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COORDINATION IN PLANTS AND ANIMALS

Common terms.

(I) Irritability: Ability of an organism to detect, interpret and respond to stimulus in the environment.

(II) Stimulus (Plural stimuli): Any change in the internal or external environment of an organism that is strong enough to evoke a physiological or behavioral response in an organism's body or its parts.

Stimulus can be categorized as,

-Chemical stimulus e.g. smell, taste.

-**Physical/mechanical stimulus** e.g. light, pressure, gravity, touch, heat.

-External stimulus i.e. Any change in the **external environment** of an organism that is strong enough to evoke a physiological or behavioral response in an organism's body or its parts e.g. sound, light, temperature, touch, smell etc.

-Internal stimulus i.e. Any change in all conditions in fluids surrounding the living cells of an organism that is strong enough to evoke a physiological or behavioral response in an organism's body or its parts.

e.g. internal body temperature, salt concentration, carbon dioxide concentration and blood sugar levels.

Living organisms are influenced by these changes and as a result, adjustments in homeostatic mechanisms occur so as organisms (i) are not adversely affected. (ii) take advantage of the opportunities arising from these changes.

(III)Receptors : Are small group of cells specialized to detect a particular stimulus; and initiate the transmission of impulses to other specialized cells via neurons.

These specialized cells sometimes combine with other types of cells form a **sense organ** e.g. eye or the ear.

Most receptors are located near the surface of the body where they are in best position to detect changes in the immediate external environment e.g. thermoreceptors in the skin, photoreceptors in the eye, sound receptors in the ear; with a few lying deep inside the body to detect changes occurring within the body itself e.g. chemoreceptors which monitor carbon dioxide concentrations in the blood stream.

Different types of stimuli and the corresponding receptor organs.

Stimulus (stimuli)	**Receptor organ**(s)
Sound and gravity	Ear
Chemical	Nose and tongue in mammals, skin of desert toads, tongue of snakes.
Temperature, pressure, & touch	Skin
Light	Eye

(IV) Effectors; Are cells or organs or body structures that produce a physiological response when stimulated. e.g. muscles and glands most commonly.

Other effectors include; light producing organs of deep sea fishes, cilia and flagella, stinging cells(nematoblasts) of coelenterates, chromatophores (specialized pigment cells) found in skin of fishes, amphibians, reptiles, octopuses and squids, and electric organs in certain fishes.

Most receptors are controlled by the nervous system and respond on receiving impulses via efferent nerves; with others having no nerves going to them, thus respond to direct stimulation.

(V) Response: Is a behavioral, muscular or physiological activity of part or whole of an organism body initiated by a stimulus.

The response made to a stimulus may usually involve movement of the whole organism as in animals or only part of the organism e.g. in plants.

Can either be towards the direction of stimulus (***Positive response***) or away from the direction of stimulus (**negative stimulus**).

(A) Reception and response in plants

Plant responses include; (i) Nastic response (ii)Tropic response (tropism)

(a).**Nastic response;**

Involves movement of part of a plant in response to some diffused non - directional stimulus. i.e. response does not depend on the direction from which stimulus is coming.

Examples of such stimuli include; changes in temperature, humidity or level of illumination (light intensity) and touch.

These movements are random, rapid and reversible; caused by changes in turgor pressure or differential growth.

Examples of nastic movements include.

(i) Folding and dropping of leaves of the sensitive plant(*Mimosa pudica)* on slight touch(thigmonasty) or due to changes in turgor pressure of the pulvini cells at the base of leaflets, and petioles.

(ii) Closing of leaves in insectivorous plants such as venus fly trap, on landing of insects between its lobes (thigmonasty)).

(iii) Closing up of flower petals (e.g. portulaca and Jonny Walker) at night in response to decreasing temperature and/or light intensity. (sleep movement).

(iv) Opening of crocus and tulip flowers in the light in response to increasing temperature and/or light intensity.

NB Opening and closure of flowers involves differential growth in one part of plant e.g. the petals, resulting in a localized bending movement i.e.

(i) flowers open when inner surfaces of the petals grow more than the outer surfaces, causing it to bend outwards.

(ii)flowers close when outer surfaces of the petals grow more than the inner surfaces, causing it to bend inwards

Importance of nastic response to organisms.

- Folding of leaves when light intensity decreases and spreading with increase in light intensity; allows maximum absorption of light for photosynthesis; more carbohydrate is made and faster; thus faster growth of plant.
- Closing of leaves in insectivorous plants such as venus fly trap, on landing of insects between its lobes; allows for trapping and digestion of insects(prey); to supplement on their nitrogen needs.
- Closing up of flower petals (e.g. portulaca and Jonny Walker) at night in response to decreasing temperature and/or light intensity; allows for protection of inner parts from moisture.
-Opening of flowers e.g. evening primrose and moonflower allows for pollination by night-flying insects.
- Folding and dropping of leaves of *Mimosa pudica* on slight touch; reduces surface area exposed to potential predators.

