The age-old question regarding the origins of the universe has plagued the minds of scholars and laymen alike for centuries. This, and the subsequent creation or evolution of life has provided the basis for numerous belief systems. Today we are faced, not with the question of who or what was responsible for the origins of the universe and life, but with what life actually is? Humans obviously stand at the center of this debate, the only voice currently available for discussion, not to mention the only being with a capacity for speech and abstract thought. Speech and abstract thought are often regarded as two of the defining characteristics of life, but in fact those are defining characteristics of being a human being, not being alive. Just because a dog is not capable of abstract thought and speech, as we are able to comprehend, it is not denied the status of being alive. In order to answer the question of what life is, we need to evaluate the defining characteristics of life on both the cellular and cosmic levels. Furthermore, let us explore the possibility that there are alternative forms of life that are 'alive', but fail to meet what we as humans put forth as our standards for life.

When seeking the definition of a term, the dictionary always seems the most appropriate starting point. The dictionary defines life as the following:

- The property or quality that distinguishes living organisms from dead organisms and inanimate matter, manifested in functions such as metabolism, growth, reproduction, and response to stimuli or adaptation to the environment originating from within the organism.
- The characteristic state or condition of a living organism.
- A living being, especially a person.
- God.¹

¹ The American Heritage® Dictionary of the English Language, Third Edition
Copyright © 1996,
How is it that the dictionary can list God as a definition of life, having just
described life as the 'property or quality that distinguishes living organisms and
inanimate matter...'? According to Nietsche, "God is Dead". Alternatively,
He/She/It is only alive within the hearts of those believers who have faith it's
presence. There have never been accounts of God responding to stimuli,
growing or reproducing². God is void of mass, and outside the realms of time
and space, thus is it ever possible to conceive that God is life? It just isn't a
possibility based on what the dictionary provides as its definitions; but then
again such a complex idea may require multiple definitions, that don't
necessarily complement each other. The dictionary provides a good start, a
stepping stone towards understanding what life is, but it lacks characteristics
necessary for comprehension and understanding.

In an attempt to answer the question, what is life? The following
definitions have been suggested by a number of Doctors, Professors and
Students at Dartmouth College when posed with this question:

- Life is not death³.
- Life is being able to perceive the world around you⁴.
- Life is a biological force capable of self-replication⁵.
- Life is the ability to think⁶.
- Life is the ability to reproduce⁷.
- Life is an observable pattern in which elements are reoccurring⁸.
- Life is the advanced placement course for souls⁹.

² Be careful not to confuse creation with reproduction, as is usually attributed to God.
³ Excerpt from interview with Ivan Collazos 05-24-01
⁴ Excerpt from interview with Nathaniel J. Riley 05-24-01
⁵ Laurence J. Davies 05-24-01
⁶ Brian D. Graner 05-24-01
⁷ Megan S. Steven 05-24-01
⁸ Excerpt from interview with Daniel S. Rothfarb 05-21-01
⁹ Excerpt from interview with Benjamin D. Herson 05-20-01
Life is the ability of a complex and changing chemical system over time to retain a high level of stability and internal organization (resistance to entropy) through the informational control of energy and material flows.\textsuperscript{10}

Perspective plays a large role in interpreting life and its components. For some, life is not hard to define. For one friend it was merely anything that is “not dead”.\textsuperscript{11} This is congruent with what the dictionary has to offer, but there are obvious flaws to this argument. Although a plastic container is not dead it is most certainly not alive, and thus not being dead can not on its own be an acceptable definition of life. All forms of ‘life’ that are no longer living would no longer be accepted. Dinosaurs, although once alive, are not forms of ‘life’ by this definition. This definition has many flaws, but also shows merit. With this definition in mind, could it then be extended to the search for life on the planet Mars? What are the implications for the fossilized nanobacteria\textsuperscript{12} discovered within the Martian meteorite ALH84001?

