

**Rangeland Plant Ecophysiology
EXAM 1, REWM 3500, Fall 2012**

Name _____

Define the following terms [2 points each]

1) Isotope

2) Physiological Ecology

3) Science

4) Acclimation

5) Adaptation

6) Stress

Define the following terms [continued]

7) Photoautotroph

8) Grana

9) Thylakoid

10) Water use efficiency

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

11) This individual during the late 18th century estimated the transpiration of a red maple forest in North America by scaling-up measurements on individual twigs:

- a) Jan Ingenhausz
- b) Alexander von Humbolt
- c) Charles Bessey
- d) Samuel Williams
- e) Thomas Jefferson
- f) none of the above are correct

12) This individual is considered one of the founders of the field of Rangeland Management in North America:

- a) Frederic Clementz
- b) Thomas Jefferson
- c) Ben Franklin
- d) Charles Bessey
- e) Theophrastus
- f) none of the above are correct

13) This individual during the early 19th century documented plant distributions in Central and South America and was a key player in the development of the field of plant geography:

- a) Charles Darwin
- b) Frederic Clementz
- c) John Babtista von Helmont
- d) Theophrastus
- e) Alexander von Humbolt
- f) none of the above are correct

14) Photosynthetically active radiation (PAR) refers to light within the:

- a) 300-600 nm waveband
- b) 400-700 nm waveband
- c) green portion of the visible spectrum only
- d) red portion of the visible spectrum only
- e) blue portion of the visible spectrum only
- f) none of the above are correct

15) The correct units for expressing quantum yield of photosynthesis are:

- a) mols CO₂ gained / mols photons absorbed
- b) μmol CO₂ gained m⁻² s⁻¹
- c) Watts m⁻²
- b) Joules m⁻² s⁻¹
- e) mols photons absorbed / mols CO₂ gained

16) Dynamic photoinhibition is best defined as:

- a) the reduction of maximum photosynthetic rate resulting from damage by excess light energy
- b) the temporary change in chlorophyll content to maximize light capture
- c) the change in light absorbance due to changes in leaf angle
- d) the adjustment of pigment composition to dissipate excess light energy as heat
- e) the temporary and reversible reduction of quantum yield resulting from non-photochemical quenching

17) The correct expression of Beer's Law applied to the decay of PPFD as light passes through plant canopies is (where I_0 = PPFD at top of canopy; I = PPFD at bottom of canopy; K = extinction coefficient; L = leaf area index):

- a) $I = Ke^{-I_0L}$
- b) $I_0 = Ie^{-KL}$
- c) $I = I_0e^{-KL}$
- d) $I = I_0e^{KL}$
- e) $I = I_0\log_{10}^{-KL}$

18) Using the correct expression of Beer's Law above, what is the PPFD at the bottom of a forest canopy if $I_0 = 1000$, $K = 0.4$, and $L = 2.0$.

- a) 0.0
- b) 4.49
- c) 2225.5
- d) 550
- e) 449

19) The correct expression of Planck's relationship used to determine the energy content in Joules (J) of a photon of light is (where e = energy of the photon in joules; h = Planck's constant [$6.63 \times 10^{-34} \text{ J s}^{-1}$]; c = the speed of light [$3 \times 10^{17} \text{ nm s}^{-1}$]; and λ = wavelength in nm):

- a) $e = h\lambda/c$
- b) $e = c\lambda/h$
- c) $e = h\lambda c$
- d) $e = h^{-\lambda c}$
- e) $e = hc/\lambda$

20) Using the correct expression of Planck's relationship above, what is the energy of a single photon of light at a wavelength of 600 nm?

- a) $1.33 \times 10^{-48} \text{ J}$
- b) $3.32 \times 10^{-19} \text{ J}$
- c) $4.97 \times 10^{-19} \text{ J}$
- d) $8.84 \times 10^{-49} \text{ J}$
- e) $2.71 \times 10^{53} \text{ J}$

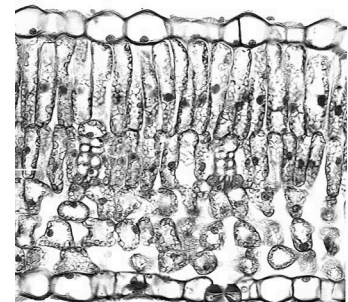
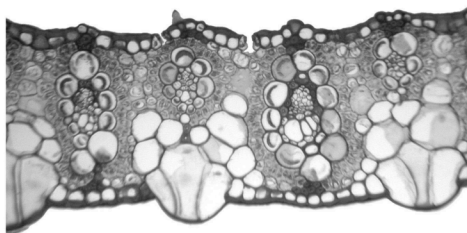
Provide concise answers to the following.