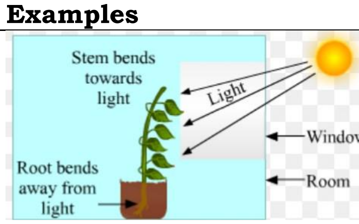
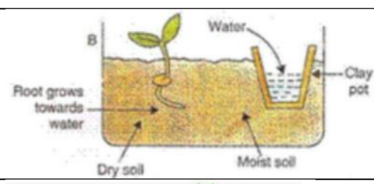
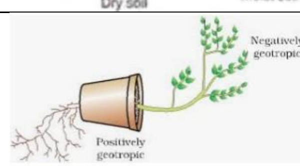
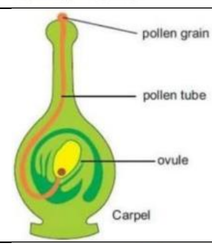
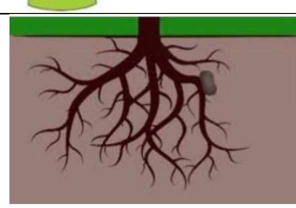
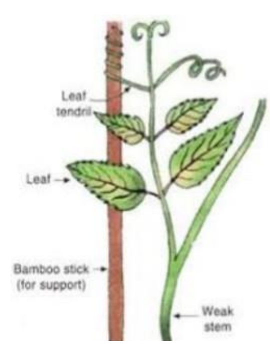
(**b**) **Tropic response**

Growth movement of parts of a plant in response to unidirectional stimuli or stimuli coming from a single direction. Most tropic movements are slow, and are usually caused by a plant growth substance, **auxins (Indoleacetic Acid)**; which bring about unequal growth of the part stimulated.

Growth of plant parts can be away from the stimulus (***negative tropism***) or towards the stimulus (***positive tropism***).

Types of tropic responses.

Classified according to the type of external stimulus involved i.e.

Stimulus	Type of tropic response	Examples
Light	Phototropism; growth movement of part of plant in response to a unidirectional light.	 -Plant shoots grow towards the direction of light (positively phototropic) -Plant roots grow away from the direction of light. (negatively phototropic)
Water	Hydrotropism ; growth movement of part of a plant in response to a unidirectional source of water.	 Plant roots grow towards a water source (positivity hydrotropic)
Gravity	Geotropism/gravitropism ; growth movement of part of a plant in response to gravity.	 -Plant roots grow downwards towards the gravitational pull (positively geotropic). -Plant shoots grow away from gravitational pull(negatively geotropic)
Chemical	Chemotropism; growth movement of part of a plant in response to a unidirectional source of chemical.	 -Pollen tubes grow towards the ovules, (positively chemotropic). -Plant roots grow useful minerals (positively chemotropic) with others growing away from harmful acids(negatively chemotropic)
Touch	Thigmotropism/Haptotropism; growth movement part of plant in response to unidirectional touch.	 (i)Root tips grow away from stones and other obstacles.(negatively haptotropic  (ii) Tendrils of young passion fruits, and pumpkins twine around support (positively haptotropic).

IMPORTANCE OF TROPISM TO PLANTS

-Positive phototropism of shoots allows plants leaves absorb sunlight for photosynthesis

-Positive phototropism allows shoots to be spread out holding flowers and fruits in best positions, enhancing pollination and dispersal respectively.

-Positive geotropism of roots allows plants to absorb water and mineral salts and provides firm anchorage to the plant in the soil, preventing physical destruction by wind.

-Negative geotropism of plant shoots, allows for upward growth, leaves are therefore in best positions to absorb sun light for photosynthesis and expose flowers to agents of pollination

-Positive hydrotropism of roots, allows plants to absorb water and mineral salts for photosynthesis.

-Thigmotropism enables plants with weak stems to obtain support.

-Positive chemotropism allows for growth of pollen tube, enhancing the process of fertilization in flowering plants.

Guiding question.

1(a) **What is tropism?**

(b**) With suitable examples, state the importance of the different types of tropisms in plants.**

<u>Experiment to show phototropism in plant shoots/ effect of unidirectional light on growth of plant shoots</u>.

Aim of experiment. To show phototropism in plant shoots/effect of unidirectional light on growth of plant shots.

Requirements. Two potted bean seedlings, 2 opaque boxes each with a window on one side, one clinostat, water.

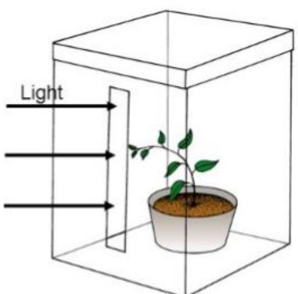
Procedure

-Two potted bean seedlings are watered.

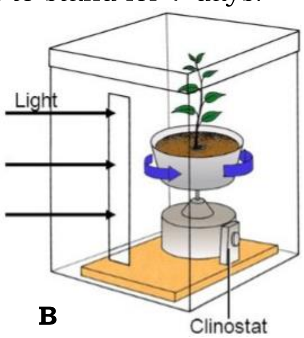
-One is placed in a box with a window on one side to allow light to reach the shoot from one direction only.

-The other seeding is placed in another box with the same conditions but on a clinostat rotating slowly so that all the sides of the shoot are equally exposed light (**control experiment**)

-The two experiments are left to stand for 7 days.



A



B

Observations

shoot of the bean seeding in box A grew bending towards light while the other seedling in B continued to grow upright.

Conclusion

shoots grow towards the direction of light and are positively phototropic.

Guiding question.

