

PLANT GROWTH REGULATORS

CYTOKININS

Skoog and his coworkers discovered cytokinins when they were trying to identify a compound to initiate and sustain the proliferation of cultured tobacco pith tissue. Crystals of a cell division inducing substance was later isolated for the first time by **Miller**, from an autoclaved herring sperm DNA in 1951 and named it as **Kinetin**. The liquid endosperm of coconut (coconut milk) is also found to be rich in cell division causing factors. **Letham** (1963) extracted, purified and crystallized cytokinin from immature kernels of maize and named it as **zeatin**.

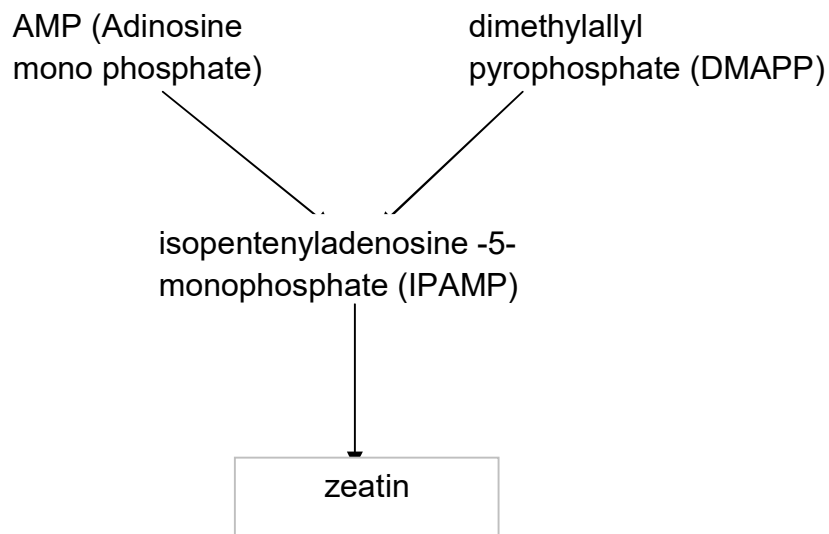
26.1 OCCURRENCE:

Naturally occurring cytokinins are N⁶- substituted adenine derivatives. Usually **Zeatin** is the most abundant naturally occurring free cytokinin. There are also synthetic cytokinin compounds that have not been identified in plants, most notably of which are the **diphenyl urea type cytokinins**, such as **thidiazuron**, which is used commercially as a defoliant and an herbicide.

Cytokinins, occur freely and also as a component of RNA of plants, microorganisms and animals. In higher plants root tips, shoot tips, developing fruits, xylem sap and germinating seeds are rich sources of cytokinins. Root tips synthesize cytokinins and transport them through the xylem to all parts of the plants. This might explain their accumulation in young leaves, fruits and seeds in to which xylem transport occurs.

26.2 BIOSYNTHESIS:

The biosynthetic pathway of free cytokines is not completely understood. There are two methods in which they may be produced. The first is the direct pathway, involving formation of Isopentenyladenosine-5-monophosphate (IPAMP) from AMP and dimethylallyl pyrophosphate (DMAPP), to form zeatin-type compounds.



Another possibility is that they may be released by the **hydrolysis of tRNA**, first to mono nucleotides and then to free cytokinins. In spite of extensive effort having been focused on these pathways information is still highly fragmented.

TRANSPORT:

When cytokinin is applied to leaves and stems, the hormone does not move and the effect is localized. Cytokinin is carried passively along the transpiration stream in xylem from root. It moves in phloem in a basipetal polar direction in very small quantities.

26.3 MODE OF ACTION:

Cytokinin is a structural component of transfer RNA molecule. They may help in binding of mRNA with tRNA - amino acid complex during protein synthesis. Cytokinins increase the synthesis of nucleic acid by increasing the enzyme t RNA synthetase and decrease the degradation by reducing the activity of ribonuclease. Cytokinin increases the incorporation of phosphorous in to nucleic acids and adenine into RNA.

26.4 PHYSIOLOGICAL ROLE:

➤ **Cell division**

Cytokinins are known to be regulators of cell division in mature cells. The most important effect of cytokinins is stimulation of cell division in excised tissues. The number of cell divisions increases proportionally to the concentration of added cytokinin when auxin is not limiting. Cytokinins alone does not promote cell division. When both auxin and cytokinins are added together, cells divide rapidly and the callus tissue grows.

➤ Morphogenesis

Root and bud differentiation

Cytokinins in interaction with auxins control morphogenesis. The cells of tobacco pith do not either grow or differentiate when only auxin or only cytokinin is added to the medium. However when the medium contains both auxin and kinetin in the ratio of 10:1 pith cells grow and forms a mass of unorganized cells (callus).

If the ratio of auxin to cytokinin is more in the medium, a number of roots are initiated from the callus. If the ratio is less (which means more cytokinins than Auxins) a number of shoot buds are initiated.

➤ Anti Senescence hormone (Richmond - Lang effect)

Cytokinins delay senescence. Generally, protein and chlorophyll content of the leaf decreases with the increase in age. Thus, when leaf becomes old, it turns in to yellow, become senescent and finally shed of. Senescence of leaves can be delayed by application of kinetin. Cytokinins delay senescence by increased synthesis of proteins.

The delay of senescence of leaves and other organs of the plants by cytokinins is called as **Richmond - Lang effect**.

In an experiment, one of the two primarily opposite leaves of a bean plant was treated with Benzyl adenine. This treatment accelerated senescence of untreated leaf. This is because of mobilization of organic metabolites and minerals from untreated leaf to cytokinin treated leaf because of cytokinin acts as mobilizing centers.

Retardation of senescence of vegetables can be achieved by cytokinins. Green vegetables like cabbage, lettuce and celery deteriorate rapidly after harvest. Post harvest spray of Benzyl adenine at 10 to 40 ppm or post harvest dip of 10 ppm increase shelf life of these vegetables.

➤ Promotion of lateral bud growth

Application of cytokinins reduces apical dominance. The action of cytokinin is antagonistic to that of auxin in apical dominance. The lateral buds of intact plants which otherwise remain arrested; can be made to grow by applying kinetin. It may be due to the differentiation of vascular tissue in the presence of cytokinins.

The pathogen *Corynebacterium facians* causes a disease called **Witches broom** in many plants. This symptom is characterized by loss of apical dominance and emergence of numerous lateral branches which give the appearance of a

broom. This effect is due to the secretion of cytokinin namely isopentenyl adenine by the pathogen.

➤ **Breaking of dormancy**

Cytokinins can replace the red light (660 nm) requirement in seed germination of lettuce and tobacco. Lettuce seeds require the presence of red light for germination in addition to moisture, air and suitable temperature. However the seeds can be made to germinate in the dark by applying Kinetin. Thus, Kinetin replaces the red light requirement for germination.

In cocklebur, each fruit (but) contains two seeds which are of unequal in size. The lower one is largest and germinates while the upper seed is dormant. Here the dormancy is due to the presence of germination inhibitors. This dormancy is overcome by the application of kinetin.

➤ **Cell enlargement**

Cortical cells of tobacco root were observed to enlarge four times of their normal size in the presence of kinetin.
