

VIVEKANANDA COLLEGE
THAKURPUKUR
KOLKATA-700063

NAAC ACCREDITED 'A' GRADE



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Name of the Teacher: Mrs. Rinku Halder Sahu
Name of the Department: Botany (Morning)

Cytokinins

They are plant growth hormones which are basic in nature, either amino purine or phenyl urea derivatives, that promote cytokinesis (= cell division) either alone or in conjunction with auxin.

DISCOVERY:

Skoog and co-workers found that callus from intermodal segments of Tobacco proliferate only when in addition to auxin, the nutrient medium is provided with extract of yeast, vascular tissues, coconut milk or DNA. They were analysed to find out the growth promoting chemicals.

The first cytokinin was discovered from degraded autoclaved Herring sperm DNA by Miller 1955.

It is called **kinetin (6-furfuryl amino-purine)**. Kinetin does not occur naturally. It is a synthetic hormone.

CHEMICAL NATURE OF CYTOKININS :

A. The first **natural cytokinin** was obtained from unripe maize grains or kernels by Letham (1964). It is known as **zeatin**. It is a

chemical compound of

6-(4-hydroxy-3-methylbut-trans-2-enylamino) purine.

- Other cytokinins identified from the same source are zeatin riboside and its 5-phosphate derivatives with one or more phosphate groups, i.e., zeatin ribotide. Both zeatin and **zeatin riboside** have been identified in the culture filtrates of mycorrhizal fungus *Rhizopogon roseolus*.
- **Dihydrozeatin** with a saturated side chain has been identified from higher plants .
- Other active cytokinins widespread in plants are N₆, N₆-dimethylallylaminopurine or **N₆ (Δ^2 - isopentenyl) adenine** (i₆ADE) and its ribosyl derivative **N₆ (Δ^2 -isopentenyl) adenosine** (i₆A). Culture filtrates of bacteria like *Corynebacterium fascians* causing fasciation disease and *Agrobacterium tumefaciens* producing crown gall have been shown to contain both i₆ADE and i₆A which have also been synthesized.
- Another cytokinin **2-methylthio-N₆ (Δ^2 -isopentenyl) adenosine** (ms₂i₆A) has been identified from yeast.

B. After kinetin, a large number of analogous compounds including those just mentioned were synthesized by replacing the N₆ side chain with a variety of groups. Very active **synthetic cytokinins** are **6-(benzyl amino) purine or benzyl adenine and diphenyl**

urea (not an amino purine derivative) which together with kinetin are largely used in laboratory experiments. Substitutions at other positions of the purine nucleus generally result in compounds with lower bioactivity.

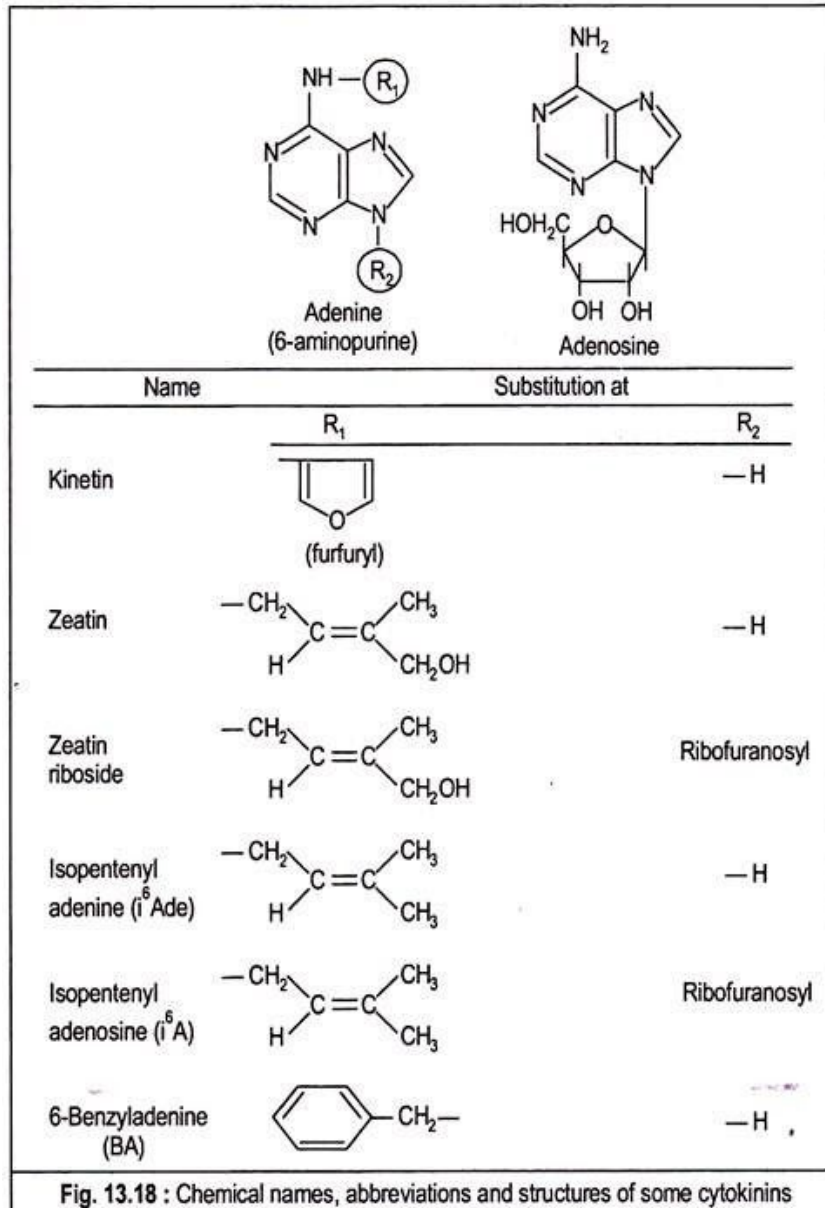


Fig. 13.18 : Chemical names, abbreviations and structures of some cytokinins

SITE OF SYNTHESIS:

Roots seem to be the major source of cytokinin synthesis. From roots the cytokinins pass upwardly through xylem.

Some cytokinin synthesis also takes place in other areas where cell divisions are occurring like the endosperm region of seeds, growing embryos and developing seeds, young fruits, developing shoots buds, etc. **Coconut milk is a rich source of cytokinin.**

Physiological Roles of Cytokinins:

Effects of cytokinins on plant growth and development:

1. Cell Division:

Cytokinins are essential for cytokinesis though chromosome doubling can occur in their absence. In the presence of auxin, cytokinins bring about division even in permanent cells. Cell division in callus (unorganised, undifferentiated irregular mass of dividing cells in tissue culture) is found to require both the hormones.

2. Cell Enlargement:

Cytokinins can bring about expansion of leaves and cotyledonary tissue by a process involving only cell enlargement. In combination

with gibberellins, cytokinins are able to modify markedly the shapes of leaves on intact plants. It has been suggested that normal leaf development could be controlled by the gibberellin/cytokinin ratio.

3. Cytokinins and Light:

They can also substitute for, or interact with, light in the control of a number of physiological and metabolic processes, such as seed germination, pigment synthesis and chloroplast development, in plants. Presence of both light and cytokinin is necessary for grana development and conversion of proplastids into chloroplast.

4. Morphogenesis:

Cytokinins not only promote cell division but also morphogenesis (i.e., differentiation of different tissues and organs). Cytokinins controlling the relative production of shoots and roots in tissue culture preparations suggests that they may perform a similar function in the intact plant. They also bring about lignification and differentiation of interfascicular cambium.

1. High cytokinins/auxin ratio- Differentiation of shoot.
2. Low cytokinins/auxin ratio – Differentiation of root.

3. Intermediate Cytokinins/auxin ratio- Differentiation of both root and shoot.

5. Stomatal movement:

The treatment of the whole leaf with cytokinin has been reported to increase the chance of opening of stomatal aperture and thereby increasing transpiration.

6. Delay of senescence:

Cytokinins have a striking quality to retard senescence (i.e., process of ageing) in plants. External application of cytokinins delay the rate of chlorophyll disappearance and protein degradation which usually accompanies the process of senescence in leaves.

Localized application of cytokinins to yellowing leaves produces green areas in which the rate of senescence is markedly reduced. This is called **Richmond-Land effect**. Because of their senescence retarding quality, cytokinins are used commercially in the storage of green vegetables. So, cytokinin is also called the '**juvenile hormone**' of plants.

7. Apical Dominance:

Presence of cytokinin in an area causes preferential movement of nutrients towards it. When applied to lateral buds, they help in their growth despite the presence of apical buds. They thus act antagonistically to auxin which promotes apical dominance.

8. Release of dormancy of seeds and buds:

Application of cytokinin can stimulate germination and breakdown of dormancy. When dormancy is imposed either by high temperature (thermodormancy) or by accumulation of inhibitors like ABA, then gibberellin alone is not capable of overcoming dormancy. Addition of cytokinin opposes the action of the inhibitors and permits germination. So, cytokinin is called a **permissive agent** in germination by antagonising the action of inhibitors, a case of cytokinin- inhibitor antagonism.

9. Resistance to high and low temperatures: Cytokinins provide resistance to plants against very high and very low temperatures, thus preventing temperature injuries.

10. Phloem Transport: They help in phloem transport. Cytokinin retards senescence by mobilizing nutrients through phloem from other parts to the corresponding parts of the plant body.

11. Accumulation of Salts:

Cytokinins induce accumulation of salts inside the cells.

12. Flowering:

Cytokinins can replace photoperiodic requirements of flowering in certain cases.

13. Sex Expression:

Like auxins and ethylene, cytokinins promote femaleness in flowers.

14. Parthenocarpy:

Crane (1965) has reported induction of parthenocarpy through cytokinin treatment.

Uses of Cytokinins:

1. Tissue Culture:

Cytokinins are essential for tissue culture because besides cell division they are also involved in morphogenesis. Instead of direct addition of cytokinins, the latter may be provided to tissue culture through the addition of coconut milk or yeast extract.

2. Shelf Life: Application of cytokinins to marketed vegetables can keep them fresh for several days. Shelf life of cut shoots and flowers is prolonged by employing the hormones.

3. Resistance:

Cytokinin application is helpful to plants in developing resistance to pathogens and extremes of temperature.

4. Overcoming Senescence:

Cytokinins delay senescence of intact plant parts.