Describe an experiment to demonstrate phototropism in plant shoots.

<u>Experiment to show geotropism in plant shoots</u>

Aim of experiment; To show geotropism in plant shoots.

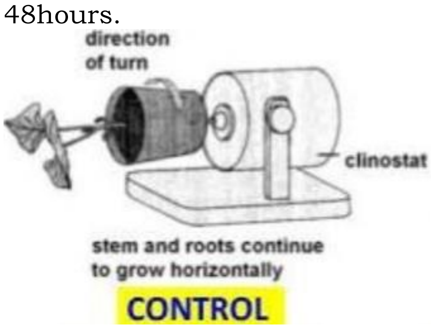
Requirements. 2 potted seedlings which have grown straight, clinostat, water, plasticine, cardboard.

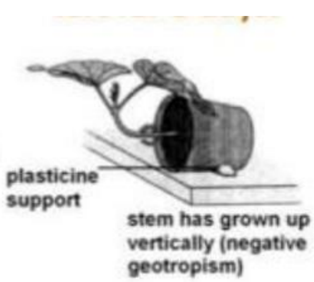
Procedure

-A shoot of potted seedling is laid horizontally in a jar fixed in position by pasticine.

-Second potted seedling is placed in a slowly rotating clinostat, so as to expose all the sides equally to the pull of gravity.

-Both experiments are covered with card board to cut off the effect of light, and experiment left to stand for 48hours.





Observation;

Shoot of stationary seedling changes direction, growing upwards, while the one in the clinostat continues growing horizontally

Conclusion.

Shoots grow away from direction of gravity, therefore negatively geotropic.

NOTE.

In the slowly rotating clinostat, plant shoot experiences gravity equally in on all sides; therefore, no specific direction of gravity, shoot continues to grow horizontally.

Shoot of seedling laid horizontally experiences a specific source of gravity, causing un even distribution of auxins in plant shoot with much concentration on lower side; therefore, grows faster and bends upwards.

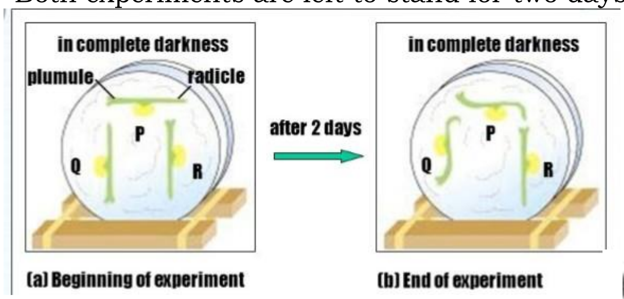
Experiment to show geotropism in plant roots

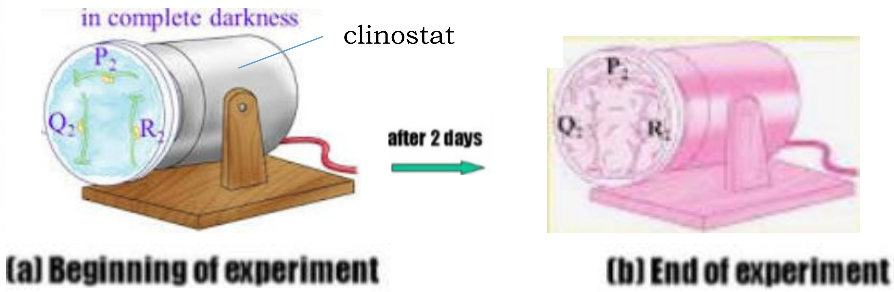
Aim of experiment; To show geotropism in plant roots

Requirements; Young bean seedling with straight radicles, moist cotton wool/blotting paper, 2 petri dishes, one clinostat, plasticine, dark cupboard, pins.

Procedure;

-Two petri dishes are tightly packed with moist cotton wool.
-Three bean seedlings with straight radicles are pinned, with one radicle vertically upwards, second with radicle horizontal, and the other radicle vertically downwards.
-The dish is fixed in position with some plasticine.
-Control experiment is set up with all seedlings pinned as above; but petri dish is placed in a clinostat.
-Both experiments are left to stand for two days in dark cupboard to avoid the effect of light.





Control experiment.

Observation

Radicles of seedlings pinned in the petri dish placed in slowly rotating clinostat continued growing straight (without bending).
All radicles of seedling pinned in the first petri dish grew bending vertically downwards.

Conclusion

Roots grow towards the direction of gravity, therefore are positively geotropic.

NOTE. *Enough cotton wool is used to press the seedlings gently against the lid of the petri dish; keeping the seedlings in position.*

Guiding question

1.Describe an experiment you would carry out to determine the effects of gravity on the root of a dicotyledonous plant.

2.When a seedling is fixed on a clinostat and placed in a horizontal position, the shoot continues to grow horizontally, but without the clinostat, it bends upwards. Which one of the following is true about the role of the clinostat?

A. Enables the shoot to receive uniform light
B. Causes auxins to accumulate on the lower side of the seedling
C. Causes auxins to accumulate on the upper side of the seedling
D. Causes auxins to accumulate uniformly on all sides.

