

# Universality

I use the term *Universality* in a special way that will be clearer as one reads on. This is really a section needed to establish consciousness on the part of the reader regarding the reader's belief system. A series of simple yes/no questions will be presented and the readers are asked to answer for themselves these questions. At some point the meaning of the question may not be understood by the reader. That signals the need for the reader to do appropriate study. The reader should do this test now and also after reading this text.

Before listing the questions, a few statements of putative fact will be made in order to set the context. It is now observed that there are in our Universe at least 100,000,000,000 galaxies, i.e.  $10^{11}$  galaxies like the Milky Way, each containing of order  $10^{11}$  stars (over the past few decades, these estimates have grown and may continue to do so. Our Sun is in the outer disk of our spiral galaxy but is otherwise a rather typical star of typical size. Astrophysicists and cosmologists have models for the formation of stars like our Sun and in these models the rotating gases and dust that begin the star formation contract under gravitational forces (collapse) while conserving angular momentum. This leads to a central spinning star surrounded by a rotating flat disk of matter in which planets can form. The inner planets typically contain the dense rocky matter, primarily silicates, and the outer planets are primarily gaseous (There are many other things in the solar disk such as asteroids and comets. Early on cometary matter is a large part of the structure, out beyond the outer gaseous planets.) In this picture it is not surprising to find a rocky, Earth-like planet at a distance from the central star that is conducive to liquid water and a stable atmosphere. These statements could be expanded upon for many pages and there would be much debate about details, but our purpose here is to merely set a stage for the questions already alluded to. Crucial to this picture is the relatively high abundance of oxygen and silicon in the Universe as a result of *stellar nucleosynthesis* (see the [\[elements of life\]](#)). The tendency of silicon and oxygen to combine and form huge three dimensional polymers called silicates explains the natural abundance of rocky planets. The crust of the Earth is, by weight, 75% oxygen and silicon, primarily as silicates.

Universality is the view that something or some process occurs everywhere in the Universe. Take the following Universality IQ test.

Do you think arithmetic is the same everywhere in the Universe?

Do you think geometry is the same everywhere in the Universe?

Do you think algebra is the same everywhere in the Universe?

Do you think vector calculus is universal?

Do you think physics is universal?

Do you think the speed of light is universal?

Do you think Planck's constant is universal?

Do you think the charge of the electron is universal?  
Do you think the periodic table of the elements is universal?  
Do you think chemistry is universal?  
Do you think organic chemistry is universal?  
Do you think biochemistry is universal?  
Do you think polymer chemistry is universal?  
Do you think the genetic code is universal?  
Do you think the protein biosynthesis machinery is universal?  
Do you think bone, muscle and nerve are universal?

These 16 questions should help readers to establish where the line between yeses and noes is drawn in their belief system. So there is no doubt about where I stand, my answer to each question is yes. Admittedly there are variations in the genetic code right here on Earth. But these are minor and my answer of yes to question 14 means that I do not expect major differences to occur. Similarly with respect to the structure of the protein biosynthesis machinery. I expect it to be based on RNA and proteins but perhaps with many differences in sequence details in these polymers. However, the basic structures will be everywhere, such as tRNA's, ribosomes and aminoacyl-tRNA-synthetases (aaRS's).

Our Sun is a fairly typical star. The Milky Way may contain as many as  $10^{10}$  of them. Most of them may have planetary systems like our own, with rocky and gaseous planets. Earth-like planets may be common. In the Universe as a whole there could be  $10^{20}$  Earth-like planets if we are optimistic. That's a lot of potential places for intelligent life, as we know it! I hope that as the reader works through the main text, he/she will begin to feel the same optimism.