

THE SCIENTIFIC EVIDENCE FOR GOD
(Revised 2010)

By

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SIGNS OF A CREATOR? THE SCIENTIFIC EVIDENCE FOR GOD

Preface

Around 5 years ago I produced and delivered my first Teaching Day in Holy Trinity Church and this had the same title as today's Teaching Day. I chose that subject for my first Teaching Day firstly because I perceived there was a general interest in this topic and secondly because it had been influential in my own journey to find Christ and I believed it might be similarly influential for others.

I have chosen this subject again today for the same reasons and also because I believe there are a number of new things to be said. Thus I have constructed a completely new presentation which bears little resemblance to the original. This new presentation forms the basis for our Teaching Day today.

Introduction

Many popular books have been written in recent years asserting precisely the opposite of today's title. Perhaps the best known of these is Richard Dawkin's "The God Delusion", but there are a number of other what we might call 'Anti-God' books such as:

Against all Gods by A C Grayling an atheist philosopher

God Is Not Great by Christopher Hitchens an atheist journalist

The End of Faith and *Letter to a Christian Nation* by Sam Harris another atheistic journalist.

But actually when we look at the totality of the scientific evidence, that evidence points, as we shall see, overwhelmingly towards the existence of an intelligent designer of such power that we must call him God. Generally the above books don't look at the whole picture and skirt around or totally fail to mention the difficult areas we shall be addressing today.

There are really two areas where the signposts point unequivocally towards the need for a creator designer – the origins and fine tuning of the universe and the origins of life from non-life. However, before we turn to look at those subjects in more detail I just want to take a brief look at the issue of the interface between science and religion and the apparent conflict which is the currently perceived picture.

Science and Religion

Dawkins and the other authors mentioned above seem to be firmly of the belief that science and religion are arch-enemies by necessity. However, this was not always so, nor do I believe that it need be, or should be, so today. Colin Russell says in his recent book that the idea of a war between science and religion is a relatively recent invention. Indeed, as I shall argue, I believe that the Judeo-Christian world-view was an essential element of the development of our modern scientific world. Westerners often unconsciously assume a doctrine of inexorable progress, as though the mere passage of time automatically and inexorably leads to increased knowledge. Yet, any archaeologist will tell us that numbers of great civilisations have arisen and disappeared without ever developing science or even the philosophical background to science. Cultures in antiquity, such as the Chinese and the

Arabs, produced a higher level of learning and technology than medieval Europe did. Yet it was medieval Europe and not these cultures which gave birth to science.

Loren Eiseley a science writer concludes that science is not natural to mankind at all. Inquisitiveness about the world is natural, but science is much more than that. Eiseley says, it has rules which have to be learned and practices and techniques which have to be transmitted from generation to generation by formal education. Even more it demands certain assumptions about the nature of the world in which we live – a particular mind set.

Scientific investigation depends upon certain assumptions about the world, and science is impossible until those assumptions are in place. As Whitehead puts it faith in the possibility of science came antecedently to the development of scientific theory. Whitehead says that this rested on certain habits of thought such as the lawfulness of nature – which came from the Christian doctrine of the world as a divine creation. In this period the whole of Europe was saturated with a Christian world-view. Christianity teaches that the world is real. That may seem obvious to us, but Hinduism and Buddhism teach that the world is an illusion. Christianity also teaches that the world is of great value, and thus a worthy object of study. The Greeks taught that the material world was evil. Christianity also teaches that although nature is good it is not a god, it is merely the creation of God. God is not a part of creation he is separate from it.

To become an object of study, the world must be regarded as a place where events occur in an orderly, reliable predictable fashion. This too is the teaching of Christianity. Instead of a plethora of different gods we have a single unified deity in sole charge of a coherent universe. Also unlike most pagan gods who were capricious, the Christian god was and is trustworthy and unchanging. Finally, and perhaps most importantly, Christianity teaches that since we are made in the image of god, the universe which he created should logically be intelligible to us.

Thus the work of Copernicus was to search out a cosmology which would “uphold the regularity, uniformity and symmetry that befitted the work of God.” The phrase ‘the laws of nature’ is so familiar to us today that we easily forget that it is unique to modern Western culture.

