Course – M. Sc. Botany Part 2 Paper IX

Topic – Phytohormone: Cytokinin

Prepared by – Dr. Santwana Rani

Coordinated by – Prof. (Dr.) Shyam Nandan Prasad

Hormone

- Biochemical which regulates growth based on biological and environmental influences
- Hormones in Plants are also called Plant hormones, plant growth regulators (PGRs). Phytohormone
- Regulate growth and development
- These are mobile throughout the plant
- Environment and stress responsive

Major plant hormones

Auxin - Greek: auxin: to grow or increase

Cytokinin - cytokinesis (cell division)

Abscisic acid - abscission

Gibberellic acid - pathogen Gibberella

Ethylene - chemical brother to ethanol.

CYTOKININ

Cytokinin are a class of plant growth substances (phytohormones) that promote cell division, or cytokinesis, in plant roots and shoots. They are involved primarily in cell growth and differentiation, but also affect apical dominance, leaf senescence and auxillary bud growth.

Discovery of Cytokinins -Folke Skoog discovered in Coconut endosperm (coconut milk) in 1940

Types; There are two types of cytokinins:

1. adenine-type cytokinins; represented by kinetin, zeatin, and 6-benzylaminopurine.

2. Phenylurea-type cytokinins like diphenylurea and thidiazuron (TDZ).

Naturally occuring Cytokinins

- Cytokinins extracted from coconut milk,
- Tomato juice Flowers and fruits of pear, plum
- Cambium tissues of Eucalyptus, Nicotina
- Immature fruits of Zea Mays, Musa sp.
- Root exudates of Sunflower

Cytokinins found in plants

1. Ribosyl Zeatin,
2. Zeatin,
3. Dihydrozeatin.

Cytokinins are produced mainly in the:

1. Roots.
2. Fruits.
3. Young leaves.
4. Developing tissues.

Occurrence:

- **C**ytokinins occur in free form or in conjugated form.
- **tRNA-**cyto are formed in every living cell in the cytoplasm, chloroplast and mitochondria.

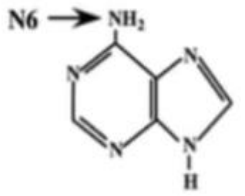
Degradation:

Cytokinins are degraded by an enzyme known as cytokinin oxidase.

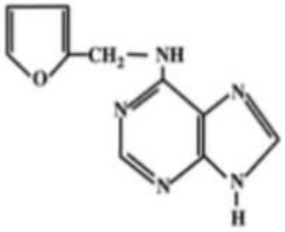
Transport

- Cytokinins move from xylem, phloem, and parenchyma cells.
- Mainly xylem from root to shoot.

