The beginning of "life", and the beginning of Biology

How was the Earth formed?

Scientists consider that the whole of the Universe with its trillions of trillions of Galaxies and Solar Systems was formed after the "Big Bang" (and those scientists who believe in a Deity say that "Big Bang" was the act of creation by a Deity[1]). Our own **solar system** (the Sun/the planets including the Earth and the Moon/the asteroids/meteors/etc), was formed by the coalescing of stellar debris under both (i) the force of gravity and (ii) as a result of massive impulses of energy that occasionally pulse/race across the Universe (and these are caused by explosions in the formation of supernovae).

After our Sun formed, smaller bits of left-over stellar debris crashed into each other (either randomly or as a result of the above forces) and thus became bigger and bigger pieces of space debris, until eventually the planets (including our own **Earth** and **Moon**) were formed[2]. However, in the impacts of small pieces of space debris upon each other, much of the kinetic energy in them was transformed into heat energy and thus all the planets were originally seething masses of molten rock (or else seething masses of enormously hot gases).

Using radio-active dating, scientists are able to estimate that the Earth as a gigantic ball of molten lava was formed (give or take) 4.5 billion years ago, and that it gradually cooled down so that a crust of solid rock formed over the molten lava. Scientists are not entirely sure where the Water on the Earth's surface came from (there are some who say that it originated from the asteroids/meteors/etc of space debris), but however it got there, it is incontrovertible that there is currently a huge amount of Water on the face of our planet. It is calculated that the Water on the face of the Earth would cover the Earth to a depth of 12,000 feet if the surface of the Earth were uniform. That is a *large* volume of Water.

When it was molten lava, any Water that there was, had to exist as steam in the Earth's atmosphere, and it was only when the surface of the Earth cooled to below 100˚C that the steam condensed into water, and then the force of gravity forced that water to fall as rain. When it started to rain, it rained and it rained for a *very* long time. Given the amount of Water that there is on the Earth today, it must have rained non-stop for *tens of MILLIONS of years*. The uniform force of gravity on the surface of a liquid medium (such as molten lava) would have caused the surface of the Earth to be flat as it cooled to form the Earth's crust, and as the conversion of the steam into liquid water was taking place, the huge forces inside the Earth (in the molten lava) caused the crust of the Earth's surface to become distorted and forced some of the land mass that existed below the surface of the oceans to be contorted upwards and caused it to jut out above the surface of the ocean that covered the face of our planet. Thus it was that "**land**" as we call it (the bits of our planet that protrude above the surface of our oceans and seas) was formed. Clearly there is "land" below the surface of the oceans and seas – but we do not label that as "land", but rather as the ocean-floor or sea-bed.

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[1] There is a scientific methodology to establish "facts", and if something is "factual" then there is no room for arguments/disputes However, if something is a belief, then we should respect each other's beliefs, and not force our beliefs/opinions on anyone else. **There is thus no reason why scientists should *ever* argue with each other.** Scientists who do not believe in a Deity cannot as yet provide a satisfactory explanation for the transformation of "nothing into something", and for those who believe in a Deity then presumably their Deity can create things in any way that He/She wants to do (either through *evolution* or through an instant act of *creation*). There is therefore no need for conflict between Religion and Reason, other than if one lot of believers wants to force its beliefs on other people (which is not a particularly nice thing to do). It is important therefore in Science to separate **beliefs** from **facts**, and not to confuse the two things. It is also important for scientists to constrain their claims to only that which can be proved by scientific methodology. For example, scientists do **not** know exactly how "life" started on Earth, and it is unprofessional for any scientist to claim otherwise. If we are not even sure how Water appeared on the face of our planet, then we are going to be less likely to be certain as to how *life* itself occurred (i.e. even supposing that we know what "life" actually is, cf. Margaret Boden's huge two-volume essay "Mind as Machine").

[2] Interestingly, there is evidence that leads one to believe that the planets were originally **not** where they are located now in relation to the sun – but that is a different story.

