Bio 328K; Fall 2009 Name: KEY
Test #1

Give succinct, precise answers in the space provided after each question. The value of each question answered is 4 points, unless otherwise noted.

5 pts. 1. (a) As scientific equipment becomes more complicated it becomes more difficult for scientists to follow the third rule of Strong Inference. Explain.

Ans.: If you do not know the actual technical limitations of equipment or supplies you are using, then it will not be possible to be sure you are carrying out an experiment so as to get a credible result.

5 pts. (b) Recently it was found that a drug company was paying for the publication of a journal that published mainly papers that described evidence supporting the effectiveness of drugs made by the company. What Rule of Strong Inference was probably being broken by the research that appeared in the published papers? State the Rule and Explain your answer.

Ans.: Probably Rule 2, because the research was probably not designed to resolve which of two alternative hypotheses was correct, but more likely was designed to prove that the drugs were effective.

2. Germinated pollen typically carries three nuclei. (a) What is the function of the tube nucleus in germinated pollen?

Ans.: The tube nucleus functions mainly to direct the transcription events that regulate the growth of the pollen tube.

(b) What is the evidence that the arrival of the pollen tube at the ovary and the release of the two sperm cells does not guarantee fertilization?

Ans.: If the GCS1 gene, which is uniquely expressed in sperm cells, is knocked out, then the sperm cells released by the pollen tube at the ovary will not fuse with the egg cell or the central cell nuclei.

(c) What are two proteins released by the transmitting tract that influence whether the pollen tube reaches the ovary, and what is the function of each?

Ans.: S-RNase, which is the female self-incompatibility factor that destroys pollen tube RNA in incompatible reaction, and HTB1, which functions to destabilize the vacuolar membrane and release the S-RNase from the vacuole.

3. (a) Regarding senescence, what are SAG genes and what could be an example of one function of a protein encoded by a SAG gene?

Ans.: SAG genes are senescence activated genes, which need to be turned on for senescence to occur in plants. An example would be any one of the genes that encode catabolic enzymes that promote senescence, such as DNase, RNase, protease,lipase, etc

(b) What is the function of ORE9, and how does it influence the onset of leaf senescence in Arabidopsis?

Ans.: ORE9 is an F-box protein that functions as part of an SCF-type E3 ligase to promote the ubiquitination of target proteins. It appears to target a suppressor of SAG gene expression for ubiquitination and destruction, thus allowing the SAG genes to be turned on.

(c) What is SAUL1 and how does it influence the onset of leaf senescence in Arabidopsis? Your answer should include a description of at least two properties that characterize the *saul1* mutant.

Ans.: SAUL1 is a E3 ligase that appears to target an Arabidopsis aldehyde oxidase (AAO1) protein for ubiquitination and destruction. AAO1 catalyzes an important step in the biosynthesis of ABA, a hormone that promotes senescence. In the saul1 mutant, that is nul for the gene encoding SAUL1, ABA is prematurely synthesized and senescence occurs prematurely.

6 pts. 4. (a) The apical tip of most dicotyledonous plants is rounded into the shape of a dome, and new leaves first emerge as a bulge that protrudes out from the side of the apical dome. Name two proteins you might expect to be highly expressed in the wall of cells in the bulge, and give a reason for your answer.

Ans. Expansin and a xyloglucanase are two proteins that promote cell wall extensibility, and to the extent that the bulge is due at least partially to an increase in the size of cells in the bulge, increased wall extensibility would be needed in these cells, and expansin and xyloglucanases could be expected to promote this change.

6 pts. (b) Why does the pH of the wall play an important role in determining whether cell expansion will occur?

Ans.: Expansin promotes cell expansion, and it is only able to do this at low pH.

5. (a) When ectomycorrhizae help increase uptake of minerals into plants, would this import be initially apoplastic or symplastic? Explain your answer.

Ans.: Apoplastic, because ectomycorrhizae associate mainly with the walls of epidermal root cells, and apoplastic transport occurs through the wall (ECM) space.

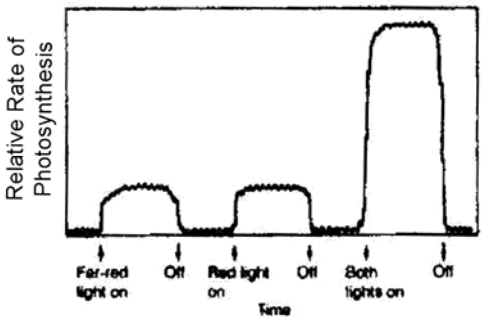
(b) What is the survival benefit to plants that transport of minerals through the ECM cannot continue through the ECM to the vascular tissue beyond the Casparian strip and the endodermis?

Ans: Transport through the ECM is apolastic and passive, and is generally not selective. The more minerals loaded into the vascular tissue are loaded non-selectively, the higher the probability that detrimental levels of some minerals could be taken up.

(c) How do minerals absorbed and transported through the ECM get transported past the endodermis and progress toward the vascular tissue?

