GROWTH HORMONES: AUXIN

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For B.Sc. Part II (Sub.) Group C (Plant Physiology)

Lecture No. 41

Plant harmones ????

Plant hormones are regulators produced by plant in low concentration regulate the Physiological processes of the plant.

✓ Hormones moves usually within plant that form a site of production to site of action.

✓ Thimann (1948) suggested using the term "Phytohormone" for hormones of plant.

Classification of plant harmones:

There are two major classes of plant hormones :

1.Growth Pramotors : Auxins , Cytokinins and Gibberellins

2.Growth Inhibitors : Ethylene

Abscisic Acid (ABA)

✓ The first plant hormone we will consider is auxin.

✓Auxin deserves pride of place in any discussion of plant hormones because it was the first growth hormone to be discovered in plants, and much of the early physiological work on the mechanism of plant cell expansion was carried out in relation to auxin action.

✓ During the latter part of the nineteenth century, Charles Darwin and his son Francis studied plant growth phenomena involving tropisms. One of their interests was the bending of plants toward light.

✓This phenomenon, which is caused by differential growth, is called **phototropism.**

✓In some experiments the Darwins used seedlings of canary grass (*Phalaris canariensis),* in which, as in many other grasses, the youngest leaves are sheathed in a protective organ called the **coleoptile**

✓Coleoptiles are very sensitive to light, especially to blue light

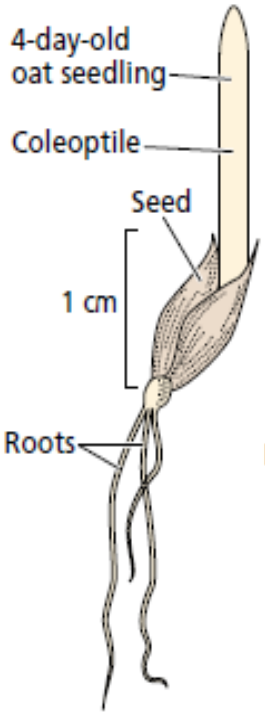
✓If illuminated on one side with a short pulse of dim blue light, they will bend (grow) toward the source of the light pulse within an hour.

✓The Darwins found that the tip of the coleoptile perceived the light, for if they covered the tip with foil, the coleoptile would not bend.

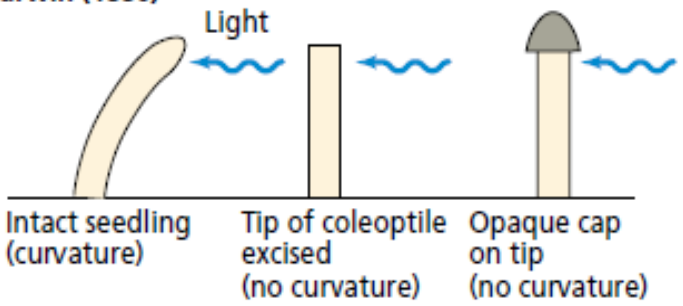
✓But the region of the coleoptile that is responsible for the bending toward the light, called the **growth zone, is** several millimeters below the tip.

✓Thus they concluded that some sort of signal is produced in the tip, travels to the growth zone, and causes the shaded side to grow faster than the illuminated side.

✓The results of their experiments were published in 1881 in a remarkable book entitled **The Power of Movement in Plants.**

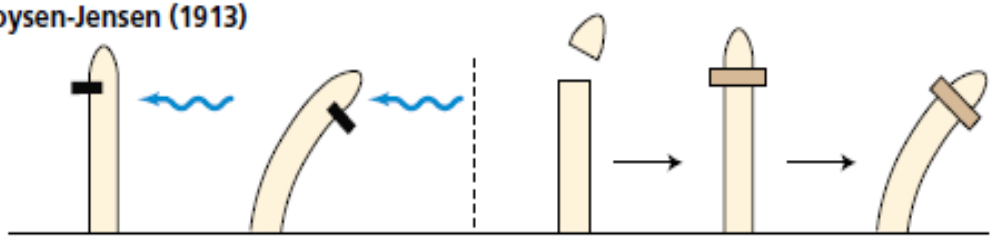


Darwin (1880)



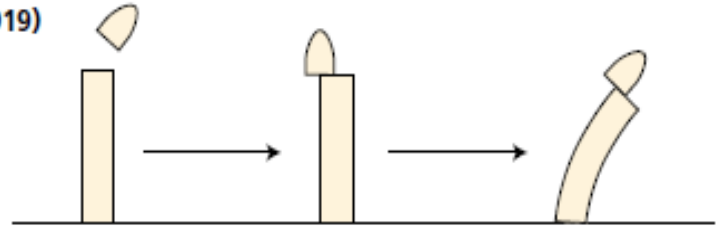
From experiments on coleoptile phototropism, Darwin concluded in 1880 that a growth stimulus is produced in the coleoptile tip and is transmitted to the growth zone.