21) Contrast **holism** and **reductionism** in ecology. Which of the two perspectives do plant physiological ecologists adopt? [8 points]

22) For each of the following processes in plant photosynthesis, note whether the process is associated with **carbon reduction reactions** or **photochemical conversion reactions** by *circling* the appropriate answer. [1 point each]

- | | | |
|--|------------------|--------------------------|
| a) CO ₂ binds to RuBP | carbon reduction | photochemical conversion |
| b) O ₂ binds to RuBP | carbon reduction | photochemical conversion |
| c) O ₂ is released from splitting of H ₂ O | carbon reduction | photochemical conversion |
| d) Zeaxanthin is activated | carbon reduction | photochemical conversion |
| e) photons absorbed by chlorophyll | carbon reduction | photochemical conversion |
| f) ATP is produced | carbon reduction | photochemical conversion |
| g) NADPH is produced | carbon reduction | photochemical conversion |
| h) RuBP is recycled | carbon reduction | photochemical conversion |

23) The two pictures below show leaf cellular anatomy in cross section. First, identify which picture belongs to a plant with “**C4 Kranz anatomy**” and which has the typical a “**C3 anatomy**.” Second, for the C4 leaf, identify clearly the **bundle sheath** and **mesophyll** cell types using two separate lines and labels. For the C3 leaf, identify clearly the **palisade parenchyma** and **spongy parenchyma** regions of the leaf using two separate lines and labels. [6 points]



24) CAM photosynthesis is thought to be an adaptation to drought. Why? What advantage do plants with CAM photosynthesis have over plants possessing the C3 and C4 photosynthetic pathways? What is the mechanistic basis for this advantage. **[8 points]**

25) For each of the following, note whether the listed trait is associated with **C3**, **C4** and/or **CAM** photosynthesis by *circling* the appropriate answer(s). More than one answer could apply in each case. **[1 point each]**

a) CO ₂ binds to RuBP	C3	C4	CAM
b) carboxylation catalyzed by PEP-carboxylase	C3	C4	CAM
c) carboxylation catalyzed by Rubisco	C3	C4	CAM
d) high photorespiration	C3	C4	CAM
e) nighttime acidification of tissues	C3	C4	CAM
f) 'Kranz' anatomy	C3	C4	CAM
g) extremely high WUE	C3	C4	CAM
h) succulence	C3	C4	CAM
i) low quantum yield at high temperature	C3	C4	CAM
j) recapturing of nighttime respired CO ₂	C3	C4	CAM
k) coordination between photosystems I and II	C3	C4	CAM
l) high CO ₂ concentration in bundle sheath	C3	C4	CAM

26) Using the conceptual analogy of "filters" that was discussed in class, explain why only a small proportion of the world's 270,000 vascular plant species occur within a particular region. **[8 points]**

27) Draw three lines on the graph below representing the **quantum yield** responses of hypothetical **C3** and **C4** plants in relation to **temperature**. One line should represent the response curve for a C3 plant in today's atmosphere (380 ppm CO₂; 21% O₂). Label this line "C3 today." Another line should represent the response curve for a C4 plant in today's atmosphere (380 ppm CO₂; 21% O₂). Label this line "C4 today." Finally, draw a line representing the likely response of a C3 plant in air with elevated levels of CO₂ concentration (700 ppm CO₂; 21% O₂). Label this line "C3 future."

In the space beneath your graph, provide a biochemical explanation for any differences in the three curves drawn. Also, predict how the latitudinal distribution and dominance of C3 and C4 grasses of the North American prairies will shift in response to an increase in atmospheric CO₂ concentration from 380 to 700 ppm. Assume all other aspects of the environment remain unchanged. **[10 points]**

