LESSON 3 // stellar habitability

mood

objective	Answer
warm-up	If the sun were to suddenly disappear, what do you think would happen right now and over the course of the next 24 hours?
	Hypothesis

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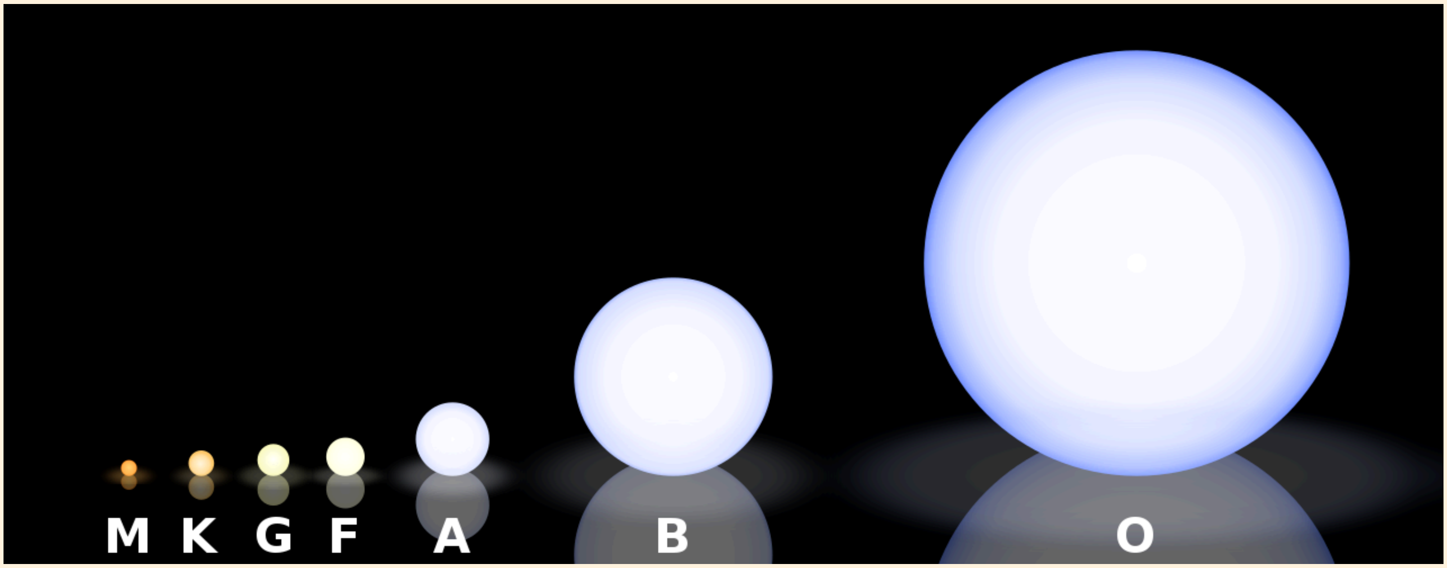
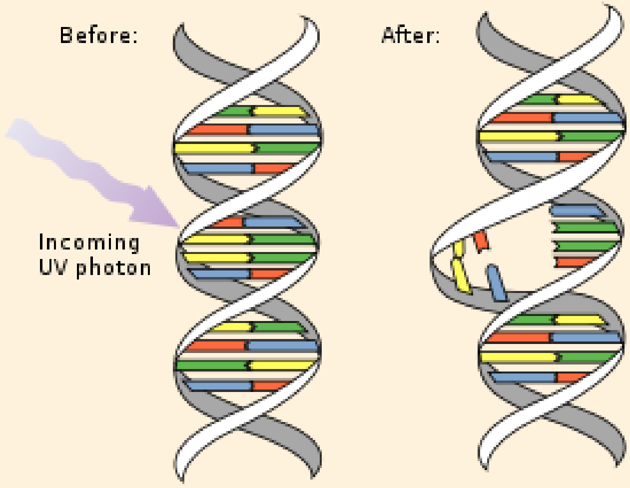
section #1	I have written an article for you on stellar habitability but it is incomplete. You will finish the article and discuss the habitability of G, K, and M-Class stars.