Boysen-Jensen (1913)

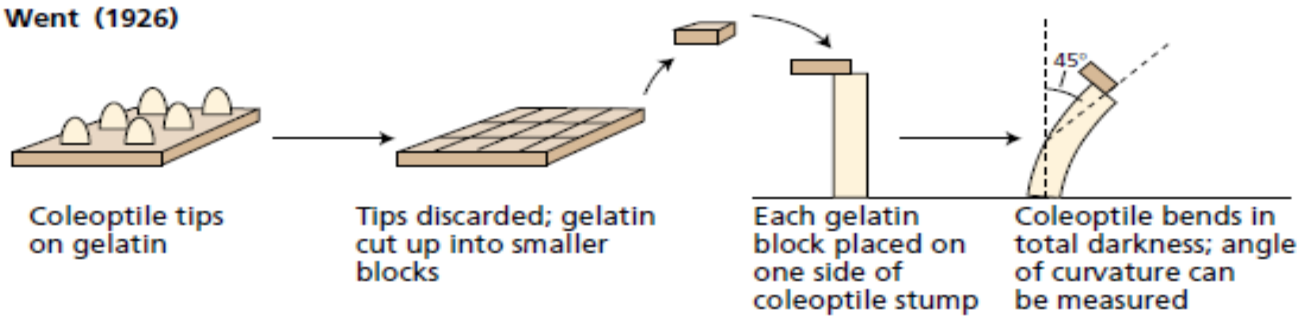


In 1913, P. Boysen-Jensen discovered that the growth stimulus passes through gelatin but not through water-impermeable barriers such as mica.

Paál (1919)



In 1919, A. Paál provided evidence that the growth-promoting stimulus produced in the tip was chemical in nature.



In 1926, F. W. Went showed that the active growth-promoting substance can diffuse into a gelatin block. He also devised a coleoptile-bending assay for quantitative auxin analysis.

