Bio 328, Spring 2006, Test #2 Name: KEY

Provide concise answers in the space provided after each question, or, if more space is needed, continue on the back of the page. The potential value of each answer is 4 pts unless otherwise noted in the margin.

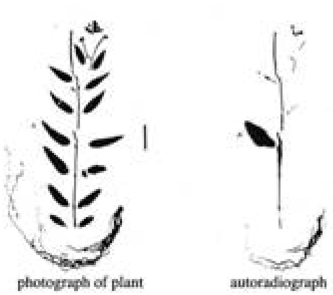
1. (a) Indicate two features of the anatomy of sieve tubes make them different from companion cells, and for each feature indicate how it aids sieve tube function.

Ans.: Sieve tubes have no nucleus and few organelles, and they have large pores on their top and bottom walls (sieve plates). Both these features facilitate sugar flow through the sieve tube.

(b) Cucumber is a symplastic loader. What chemical gradient exists between the companion cells and sieve tubes of these plants that helps explain symplastic loading, and how is this gradient formed?

Ans.: The concentration of polymers stachyose and raffinose is higher in companion cells than in sieve tubes. These polymers are products of enzymatic reactions that use as substrates sucrose entering the companion cells symplastically, thus allowing sucrose to continue to flow passively into the companion cells. The polymers that move passively into the sieve tubes are there converted back to sucrose, thus allowing sucrose loading into the tubes.

(c) In the Figure below, what is the question, what is the answer, and why is so much of the plant not visible in the image on the right?



The question is when sugar is formed from labeled carbon dioxide in a leaf, where is that sugar preferentially transported? The answer is the labeled sugar formed in leaf A (source) is preferentially transported to roots and apical buds, as revealed in the autoradiograph on the right, where other parts of the plant are not visible because they are not labeled.

2. (a) What experiment and result led scientists to conclude that a protein in the wall played a critical role in promoting the gravity response in *Chara*?

Ans.: Using proteases to digest wall proteins on the top and bottom walls of the Chara cells blocked the gravity response in these cells.

(b) Figuratively speaking we all have rocks in our heads. What gravity response does this control?

Ans.: These "rocks" are particles in our inner ear which slide in the direction we tilt our heads, and they allow us to orient and balance ourselves in the gravity field.

(c) What experiment shows that hydrostatic forces can mimic gravitational forces in *Chara*, and what treatment blocks the effects of both forces?

Ans.: Normally the cytoplasmic flow in a horizontally positioned Chara cell is equal to the left and to the right. If positive or negative hydrostatic pressure is applied to cells in this position the polar ratio of cytoplasmic flow changes by 10 % (goes to 1.1 or 0.9). Treatment with nifedipine (calcium channel blocker) blocks this effect.

3. (a) In gravitropism, what asymmetry precedes the growth asymmetry? Give an example of the earlier asymmetry.

Ans.: The growth asymmetry is preceded by an asymmetry in the distribution of growth-affecting substances across the responding tissue. An example would be that auxin accumulates on the lower side of a horizontally positioned root, where it inhibits growth. (Calcium also accumulates preferentially in the walls of cells on the lower side of roots).

(b) In horizontally positioned cucumber hypocotyls, there is no increase in growth rate on the lower side as it curves upward. What growth change is most likely to drive its upward curvature?

Ans.: The growth rate of the upper side decreases, while the lower side continues to grow at the same rate.

4. (a) What is the evidence that phototropin can affect leaf movement in kidney bean?

Ans.: Phototropin is activated by blue light and undergoes autophosphorylation. Unilateral blue light induces both the autophosphorylation of phototropin and the leaf movement in kidney bean.

(b) In the kidney bean leaf movement referred to above, what leaf organ is affected and what change does it undergo to promote the leaf movement?

Ans.: Cells on the irradiated side of the leaf pulvinus shrink in response to blue light, becoming smaller than cells on the other side, and this change forces the leaf to move toward the light.

(c) Describe one intermediate cellular/biochemical change that is altered by phototropin to promote leaf movement and describe how this change compares with a parallel cellular/biochemical change induced by phototropin to promote stomatal opening.

Ans.: In leaf pulvini the photoactivation of phototropin leads to the dephosphorylation and inactivation of a proton-pumping ATPase, which induces membrane depolarization and movement of salt and water out of the irradiated cells. In the guard cells of stomata, the photoactivation of phototropin leads to the phosphorylation and activation of a proton-pumping ATPase, which induces membrane hyperpolarization and movement of salt and water into the irradiated cells, causing the cells to swell and stomates to open.

5. (a) Give two examples that illustrate why phytochrome sensitivity to **far-red** light has survival benefit to the plant.

Ans.: Far-red light signals seeds that they are in the shade of other plants and puts phytochrome in the Pr form, which inhibits seed germination in this negative environment; far-red light signals green plants that they are in the shade of other plants which stimulates their stems to elongate faster, thus enabling them to compete better for sunlight and enhance their survival.

(b) Describe a "real-life" situation in which a plant's ability to respond to VERY low levels of red light has survival benefit, and explain why the light response has survival benefit.

