What Would Happen to the Photosynthesis Process, and the Plant as a Whole If…

1. The temperature around a C3 plant was raised to 40 ˚C for one hour, and then increased again to 60 ˚C for three hours? Photosynthesis would eventually come to a halt because the enzymes required in the Calvin cycle have optimal temperatures between 10°C and 30°C. As the temperature is at 40°C stomata will close to conserve water which will put the plant into photorespiration due to lack of CO_2 and increased concentration of oxygen inside the leaves. As temperatures rise above 40°C the enzymes become denatured and can no longer function. Both photosynthesis and photorespiration will stop and the plant would die.

2. A C3 plant was exposed to an atmosphere with 78 % oxygen, and 22 % Carbon Dioxide? Oxygen has an inhibitory effect on photosynthesis. It binds more readily to Rubisco. When oxygen binds, photorespiration occurs reducing the rate of photosynthesis and little to no carbohydrates would be produced using the Calvin cycle. The plant would then begin to break down structural carbohydrates in order to sustain cellular respiration. Whereas when carbon dioxide binds, it is fixed into carbohydrates by photosynthesis. If exposed to his environment for a long period of time it would die.

3. All of the stomata on a C4 plant closed during the day? C4 plants have an alternative mechanism of carbon fixation, so they are resistant to lower levels of CO_2 that would occur if the stomata were closed during the day. However, if all stomata were closed there would eventually not be enough CO_2 available to be pumped into the mesophyll to allow this process to continue. The plant would die if this were to continue.

4. Photosystem II was denatured, and its pigments were damaged? Photosystem II is required in the light reactions to absorb the energy from photons and convert it to chemical energy in NADPH and ATP via electron transport. If it was denatured then photosynthesis would stop all together as no ATP or NADPH would be produced with are reactants in the Calvin cycle and needed to carry out photosynthesis. If its pigments were damaged a similar result would be seen as the pigments are responsible for the absorption of light energy.

5. Plastoquinone was damaged, and only pumped 2 H^+ for every two electrons, rather than 4 H^+? Nothing, as plastoquinone does not pump protons. However, if cytochrome b-6f complex was to have this happen then the rate of ATP generation would be greatly reduced. Each H+ that travels through ATP synthase after being pumped into the thylakoid space because of plastoquinone's transfer of electrons produces 1 ATP. Therefore, if half the H+ are being pumped there are half as many ATP that can be used in the Calvin cycle to create carbohydrates.

6. NADP+ Reductase was removed from all of the thylakoid membranes in a plant? $NADP^+$ is responsible for reducing $NADP^+$ to NADPH. If it was removed than the product, NADPH, from the light reactions needed for the Calvin cycle would not be available. It would therefore stop the Calvin cycle and the production of carbohydrates. The plant would die.

7. The plant was not given water for 1.5 weeks. Water is needed in the light reactions. It is split into oxygen, hydrogen ions, and electrons. Two of the electrons are used to replace the missing electrons in cholorophyll P680. The protons remain in the thylakoid space contributing to the concentration gradient allowing protons to passively move through ATP synthase and produce ATP. If the plant is not getting water then ATP is not being generated and the Calvin cycle is not occurring because it is lacking reactants.

8. The light intensity was constantly increased past the light saturation point. Nothing would happen to the rate of photosynthesis process. Only light reactions are light limited and once the light saturation point is reached those reactions cannot occur any faster. Changing light intensity does directly affect Calvin cycle.

9. The carbon dioxide level was increased past the saturation point. CO_2 concentration has a direct effect on the rate of the light-independent reactions (Calvin cycle). Up until the saturation point CO_2 concentration would increase the rate of photosynthesis. Beyond the saturation point it cannot speed up the reactions any more as all active sites of Rubisco are full. The Calvin cycle at this point is limited by enzyme concentration, not substrate concentration.