Ans.: The apoplastically transported minerals get taken up by selective transporters across membranes into cells at the endodermal border, and from here they can cross the barrier symplastically.

6 pts. 6. (a) In the Figure below, why does the rate of photosynthesis go up after far-red light, why does it go up after red light, and why does the combination of both red and far-red light increase the rate of photosynthesis more than the additive amount of each color light individually? Your answer should define precisely what is absorbing each color of light.



Ans.: Far-red light activates the reaction center chlorophyll in Photosystem I, and Red light activates the reaction center chlorophyll in Photosystem II, and both these activations initiate electron transport and the light reactions of photosynthesis. The simultaneous activation of both PSII and PSI optimizes the flow of electrons between the two photosystems and thus optimizes the rate of photosynthesis, whereas activating preferentially only one of the photosystems imbalances the flow between the two systems and thus results in a relatively lower rate of photosynthesis.

6 pts. (b) (i) What condition favors cyclic electron transport?; (ii) What key product of the light reaction of photosynthesis continues to be generated during cyclic electron transport?; and (iii) what key product of the light reaction of photosynthesis is not made during cyclic electron transport?

Ans.: (i) Cyclic electron transport is favored when the rate of delivery of electrons to the primary electron acceptor in PSI exceeds the availability of oxidized NADP to receive these electrons; (ii) The build up of protons in the thylakoid lumen continues, which provides more proton motive force for ATP synthesis; (iii) more NADPH is not made during cyclic electron flow.

7. (a) What condition makes RUBISCO function as an oxygenase, and what is the logic of naming the process to which this condition leads "photorespiration"?

Ans.: RUBISCO functions as an oxygenase when [CO2] in the leaf drops below the compensation point. The logic is that drop in [CO2] is typically induced by high light conditions, which drive photosynthesis fast enough to deplete the

CO2 level in the leaf, and photorespiration results in decarboxylation and release of CO2 in mitochondria, just as respiration does.

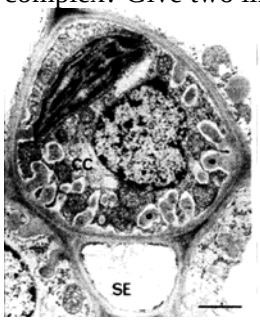
(b) Describe the formation, transport and breakdown of malate in C4 plants, and indicate what is the survival benefit for plants that carry out these processes.

Ans.: Malate is a 4-carbon product derived from oxaloacetic acid, which is the first stable 4-C product of carbon fixation by the action of PEP carboxylase. It is transported from the outer mesophyll cell into the bundle sheath cell where it is decarboxylated to release CO2, which is then fixed by RUBISCO in the Calvin cycle. The benefit of these processes is that it allows plants to continue to fix CO2 even at low CO2 levels, thus reducing the problem of photorespiration

(c) Contrast the leaf anatomy of C3 and C4 plants.

Ans.: C4 plants have specialized outer mesophyll cells in which PEP carboxylase is the enzyme that fixes CO2, and more interior bundle sheath cells which fix CO2 by the Calvin cycle. C4 plants typically do not have this anatomical arrangement and specialization.

8. (a) The micrograph below describes the CC-SE complex of a plant. How does this plant load sugar into this complex? Give two lines of evidence from the micrograph for your answer.



Ans.: This plant loads sugar into the CC-SE complex via the apoplastic pathway. Its CC cell has two anatomical features characteristic of apoplastic loaders: wall indentations and the lack of plasmodesmatal connections with any of the surrounding cells except the SE.

(b) In some plants phloem loading requires an ATP-driven gradient. What is this gradient, and why is it required?

Ans.: The gradient is a pH or proton gradient, and it is required to drive the symport of sugar into the CC across the sugar-proton symporter.

(c) What is the function of GAS1 and GAS2 and what is the evidence that this function is needed by some plants for phloem loading?

Ans.: The GAS proteins are galactinol synthases, and they are needed to produce galactinol a key intermediate in the synthesis of stachyose and raffinose, which have to be synthesized in order to create the "polymer trap" that allows sugar to be loaded symplastically into the intermediary (CC) cell.

9. (a) Define transpiration and explain why the rate of transpiration is related to relative humidity.

Ans.: Transpiration is the loss of water vapor, primarily through the stomatal pores, into the outside air.
The higher the relative humidity the less negative the water potential of air, and the lower the water potential difference between the intercellular air spaces and the outside air. When this difference is zero transpiration stops.

6 pts. (b) One could make an argument that under high temperature conditions, stomates should open, or stomates should close. Briefly defend each side of the argument, and then explain why, in most cases, plants choose to close their stomates under high temperature conditions.

Ans.: At high temperatures the relative level of CO2 in the stroma would drop, and low CO2 levels usually induce stomata to open. However at high temperatures, the rate of transpiration goes up and water loss is accelerated, and this can induce stomates to close. Stomates typically close under high temperature conditions, because significant water loss from leaves would reduce photosynthesis, which would make low CO2 levels less problematic.