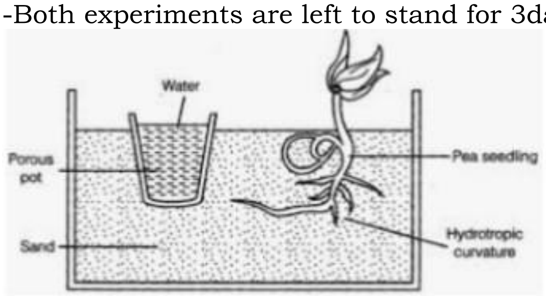
Experiment to show hydrotropism in plant roots

Aim of experiment; To show hydrotropism in plant roots

Requirements; porous pot, dry soil, water, glass trough, pea seeds

Procedure

-Trough is two-third filled with dry soil.
-A porous pot is placed at the centre of the trough.
-About six viable pea seeds are planted in the soil about 6cm from the pot.
-The soil is daily watered until just the plumules appear.
-Porous clay pot is then partly filled with water.
-Control experiment is set up as above but with no water in the pot, and anhydrous calcium chloride added to absorb any moisture in the trough.
-Both experiments are left to stand for 3days.



Observation

Radicles grow inwards towards the water source as the shoots continue growing vertically upwards.
Radicles of seedlings in the control set up, do not grow curved.

Conclusion

Roots grow towards water, therefore positively hydrotropic.

CHEMICAL CONTROL OF PLANT RESPONSES

Upward growth of shoots and down ward growth of roots in plants is controlled by **plant growth substances.**

Examples of plant growth substances include; **Auxins, Gibberellins, Abscissic acid, Cytokinins, and ethene**.

Growth substances in plants are made in one part of plant, transported to another part where they cause an effect on growth.

Movement of these growth substances from cell to cell is by **diffusion**, so it takes time for them to reach their target cell, thus response in plants is slower than in animals.

(a). Auxins;

Are produced in the shoot and root tips.

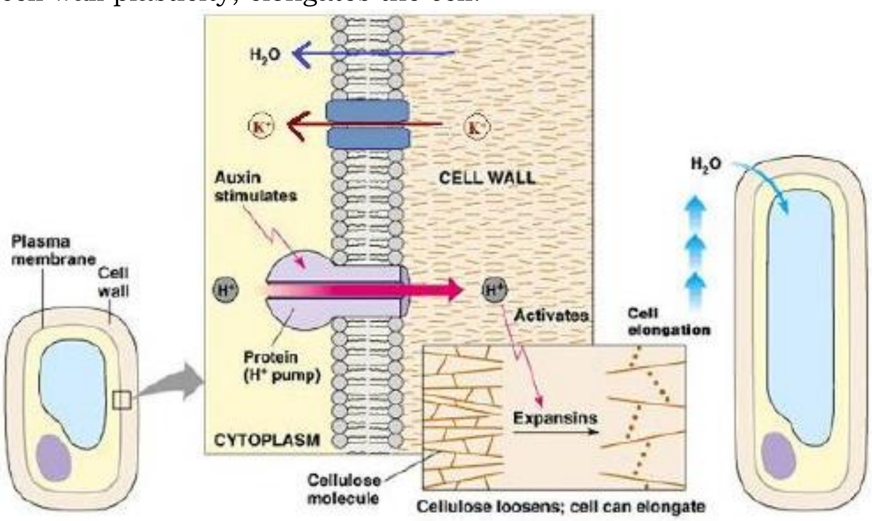
Short distance movement of auxins from cell to cell is by **diffusion**; with long distance transport occurring by **translocation** in the phloem.

Example of auxin is **Indoleacetic acid**(IAA).

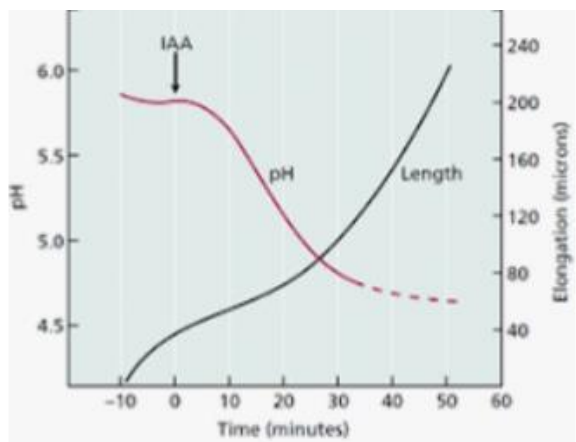
Effects of auxins on plant growth.

(i)Cell elongation

- Auxins stimulates the plasma membrane's protein/ proton(H^+) pumps; protons are pumped across cell surface membrane from cytoplasm to cell wall; which on accumulation, lowers the pH of the cell wall; activating enzymes called **expansins** that break the hydrogen bonds between the cellulose micro fibrils; loosening the wall's fabric. K^+ channels are stimulated to open; K^+ diffuse into the cytoplasm from the cell wall; water potential inside the cytoplasm is lowered; water enters the cytoplasm by osmosis; increasing turgidity of the cell; which together with cell wall plasticity, elongates the cell.



Variation of pH in cell wall and length of cell on application of auxin.

