Life in the Universe

Ever since mankind has been contemplating the heavens, people have thought about what aliens might be out there. Even the Greeks had aliens of sorts in their writings. In the 16th century, Bruno suggested that every star had planets and life (the first to conceptualize the universe this way, he was eventually burned at the stake, though not solely for this view).

Later, when Percival Lowell used his telescope to look at Mars, he even imagined he saw canals signifying life (partly due to a mistranslation of Schiaparelli's c*anali*, which means channels, not canals). Of course, the human brain is very good at drawing connections where they don't really exist, and today we know that those “canals” were just the human eye connecting unrelated features.

Whether or not planets actually exist around other stars was an open question until we started detecting them. At first, we could only find planets that were very large – bigger than Jupiter – and very close to their parent stars. These huge, hot gaseous planets aren't especially good for life as we know it. However, as our technology improves, we find more planets – recently even planets and stellar systems similar to our own Solar System. We are beginning to have evidence that Bruno was more or less correct: while not all stars have planets around them, many probably do.

Today, what we know about other planets in our solar system, as well as life here on Earth, lets us imagine what life might be like on planets around other stars. In this lab, we will investigate what conditions life needs, and look at where else we might find it.

Part 1: What is "Life"?

The Kepler mission is searching for terrestrial planets in the "habitable zone" around the parent star. In choosing this mission goal, scientists are trying to find places where life as we know it could exist.

With your group, answer **questions 1-3** based on what ***you*** think**. We will then discuss this as a class.**

For the remaining questions, you have several resources available:

- Textbooks
- The Internet
- Yellowstone Pamphlet
- Your brain!

Use each of these to think about **questions 4-7** in this section.

Part 2: Life in Extreme Environments on Earth

Of course, life even now exists in some crazy places on Earth. We have found life at the bottom of 1 km deep mines, in superheated (above the normal boiling point) pools of water, in extremely salty situations, and even in clouds. Microbes that live in extreme environments are called extremophiles.

Before we can know where to look for life elsewhere, we need to investigate properties of extreme life on Earth. "Extremophiles" are organisms that live in crazy, weird, extreme conditions.

Go to the lab website:
http://phys.stthomas.edu/ExtraSolar/

You will want to come back to this page often in this lab!

Some extremophiles are described at the first two websites linked on the web page above.

1. Using the **World Map of Extreme Environments** from the **Montana** website, investigate the most extreme conditions life can be found. For more details on the Yellowstone extremophiles, you can click on the Yellowstone map. You may also use any other websites to find more information about other extremophiles.

2. Think about what properties of these areas make them "extreme" and **answer questions 1 and 2**.

We typically define the "habitable zone" around a star to be the range of distances that could potentially support life as we know it.

3. Using this *general* definition and Kepler's discussion of habitable zone, **answer questions 3 and 4** in the packet.

Part 3: Finding Life – our own solar system and beyond

Now that you have some idea of the parameters life might require, let's take a look at some nearby (in our own solar system) places that might contain life.

1. Compare your criteria for "habitable" to locations within the solar system. What planets should you consider? What moons? Answer **questions 1 and 2** for planets and moons *within* our solar system. *You may wish to answer both questions at the same time!*

The Kepler space telescope mission was designed to search for worlds that could potentially support life.

Check out the **Kepler Mission Homepage** to see what its capabilities are. There are many parts of the website that are useful; in particular the menu Science → About Kepler has both a FAQ and science goals. You can also look at the data table Mission → Kepler Discoveries to see what columns are included – but be aware some of these are derived properties, not directly observed. *Note: when actually using the data table, go back to our website!*

2. Use the Kepler website to answer **questions 3 and 4**.

3. Think about what you have learned about life here on Earth, along with the capabilities of the Kepler mission, answer **question 5**. These will be the criteria you use when deciding on which planets ***you*** think might be worth considering in our search for life!

3. Next, **download the table of extra-solar planet data from the lab website**. Most of these have been found by the Kepler mission. Using this data and what you have learned so far, answer the remaining questions.