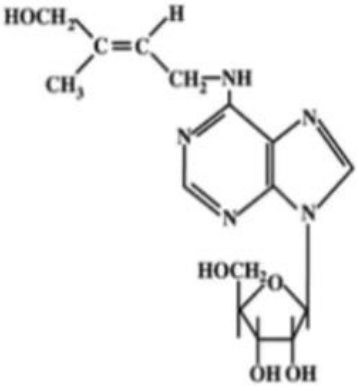
Naturally occurring cytokinins



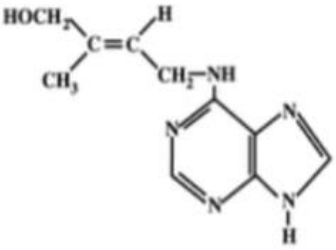
adenine



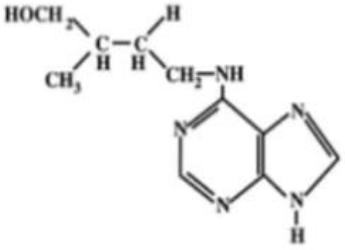
kinetin



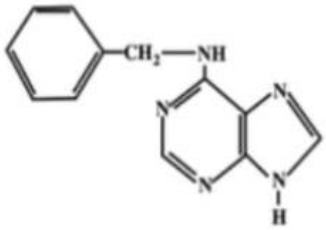
zeatin riboside



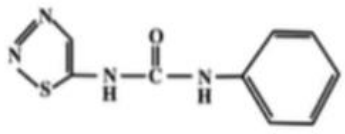
trans-zeatin



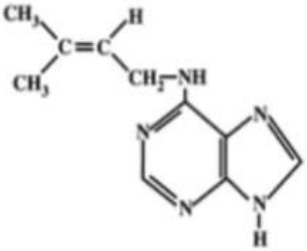
dihydrozeatin



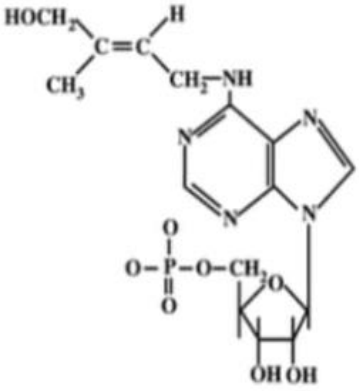
6-benzylamino purine (BA)



thidiazuron



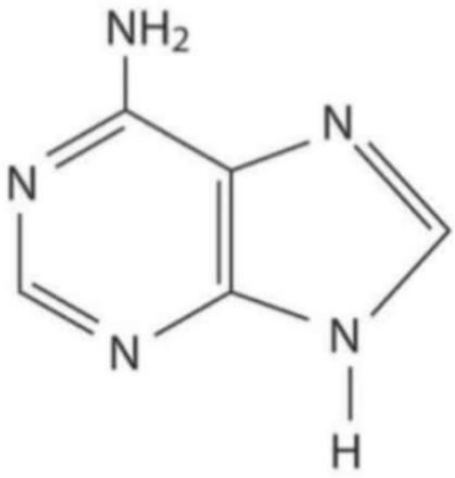
N^6–(^{2}–isopentyl) adenine
(2iP)



zeatin ribotide

Basic chemistry

- All cytokinins have basic Adenine ring structure.



(a) Adenine

Biosynthesis of cytokinin

- Adenosine phosphate-isopentenyltransferase (IPT) catalyses the first reaction in the biosynthesis of isoprene cytokinins.
- It may use ATP, ADP, or AMP as substrates and may use dimethylallyl pyrophosphate (DMAPP) or hydroxymethylbutenyl pyrophosphate (HMBPP) as prenyl donors.
- This reaction is the rate-limiting step in cytokinin biosynthesis.
- DMADP and HMBDP used in cytokinin biosynthesis are produced by the methylerythritol phosphate pathway (MEP).
- Cytokinins can also be produced by recycled tRNAs in plants and bacteria.
- TRNAS with anticodons that start with a uridine and carrying an already-prenylated adenosine adjacent to the anticodon release on degradation the adenosine as a cytokinin.
- The prenylation of these adenines is carried out by tRNA-isopentenyltransferase.
- Auxin is known to regulate the biosynthesis of cytokinin.

Cytokinin Mode of Action

- Initially the cytokinin signal binds to a receptors CHASE domain. This triggers a cascade of phosphorylation of proteins, ultimately ending in phosphorylation of a shuttle protein, AHP.
- The phosphorylated AHP protein enters the nucleus, phosphorylates type B ARR proteins, that turn on the synthesis of type A ARR proteins. When these gene products are, in turn, phosphorylated, they influence other effectors that result in cytokinin responses.
- There is also a negative feedback loop here to shut down the system when enough phosphorylated ARR is present.

Functions of cytokinins:

1. Promote cell division in target cells.

2. Promote axillary bud outgrowth.

3. Balance root/shoot growth so vigorous roots can support greater shoot system.

4. Important in seed development - find in endosperm (including coconut milk) and in cotyledons.

5. May delay senescence in leaves.

6. May play role in differentiation of vascular cambium in spring in conjunction with auxin Stimulates.

7. Morphogenesis (shoot initiation/bud formation) in tissue culture.

8. Stimulates the growth of lateral buds-release of apical dominance.

9. Stimulates leaf expansion resulting from cell enlargement.

10. May enhance stomatal opening in some species.

11. Promotes the conversion of etioplasts into chloroplasts via stimulation of chlorophyll synthesis.

12. Resistance against extreme temperature.

13.Physiological roles:

a. Cytokinins effect on translation but not transcription.

b. cytokinins are involved in the regulation of the cell cycle.