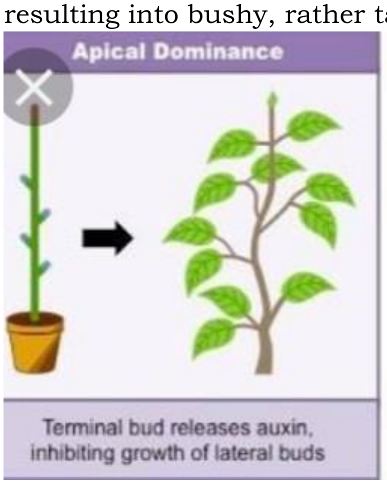


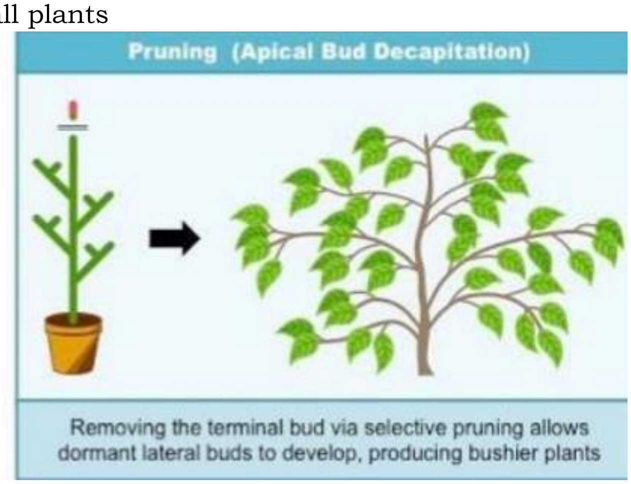
(ii)Inhibits the formation of side branches from lateral buds.

Auxins transported down the shoot from the apical bud directly inhibits growth of lateral buds, shoot lengthens at the expense of lateral branching, a phenomenon called **apical dominance**.

Growth of main root can similarly suppress the growth of lateral buds.

Removal of the shoot apex including the apical bud results in lateral branching. This phenomenon is made use of in pruning fruit trees, tea and coffee bushes; where the young shoots are cut off at about one half of their length, resulting into bushy, rather tall plants

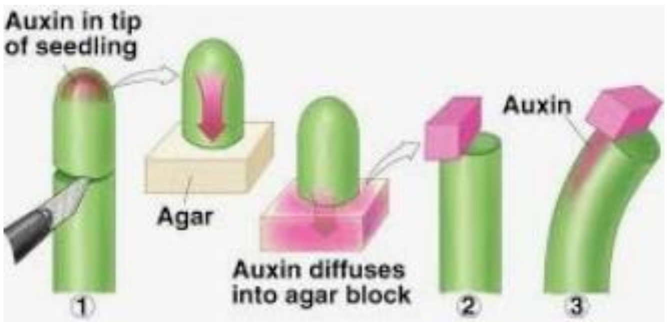




-Simulating the development of adventitious roots
-Inducing parthenocarpy (formation of fruits without fertilization)
-Inhibiting abscission/ falling of fruits, young leaves and flowers before maturity.
-Promoting mature leaf fall(abscission)
-Initiating secondary growth by stimulating cell division in the cambium.
-Stimulating translocation of organic substances in the phloem
-Increases ethene production
-Promotes cell division.

<u>Experiment to show effect of uneven distribution of Auxin on growth of shoots</u>.

Aim of experiment. To verify that uneven distribution of Auxin causes unequal growth at the tip of shoots.
Requirements. Two seedlings with straight coleoptiles, razor blade, agar block.
Procedure.
-Seedlings with straight coleoptiles are selected.
-Tip of some coleoptiles are removed by cutting with a razor blade and then put back on one side.
-Tip of another coleoptile is removed, placed on agar block for some time.
-Tip is removed from agar block and block placed on one side of the decapitated coleoptiles and both experiments left to stand for 48hours in the dark.



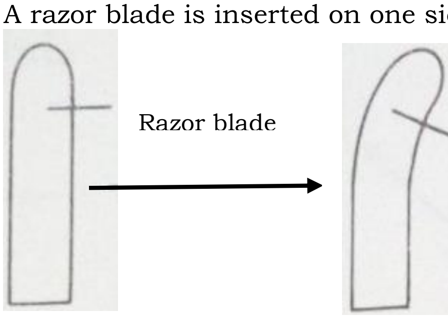
B

A

Observation
Seedling B, coleoptiles grow while bending towards the side without the tip.
Seedling A, coleoptiles grow bending towards the side without the agar block.
Conclusion
Faster growth occurs on the side of coleoptile with more auxins and slowly on the side with less auxins.
NOTE.
In seedling B, placing the tip on one side, diffusion of auxins down on one side of the coleoptiles occurs; causing it to grow more rapidly than the other side with less auxin, causing it to bend.
In seedling A, auxins from the cut tip diffused into the agar block, and on placing the block on one side of cut coleoptiles, auxins diffused down that side, increasing its growth, and causing bending.

<u>Experiment to show the effect of auxin distribution on the growth of the shoot.</u>

Aim of experiment. To show the effect of auxin distribution on the growth of the shoot
Requirements; seedlings with straight coleoptiles, razor blades.
Procedure;
-Seedlings with straight coleoptiles are selected.
A razor blade is inserted on one side of the coleoptiles tip and the coleoptiles are left to grow in the dark 48 hours.



coleoptile

Observation
Coleoptiles continue to grow upwards but grows bending towards the side with a razor blade.
Conclusion
Side of coleoptiles with razor blade grows slower than the side without razor blade.