Another distinctive aspect of modern science is the application of mathematical formulas to the world. This can also be traced back to Christian roots. The Christian God created the universe *ex nihilo* and hence has absolute control over it. He is completely in charge of His materials and the structure of the universe is precisely what God wants it to be. This idea is alien to the ancient world where gods started creation with a pre-existing substance with its own inherent nature. In such a world the creator god does not have complete control over the nature of the universe. For example, in Greek philosophy, the creator god merely injected reason into reasonless matter – and even this was accomplished imperfectly due to the imperfection of matter. Thus in these ancient models, nature is fuzzy around the edges and not subject to mathematical concepts and laws.

An example of the effective application of such differences can be found in the work of Kepler who struggled for years over a difference of 8 minutes between observation and calculation for the orbit of Mars. Eventually he was driven to abandon the idea of circular planetary orbits and opt for elliptical orbits. However, if he had merely felt nature was an

imprecise representation of the circular ideal, there would have been no incentive to struggle with the difference.

Historically, science stemmed from three acts of faith (i) that the universe possessed order, (ii) that this order was universal, and (iii) that this order could be interpreted by the rational faculties of human minds. A cross-cultural comparison can help clarify the importance of this point. Joseph Needham a scholar of Chinese culture asks in his book *The Grand Titration* why the Chinese never developed science. He says that the reason is that the Chinese had no belief either in an intelligible order in nature, nor in the human ability to decode it. By contrast, in Europe, Christianity did provide a guarantee of these propositions. The theory of knowledge developing in Medieval Europe and undergirded by Christianity was that God, having placed man on earth, could not have been so wasteful or so ironic as to blind him to the truth.

Christians became troubled by the old Aristotelian concept of Forms. They felt that this limited God's creative activity as Forms were inherent in the properties of matter. Thus in 1277 the Bishop of Paris, Etienne Tempier, condemned the ideas that God could not allow any form of planetary motion other than circular, that He could not permit a vacuum and many more. Natural Law came to be regarded as imposed from without nature and not inherent within Forms within it. This kind of philosophy helped to inspire an experimental methodology. For if God created freely, then we cannot attain knowledge by logical deduction, but only by observation. Certainly this kind of thinking inspired Copernicus to reject the Aristotelian notion that the earth must be the geometric centre of the cosmos.

Such thought did not mean that the universe was supposed to be chaotic or disorganised. God in His creation was bound by His own nature – which is rational, logical and orderly. But, we are not able to say what particular rational pattern the created universe should follow. Instead we must observe how nature operates. We must observe and experiment. For Christians, Genesis gives divine justification – perhaps even the duty – to study, analyse and master the natural world.

Many modern historians such as R K Merton and P M Rattansi now accept that modern science owes much to Christianity. Rattansi states that the Christian religion provided “a powerful motive” for engaging in experimental science.

Christian doctrine also provided a basis for assuming that suffering human beings could be lifted up as “children of God”. This revolutionary idea that the human estate could be improved – rather than determined by a fatalistic or deterministic view of nature – was revolutionary.

The idea that Christianity was opposed to the development of science has been exaggerated and distorted. For example Aristotelian cosmology placed the earth at the centre of the universe, but the displacement by the Copernican worldview was not opposed by the reformed churches. Perhaps the textbook case of supposed religious persecution of science was Galileo. Actually, according to the leading historical account of the affair by Martin Rudwick¹ the major part of the church intellectuals were on the side of Galileo and the main opposition came from secular ideas, particularly the other leading scientific figures of the day. In fact the main opposition to Galileo derived from his attack on Aristotelian

¹ Martin Rudwick, *The Sciences and Theology in the Twentieth Century*, University of Notre Dame Press, p242

philosophy, which at the time was regarded as essential to the formation of moral and religious laws. Also the heliocentric idea had no intellectual framework to support it at the time. This was not to be forthcoming until Newton gave it a physical mechanism.

In fact at the time of its initial pronouncement, the Copernican world-view had little to commend it. It reduced the number of epicycles required to explain the motions of the planets from more than 80 to 34 – significant, but not decisive. Also objections to heliocentric views were largely on the basis of their being bundled with a neo-platonic philosophy – early adherents, including Copernicus, ascribed quasi-divine qualities to the sun². Also the positive evidence for the theory at the time it was initially advanced was nil – apart from the slight mathematical simplification.

