involved in all aspects of development;
- often synthesized long distances from their sites of action;
- not directly involved in the chemistry of synthesis of plant compounds (other than messenger chemicals).
- The roots synthesize most hormones although hormones are not made exclusively by the roots.

List of plant hormones (probably more will be discovered):

Auxins

Abscisic acid

Brassinosteroids

Cytokinins

Ethylene

Gibberellins

Jasmonic acid

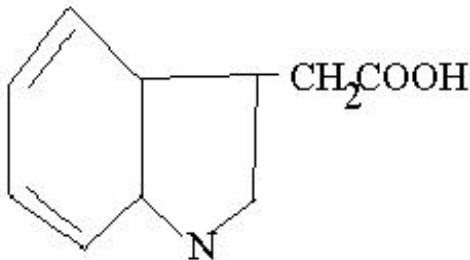
Polypeptide hormones

Salicylic acid

Also, note on polyamines

Auxins

"cause to grow"

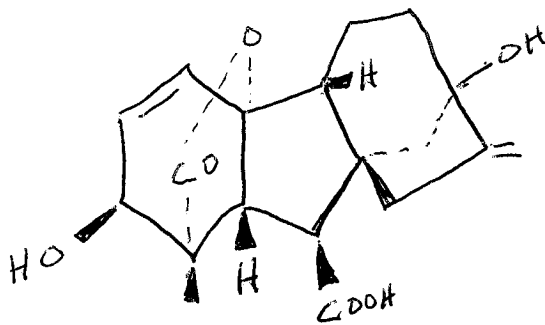


Indoleacetic acid

Auxins were the first plant hormone to be identified and were part of initial observations on plant movement by coleoptiles. These observations were that coleoptiles bent toward light. The bending toward light was eliminated when the tip of the coleoptile was removed. Later the substance allowing this bending toward light was identified as indoleacetic acid which is the plant auxin. Several auxin compounds, either synthetic or animal produced have been identified. Dichlorophenoxyacetic acid (2,4-D) and dicamba are synthetic auxins which are used as herbicides. The auxins have a pronounced polar transport direction. For instance, when a section under the tip of the coleoptile is removed and replaced in the same manner, auxin transport continues. When, however, the sections are reversed, auxin transport is interrupted.

Auxins are sensed by receptors which lead to activation of genes via transcription factors. One type of genes are quickly transcribed (within minutes) and another set of genes require a longer time period.

Gibberellins



GA₃

One active form of gibberellic acid

Strongly promote plant growth especially stem elongation.

Rice farmers in Japan noted "foolish seedling" disease. The diseased plants grow tall but do not produce seeds. Japanese scientists produced impure crystals of these materials. The fungus *Gibberella fujikuroi* secretes the chemical, a gibberellin, which caused the foolish seedling disease.

There are many gibberellins but only a few, evidently three, are active. To obtain purified quantities of Gibberellins, the scientific staff shelled truckloads of green beans. These allowed enough purified gibberellic acid to be identified and characterized. (Seeds have higher levels of gibberellins than vegetative tissue.)

Experimentally, chemical identification of gibberellic acids was a problem. Gibberellic acids do not absorb UV, do not fluoresce and have no distinguishing chemical features which help identify specific chemical assay. The development of HPLC and mass spectrometry has allowed the chemical quantification and characterization became successful.

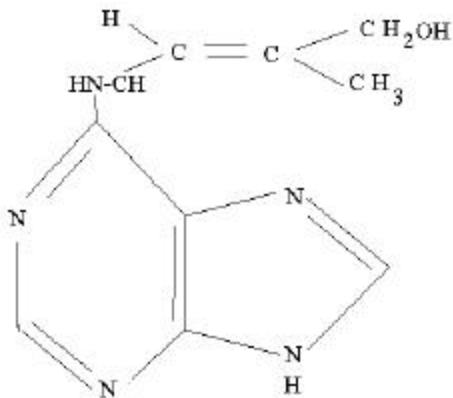
Gibberellic acid

- stimulates stem growth in dwarf and rosette plants;
- functions to stimulate stem elongation in plants such as rice;
- regulates transition from juvenile to adult plants;
- promotes seed germination (by transcription of α -amylase in the aleurone layer and the protease which leads to activation of the β -amylase in the starchy endosperm).

Commercial applications

- increased stalk length of seedless grapes
- Enhanced malting
- Increased sugarcane yield
- Plant breeding
- GA inhibitors

Cytokinins

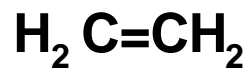


Zeatin (trans - form)

Cytokinins delay leaf senescence

Nutrient mobilization to leaves receiving cytokinins.

