8-1. Why are extreme life-forms on Earth, such as those shown in the photograph that opens this chapter, of interest to astrobiologists?

Because they show that life can exist in more hostile environments than, only several years ago, were believed capable of supporting life. This perhaps implies that hostile environments on other solar system bodies, once or now believed incapable of supporting life, could possibly do so.

8-7. Explain which variable in the Drake equation is the most difficult to estimate and suggest why this would be.

The variable most difficult to assess in the Drake equation is $L$, the average lifetime of an advanced civilization. We are not even capable of using our own civilization as a helpful example because we have almost no ability to predict how long our civilization will survive on the earth. We have no idea how civilization on the earth will be extinguished. Warfare, extinction induced by pollution, famine, climate change, a major epidemic or even a major impact event all are possibilities. Will we solve our major social problems on Earth, or will a lunatic tyrant, in some outlaw nation start a civilization-ending nuclear war? Have other worlds solved such problems, or have other civilizations self-destructed almost as soon as they have risen. Scriptural evidence suggests we won’t last too long, but history suggests that we tend to think the end is closer than it really is.

8-9. Why are most searches for extraterrestrial intelligence made using radio telescopes? Why are most of these carried out at frequencies between $10^3$ and $10^4$ MHz?

Radio telescopes can be built much larger than optical telescopes, making them capable of detecting much fainter signals. Furthermore, the radio sky is much darker than the optical sky, another great advantage when attempting to observe a faint signal. The $10^3 – 10^4$ MHz frequency range is the darkest part of the radio spectrum. Frequencies lower than $10^3$ MHz are progressively more noisy with decreasing frequency because of radiation emitted by galaxies. Frequencies higher than $10^4$ MHz are progressively more noisy and contaminated with increasing frequency because of radiation, both emitted and absorbed by Earth’s atmosphere. This $10^3 – 10^4$ MHz frequency range is sometimes referred to as the “water hole” because it contains emission features produced by H, atomic hydrogen, and the hydroxyl radical, OH, which, when united, make $H_2O$, a water molecule. (As our ancestors may have done thousands of years ago, we still look for life at the “water hole.”)

8-10. Explain why planet-hunting infrared telescopes need to be placed in space?

There are at least two reasons: (1) The earth’s atmosphere is partially opaque to IR radiation. Furthermore that opacity is highly variable over even short periods of time. Also that opacity is greatest at those wavelengths we wish to observe where absorption features of water vapor, carbon dioxide and ozone may be capable of revealing the presence of life as we know it on other planets. Those same gases are abundant in our own atmosphere and would make it virtually impossible to observe them accurately in the weak signal we would receive from any other planet. (2) The earth is a strong emitter of IR radiation; even a ground-based IR telescope glows in the infrared. Looking for weak IR signals from a ground-based IR telescope would be something like looking for a very faint star with an optical telescope illuminated with floodlights.