Exploring The Dynamics of Auxin: Biosynthesis and Function

M. Madhumitha[1*], V. Sundaram[2] and M. Karthikeyan[1]

[1]PG Scholar, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, U.T. of Puducherry, India.

[2]Faculty, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, U.T. of Puducherry, India.

[*]Corresponding Author: madhumithamurugaiyan68@gmail.com

Auxins are a group of phytohormones produced in the shoot and root apices and they migrate from the apex to the zone of elongation. Auxins promote the growth along the longitudinal axis of the plant and hence the name (auxeing: to grow). The term, auxin was introduced by Kogl and Haagen- Smit (1931). Went (1928) isolated auxin from the Avena coleoptile tips by a method called *Avena coleoptile or curvature test* and concluded that no growth can occur without auxin. Auxins are widely distributed throughout the plant however, abundant in the growing tips such as coleoptile tip, buds, root tips and leaves. Indole Acetic Acid (IAA) is the only naturally occurring auxin in plants.

The synthetic auxins include,

- **IBA**: Indole Butyric Acid
- **NAA**: Naphthalene Acetic acid
- **MENA**: Methyl ester of Naphthalene acetic acid
- **MCPA**: 2 Methyl 4 chloro phenoxy acetic acid
- **TIBA**: 2, 3, 5 Tri iodo benzoic acid
- **2, 4-D**: 2, 4 dichloro phenoxy acetic acid
- **2, 4, 5-T**: 2, 4, 5 – Trichloro phenoxy acetic acid

Natural auxins may occur in the form of either *free auxins*- which freely move or diffuse out of the plant tissues readily or *bound auxins*- which are released from plant tissues only after hydrolysis, autolysis or enzymolysis.

Biosynthesis of Auxin

Indole-3-acetic acid (IAA), the most important natural auxin in plants, is mainly synthesized from the amino acid tryptophan (Trp). The amino acid tryptophan (Trp) is a pre cursor of IAA as it has a close similarity with it and is presumably present in all cells. The progress in auxin biosynthesis also lays a foundation for understanding polar auxin transport and for dissecting auxin signaling mechanisms during plant development.

IAA Biosynthesis Pathways in Plants

(i) The Indole-3-Pyruvic Acid (IPA) Pathway

In this pathway, first of all the amino acid tryptophan donates its amino group to another α- keto acid by transamination reaction to become indole pyruvic acid. The reaction is catalyzed by enzyme indole tryptophan transaminase. Then indole pyruvic acid undergoes decarboxylation in the presence of enzyme indole pyruvate decarboxylase to become indole acetaldehyde. Finally, indole acetaldehyde oxidizes to become indole-3-acetic acid. This reaction is catalyzed by enzyme indole acetaldehyde dehydrogenase. Examples- sterile pea shoots, in cucumber seedlings, etc.

(ii) The Tryptamine (TAM) Pathway

Tryptamine occurs sporadically in higher plants. It was first isolated from *Acacia* and since been found in several other species. In this pathway Tryptophan is decarboxylated to form Tryptamine in the presence of enzyme tryptophan decarboxylase, followed by deamination to form indole acetaldehyde in the presence of enzyme tryptamine oxidase. Indole acetaldehyde is then oxidized to form Indole-3-acetic acid in the presence of enzyme indole acetaldehyde dehydrogenase.

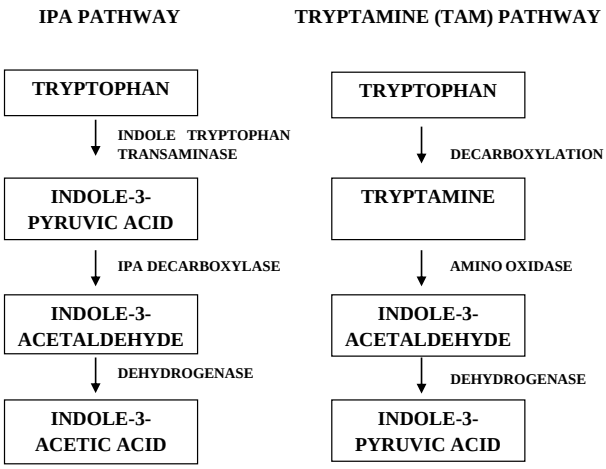
(iii) The Indoleacetaldoxime (IAN) Pathway

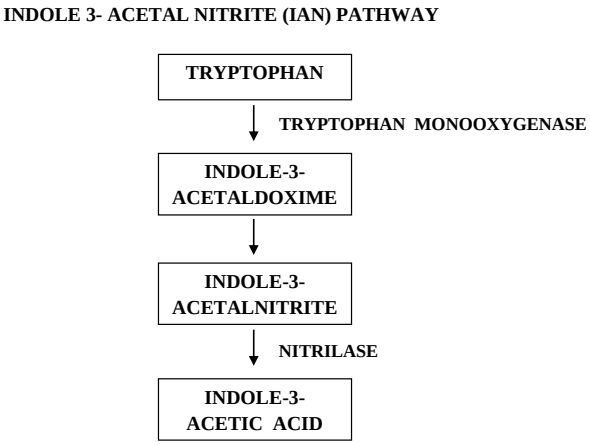
This pathway is characteristic of the family Cruciferae. In this, tryptophan is converted into Indole-3-acetaldoxime which in the presence of Indole-3-acetaldoxime hydrolase converts it into indole-3- acetonitrile (IAN). The enzyme nitrilase coverts indole-3- acetonitrile to IAA.

Mode of Action

IAA increases the plasticity of cell walls so that the cells stretch easily in response to turgor pressure. It has been suggested that IAA acts upon DNA to influence the production of mRNA. The mRNA codes for specific enzymes responsible for expansion of cell walls. Recent evidences indicate that IAA increases oxidative phosphorylation in respiration and enhanced oxygen uptake. The growth stimulation might be due to increased energy supply and it is also demonstrated that auxin induces production of ethylene in plants.

IAA Biosynthesis Pathways





Function

- ✓ Auxin responsible for **geotropism and graviotropism**
  - Geotropism – bending shoots of plant towards light
  - Graviotropism – growth of plant is response to gravity
- ✓ Influence root initiation – NAA
- ✓ Flower initiation in pineapple - NAA
- ✓ Auxin delay abscission
- ✓ Auxin helps in cell elongation
- ✓ Auxin produced in the apical buds inhibits the growth of lateral buds
- ✓ Induction of parthenocarpy
- ✓ Auxin is also used as a herbicide 2,4-D

Destruction / Inactivation of Auxin in Plants

Auxin is destructed by the enzyme IAA oxidase in the presence of O_2 by oxidation.

$$IAA + H_2O_2 + O_2 \xrightarrow{\text{IAA Oxidase}} 3\text{-methyl-oxindole} + H_2O + CO_2$$

Auxin may be temporarily inactivated in plants by its conversion into its bound form (bound auxin or conjugated auxin) in which auxin is conjugated to a variety of substances such as carbohydrates, amino acides, proteins and inositol.

Rapid inactivation may also occur by irradiation with x-rays and gamma rays. UV light also reduces auxin levels in plants. Inactivation or decomposition of IAA by light has been called as photo oxidation.

Reference

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