Scientists believe that life as we know it on Earth (and scientists have no reason to exclude the possibility of there being life forms other than those that we have here on Earth), began about 800 million years after the Earth was formed (i.e. about 3.7 billion years ago). *However, scientists are very willing to admit that as yet we are not clear as to how life started.* It may have been a purely random occurrence, but there are other scientists who believe that an act of "creation" (i.e. the transformation of a combination of chemical materials into something that possibly has a non-material element to it) by some sort of Deity is needed to explain life itself – and **there is no scientific way of deciding such issues**. However, there are also other scientists who believe that "life" is merely the appearance that enormously sophisticated **material entities manifest**, and that there is no non-material element to such entities (and this lies behind the 'Deus ex Machina' mechanical movements built in certain German towns in the 17th and 18th centuries). There is a similar debate as to whether or not there is such a thing as a non-corporeal "mind", or whether entities such as consciousness/emotions/etc are merely the manifestation of the enormously complicated/sophisticated computer that we call the "brain". (Margaret Boden has written an extremely interesting two volume book called "Mind as Machine" on this subject – and the first volume *alone* runs to 700 pages!)

Whatever one's beliefs, it is important to recognise them as beliefs and not to confuse them with facts – and this I shall always attempt to do. A good scientist never claims more than can be proved by science and admits to ignorance where there is insufficient evidence to prove something one way or another.

Life exists on the Earth

In the olden days, Education in Europe and the Middle East was heavily controlled by Judaeo-Christian-Islamic culture[3], and European scientists used to define "life" in a way that made it clear that they had a pre-conception of what they wanted to include and what they wanted to exclude from the definition. This pre-conception derived from the old religious descriptions of "life" in the Bible, and this pre-conception was, of course, not shared by scientists in the Far East who knew nothing whatsoever about the Bible (any more than we did about the Upanishads in India, and whatever sacred books the Chinese and other Far Eastern people may have had). In modern times, we have gradually moved away from religiously influenced pre-conceptions and beliefs and moved more to things that can be *proved (or disproved) by scientific methodology*.

Even today, scientists are heavily influenced in their thought process about "life" by the life forms that exist on Earth. However, there is no necessity *whatsoever* for life in other parts of the Universe to be Oxygen and Water based. There could easily be life forms that have evolved in a manner that is so 'alien' to our own life that we have no idea of what to look for to recognise other forms of "life".[4] If as scientists we cannot explain 85% of the matter in the Universe, then we certainly have almost no chance of understanding what 'life' is.

The things that we on Earth call "living things" may or may not have a non-material dimension to them and there is no scientific way of clarifying the issue – but it certainly **looks as though** plants/animals/insects/etc are in *some* way different from pieces of rock/the oceans/water/fire/etc. It is possible to (and we do) divide things on our planet into two groups: living things and non-living things. One definition of a living thing is covered by the mnemonic "MRS GREN" where the capitals stand for

- **M**ovement - all living things move, even plants
- **R**espiration - getting energy from food
- **S**ensitivity - detecting changes in the surroundings
- **G**rowth - all living things grow
- **R**eproduction - making more living things of the same type
- **E**xcretion - getting rid of waste, and
- **N**utrition - taking in and using food

[3] From about 800-1200 AD, the Muslims were the main repository of virtually all European scientific knowledge. While we were dressing up in suits of armour and killing each other, they placed a huge value on *knowledge*. The Roman Catholic Church controlled all education at that time, and when our biggest monasteries contained a few hundred books at most, the great library in Cordoba (the centre of European Islamic culture at the time) contained some **400,000 books**.

[4] If you can get hold of a copy of Sir Fred Hoyle's "The Black Cloud", then I would strongly urge you to read it. Hoyle (a Fellow of St John's, Cambridge) was one the greatest Astronomers that this country has ever produced (he was the man who invented the phrase "Big Bang"), and in his book he puts forward a description of life that is as startling as it is revolutionary.

and another definition says that

> "All groups of living organisms share several key characteristics or functions (viz.) order, sensitivity or response to stimuli, reproduction, adaptation, growth and development, regulation, homeostasis, and energy processing. When viewed together, these characteristics serve to define life."

but it is possible to argue that the Earth/the solar systems (and even the Universe itself) does all these things, but if everything is considered to be "alive" then the distinction that we make about rocks versus animals would cease to have any meaning – and the discussion about Biology therefore has to start with the ***assumption*** that there really is a difference between living things and non-living things, or that for the purposes of the science of Biology that there is such a difference.

It can be said that all life forms are made up of **cells**, and indeed evolutionary Biology teaches us that life on Earth as we know it today started with single cell organisms, and over the period of life of the Earth, single cell organisms have evolved into extremely complicated multi-cellular entities such as whales/elephants/etc.