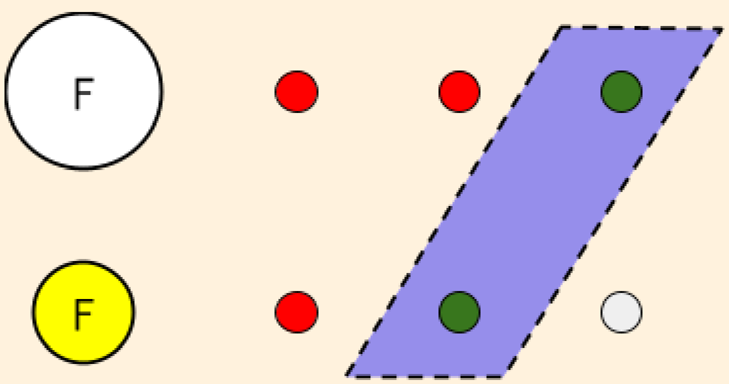
There are 200 billion trillion stars in the Universe and not all are created equal when it comes to the discussion of how well suited they are for habitability. In this analysis, we will define habitability as the ability for carbon based life to survive on a planet that is orbiting one of these stars. Lucky for us, we do not need to memorize how good each of the 200 billion trillion stars are for promoting life on their orbiting worlds because they can all be categorized as one of 7 classes of stars ranging from the small, relatively cool M-class stars to the massive and blazing hot O-class stars. To make things easier to follow, we will look at the largest stars first and then make our way down in scale.

If there is one thing life needs above all else, it's time. Sure, humans were able to selectively breed wolves roaming our prehistoric campsites into modern day poodles in just 10s of thousands of years but when it comes to the organic evolution of life, things take time. A long time...time that O, B, and A-class do not allow for because they rapidly use up their nuclear fuel in less than 10-million years and then die violent, explosive deaths.

Another major issue for these stars is that even if they did have a longer life span, they still give off far too much UV radiation. As all life is based on molecules that replicate (DNA), and the intensity of the UV radiation would damage and mutate the delicate molecules. Even on our own Earth, UV radiation damages the DNA in your skin cells (shown on the image to the right). Fortunately, our planet has an ozone layer that blocks most of this harmful UV radiation but even the small amount that gets through can cause skin cancer.



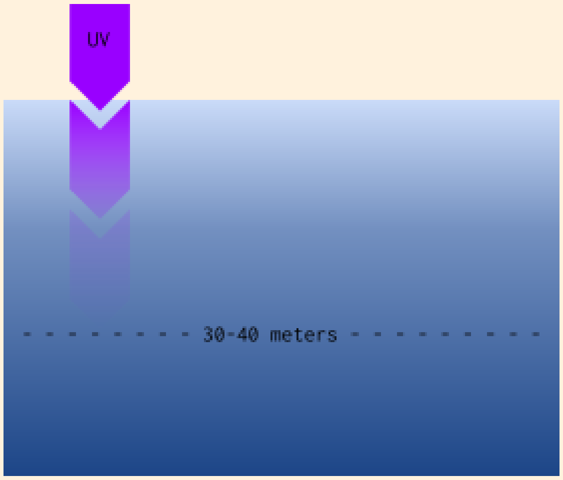
Moving down in mass we encounter the F-class stars. These stars also have similar issues with life span and UV radiation, although recently it has been hypothesized that they might be able to support life. The key to this is to look at the smaller F-class stars, called F8 stars. Since F-class stars are hotter than our own star, the habitable zone (distances where liquid water is possible) for orbiting planets would be considerably farther away from the star.



F-class stars have a habitable zone or *Goldilocks Zone* that is further from the star than our own. For F8 stars, this zone is from 1.1 - 2.2 AU. The term AU is Astronomical Unit and refers to the distance between the Sun and our Earth.

If you put an F8 star in place of our own, the Earth would be too close (1 AU) but Mars (1.52 AU) would be in the Goldilocks Zone.

For planets orbiting an F8 at the right distance, any life that might evolve would be quite simple and never able to develop much complexity. This is because F8 stars exist in their stable phase for 2-4 billion years and by comparison, earth had evolved simple life forms around 3.7 billion years after its formation. It wasn't until 4.5 billion years after Earth's existence that a proliferation of complex, aquatic life was able to evolve.



As it was with the earliest life on earth, any organisms that would evolve in an F8 solar system would also be permanently confined to life underwater. It was stated earlier that F-class stars emit more UV radiation and without any significant atmosphere or ozone layer, life forms would need to stay 30-40 meters underwater to escape this radiation. Studies have shown that UV light is only detectable at 1% of its initial levels at these depths and this would be sufficient for fragile and sensitive molecules such as DNA to survive.

Taken in sum, stars in class O, B, A, and F seem unlikely candidates for the evolution of complex life forms related primarily to their short lives and intense radiation in the UV part of the spectrum. There is one other consideration that makes them poor candidates and that is their relative lack of abundance in the Universe. Of these, only F-class stars hold any real chance of having simple life and with only 3% of all stars being F-class the odds are not in their favor. We must also consider that of all F-class stars, only the smallest and coolest can potentially harbor life, lowering this figure even more. So then, where should we turn to find more habitable stars?