In spite of all this Galileo probably never repudiated his faith. His behaviour cannot really be understood unless we accept his own claim that he was a believer. As Rudwick writes, only Galileo's determination to remain within his religious tradition seems an adequate explanation of why he tried so hard to persuade everyone from the Pope downwards, and why he declined all chances to escape to the safety of the Venetian Republic³.

Many of the early scientists hoped to use science to bolster religious belief. Newton wanted his work used for apologetics. Mersenne and Descartes were actively concerned to defend religion. To omit or dismiss these religious motivations is to misunderstand the true history of science.

It was not until the nineteenth century that science began to develop a positivist element that led to a divorce from religious belief. This was largely driven by mechanistic world-views based on over simplified mathematical models and a materialistic view of creation.

Yet alien Pythagorean elements were at work, which eventually elevated mathematics into an idol. Inevitably that idol fell, and today mathematics is no longer regarded as a means of discovering truth about the world. At best it is able to model certain aspects of already formulated world-views. Christians can help to rebalance this view of mathematics – it does give a truth, but a contingent, open truth, rather than a closed, autonomous truth – and *redeem* it by restoring its proper dignity.

Thus the popular idea today of a 'war' between science and religion is a relatively recent invention (probably nurtured by those who hope the victor will be science). However, all reasons for such a war have now disappeared, because scientific developments such as chaos theory and quantum mechanics have forced scientists to abandon the simplistic mechanistic view of the universe of a materialist philosophy. But, what will now happen to science as largely separated from its religious and philosophical roots? As Hume has demonstrated, pure empiricism gives no grounds for belief, even in such fundamental principles as cause and effect. As a result I contend that scientists today maintain a kind of "scientific faith" in the order of nature and the principles of cause and effect, whilst lacking any rational basis for such faith⁴. Indeed I would contend along with Whitehead, that any detachment of science from Christianity is dangerous for *science*. Without a trustworthy rational God science has no philosophical ground for its most basic assumption – an ordered, rational, lawful universe. Indeed we are starting to see the first signs of dangerous results of this separation in the

² Burt, *Metaphysical Foundations*, pp 36, 52-53

³ Rudwick, pp256-257

⁴ Whitehead, *Science and the Modern World*, p4

growth of scientific embracing of multiverse ideas – which ultimately lead to the position that we can know or predict nothing.

However, Christians must also be careful how we embrace this new physics. Christian philosophers such as Gordon Clark rejoice that scientists today are “more willing to admit that science does not discover absolute truth, more willing to recognise that science does not utter pronouncements about ultimate reality.” Yet Christians need to stand back from the more radical, subjectivist even mystical interpretations of quantum phenomena advocated by some New Age physicists. Order is not absolute, but I believe it is real.

Finally I would say that, whilst science cannot prove the existence of our Christian God, developments in science over the last 30 years (particularly in the fields of evolutionary biology and cosmology) provide compelling evidence for the existence of a creator designer god. I shall endeavour to make the case for that view in my talk today. In many ways that takes us full circle, back to the point where the Christian concept of such a God generated the idea of science.

Returning for a moment to Dawkins’ book rejecting the notion of God, we find that towards the end of his book Dawkins endorses a certain limited scepticism. He theorises that since, according to his belief, we have been cobbled together by (unguided) evolution it is unlikely that our view of the world is accurate. Natural selection is interested in adaptive behaviour, not true belief. However, Dawkins fails to explore the real philosophical implications of this viewpoint. One has to agree with his view as stated above – given his assumption. But, the principle goes much deeper. On this basis why assume that our cognitive facilities are reliable? If not how can we form correct beliefs and achieve true knowledge. If that is correct why believe that Dawkins belief that we are a product of natural selection is correct? At bottom the belief that our cognitive faculties are reliable can only find a solid basis in the religious belief that we are created in God’s image. I would contend that the conflict which Dawkins believes arises between science and theism is actually a conflict between science and the kind of unbridled naturalism which Dawkins propounds.

The Origins of the Universe

Let’s move on to tackle the first of the issues which I earlier said were indicative of the existence of a creator designer god – the origins and fine tuning of the universe.

We live in a truly wonderful and amazing universe. It is vast beyond our imaginings or comprehension containing perhaps 100 billion galaxies each containing around 100 billion stars. That’s a huge number of galaxies, in fact if galaxies were frozen peas you could comfortably fill the Albert Hall with them.