NOTE
Auxins in the dark diffuse evenly down to all the sides of the coleoptiles.
insertion of the razor blade on one side of the coleoptiles, prevents diffusion of auxin on that side.
growth on the side of the razorblade is reduced and the side without the razor blade grows fast becoming longer which result in the bending of the coleoptiles towards the side of razor blade

<u>Experiment to show effect of uneven distribution of Auxin on growth of shoots</u>

Aim of experiment; To verify that uneven distribution of Auxin causes unequal growth in roots.

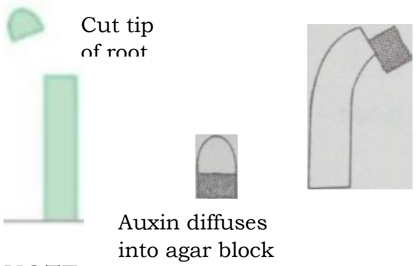
Requirements; Seedling with straight radicals, razor blade, agar block.

Procedure

-Tip of the root is cut removed and placed on the agar plate for some time.

-Tip of the root is removed from the agar block and agar block placed on one side of the cut root.

-Experiment is left to stand for 2 days.



Observation

Root grows bending towards the side with agar block.

Conclusion

Faster growth occurs on the side root with less auxins and slowly on the side with more auxins.

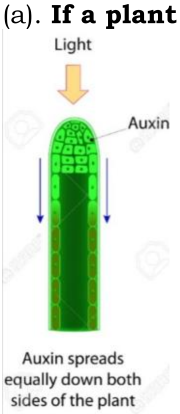
NOTE.

Auxins diffused from the root tip to the agar block, and on placing the agar on one side of the root, auxins diffused from the agar block to one side of the root. The part with agar had more auxins hence slowing down growth on this side and side with less auxins, grows more rapidly causing the bending.

AUXIN AND PHOTOTROPISM

Effect of auxins on phototropism was studied using coleoptiles (protective sheath around germinating seeds of grasses) because; (i) Their response to light is easy to observe (ii) Easy to grow in large numbers (iii) Are small in size

(a). **If a plant shoot is exposed to light coming from all directions/ total darkness,**

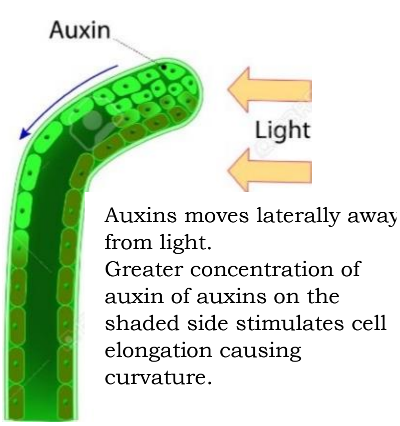


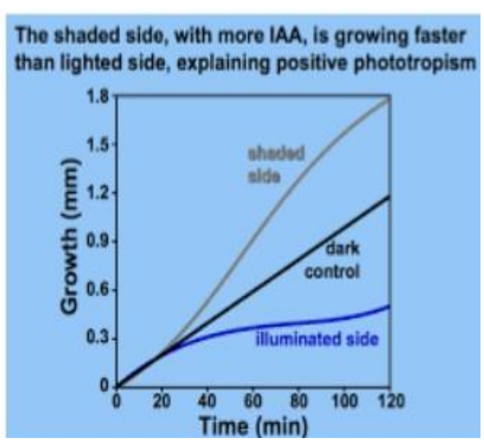
Auxins produced at the shoot tips diffuse uniformly down the shoot,
This causes all cells in the zone of cell elongation to elongate uniformly, therefore uniform upward growth of shoot occurs.

(b) If a plant shoot is exposed to a unidirectional light source/ light coming from one direction;

Receptors, coenzyme FAD on the tips of the coleoptiles is stimulated; causing redistribution of auxins , with more auxins on the shade side than on the lit side.

Higher concentration of auxin on the dark side, rapid growth of cells here occurs, causes them to elongate more than cells on the side exposed to unidirectional light, therefore shoot bends towards the unidirectional light.





Guiding question

1.Figure **1** below represents a setup of experiments to show the effect of unilateral lighting on plant shoots.

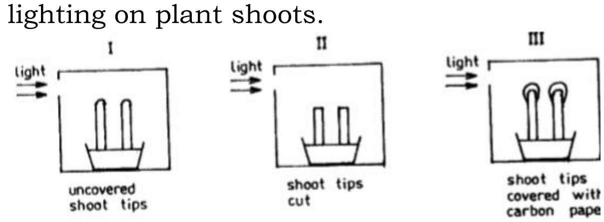


Fig 1

From figure .**1** above, in which experiment would the shoots grow straight?

A. I and II
B. I and III
C. II and III
D. III only.

2. Which one of the following best describes the effect of one sided illumination on the distribution of auxins in a shoot tip?

