Question 1:

Dear Cheap Astronomy - Was their life before Theia?

Theia is a hypothetical Mars-sized object thought to have struck Earth Mark 1, which was quite possibly moon-less at the time. Theia reformed Earth Mark 1 into the Earth Mark 2 that we know today, along with its very substantial Moon.

The Theia impact is thought to have blasted off much of the crustal material from Earth Mark 1, as well as most of Theia's crust. The cores of the two objects are thought to have merged, while much of the combined crustal debris went into orbit, perhaps as a brief and chaotic ring system before it quickly coalesced into what is now the Moon.

The mathematics of the collision are that Earth Mark 1 was probably 90% of the size it is now. Theia, like Mars, was just over 50% of the size Earth is now. After the collision, Earth became 100% of the size it is now and the Moon became 27% of the size that Earth is now. The Moon is thought to be a 50/50 mix of crustal material from Earth Mark 1 and Theia, while the merging of Theia's dense core with Earth Mark 1's dense core has made Earth Mark 2 the densest planet in the Solar System.

If there was life on Theia before the collision it was almost certainly wiped out in the collision. If there was life on Earth Mark 1 before the collision, it was very likely wiped out in the collision. The Theia collision would have been orders of magnitude more destructive than any of the subsequent mass extinction events that remain recorded in Earth Mark 2's geological history. Getting a big chunk of the crust scraped off your planet and a new addition made to your planet's core , makes getting whacked by a 10 kilometre asteroid, like the one which took out the dinosaurs, a bit like a flea bite.

But even if it didn't survive the collision, could there have been life on Earth before Theia? Apart from being 90% of the size of the current Earth, Earth Mark 1 probably didn't spin as fast as Earth Mark 2. We think the Theia collision initially spun the Earth up to a five hour day, which over the subsequent 4 and a half billion years has slowed to the current twenty four hour day. Even so, a full rotation in 24 hours is fast, for a planet so close to the Sun. Our current rotation is a tiny bit faster than Mars and breath-takingly faster than either Mercury or Venus's rotations.

Although, to be fair, Venus is also thought to have suffered a substantial impact in its distant past – which has sent it spinning in the wrong direction, or otherwise flipped it upside down while still spinning in the right direction.

As we said earlier, it's unlikely that Earth Mark 1 had moons, after all neither Mercury or Venus do and Mars only just managed to grab a couple of passing boulders. If Earth Mark 1 didn't have moons, then it didn't have tides either. Indeed, we are not even sure if it had oceans. If you need to be bombarded by comets for millions of years to get oceans then it probably didn't have any, but if oceans arise naturally on Goldilocks-zone planets built from high moisture content minerals, then it probably did have oceans.

But even assuming that there was water, there was still only a limited time-period available for life to develop on Earth Mark 1, before Theia came along and wiped the slate clean. But just maybe, a primitive self-replicating chemical template had developed, bound to a dust

grain that was blown out into space in the Theia collision. And just maybe that dust grain eventually settled back onto a freshly-remodelled Earth Mark 2 and the replication and the evolution really got going

Or maybe we owe it all to Theia, whose impact may have adjusted our orbit, our rotation or our geochemistry in just the right way that life could get started on Earth Mark 2.

Whatever happened, there's a little bit of Theia in all of us.

Question 2:

Dear Cheap Astronomy – What would the Earth look like from the Moon?

Well firstly, from more than 40% of the Moon's surface you wouldn't even know the Earth existed. The Sun would rise and then set nearly two weeks later, followed by nearly two weeks of night before it rose again. Throughout that period of time, stars would be tracking across the sky, visible in both day and night, but you would never see an Earth in the sky. Mind you, near the Moon's north and south poles, the day lengths would be different and from those vantage points you might just spy the edge of the Earth on the horizon now and again.

But anyway, with all that out of the way, if you actually want to observe the whole of the Earth from the Moon, you should pick a spot that is somewhere around the lunar equator on the side of the Moon that is adjacent to the Earth. Any of the Apollo landing sites would work just fine. From those vantage points, the Earth will always be in your sky and it will only seem to shift around a bit against a background of stars that will continue to rotate through a complete cycle once every 27.3 Earth days, just as they appear to do everywhere else on the Moon.

The reason why the Earth appears to shift around a bit in the Moon's sky is for much the same reason why we, on Earth, get to see 59% of the Moon's surface rather than just 50% of it. Firstly, the Moon's rotational path about the Earth is not directly over the Earth's equator. It may have been, once upon a time, but as the Moon has slowly shifted further and further out of the Earth's gravitational grip, it has increasingly come under the influence of the Sun's gravitational grip, so that its orbit is being steadily reshaped into line with the orbital plane of the Solar System, which is roughly in line with the Sun's equator.

If the Moon really did follow an orbit around the Earth's equator you would only get to see a bit more than 50% of its surface, since you would see a bit more of its approaching side as it rises in the East and see a bit more of its receding side as it sets in the west. But in addition to that, since the orbit of the Moon does shift up and down around the Earth's equator, you also get to see a more of its upper latitudes when it's in one half of our sky and more of its lower latitudes when it's in the other half of our sky.

So, although the near side of the Moon is fixed upon the Earth, if you stood on its surface over the course of its 27 day orbit of the Earth you would see a very slow and very slight shifting of the Earth's position in the Moon's sky as a result of the steadily changing angle from which you view the Earth. A side to side shift would be apparent as you viewed its orbital approach and recession and a slight vertical movement would be apparent as a result

of the relative axial tilt of the Moon's orbit around the Earth. There would also be a very slight growth and diminishing of the size of the Earth in the Moon's sky due to the elliptical orbit of the Moon, which sometimes brings its closer to the Earth and sometimes takes it further away.

As well as seeing the shifting of the Earth in the Moon's sky, you will also see the Earth continuing to rotate on its axis, once every 23 hours and 56 minutes. So from your vantage point near one of the Apollo landing sites you will be able to see the entire surface of Earth.

Beyond that, the Earth's face will only appear fully lit once every 27.3 days, because it will only be fully lit when the Sun is behind the Moon, which will occur at the same moment at which a new Moon is visible from Earth. Furthermore, the Earth's face will only be fully dark when the Sun is behind the Earth. So at midnight on the Moon, which only happens once every 27.3 days, the Earth will be fully lit and at midday on the Moon which also only happens once every 27.3 days, the Earth will be fully dark.

All the rest of the time, it will be waxing or waning between either a crescent or a gibbous Earth.

And that's how the Earth looks from the Moon… more or less.