(1) Multiple choice. Please place the equation or symbol on the right with the statement on the left that best matches. (4 points)

__F__ Carboxylation                        (A) $O_2 + RuBP \rightarrow 1 \text{ 3PGA} + \text{Phosphoglycolate}$
__E__ Euler Buckling equation              (B) $A$
__H__ Allometric equation                  (C) $J_{CO2} = (C_i - C_a) / \Sigma R$
__G__ Enzymatic reactions                  (D) $\phi$
__C__ Fick’s Law                           (E) $H_{max} = C(E/\rho)^{1/3} D^{2/3}$
__A__ Photorespiration                      (F) $CO_2 + RuBP \rightarrow 2 \text{ 3PGA}$
__D__ Quantum yield                        (G) $A + B \leftarrow \text{catalyst} \rightarrow C + D$
__B__ Assimilation Rate                    (H) $Y = aM^b$

(2) First, please give the equation for $\Psi_{Total}$. Second, please list and then describe (or give the equation with definitions) for each component of $\Psi_{Total}$? (3 points)

$\Psi_{Total} = \Psi_s + \Psi_p$

$\Psi_s = \text{Solute potential} = miRT$, where $m$ is molar concentration, $i$ is a constant, $R$ is the gas constant and $T$ is the temperature. The solute potential can be controlled by plants to manipulate the water potential. By increasing the solute concentration, $\Psi_s$ becomes more negative and the water potential increases.

$\Psi_p = \text{Pressure potential or turgor pressure}$. This is the pressure of water in plant cells, and can be changed via the elasticity of cell walls.
(3) List 5 xeromorphic traits of plants (5 points)

Here are a few:
- succulence and water storage organs
- leaf pubescence to increase reflectivity
- reduced leaf area
- vertical orientation of leaves or stems to reduce incident radiation
- deciduousness
- deep roots or widespread shallow root system
- annual habit
- CAM photosynthesis
- waxy cuticle covering exposed surfaces
- sunken stomata

(4) Describe the movement of water through from the soil into the xylem of a root using a drawing. Show on your diagram where the flow of water is through the apoplastic, the symplastic or both. On your diagram, please mark the parts of the root most important to water flow. (5 points)
(5) On the following chart mark *reasonably* water potential values at various different heights (arrows) in the plant and in the environment. The tree on top is during the middle of the night—the bottom is the same tree but during the middle of the day. (5 points)

(NIGHT)

-20

-1.2 mPa

-0.4 mPa

-0.6 mPa

(DAY)

-40 mPa

-2.2 mPa

-0.3 mPa

-0.6 mPa
(6) On the following arrows please label the following: (i) The Supply Function, (ii) $C_i$, (iii) $C_a$, and (iv) The Demand Function (2 points)

(7) Lastly, mark the regions of the graph where (a) RuBP is saturated, (b) products from the light harvesting reactions are limiting. (2 points)

(8) First, please list two attributes of plants that selection can act upon to change The Supply Function. Second, please list two attributes of plants that selection can act upon to change The Demand Function. (4 points)

The Supply function can be controlled by the concentration of CO$_2$ and the rate of CO$_2$ flux into the cell. Selection can act on the stomatal response to environmental variables, and on stomata architecture.

The Demand function is controlled by the photosynthetic machinery of the plant. Selection can act on the Nitrogen investment to Rubisco, the proportion of light harvesting to carbon fixation apparatus.