Each galaxy is quite large – around 100,000 light years across, but the spaces between galaxies are truly vast. The average separation between galaxies is more than 10 million light years (although this average separation is complicated by the fact that galaxies tend to clump together in clusters).

In astronomy and especially cosmology we use the concept of the light year to measure distance because the distances are so vast in ordinary human terms – they’re big enough even in light years. As its name suggests a light year is simply the distance light travels in a year

at its enormous velocity of around 300,000 kms per second. So a light year is around 10^{13} kms or ten thousand billion kms. In future, we'll talk about distances in light years.

Turning back to galaxies, broadly speaking galaxies are of three varieties.

Firstly, Elliptical like this which generally contain mainly older stars.

Secondly, irregular like this which often have strange features and emit lots of energy, and

Thirdly, barred spiral like this and finally ordinary spiral like this which contain a mixture of younger and older stars. Our own Milky Way galaxy is an ordinary spiral galaxy.

Even within galaxies, distances are vast. The nearest star to the solar system is Proxima Centaurus, about 4.2 light years from the sun. To put that in human terms, if we shrank things so that the sun was the size of a sugar lump, the Centaurus system would be 1,000 miles away. The universe is vast and, as far as matter is concerned, it's mostly empty.

We live in a not particularly large spiral galaxy we call the Milky Way on a planet circling a rather ordinary star about two thirds of the way out on one of the spiral arms of that galaxy.

I expect some of you are wondering how we measure all the distances I've been talking about. That's too big a subject to talk about in detail, but I'll just give you a brief overview.

We can find the distances to nearby stars directly by trigonometry, measuring the direction to them at six month intervals and thus from opposite sides of the earth's orbit around the sun. Using the earth's orbit as a baseline, we can easily calculate the distance to the star by simple trigonometry.

Further away, we have stars of standard brightness called Cepheid variables. These are variable stars, which get brighter and darker in a very regular cycle. The brightness of a particular Cepheid star depends very accurately on its period of variability. Thus by measuring their apparent brightness and knowing their absolute brightness from their period, we can calculate their distance away. Cepheids are unfortunately not bright enough for us to see them in many galaxies other than the Milky Way. We can only see them in those other galaxies which are nearest to us. For further galaxies, we need something brighter.

Fortunately, we have that something brighter in the shape of supernovae. These are exploding stars, which very briefly shine 4 billion or more times brighter than a normal star. They briefly outshine the whole galaxy which they are in. The most famous supernovae of which we can still see the remnants is the crab nebula which exploded nearby in 1054. Unfortunately, (from the measurement point of view), supernovae only happen in any particular galaxy about once a century or so, but if you look at a lot of galaxies you can find them. They are not quite each of the same brightness, but if we observe their build up to maximum brightness and their decay from it, we can work out how absolutely bright they are and thus use them, like Cepheids which we used in the same way nearby, to calculate the distance to the galaxy they are in.

Returning then to the history of thinking about the universe we live in, by 1929 Hubble had realised that virtually all the many new galaxies he was observing had something strange about them. The light he was receiving from almost all of them was red-shifted. That means that the wavelengths in that light were much longer (i.e. towards the red end of the spectrum) than normal. He could know that because the chemical elements present in stars each have their own characteristic pattern of frequencies at which they emit or absorb light – that's how

we can know what distant things like stars are made of. That property arises because of their atomic structure (different in the case of each element), but it's too long and complex a topic for us to cover today and I'm just going to have to ask you to take my word for it. But you can see the pattern of emission and absorption of light at different frequencies on the slide.

Furthermore, Hubble had determined that the amount of the red shift increased for galaxies further away from us, by an amount proportional to their distance. Because all wavelengths in the light from any particular galaxy were red shifted by the same amount, Hubble assumed that these galaxies were all moving away from us. Today we believe he was correct in that assumption. Alternative explanations which have been proposed such as the "tiring" of photons over long distances, don't satisfy all the observational evidence, particularly the slowing of clocks (and clocks are provided for us by the rate of decay of radiation from supernovae) in galaxies with large red shifts.