What is incontrovertible is that living things have evolved over time. The evidence for this is in the "fossil record". When a living thing dies, if it is an aquatic creature then its body falls to the bottom of the river/lake/sea/ocean and is covered by growing layers of mud/silt and becomes a "fossil"; and, if it had been a land-creature, then its body would have fallen to the earth and become covered in leaves/dust/mud/etc and would also have become "fossilised" *(and Susannah Maidment believes that we have a fossil record of only a few percent of the species that have lived on the Earth.)* From radio-active dating we can date the different layers of rock in the Earth's surface with considerable accuracy, and we can therefore use fossils to see how life forms have evolved through time. Sadly Professor Aubrey Manning (UCL and Merton, Oxford) who was a Zoologist and Professor of Natural History at Edinburgh University for a quarter of a century died last year (2018). He was a pioneering evolutionary geneticist, and if you can get hold of a copy of his dvd "Earth Story" then you could not get a better introduction to Biology (and Geology) than that seminal work[5].

The very foundation of the study of Biology lies in the study of cells

It may be difficult to state exactly what "life" is, but luckily there is no such problem when it comes to biological **cells**. Scientists have merely to use microscopes to look at how cells are constituted – and this scientists have been doing ever since the magnifying lens was invented[6].

Just as human beings live in a house whereas many animals live in the open, so also some cells (called "eukaryotic" cells) have nuclei that are contained inside a membrane[7], while other cells (called "prokaryotic" cells) do not have nuclei within a containing membrane. Thought.co says that "**Prokaryotes** are organisms made up of cells that *lack a cell nucleus or any membrane-encased organelles,* whereas **Eukaryotes** are organisms that are made up of cells that possess a *membrane-bound nucleus that holds genetic material as well as membrane-bound organelles*"[8]. All life forms are composed of cells, and the cell membrane itself is composed of cells. Cells themselves are "living" entities.

Some cells also have **cell walls** in addition to their cell membrane. For example, plant cells have not only a cell membrane, but they also have a stiff non-living cell wall that is made of cellulose. That cell wall encircles each cell membrane. Animals have skeletons made of bone to hold up their tissue/organs/etc, but plants do **not** have skeletons, and that is why they need stiff non-living cell walls to keep them erect! Just think how tall trees can grow (e.g. a gigantic 3-500 foot Californian Redwood) – and since trees/bushes/plants have no skeletons, they certainly could not grow to more than a few millimetres in height were it not for the whole edifice of cell walls that holds their cells together and give them their massive strength.

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[5] Aubrey Manning did his Doctoral work under the renowned Nobel Laureate Niko Tinbergen who also supervised Richard Dawkins (with whom I shared an adjoining seat in an aeroplane coming back from California in the 1970s, shortly after he was awarded a prize by a Californian University for his now-famous book "The Selfish Gene").

[6] The Muslim scientist Ibn al-Haytham published a book on Optics well before the English scientist Roger Bacon wrote about magnification, and the ancient Greek philosophers were writing about magnification a good 2,500 years ago.

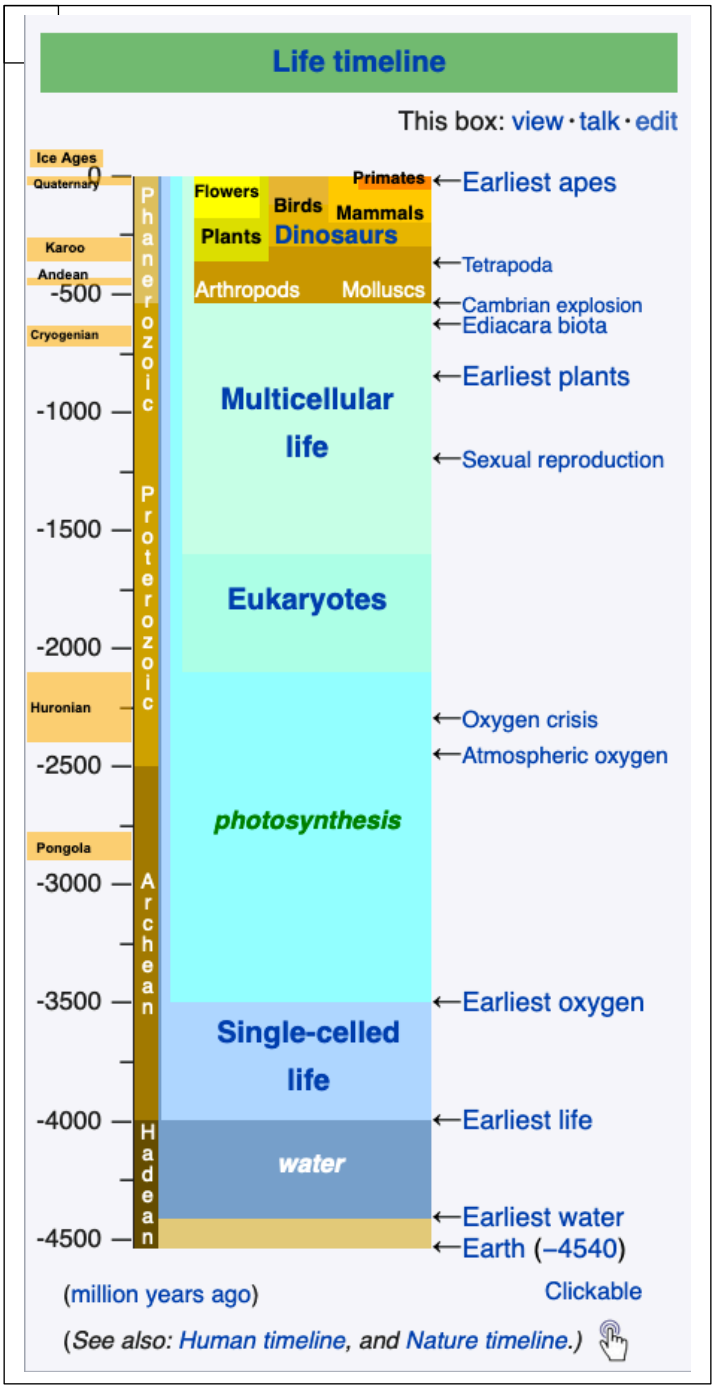
[7] A 'nucleus' is to a cell what a hard disk drive is to a computer.