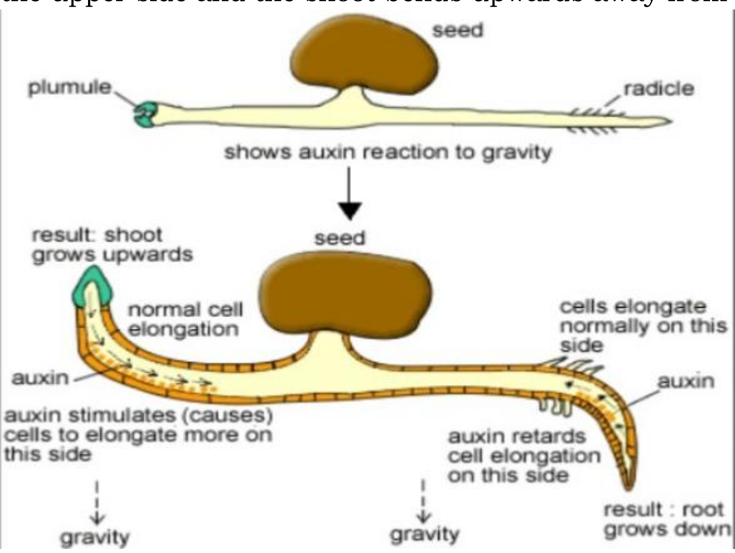
A. The auxins are evenly distributed around the tip
B. The light inhibits movement of auxins down the tip
C. There is reduction of auxins on the illuminated side of the tip
D. The auxins increase on the illuminated side of the tip

AUXIN AND GEOTROPISM

In a horizontally growing seedling/ seedling with straight radicle and shoot, radicle grows bending downwards, and shoot grows bending upwards because, gravity causes large starch grains (statoliths) to sink to the lower sides of the cell; more auxin accumulates in the lower areas of the root and shoots;

In the root, a high concentration of auxin slows down growth therefore the lower side grows slowly while the upper side grows faster due to more cell elongation, causing the bending of the root downwards (positive geotropism)

In the shoot, a high concentration of auxin stimulates faster growth on the lower side which makes it longer than the upper side and the shoot bends upwards away from gravity (negative geotropism)



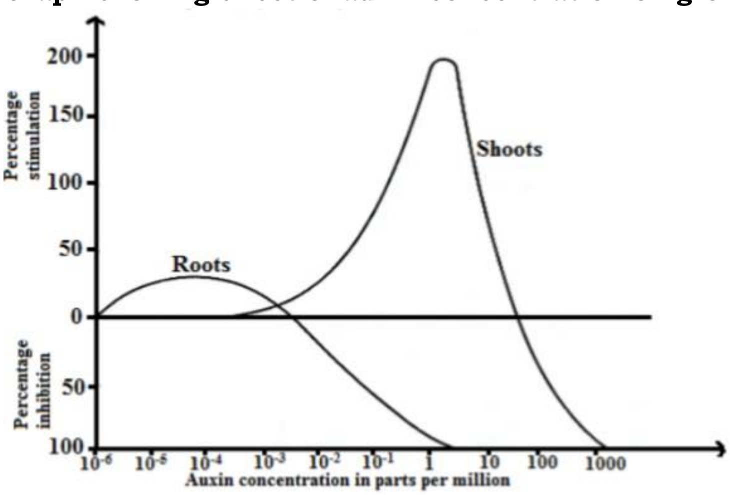
Guiding questions

1.When a growing shoot is placed horizontally, it bends upwards after sometime. Which of the following best explains this response?

A. High auxin concentration on the upper side inhibits growth on the upper side.
B. High auxin concentration on the lower side makes the lower side grow faster
C. Lack of auxin on the upper side inhibits growth on the upper side.
D. Low auxin concentration on the lower side makes the lower side grow faster.

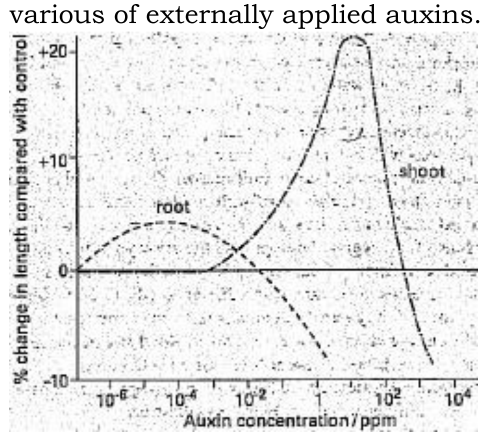
2.Describe an experiment you would carry out to determine the effects of gravity on the root of a dicotyledonous plant.

Graph showing effect of auxin concentration on growth responses of roots and shoots



Guiding questions.

1.The graph below shows the response of Oat seedling to various of externally applied auxins.



(a).Give **two** differences between the shoot and root responses shown by the graph
(b).Suggest a suitable control for this investigation
(c)Describe how the action of auxins on a plant shoot promote growth.
(d)Explain why auxins may be used as selective weed killers in cereal crops.

POSSIBLE SOLUTIONS

(a).

