

# [Photosynthesis – limiting factors](https://assignbuster.com/photosynthesis-limiting-factors/)

[pic] Photosynthesis Outline Terms and Vocabulary Autotroph Photosynthesis Photon Pigment Chloroplast Reaction Center Electron Donor Molecule Electron Transport System Ferredoxin NADPH RuBP PGA Cuticle Stomata Rubisco Photorespiration C4 Pathway Concepts 1. What are two Adaptations of plant leaves for capturing light? 2. Describe the properties of Light Energy in terms of energy and wavelength. 3. Why are Pigments important for Photosynthesis? 4. What two types of reactions take place during photosynthesis? 5. Summarize the results of Light dependent Reactions. . Summarize the results of Light-Independent Reactions. 7. Where are the pigments for the light-dependent reactions located in the leaf? 8. What is the function of a photosystem? 9. What is the function of water in the light-dependent reactions? 10. Describe the similarities and differences of Photosystems I & II 11. What are the limiting factors to photosynthesis? 12. Describe adaptations that allow the leaf to retain water. 13. Explain how photorespiration reduces production of glucose. Look at the graphs below. A |[pic] | B |[pic] | | C |[pic] | D |[pic] | 1. Which graph best shows the effect of increasing light intensity on the rate of photosynthesis? 2. 3. Which graph best shows the effect of increasing carbon dioxide concentration on the rate of photosynthesis? 4. Which graph best shows the effect of increasing temperature if light and carbon dioxide are not limiting (i. e. he levels of light and carbon dioxide are high). If you plot the rate of photosynthesis against the levels of these three limiting factors you get graphs like the ones below. [pic] Limiting Factor In biology, agriculturalscience, physiology, and ecology, a limiting factor is one that controls a process, such as organism growth or species population size or distribution. The concept is based upon Liebig's Law of the Minimum put forth by German geochemist, Justus von Liebig, in 1840. It can be easy to conceive how a limiting resource (say, food) controls a process (say, growth) by running low or running out.

However, some biological and ecological processes are controlled by too much of a factor (such as heat) rather than too little. Or, processes may be controlled by complex interactions of factors (Shelford, 1952). At any given moment, the rate of a physiological process is limited by the one factor which is in the shortest supply. (Toole pg 273) - The factor which is nearest its minimum value determines the rate of the reaction. - Changing the levels of this factor will change the rate of the reaction. Changing the levels of the other factors will have no effect on the rate of the reaction. Example [pic] [pic] 1. Up to A1, A2 and A3 the concentrations of CO2 is the limiting factor for the respective light intensities. 2. Low Light Intensity: beyond A1 light intensity is the limiting factor because increasing the light intensity (medium value) increases the rate of photosynthesis. 3. Medium Light Intensity: beyond A2 light intensity is the limiting factor because increasing the light intensity (high value) increases the rate of photosynthesis. . High Light Intensity: beyond A3 the limiting factor could be light intensity, chlorophyll content, temperature or the enzyme system. It cannot be CO2 concentration because increase in CO2 concentration does not lead to an increase in photosynthesis. [pic] 1. Up to A1, A2 and A3 the light intensity is the limiting factor for the respective CO2 concentrations. 2. Low CO2 concentration: beyond A1 CO2 concentration is the limiting factor because increasing the CO2 concentration (medium value) increases the rate of photosynthesis. . Medium CO2 concentration: beyond A2 CO2 concentration is the limiting factor because increasing the CO2 concentration (high value) increases the rate of photosynthesis. 4. High CO2 concentration: beyond A3 the limiting factor could be CO2 concentration, chlorophyll content, temperature or the enzyme system. It cannot be light intensity because increase in light intensity does not increase photosynthesis. [pic] In commercial greenhouses horticulturists try to maximise productivity by maximising the rate of photosynthesis.

How do they achieve this? - Clear glass maximizes light intensity - Extra lighting in winter - Glass traps heat energy from solar radiation - Heaters raise night time temperature - Gas and oil heaters put extra carbon dioxide into the air. [pic] Photosynthesis and productivity •       carbon gain by the plant (biomass) is dependent on the balance between carbon uptake by photosynthesis and carbon loss by respiration •       factors influencing productivity include - light, - CO2, - temperature, - environmental factors: light:        at low fluence levels, there is a net loss of CO2 •       light compensation point is where CO2 uptake and exchange equal zero (equivalent to an office or room) •       as fluence rate increases above compensation point, so does photosynthesis (C3 plants) until light saturation is reached (1/4 to ? full sun) •       light saturation occurs because CO2 is limiting •       C4 plants don’t achieve light saturation as rapidly as C3 plants CO2: •       CO2 content in atmosphere is about 0. 035% by volume (well below CO2 saturation point in plants) •       at higher fluence rates when CO2 is not imiting, photosynthesis increases •       some commercial growers practice CO2-enrichment to increase yield and biomass  temperature: •       temperature response is influenced by temperature dependence of enzymes and chemical reactions •       cardinal points are used to describe temperature minimum maximum, and optimum of a reaction •       many reaction rates tend to decline sharply following optimum due to enzyme denaturation •       for photosynthesis, temperature response curves represent the average of many different enzymes, but are dominated by rubisco (C3 plants) and PEPcase (C4 plants) water:        waterstresscauses a decline in photosynthesis •       water stress triggers stomatal closure and subsequent decrease in CO2 levels •       turgor pressure reduces leaf expansion decreasing photosynthetic surface area •       even mild water stress causes decrease in net photosynthesis nutrients, pathology, and pollutants: •       photosynthetic capacity is especially sensitive to nitrogen •       rubisco accounts for ; 50% of total leaf nitrogen •       pathogen stress reduces photosynthetic capacity •       environmental pollutants (sulpher dioxide, ozone, heavy metals) also reduce capacity eaf factors: Question:  Which has a higher photosynthetic rate - a pine tree needle or a maple tree leaf? Why might needles be favored over leaves on pine trees? •       productivity of plants is impacted by leaf canopy •       canopy is determined by age, morphology, angle and spacing of individual leaves •       in older plants, lower leaves may be shaded and fall below light compensation point (negative carbon gain) and are a burden to the plant •       many annuals undergo sequential senescence to avoid the burden •       some leaves change with the angle of the sun [pic] pic] [pic] ----------------------- A plant in the dark does not photosynthesize. [pic] Increasing the amount of light increases the amount of photosynthesis. [pic] Even if a plant in the dark is well watered and given increasing amounts of carbon dioxide it will not photosynthesize. Only a change in light intensity will alter the rate. Light is the limiting factor.