Synthesis and transport of auxin

✓Auxins are not synthesized in all cells,

✓The **shoot apical meristerm is primary source of auxin in plant.**

✓Auxin will transported through the vascular parenchyma tissue most likely

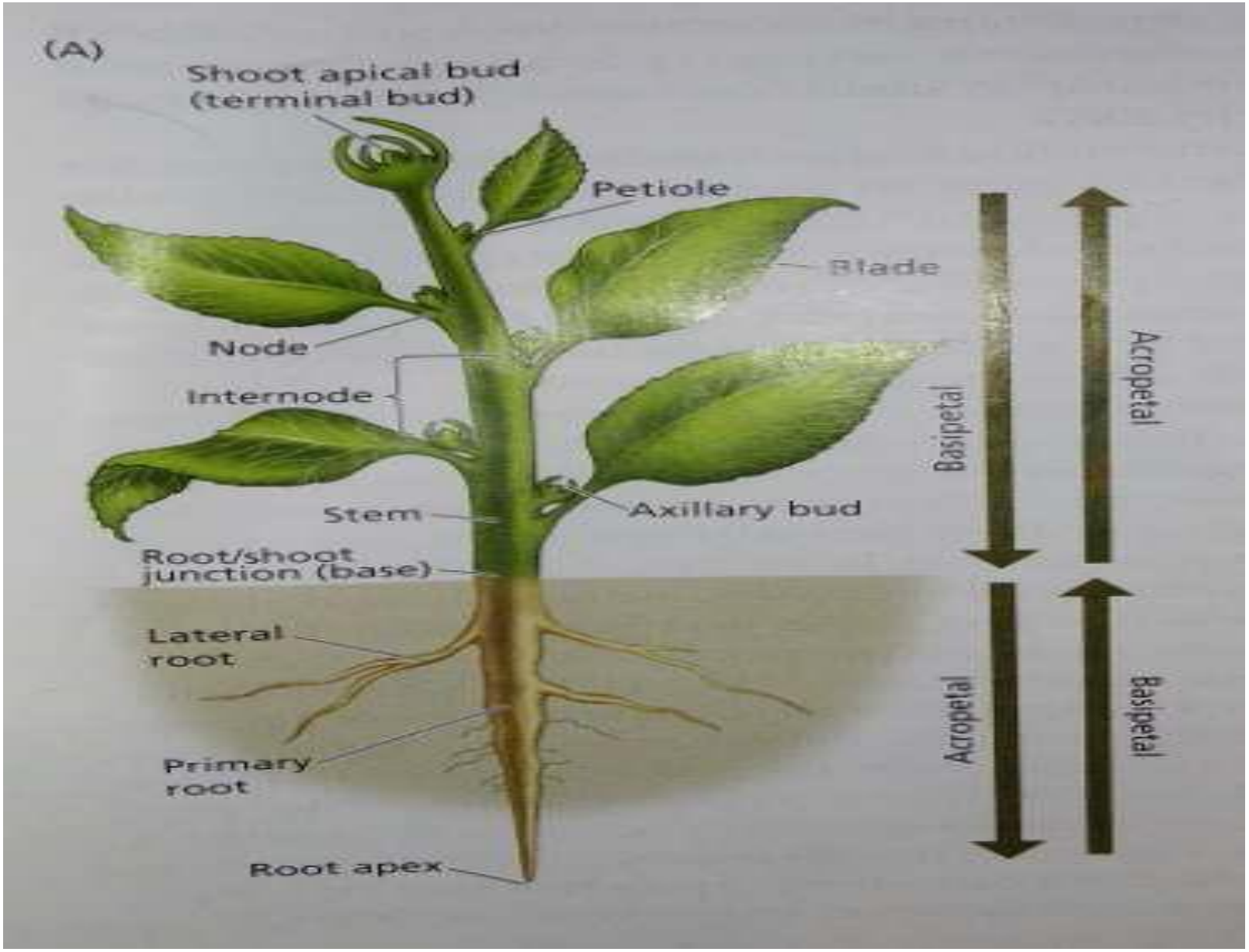
xylema and phloem.

✓Auxin synthesized via **tryptophan-dependent pathways.**

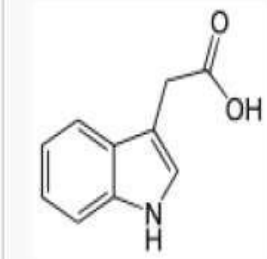
✓Went discovered that IAA moves mainly from the apical to basal end **(**basipetally)[coleoptile curvature test]

✓This type of unidirectional transport is termed polar transport

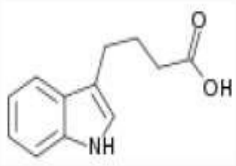
Basipetal and acropetal transport



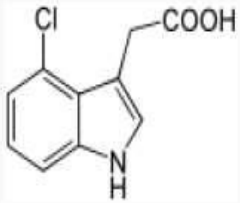
Native auxins:



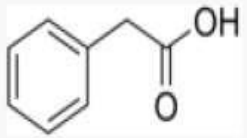
indole-3-acetic acid (IAA)



Indole-3-butyric acid (IBA)



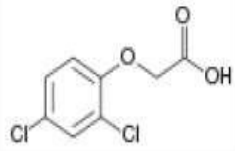
4-chloroindole-3-acetic acid (4-Cl-IAA)



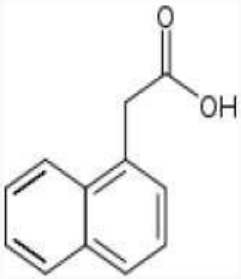
2-phenylacetic acid (PAA)

Gallery of synthetic auxins

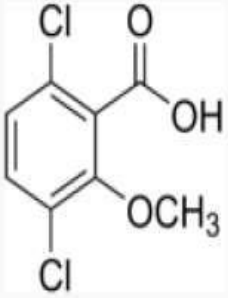
Synthetic auxins:



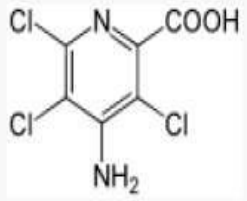
2,4-Dichlorophenoxyacetic acid (2,4-D)



α-Naphthalene acetic acid (α-NAA)



2-Methoxy-3,6-dichlorobenzoic acid (dicamba)



4-Amino-3,5,6-trichloropicolinic acid (tordon or picloram)

Auxins have an aromatic ring and a carboxylic acid group

Biosynthesis of Auxin

There are two pathways in Biosynthesis of Auxin

1.Tryptophan dependent pathway

2.Tryptophan Independent pathway

Physiological Effects Of Auxin

1.Cell Elongation

2.Apical Dominance

3.Root Initiation

4.Prevention of Abscission

5.Parthenocarpy

7.Callus Formation

8.Vascular Differentiation

1.Cell Elongation

The primary physiological effect of auxin in plants is to stimulate the elongation of cells in shoot.