Shoot	**Root**
Attains a peak at a higher auxin concentration ✓	Attains a peak at lower auxin concentration
No change in length from auxin concentration 10^{-6}mm to 10^{-3} ppm ✓	Change in length occurs from auxin concentration 10^{-6} ppm to 10^{-3} ppm
Percentage change in length rapidly increases to a peak from 10^{-3}ppm to 1ppm ✓	Percentage change in length gradually decreases from 10^{-3}ppm to 1ppm
Higher peak is attained ✓	Lower peak is attained

(b)Use of distilled water because it lacks nutrients. ✓

(c) - Auxins stimulates the plasma membrane's protein/ proton(H^+) pumps; ✓ protons are pumped across cell surface membrane from cytoplasm to cell wall; ✓ which on accumulation, lowers the pH of the cell wall; ✓activating enzymes called **expansins** that break the hydrogen bonds between the cellulose micro fibrils; ✓ loosening the wall's fabri; ✓.

K^+ channels are stimulated to open; ✓K^+ diffuse into the cytoplasm from the cell wall; ✓ water potential inside the cytoplasm is lowered; ✓water enters the cytoplasm by osmosis; ✓ increasing turgidity of the cell; ✓ which together with cell wall plasticity, elongates the cell; ✓

(d) Selective action of auxins affects broad leaved plants more than cereals; ✓ thus cereals are less sensitive to auxins than dicotyledonous plants; ✓ weeds are made to use up their stored energy for stem elongation; ✓ instead of developing leaves for photosynthesis; ✓

2. An investigation was carried out on the effect of applying different concentrations of auxins on roots and shoots of oat seedlings. The results in Table **1** obtained were expressed as percentage stimulation (+) or inhibition (-) of growth compared untreated controls. Use the information to answer the questions that follow.

% stimulation of growth		**Concentration of applied auxin (ppm)**								
		10^{-6}	10^{-5}	10^{-4}	10^{-3}	10^{-2}	10^{-1}	10^{0}	10^{+1}	10^{+2}
	Root	+5	+20	+20	+10	-18	-55	-90	-95	-98
	Shoot	0	0	0	+5	+20	+100	+180	+150	+10

(a). Present the results in a suitable graph.

(b) Using your graph in (a) ,

(i) describe the effect of different concentrations of auxins on root growth.

(ii) point out differences between responses of the roots and shoots to the different concentrations of auxins.

<u>Commercial applications of auxins.</u>

-Synthetic auxins stimulates root development from stem cuttings

-Selective weed killers.

-Retards abscission in young fruits

-Inhibits sprouting of potatoes

-Fruit setting; i.e. Auxins induce a series of changes after fertilization in the ovary leading to the development of young fruit e.g. in tomatoes, pepper and tobacco etc.

Comparison of tropic and nastic responses in plants

(a). Similarities

Both**;**

-Are plant responses to external stimuli

-Involve some growth curvature

-Responses involve some chemical messenger

-Do not involve any form of plant locomotion

(b). **Differences**

Tropic response	**Nastic response**
Direction of growth is determined by direction of stimulus	Direction of bending independent of direction of stimulus
Response is restricted to root and shoot tips, mid ribs and tendrils.	Response is found in many parts e.g. leaves and flowers
Response have permanent effects on plants	Response have temporary effects on plant parts
Responses are generally slower	Responses are fairly quick
Stimulus is directional	Stimulus is non-directional
Only brought about by differential rates of cell elongation during growth	May be caused by changes in turgidity of specialized cells
Influenced by a growth substance, auxins	Not influenced by a growth substance, auxins.

(b) **Other important plant growth substances, sites of production and their effects in plant growth**

Growth substance	Site of production	Effect on plant growth
Gibberellins	Young leaves, embryo of seeds, root apex	-Breaks seed dormancy in some plants which require light for germination -Elongation of internodes of dwarf plants e.g. cabbage. -Stimulates germination of seeds by synthesis of amylase which hydrolyses starch to maltose for respiration. -Simulate flowering in some plants -Inhibits growth of adventitious roots -Promotes growth of side branches (inhibits apical dominance) -Delays senescence in leaves
Cytokinins	Fruits, root apex and endosperm of seeds	- Slows down ageing of leaves -Breaks dormancy in both buds and seeds -Stimulates cell division (with auxin) -Enlargement of cotyledons -Stimulate formation of callus tissue that heals damaged tissues in plants
Abscissic acid	Buds, base of leaves, fruits, seeds, tubers	-Stimulates premature leaf fall -Inhibits germination in seeds by prolonging dormancy -Stimulates closure of stomata in leaves under water stress -Promotes ageing
Ethene/ethylene	Nodes of stems, ageing leaves, flowers, outer covering of fruits	-Promotes ripening of fruits -Breaks bud dormancy -Stimulates abscission of leaves -Induces flowering in pineapples -Inhibits root growth

Comparison of the effects of auxins and Gibberellins

(a)**Similarities**

Both;

-Promote fruit development without fertilization

-Promote plant growth through cell division and elongation

(b) **Differences**

Auxins	Gibberellins
Causes bending of shoots	Does not cause bending of shoots
Does not break seed dormancy	Breaks seed and bud dormancy
Inhibits growth of side branches from lateral buds/promotes apical dominance	Stimulates growth of side branches from lateral buds/ inhibits apical dominance.
Stimulates growth of adventitious roots	Inhibits growth of adventitious roots
Promotes cell elongation and division of shoot tips	Promotes cell division and elongation of internodes

Guiding questions

1. Compare the effects of auxins and gibberellins
2. Explain how auxins are used in agriculture