[8] An **organelle** is a tiny cellular structure that performs specific functions within a cell.

Thought.Co says that

The foundation of Biology as it exists today is based on five basic principles. They are the cell theory, gene theory, evolution, homeostasis, and the laws of thermodynamics.

- Cell Theory: all living organisms are composed of cells. The cell is the basic unit of life.
- Gene Theory: traits are inherited through gene transmission. Genes are located on chromosomes and consist of DNA.
- Evolution: any genetic change in a population is inherited over several generations. These changes may be small or large, noticeable or not so noticeable. (Life on Earth started as a single cell organism possibly about 3.8 billion years ago, and has then evolved over the following 3.8 billion years. This can be ascertained from the 'fossil record'.)
- Homeostasis: is the ability to maintain a constant internal environment in response to environmental changes.
- Thermodynamics: The total amount of Energy in the Universe is constant. It can neither be created or destroyed other than by God if there is a God, but the existence of a Deity cannot be confirmed one way or other – and is thus a **belief** and not a **fact** (*cf. my earlier remarks in this essay*).



Source: Wikipedia

Oxygen was first produced somewhere around 2.7 billion to 2.8 billon years ago (and scientists such as Bettina Schirrmeister of Bristol University have done extensive research into the production of Oxygen in different era).

The first thing that Oxygen appears to have done is to oxidise the free Iron in the world's oceans and land. "Oxygen took up residence **in the atmosphere** around 2.45 billion years ago" says the geochemist Dick Holland, a visiting scholar at the University of Pennsylvania. "It's not that easy to see why it should balance out at 21 percent rather than 10 or 40 percent," notes geoscientist James Kasting of Pennsylvania State University. Climate, vulcanism, and plate tectonics all played a key role in regulating the Oxygen level during various time periods. As yet no one has come up with a rock-solid test to determine the precise Oxygen content of the atmosphere at any given time from the geologic record. However, one thing is clear – the origins of Oxygen in the Earth's atmosphere derive from one thing: **life forms**.

Tiny organisms known as **cyanobacteria**, or blue-green algae produced the Oxygen. These microbes conduct photosynthesis: using sunshine, water and carbon dioxide to produce carbohydrates and Oxygen. In fact, even today, all the plants on Earth incorporate symbiotic cyanobacteria (known as chloroplasts) to do their photosynthesis for them.

Cf.: https://www.scientificamerican.com/article/origin-of-oxygen-in-atmosphere/

Please do not take the accompanying timeline as "Gospel" e.g. cyanobacteria produced the first oxygen by photosynthesis, and it is therefore 'maladroit' to place "earliest oxygen" below "photosynthesis". Even so, the timeline is a useful guide to the Earth's evolution.

If you can get hold of a copy of Prof Aubrey Manning's "Earth Story" then do so and watch it (as fascinatedly as has my 9-year granddaughter does!). You will not regret it.