\textsuperscript{13}

\textbf{Figure 1 Image of Possible Fossilized Bacteria within Martian Meteorite ALH84001}

\textsuperscript{12}Nanobacteria are described as the observed elliptical, rope-like, and tubular structures in fractures in the carbonate mineral globules; they interpret the structures as possible fossil bacteria, but warrant the prefix nano due to their miniscule size, 20-100 billionths of a meter across (or nanometer). Source: http://www.lpi.usra.edu/lpi/meteorites/life.html

\textsuperscript{13} http://www.lpi.usra.edu/lpi/meteorites/life.html
Or, could this discovery be proven irrelevant with consideration of the previous definition? If in fact a dead, fossilized nanobacteria is not life, what was the big commotion back in 1996 that shook the planet upon its discovery? There is no definition that life is something that was once alive, but rather always specifies being ‘not dead’ as the defining property of life. A fossilized nanobacteria is obviously dead. To conceive that the nanobacteria was once not dead, and thus alive, and consequently constituting life would be an amazing discovery. Or would it? Would the discovery of a previous form of ‘life’ prove that we are not alone in the known universe, or more accurately that there was once life anyplace other than on planet earth? The problem is that when we search for life we are searching for something that we expect to mimic what we know to be life on earth. Again, perspective plays the most important role in distinguishing what ‘life’ is. Does a rock constitute life? The common answer would be no, but you could expect that if bacteria was present on the outside or in cracks of this rock that this answer would be subject to change. When one goes to the beach and walks on the sand are they walking on life? Think about what goes into sand, or sandstone for that matter. Most of the components were once alive, and thus not dead, meaning that those substances (sand and sandstone) are ‘life’. Alternatively, does the grass on your front lawn constitute life? Most definitely! But, what about the patches of brown ‘dead’ grass? Those blades are no more animate than a rock, but yet they were once alive and thus by our new definition are life. For that matter it could be argued that the rocks and every other object in and on this Earth is alive. It is all part of the Earth as a whole, the Earth which
stands as the epitome of organization, reproduction and response to stimuli…

LIFE!

Thinking of the Earth as an independent living being dates back to Dr. James Lovelock’s *The Gaia Hypothesis*. A British Chemist specializing in the atmospheric sciences, Lovelock stumbled into his idea of a living Earth while looking for evidence of extra-terrestrial life on Mars. Lovelock’s hypothesis is based on the idea that the Earth is the way it is because it has adapted to the diversity of life that resides within it, straying from the popular belief and sentiment that life adapted to fit the conditions of the Earth. In Lovelock’s own words,

...The physical and chemical condition of the surface of the Earth, of the atmosphere, and of the oceans has been and is actively made fit and comfortable by the presence of life itself. This is in contrast to the conventional wisdom which held that life adapted to the planetary conditions as it and they evolved their separate ways... The entire range of living matter on Earth from whales to viruses and from oaks to algae could be regarded as constituting a single living entity capable of maintaining the Earth’s atmosphere to suit its overall needs and endowed with faculties and powers far beyond those of its constituent parts...[Gaia can be defined] as a complex entity involving the Earth’s biosphere, atmosphere, oceans, and soil; the totality constituting a feedback of cybernetic systems which seeks an optimal physical and chemical environment for life on this planet.\(^\text{14}\)

Consider the Carbon and Nitrogen cycles that are known today and used to describe past conditions of the planet. Now think whether or not it was the presence of life that shaped the Earth and thus brought it to life, or whether by some unique chance life evolved to fill the niche that was appropriated it. A combination of the two seems most likely, but in either case you can still readily

arrive at a living Earth hypothesis, which is precisely what Lovelock did. He goes on to further specify and explain the nature of Gaia:

The name of the living planet, Gaia, is not a synonym for the biosphere - that part of the Earth where living things are seen normally to exist. Still less is Gaia the same as the biota, which is simply the collection of all individual living organisms. The biota and the biosphere taken together form a part but not all of Gaia. Just as the shell is part of the snail, so the rocks, the air, and the oceans are part of Gaia. Gaia, as we shall see, has continuity with the past back to the origins of life, and in the future as long as life persists. Gaia, as a total planetary being, has properties that are not necessarily discernable by just knowing individual species or populations of organisms living together... Specifically, the Gaia hypothesis says that the temperature, oxidation, state, acidity, and certain aspects of the rocks and waters are kept constant, and that this homeostasis is maintained by active feedback processes operated automatically and unconsciously by the biota.\footnote{15}

In the Gaia Hypothesis there is no place for a layer of life on Earth, but an encompassing definition of life that extends from the inner most core to the outer most layers of the atmosphere. Lovelock defends this definition with the image of the giant redwood, explaining that less than 1% of the actual tree (basically it’s bark) is alive, that it is essentially an "ancient spire of dead wood, made of lingin and cellulose"\footnote{16}. Lovelock argues that the tree is alive, and thus the Earth is alive.

