

**Rangeland Plant Ecophysiology
EXAM 2, REWM 3500, Fall 2012**

Name _____

1) Define the following terms [2 points each]

Homeohydric plant

Water potential

Permanent wilting point

Apoplasm

Cavitation

Embolism

Cell wall elasticity

Define the following terms, continued [2 points each]

Phreatophyte

Heliotropism

Convective heat loss

Supercooling

Multiple choice. Circle the letter corresponding to the single most correct answer for each of the following. [2 points each]

2) The equation or law describing the flow rate of liquid water through a plant in relation to the pressure gradient in the xylem and the xylem conductivity is:

- a) Poiseuille's law
- b) Steffan Boltzman law
- c) van't Hoff's equation
- d) Darcy's law
- e) Newton's law of cooling

3) The correct mathematical expression for the relationship referenced in question #2, above, for the flow rate of water from roots to leaves in a plant (where J is flow rate in $\text{m}^3 \text{s}^{-1}$, Ψ_{roots} is the water potential of the roots in MPa, Ψ_{leaves} is the water potential of leaves in MPa, and k is the hydraulic conductivity from roots to leaves in $\text{m}^3 \text{s}^{-1} \text{MPa}^{-1}$) is:

- a) $J = (\Psi_{\text{roots}} - \Psi_{\text{leaves}}) \times k$
- b) $J = (\Psi_{\text{roots}} + \Psi_{\text{leaves}}) \times k$
- c) $J = (\Psi_{\text{roots}} / \Psi_{\text{leaves}}) - k$
- d) $J = k / \Psi_{\text{roots}} + k / \Psi_{\text{leaves}}$
- e) $J = (\Psi_{\text{roots}} - \Psi_{\text{leaves}}) / k$

4) The water flow rate through a plant, J (in $\text{m}^3 \text{s}^{-1}$), from roots to leaves, when Ψ_{roots} is -0.3 MPa, Ψ_{leaves} is -2.0 MPa, and k is $0.09 \text{ m}^3 \text{ s}^{-1} \text{ MPa}^{-1}$ is:

- a) -0.153
- b) -0.052
- c) 0.153
- d) -32.5
- e) 0.0440

5) The equation or law describing the osmotic potential of a solution in relation to the solute concentration and temperature is:

- a) Darcy's law
- b) Steffan Boltzman law
- c) van't Hoff's equation
- d) Newton's law of cooling
- e) Poiseuille's law

6) The correct mathematical expression for the relationship referenced in question #5, above, for the osmotic potential of a solution (where Ψ_o is the solution osmotic potential in MPa, R is the universal gas constant [$8.3134 \text{ J K}^{-1} \text{ mol}^{-1}$], T is temperature in kelvins, and c is solute concentration in mols m^{-3}) is:

- a) $\Psi_o = (-R / Tc) \times 10^{-6}$
- b) $\Psi_o = (-RTc) \times 10^{-6}$
- c) $\Psi_o = (R - Tc) \times 10^{-6}$
- d) $\Psi_o = (c / (R - T)) \times 10^{-6}$
- e) $\Psi_o = (RTc) \times 10^{-6}$

7) The osmotic potential of a solution, Ψ_o (in MPa), when temperature, T , is 295 kelvins and solute concentration, c , is 500 mols m^{-3} is:

- a) -1.60×10^{-6}
- b) -1.08
- c) -1.23
- d) -0.13
- e) -1.29×10^{-5}

8) The equation or law describing the rate of longwave radiation emitted by a leaf in relation to leaf temperature is:

- a) Newton's law of cooling
- b) Darcy's law
- c) van't Hoff's equation
- d) Steffan Boltzman law
- e) Poiseuille's law

9) The correct mathematical expression for the relationship referenced in question #9, above, for the longwave radiation emitted by one side of a leaf in W m^{-2} (where ϵ is emissivity [=0.97 for plant leaves], σ is a constant [$5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$] and T is temperature in kelvins) is:

- a) $\text{LR}_{\text{em}} = \epsilon \sigma T^4$
- b) $\text{LR}_{\text{em}} = \epsilon \sigma / T^4$
- c) $\text{LR}_{\text{em}} = \epsilon - \sigma T$
- d) $\text{LR}_{\text{em}} = \epsilon^4 / \sigma T$
- e) $\text{LR}_{\text{em}} = \epsilon \sigma T$

10) The longwave radiation emitted by one side of a leaf, LR_{em} (in W m^{-2}), when leaf temperature is 290 kelvins is:

- a) 389
- b) 1.5×10^{-5}
- c) 9.6×10^{-18}
- d) 4.3×10^9
- e) 314.5

11) The law describing the rate of convective heat loss from a leaf in relation to the leaf temperature, air temperature and boundary layer thickness is:

- a) Newton's law of cooling
- b) Darcy's law
- c) van't Hoff's equation
- d) Steffan Boltzman law
- e) Poiseuille's law

12) The thickness of the air boundary layer over a leaf is related to these two parameters:

- a) wind speed and leaf width
- b) solar radiation and leaf color
- c) leaf color and wind speed
- d) leaf volume and solar radiation
- e) leaf width and leaf volume

13) Of the total amount of energy absorbed by plants from shortwave solar radiation, approximately what proportion comes from the 0.3 to 0.4 micrometers wavelength band?

- a) 18%
- b) 75%
- c) 25%
- d) 7%
- e) 80%

14) The available soil water for plants at a site is defined as the:

- a) mass of oven dry soil divided by its saturated water content
- b) permanent wilting point minus the osmotic potential
- c) total amount of soil water held after complete wetting and gravitational drainage minus the amount of water at the permanent wilting point
- d) water content of soil after complete wetting and gravitational drainage
- e) osmotic potential of soil at standard temperature and pressure conditions

15) Active osmotic adjustment:

- a) allows plants to maintain positive cell turgor pressure as total water potential of tissues declines
- b) involves synthesis of compatible solutes in cells
- c) may reduce the freezing point temperature of cell sap
- d) all of the above
- e) none of the above

Short answer and essay questions

15) Describe six (6) adaptations in sagebrush (*Artemisia tridentata*) that allow this beautiful shrub to survive the hot, dry summers on western rangelands. **DO NOT** just **LIST** these adaptations. Rather **describe** each one in enough detail to show that you know why these adaptations are important for sagebrush. **[12 points]**

16) Chilling temperatures (between 0 and 10°C) can be very detrimental to some plant species because of cell membrane impairment. What functions of cell membranes do chilling temperatures impair, and why are membranes sensitive to the cold temperatures? Provide a detailed explanation. **[8 points]**

17) Describe the mechanism causing cavitation in tracheids and vessels of plant xylem during a freeze-thaw event. Now explain why there is a trade-off between vulnerability to freeze-thaw cavitation and hydraulic conductance through a plant. **[8 points]**

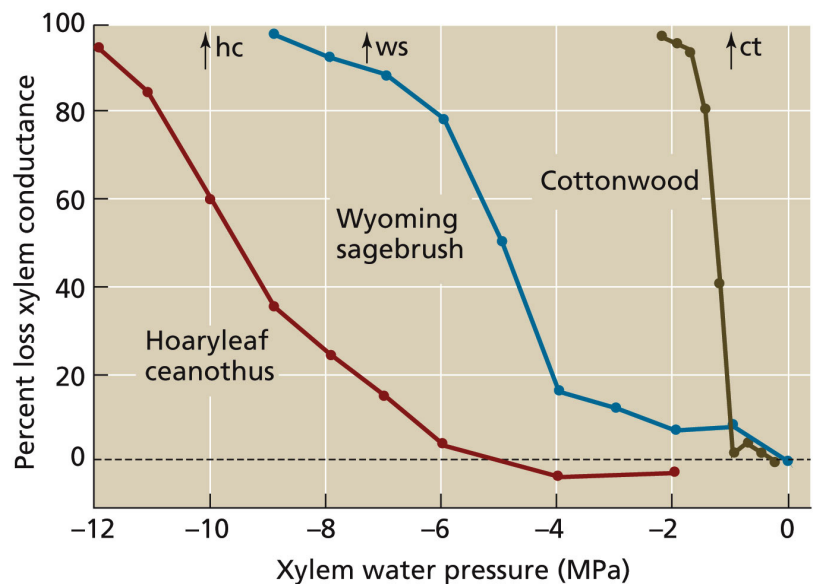
18) **Describe**, do not just list, five (5) mechanisms or characteristics that allow plants to survive in the alpine environment at high elevation. [10 points]

19) Consider the hydraulic vulnerability curve below to answer the following [12 points]:

At what xylem water pressure does Wyoming sagebrush lose ½ of its water conducting capacity through the xylem?

Briefly describe the mechanism responsible for the loss of hydraulic conducting capacity as xylem pressures decline in these species.

If these species were to evolve greater resistance to low xylem pressure potentials, what traits in the xylem would be altered?



PLANT PHYSIOLOGY, 5e, Figure 4.9

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