✓A very common example of this can be observed in phototropic curvatures where the unilateral light unequally distributes the auxin in the stem tip (i.e., more auxin on shaded side that on illuminated side).

✓ Many theories have been proposed to explain the mechanism of cell elongation probably :

✓By reducing the wall pressure,

✓By increasing the permeability of cells to water,

✓By an increase in the wall synthesis and, by inducing the synthesis of RNA and Protein which turn lead to an increase in cell wall plasticity and extension.

2.Apical Dominance

In most higher plants, the growing apical bud inhibits the growth of lateral (axillary) buds—a phenomenon called **apical dominance. Removal of the shoot apex (decapitation)** usually results in the growth of one or more of the lateral buds. Not long after the discovery of auxin, it was found that IAA could substitute for the apical bud in maintaining the inhibition of lateral buds of bean (*Phaseolus vulgaris)* plants.

✓Apical dominance is due to much higher auxin content in the apical buds than lateral buds.

✓Skoog and Thimann(1934) first pointed out that the apical dominance might be under the control of auxin produced at the terminal bud and which is transported downward through the stem to the lateral buds and hinders their growth.

✓They removed the apical bud of broad bean plant and replaced it with agar block.

✓This resulted in rapid growth of lateral buds.

✓ But ,when they replaced the apical bud with agar block containing auxin lateral buds remained suppressed and did not grow.

3.Root Initiation

✓Auxin promotes the formation of lateral and adventitious roots.

✓ In contrast to the stem, the higher concentration inhibits the elongation of root but the number of lateral branch roots is considerably increased i.e. the higher conc. of auxin initiates more lateral branch roots.

✓Application of IAA in lanolin paste to the cut end of a young stem results is an early and extensive rooting.

✓This fact is of great practical importance and has been widely utilised to promote root formation in economically useful plants which are propagated by cuttings.

4. Auxin delays the onset of leaf abscission

The shedding of leaves, flowers, and fruits from the living plant is known as **abscission.** These parts abscise in a region called the **abscission zone,** which is located near the base of the petiole of leaves. In most plants, leaf abscission is preceded by the differentiation of a distinct layer of cells, the **abscission layer, within the abscission zone.**

✓During leaf senescence, the walls of the cells in the abscission layer are digested, which causes them to become soft and weak.

✓The leaf eventually breaks off at the abscission layer as a result of stress on the weakened cell walls.

✓Auxin levels are high in young leaves, progressively decrease in maturing leaves, and are relatively low in senescing leaves when the abscission process begins.

✓The role of auxin in leaf abscission can be readily demonstrated by excision of the blade from a mature leaf, leaving the petiole intact on the stem.

✓ Whereas removal of the leaf blade accelerates the formation of the abscission layer in the petiole, application of IAA in lanolin paste to the cut surface of the petiole prevents the formation of the abscission layer.

(Lanolin paste alone does not prevent abscission.)

These results suggest the following:

✓ Auxin transported from the blade normally prevents abscission.

✓ Abscission is triggered during leaf senescence, when auxin is no longer being produced.

5.Parthenocarpy

✓Auxin can induce the formation of parthenocarpic fruits.

✓ In nature also,this phenomenon is not uncommon and in such cases the concentration of auxins in the ovaries has been found to be higher than in the ovaries of plants which produce fruits only after fertilization.

✓In the latter cases, the concentration of the auxin in ovaries increases after pollination and fertilization.

6.Callus Formation

✓Besides cell elongation the auxin may also be active in cell division.

✓ In fact,in many tissue cultures where the callus growth is quite normal, the continued growth of such callus takes place only after the addition of auxin.

Auxin Induces Vascular Differentiation

✓Auxin induces vascular differentiation in plant.

✓This has also been confirmed in tissue cultureexperiments and form studies with transgenic plants.

✓Cytokinins are also known to participate in differentiation of vascular tissues and it is belived that vascular differentiation in plants is probably under the control of both auxin and cytokinins.

References:

Plant Physiology**,** by Lincoln Taiz and Eduardo Zeiger

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Thank You!!!