Ans.: When seedlings growing through soil in darkness come within an inch of the soil surface they encounter the first few photons of light, which can induce them to begin making the chlorophyll proteins and other proteins needed for photosynthesis, so that by the time they emerge into full sunlight they are already capable of making their own sugar. This "head start" helps assure that they can produce the energy they need for growth before they run out of the food reserves in the seed.

(c) In general, mature plants do not have the ability to respond to VERY low levels of red light, and the reason is related to the postulate that plants follow the "waste not, want not" rule. Explain.

Ans.: The sensitivity of plants to very low levels of red light is due to the high concentration of phytochrome molecules in dark-grown seedlings. Once plants emerge into a lighted environment there is no need for such a high concentration of phytochrome and the plant both reduces its rate of synthesis of phytochrome and ubiquitinates and recycles much of the excess phytochrome protein it now no longer needs.

6. (a) What is PIF1,where is its subcellular locale?

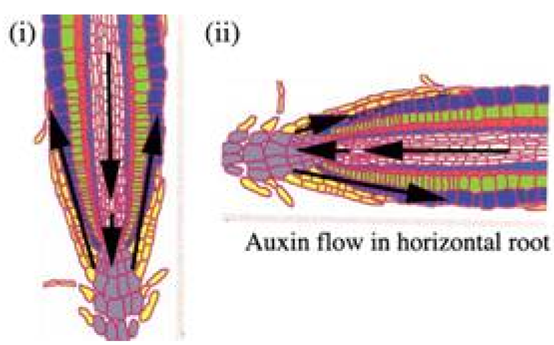
Ans.: PIF1 is a protein transcription factor localized in the nucleus.

(b) How is PIF1 altered by red light, and what interactions lead to this alteration?

Ans.: Red light activates phytochrome and induces it to go into the nucleus where it binds to PIF1 and promotes its proteolytic destruction.

7. (a) In the space below draw a model that describes the flow of auxin toward and away from the tips of (i) vertically oriented and (ii) horizontally-oriented roots.

Ans.:



(b) According to the Nature paper by Abas et al. (2006), what cellular/biochemical changes induced by gravity help explain the distribution of auxin in horizontally-positioned roots?

Ans.: PIN2, a membrane protein that is critical for the transport of auxin out of cells, is selectively ubiquitinated and destroyed on the upper side of cap cells in horizontally positioned roots, thus helping to create an asymmetry of PIN2 distribution preferentially on the lower side of cells. This promotes the preferential transport of auxin to the lower side of horizontally-positioned roots.

(c) To follow auxin distribution in living cells, scientists use transgenic plants modified with a special genetic construct that combines a specific promoter with a specific reporter gene. What is the promoter and what is the reporter in this construct?

Ans.: The promoter is one that becomes more active as auxin concentration increases (e.g., DR5 promoter), and the reporter is a gene encoding a green fluorescent protein (GFP).

8. (a) What is the function of TIR1 and how is it "activated"?

Ans.: TIR1 is an F-box protein and it is "activated" by binding to auxin.

(b) After its activation, TIR1 interacts with certain target proteins. Indicate one of these target proteins, state the normal function of this target, and describe what happens to it after TIR1 interacts with it.

Ans.: One of the target proteins is the Aux/IAA transcription regulator protein. Many Aux/IAA proteins serve as transcription repressors. After TIR1 interacts with it, it is ubiquitinated and proteolytically destroyed.

(c) The target protein that interacts with TIR1 itself interacts with and affects the function of another protein. What is that other protein, and what does it have to do with auxin responses?

Ans.: The other protein is ARF1 which is a positive transcription regulator that turns on many genes that have to be up-regulated by auxin in order for this hormone to have its physiological effects.

9. (a) In seeds after increases in gibberellin, what happens to SLN1 and a-amylase levels, what is the mechanism for these changes, and what is the relationship between the two?

Ans.: After GA increases, SLN1 is phosphorylated and subsequently ubiquitinated, which marks it for destruction by the proteosome. The absence of SLN1 releases GAMyb to increase a-amylase transcription, leading to an increase in protein levels of this enzyme.

(b) Compare the responses of *fca-1* mutants (plants that cannot make FCA) to wild type plants in their responses to ABA for flowering, stomatal opening and seed germination.

Ans.: *In wild-type plants as ABA concentrations increase, flowering time increases, stomate closing is promoted, and seed germination is inhibited. The fca-1 mutant shows no increase in flowering time with* *added ABA , but for seed germination and stomata closing, no difference was noted between wild-type and fca-1 mutant's response to ABA .*

10. (a) What is the effect of AVG on cotton fiber growth? Why does AVG have this effect?

Ans.: AVG inhibits cotton fiber growth, because it inhibits the production of ethylene by inhibiting the activity of ACC synthase enzyme needed for ethylene synthesis, and ethylene production enhances cotton fiber growth.

(b) Seedlings responding to ethylene show the triple response of shortened hypocotyls, thicker hypocotyls, and disoriented gravity response. Mutants that are defective in the gene encoding CTR1 ("**C**onstitutive **T**riple **R**esponse mutants") always show the triple response even when they are not treated with ethylene. Why?

Ans.: The effects of ethylene on seedlings are mediated by the ethylene-induced release of CTR1 from its binding to the ethylene receptors. In the absence of CTR1 there is no need for ethylene to release CTR1 from binding to ethylene receptors, so ethylene responses are constitutively on all the time.