We now believe that all the galaxies in the universe are moving away from one another unless they are close enough together to be tied by gravity into a cluster. Our galaxy, the Milky Way, is part of a cluster of galaxies known as the Virgo cluster. Or, to put it another way, the universe is expanding. We mustn't think of that expansion as things moving away from each other in a space which already exists – as I can move away from you in this room [walk away]. The expansion is of space itself. A two dimensional analogy is provided by points drawn on the surface of a balloon. If we blow up the balloon, its surface area stretches or increases, and all the points on it move apart. That is a two dimensional analogy of space expanding in three dimensions. So when we talk about galaxies moving away from one another, we don't mean they're moving away in space (as I could move away from you in the room) rather space itself is expanding, like the balloon being blown up.

The logical result of believing that space is expanding is to suppose that at some time in the past everything was very close together. By 1948, George Gamow had formulated a theory of the origin of the universe from an infinitely small point of infinite density. This theory came to be popularly known as the Big Bang theory (even though Fred Hoyle, fanatic supporter of another theory, had originally coined the term as an insult).

Not all scientists accepted that theory then, including me! Many, (including me), believed in an alternative theory called the Steady State Theory where matter was continuously created to make up for the reduction in density caused by expansion.

However, the Big Bang theory eventually triumphed in 1965 when Penzias and Wilson (two scientists working on microwaves at Bell Laboratories in the USA) discovered faint microwave radiation coming equally from all directions (even though they didn't know what they had discovered at the time and spent months looking for faults in their equipment). This radiation, which comes from all points of the sky, is what we now call the cosmic microwave background radiation. This is the radiation left over from the massive fireball of the Big Bang, now red-shifted out into microwave frequencies. The existence of this radiation as a consequence of the Big Bang had been predicted 15 years earlier by Gamow. In fact this radiation is what causes the static on old style TV sets when they're not tuned into a station.

Apart from the existence of the cosmic microwave background radiation, we now have many reasons for having confidence in the Big Bang theory of the origin of the universe. It accurately predicts the relative quantities of elements which we find, particularly Helium and Deuterium. Apart from the Big Bang Theory there is far too much Helium and rather too

much Deuterium in the universe. Also it accurately predicts the ratio of ordinary matter (neutrons, protons and electrons) to photons and neutrinos. Stephen Hawking and Roger Penrose established in 1970 that provided general relativity was correct and the universe contained at least the amount of matter we observe, then the universe must have had a Big Bang origin.

The Big Bang theory says that at some time in the past, the universe and everything in it came into existence from the explosionary expansion of an infinitely small point of infinite density. We now believe from measurement of the rate of recession of galaxies that this origin was about 13.7 billion years ago. At that point of origin, or singularity as we call it, all our scientific theories break down. This includes general relativity, which actually predicts the existence of this point or singularity but is unable to deal with it.

You can't think of that singularity as a point in space. Before the Big Bang there was no space and there was no time. The Big Bang happened, space started to expand, and the clock began to run. God spoke "Big Bang" and it all began.

This early universe was very hot and contained mainly photons. In fact it all sounds rather like Genesis 1:3 "And God said let there be light and there was light."

As I just said, the early universe was very hot. After one second, the temperature would have fallen to around 10,000 million degrees or about 1,000 times the temperature of the centre of the sun. That's incredibly hot although we can experiment with such conditions as we are able to generate temperatures as high as this in H-bomb explosions.

During the initial one second, we are less sure of what happened than in the time following, because the conditions are so exotic that we cannot duplicate them. However, current theories of nuclear physics predict that during this time elementary particles – that's the neutrons, protons and electrons we mentioned earlier - would have been formed, mostly along with their antiparticles. However, we predict from theory and observation now confirms that the antiparticles would have been in a very small minority. For every 10^9 particle antiparticle pairs there would have been one extra normal particle.

The particles and antiparticles annihilated each other, producing photons and neutrinos, but leaving a small excess of normal matter, which is the matter, all the matter, we have today. This explains why the universe contains so many photons and neutrinos (about 400 billion per cubic meter of each) and so little normal matter – about 2 hydrogen atoms per cubic metre (although it's difficult to be absolutely certain of this figure).

However, it's a surprising coincidence that the laws of physics favour the existence of one kind of matter over another. We shall be coming across many coincidences both large and small today.

