Photosynthesis & The Environment Questions

1. A plant completes the light reactions of photosynthesis and produces ATP and NADPH. However, the enzyme Rubisco is ineffective as it has been denatured. What do you suspect has happened to this plant? What makes you think this?
   The environment in the stroma may have changed (acidic, basic…). We know Rubisco is an enzyme and depends on its environment for its tertiary structure. If the shape changes it will no longer be able to bind CO2 & RuBP.
   It is most likely not due to overheating as that would also have potentially denatured the proteins in the light reactions like b-6-f & NADP+ reductase which would prevent the production of ATP & NADPH.

2. What do you suspect would happen to a plant if it was grown in an atmosphere with 90% O_2 levels? Explain.
   It will die. Oxygen will out complete CO2 for active site on Rubisco (photorespiration). The plant will not be able to create needed sugar/carbohydrate molecules in the Calvin cycle. Therefore it will not have molecules to go to mitochondria to generate energy needed for survivial.

3. What do you predict will happen as environmental levels of CO2 increase? Explain why?
   At first there could be an increase in Calvin cycle as there is more substrate available. Eventually it will hit substate saturation and all active sites on Rubisco will be used at any given time.

   Also, it may eventually lead to a decrease in photosynthesis and increase in photorespiration as higher CO2 levels are associated with increased environmental temperatures. Plants will close their stomata more in warmer temperatures to conserve water loss. If stomata are closed then no CO2 is getting in to bind with Rubisco, but oxygen is still present as a product of the light reactions. It is trapped inside the plant cell and can easily bind to Rubisco.

4. Why can the temperature graph for rate of photosynthesis not be explain simply by stating that enzymes denature?
   The initial reason for the decrease in photosynthesis is NOT because enzymes are denaturing. It is because stomata close in warmer temperatures to conserve water loss. This leads to a decrease in photosynthesis because there is less CO2 coming in to bind to Rubisco – which means less ADP & NADP+ are created to go back to light reactions. This also leads to an increase in photorespiration rather than photosynthesis.

5. Explain this statement "At **low light** intensities, rate of photosynthesis increases as light **intensity** increases (not temperature). At **high light** intensities, rate of photosynthesis increases by increasing the **temperature** (not light intensity)."
   At low light intensities, light is the limiting step in photosynthesis. The Calvin cycle is "waiting" for the products (ATP & NADPH) from the light reactions. As light intensity increases so does the amount of light reactions. Eventually though, photosystems will not be able to absorb any more light and saturation point has been reached.
   At these high intensities, Calvin cycle is the limiting step. This is because there is a lot of ATP & NADPH available but Calvin cycle is limited by how fast the enzymes can catalyzed the reactions. Small increases in temperature will increase these reactions as it will speed up particle movement which means enzymes & substrates will collide more often → more reactions. This will occur until the heat becomes too hot & enzymes will denature.