If the Earth is alive, what about our nearest neighboring planet Mars? For that matter, what about the Sun, the Solar System and the Universe? Despite our advancing knowledge of Mars’ atmospheric conditions, soils, temps, etc. we are no closer to proving or disproving life than when we started. Instead, compare Mars to a seed while keeping the principles of the Gaia Hypothesis in mind. Seeds are seemingly lifeless entities, and yet they contain within them the genetic blueprint for life. It is possible that a seed may lay dormant for ages, but given

\footnote{15} Ibid  
\footnote{16} Ibid
the right circumstances of temperature, moisture and an energy source will undergo germination. Is a seed thus to be considered life? It seems viable. Could then Mars be considered a dormant seed waiting patiently for the conditions to arise that will aid in its germination?

A professor of medicine stated rather confidently that life was ordered processes, with complex molecules responsible for construction and function\textsuperscript{17}. Asked to think outside our realm of terrestrial knowledge, he responded that what we define as elements and molecules have been based on arbitrary features, "thinking about only the molecules we know, the three dimensions in which we operate and the very concept of mass, energy and time"\textsuperscript{18}. He then went on to propose that the Sun could very well be considered alive, congruent with the defining characteristics he previously established. The Sun is in fact an ordered process of chain reactions of elements, which produces an immense amount of heat and energy. The Sun acts as the life sustaining unit of the Solar System, and without it, there would most certainly be no life anywhere in this planetary system and this conversation would be a moot point. Again turning to the dictionary, the official definition of Sun reads, "A star that is the basis of the solar system and that sustains life on Earth, being the source of heat and light"\textsuperscript{19}. The Sun equals life for planet Earth, and thus the Sun must itself be life. Where the Sun acts as the center of the Solar System it could easily be seen as a living whole just as the Gaia Hypothesis proposes that the entire Earth is one living system. Furthermore, where our Solar System is a part of the Universe, it could

\textsuperscript{17} Lee A. Witters
\textsuperscript{18} Ibid.
\textsuperscript{19} The American Heritage® Dictionary of the English Language, Third Edition
then be surmised that the entire Universe is in fact one large living and ordered entity, which would not be possible without any of it’s parts which collectively give it this identity.

Considering the seed simile, would the definition of life then have to be extended to include those things that possess the potential for life? Or, is it only at that moment when conditions are right, when life germinates or is born and given the title 'life'? On the other hand it seems unfair to define birth as a characteristic of life. When an unborn fetus dies en utero, has it really died? Can something that never achieved birth ever be considered alive, and thus have the properties necessary to die? Absolutely! Not only does a fetus en utero possess all of the precursors to life which obviously give it potentially for life, but also processes of growth and differentiation have begun which necessitate life. The argument could be made that this is merely the fetus acting as a parasite living off it’s host, but that is no matter, because despite whether it be a parasitic or symbiotic relationship, parasites are still alive.

Life is everywhere. It exists all around us in processes too small for the naked eye to perceive, but also in those too astronomically large for conception. Life is present in birth and death alike. It is both potentiality and actuality, that which could be, and that which already is. Life represents the harmony and order in all structures, and the mere fact that there is structure points to the existence of life. It is said that out of chaos comes life, but equally true is that life opposes chaos, and anything with inherent order could thus be conceived of as life.
I would like to propose that 'life' and it's defining characteristics be anything past, present or future that has, does or could possess self regulating principles of organization and growth, that demonstrates response to stimuli and is made up of matter that occupies physical space. Beyond that, it is a question that can only be answered on an individual basis based on personal, societal and cultural beliefs and conceptions.