The initial rate of expansion of the universe is extremely critical. If the rate of expansion one second after the Big Bang had been smaller by even one part in a hundred thousand million million the universe would have already recollapsed. That's one of the larger unexplained coincidences! Stephen Hawking and other cosmologists have computed that that value was critical to one part in a hundred thousand million million.

After 100 seconds, the temperature would have fallen to 1,000 million degrees – about the same as the interiors of the hottest stars today. At this temperature protons and neutrons would no longer be able to overcome the strong nuclear force and would combine together to form the nuclei of deuterium atoms. Deuterium nuclei would in turn combine together to form helium nuclei. Small amounts of Lithium and Beryllium nuclei would also be formed, but the universe would now be too cool to produce heavier elements.

We can calculate the proportions of these elements which would have been formed - and there is very good agreement with observation. We find no part of the universe with less than 24% helium - theory actually predicts that nothing may have less than 23% Helium. Because very little helium is synthesised in stars - it is actually made but it gets burnt up - it is difficult to explain the large amount of helium we see in the universe in other ways.

In fact, neutrinos control helium production in the Big Bang. A helium nucleus is made from two protons and two neutrons sticking together. The amount of helium depends on the number of neutrons surviving until the universe had cooled sufficiently to enable these particles to stick together under the strong nuclear force. Neutrinos tend to remove neutrons converting them into protons and electrons. The more efficient this reaction is the fewer neutrons survive. If the reaction had been only a few percent more efficient no neutrons would have survived and there would have been no complex elements in the universe. The strength of that reaction was critical to within two or three percent. The strength of the reaction between neutrinos and matter is also important for the production of heavy elements in supernovae, which we're going to deal with in a minute. This is yet another remarkable coincidence which we might pass off as pure chance were it not for many other suspicious coincidences we're going to find elsewhere. The whole thrust of my arguments in this session will be that the universe is exquisitely finely tuned so as to make life possible in such a way and to such a degree as cannot be explained by chance.

Within only a few hours after the Big Bang the universe would have cooled so much that the production of the nuclei of the elements would have ceased and for the next million years or so the universe just carried on expanding and cooling.

Eventually, when the temperature had dropped to a few thousand degrees, electrons and nuclei would no longer have enough energy to overcome the electromagnetic attraction between them, and atoms started to form.

The universe continued to cool and expand, but there were tiny density variations in it – this is very important and I shall be coming back to this point in a minute – and denser regions condensed under gravitational attraction to form the galaxies we see today. Eventually regions within these galaxies condensed into stars.

As individual stars collapsed under gravitational attraction, the movement of the collapsing particles of hydrogen and helium gas comprising the condensing star manifested itself as heat. When the temperature of that gas was high enough nuclear fusion reactions started within it, within the star, hydrogen being fused into helium at first.

The heat generated by this nuclear fusion would create an outward pressure within the star to balance the inward pressure of gravity. In this way stars can remain in a stable state with radiation and gravitational forces balancing one another for a very long time - up to 10 or 12 billion years.

However, massive stars use up their fuel much more quickly, burning up their nuclear fuel at a greater rate to resist the stronger force of gravitational collapse. Because their greater fusion activity makes them hotter, larger stars also fuse helium nuclei to form carbon and oxygen and some elements heavier than that. The production of the heavy elements above iron actually absorb energy and these are only produced in stellar explosions, the supernovae we mentioned earlier in relation to distance measurement. That's why the heavy elements are relatively rare.

However, if the coupling between neutrinos and atoms was either slightly stronger or slightly weaker than it is, then the heavy elements would either not be produced or they would not be dispersed in supernovae explosions. Another remarkable coincidence which is a small but significant part of making life possible.

Our knowledge of nuclear physics is now sufficient that we can follow and account for the production of all the elements we find on earth and observe in the universe firstly as a result of initial manufacture immediately following the Big Bang and secondly as a result of nuclear fusion reactions within stars.

However, as cosmologist Fred Hoyle (who was a pioneer in establishing the synthesis of elements in stars) said "somebody has been monkeying with the physics". Stars produce much more carbon and oxygen than we would, on the face of it, expect.

As I expect you all know these elements are extremely important for life, and if stars didn't overproduce them there would be much less of them on earth or any other possible earth-like planet. The reason why stars overproduce these elements is because they have a strange resonance state which favours lighter elements combining together to produce them. A resonance is simply a matching of energy states, like the resonance of a bell or a tuning fork.

