Review Questions on Energy Flow and Water Relations

1. What are the two primary energy transformations in plants?
2. The energy balance of a leaf is an application of which law of thermodynamics?
3. State that law in your own words.
4. Does oxidation of glucose to form CO\textsubscript{2} and H\textsubscript{2}O increase or decrease entropy?
5. What’s the difference between reduction reactions and oxidation reactions?
6. In the process of hydrolysis of ATP, what is removed from the ATP molecule?
7. Write the reaction for hydrolysis of ATP.
8. Does hydrolysis of ATP require an input of energy or release energy?
9. Where do membranes in mitochondria get their energy to make ATP from ADP and Pi?
10. Where do chloroplast membranes get their energy to maintain proton gradients?
11. Where do mitochondrial membranes get their energy to maintain proton gradients?
12. How do enzymes increase rates of biochemical reactions in cells?
13. What are the components of water potential?
14. What is the symplast?
15. What is the apoplast?
16. What accounts for low values of osmotic potential in the symplast?
17. What happens to osmotic potential in the symplast when water is removed from the cell? Why?
18. What accounts for the high, positive pressure potential in the symplast?
19. What happens to the pressure potential (turgor) in the symplast when water is removed from the cell? Why?
20. Water has four major functions in the plant. What are they?
21. As water flows from the root to the leaf, what holds the water column together in the xylem?

22. In mature roots, what prevents apoplastic flow of water from the root surface into the xylem?

23. What are the two kinds of water-conducting elements in xylem?

The following questions are related to diurnal changes in the water relations of a cucumber plant.

24. Immediately before sunrise, the water in the symplast is in equilibrium with water in the apoplast. If the osmotic potential in the symplast is -1.8 MPa, and the pressure potential (turgor) is 1.3 MPa, what is the total water potential in the symplast? What is the total water potential in the apoplast?

25. What color of light is most effective in causing stomata to open?

26. When the stomata of the cucumber leaf open, transpiration begins. What is the driving force for transpiration?

27. What happens to transpiration of the cotton leaf when leaf temperature rises? Why?

28. What is the driving force for water flow from soil through the root to the leaf?

29. Describe how negative pressure potentials (tension) are generated at cell wall-air interfaces.

30. At noon, the water vapor concentration in the leaf is 1 mol m⁻³ higher than that of the air. If the boundary layer and stomatal resistances are 30 and 100 s m⁻¹, respectively, what is the flux density of water loss from the leaf (e.g. transpiration)?

31. Based on the previous question, if one mole of water vapor contains 44,000 J of energy, what is the latent heat flux?

32. At noon, the water potential in the xylem of the cucumber leaves is 0.1 MPa lower than that in the cytosol. Is water flowing from symplast to apoplast, or apoplast to symplast?

33. If the total water potential of the symplast is -0.8 MPa, and the osmotic potential of the symplast is -1.6 MPa, what is the turgor? What accounts for the lower turgor pressure at midday than at sunrise?
34. What is the main pathway for water movement through the plasma membrane?
35. Write the energy balance equation for a leaf, and identify each component.
36. What causes water to flow from the soil to the root?
37. As the soil dries, the volume rate of flow of water to root declines dramatically? Why is this the case?
38. In the middle of the afternoon, stomatal resistance to vapor transport is double the value at noon, indicating stomatal closure. Describe the mechanism of stomatal closure.
39. Perception of what hormone triggers stomatal closure?
40. In the middle of the afternoon, the difference in water vapor concentration between leaf and air is 1 mol m\(^{-3}\). If the boundary layer and stomatal resistances are 30 and 1000 s m\(^{-1}\), what is the transpiration?
41. In the middle of the afternoon, the osmotic potential in the roots drops significantly due to active changes in the solute concentration in the cells. What do we call this process? Where do these solutes originate?
42. Leaf water potential is at its maximum at sunrise, and at its minimum at sunset. Why does water potential decline throughout the day?
43. Stomata close at sunset, and transpiration effectively ceases. Does this mean that water flow in the xylem also stops? Explain