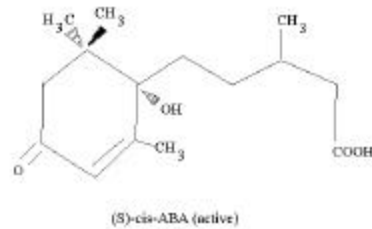
Ethylene



Ethylene is lighter than air. It burns readily.

Involved in disease resistance and susceptibility.
Involved in fruit ripening such as banana yellowing.
Involved in aerenchyma formation in rice.

Abscisic acid



Involved in seed germination responses by allowing dormancy in seeds and preventing premature sprouting of seeds.

Involved in the function of stomatal opening.

Involved in sugar sensing.

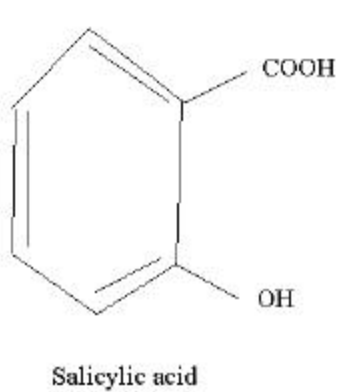
Signal to plant regarding drought..

Occurs as both free and conjugated forms.

Polypeptide hormones

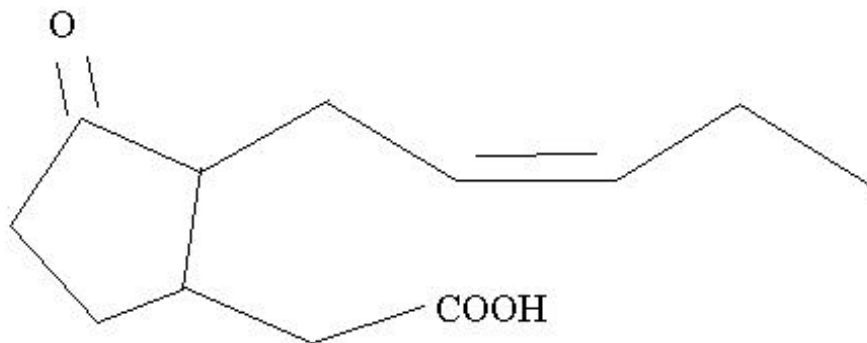
Similar in structure to proteins. The role of these hormones is relaying chemical messengers rather than direct catalytic involvement in metabolism. One example is systemin.

Salicylic acid



Salicylic acid is the active ingredient in aspirin. In plants, salicylic acid is involved in disease resistance via programmed cell death. Salicylic acid is involved in signal transfer in thermogenic (heat generating plants such as stinking flowers which induce pollination by heating up the flower and bringing in flies which pollinate.).

Jasmonic acid



A volatile signal of wounding in plants. Jasmonic acid also appears to be involved in disease resistance and susceptibility in plants.

Brassinosteroids

Plant sterols which affect plant morphological expression including gibberellic acid independent stem elongation, pollen tube growth and increased ethylene production. There are several of these compounds and only some have been identified.

Polyamines

Polyamines are a group of materials which have critical influences on plant development. Unlike hormones, polyamines are not translocated to any great extent. These materials are required for certain aspects of cell division. Also, unlike most hormones they are present in large (millimolar) concentrations.

Aerenchyma formation in rice

When the rice crop is flooded a series of events take place. The amount of oxygen in the soil is quickly depleted. Oxygen contents are very low- near zero. Ethylene concentrations in the rice plant increase in response to the flooding. The increased ethylene concentrations lead to increases in cellulase activity which break down the cellulose in cell walls in the roots. Consequently, the roots have progressively broken down intercellular spaces. These spaces serve to conduct oxygen to the roots from the shoots. The increased aerenchyma tissue leads to roots which are lighter than roots with less aerenchyma.

Deepwater rice

When rice is flooded but the tops of the plant are above the flood, stem elongation is normal. If the rice is submerged as in deepwater rice (sometimes 2 m or more [$> 6\frac{1}{2}$ ft]) ethylene concentrations increase. These increased ethylene concentrations suppress the action of abscisic acid which ordinarily suppresses the action of gibberellic acid in stem elongation. Consequently stem elongation rates are much greater than normal (approximately 25 cm/day).

Summary

Hormones provide the informational networking of plant metabolism, growth and development. We will discuss several hormone-mediated processes in plants in the coming weeks.