

There are few ecosystems that we know of that can run independently of from the influence of photosynthesis. Though we may only know of a few, these environments do exist. One such environment, as given in the prompt, is underground where organisms use the chemical interactions of the rocks around them to produce hydrogen which acts as an electron donor to a carbon dioxide acceptor producing methane. Because this form of respiration/energy can take place deep within the Earth, there is plenty of real-estate for these organisms to thrive – we probably just do not have the means of discovering them. For example, 95% of the ocean and about 99% of the ocean floor remains unexplored¹. At these depths where the ocean meets the oceanic crust, there would likely be an abundance of iron and silica, along with the oxygen and hydrogen from the ocean water. This could allow for reactions similar to the methanogens mentioned earlier. Thus, I would suspect that these types of environments that run independently of photosynthesis are more abundant than we currently think. The organisms that would survive here would also need to be some sort of extremophile due to the extreme depth/pressure and heat from the Earth's crust.

It is important to note that the environments and reactions which I have just described rely on the use of oxygen which was most likely produced by photosynthesis at one point in the past.² So, technically those environments are not 100% independent of photosynthesis – they are just not directly impacted by it. Oxygen can be generated from abiotic sources, but because of the Cambrian explosion where oxygen concentrations rose dramatically due to cyanobacteria, we cannot necessarily distinguish if oxygen here or there was produced from this photosynthetic event. Thus, to be 100% sure that an environment and its organisms are existing entirely outside the influence of photosynthesis, it must be entirely void of oxygen because that oxygen may have been produced through photosynthesis. In this case, could environments support organisms entirely void of oxygen? As stated in the book, anaerobic respiration does exist and “there are plenty of other molecules and elements that will [accept electrons].” Though, because the Earth is composed of mostly SiO₂, finding such an environment may be difficult, but I do not believe it is impossible. Especially on other worlds that have thick atmospheres composed of other gasses or crusts that are different from Earth's.

¹ <https://www.livescience.com/14493-ocean-exploration-deep-sea-diving.html>

² <http://www.southernfriedscience.com/ocean-of-pseudoscience-shortie-chemosynthetic-ecosystems-and-independence-from-the-sun/> *I got this source from Bree Tatum's paper