The resonance exists at exactly the sum of the kinetic energies, which the components of the heavier nucleus have as they impact together in an average star. If the resonance level for forming carbon were just 0.5% different from the level it is then no carbon would be formed. If the resonance level for forming oxygen were not 1% higher than the optimum level for forming oxygen, then all carbon would be converted to oxygen.

Scientists estimate that the probability of these favourable resonance states existing by chance alone is at least 100 to 1 against but if they didn't exist there wouldn't be enough carbon and oxygen for life as we know it. Who monkeyed with the physics here and elsewhere – I suggest a designer God is the most reasonable explanation. Even the atheist cosmologist Fred Hoyle who discovered these resonances said "nothing has shaken my atheism as much as this discovery".

As we saw a moment ago, the primary nuclear reaction which fuels stars, is the conversion of hydrogen to helium. When 4,000 kg of hydrogen are converted into helium they make 3,972 kg of helium. The remaining 28 kg of mass is converted into energy in accordance with Einstein's famous equation $E = mc^2$. That's what happens in all nuclear processes, whether they be atomic bombs, H bombs or stars. Some of the mass is converted into energy. Because c , the velocity of light, is (as we've already seen) such a big number, you get a lot of energy.

Now if that conversion ratio of 0.007 was only very slightly less, say 0.006, then the reaction couldn't work in stars and the universe would have no heavy elements and stars wouldn't shine. If the conversion ratio was slightly increased to 0.008 then conversion would be so prolific that all the hydrogen in stars would long ago have been burnt up and we wouldn't be here. This factor is critical to at least one part in a million. Again, who monkeyed with the physics?

The properties of the elementary particles are also important. Neutrons are around 0.14% heavier than a proton – which is heavier than a proton and an electron combined. If that were not so than all the protons and electrons would have already combined into neutrons and matter as we know it would not exist. Fortunately in our universe, this only happens at the huge pressures, which exist in neutron stars.

Neutrons and protons are very heavy compared with electrons as we've seen. This enables the nuclei of atoms to have relatively certain positions and that enables large and complex molecules like DNA to exist. At this point I should perhaps explain that molecules are simply two or more atoms chemically linked together. The light weight of the electron determines the overall size of atoms, as opposed to the size of their nuclei which is determined by the sizes of protons and neutrons. The light weight of the electron determines the positions they can be in around the nucleus of an atom, the large number of electron "orbitals" in atoms. These orbitals in turn determine the chemical properties of atoms. That enables larger molecules with the complex chemical properties required for life.

Furthermore, the exact value of the strong nuclear force (the force which holds particles together in the nuclei of atoms) is of great importance. If it were only slightly stronger no hydrogen would exist and stars could not evolve, but if it were only a few per cent weaker no elements more complex than hydrogen could exist.

Altogether that's a lot of values which happen to be just right for life when they might easily have had very different values which would have made life impossible.

Let's return to the question of variations within the universe I mentioned a while ago. On a large scale, the universe is remarkably uniform. As we probe deeper and deeper – further and further away – we see more and more objects like those in our local area. On a large scale the universe is remarkably uniform, yet it has local concentrations of matter which have formed the galaxies, and the various galaxies are themselves of relatively uniform sizes. This is extremely surprising. Cosmologists are still wrestling with this problem.

If the universe had initially been completely uniform, there would be no stars or galaxies and thus no planets and no life. However, very small ripples during the initial stages of expansion of the universe would evolve into quite significant, perhaps very large, structures as the universe expanded further. Nevertheless, these ripples would themselves have had to have exactly the right magnitude and also be very uniform, otherwise the large scale structure of the universe would not be as even, so uniform, as we see that it is.

This property is called Q by cosmologists and Q has to have a value of almost exactly $1/100,000$ for the universe to be the way it is. Given that Q could have had virtually any value, the odds of this happening by random chance are very small – at least 10 trillion trillion to one against (not much chance of winning that lottery!). This factor and this factor alone would be strong evidence for a creator designer God.

Alan Guth, an American cosmologist, suggested that the problem could be resolved if the expansion in the early universe accelerated massively and then slowed down again when the universe was around 10^{-36} seconds old – a point at which it was around the size of a golf-ball. This *might* have enabled the ripples to be evened out for reasons that are too complicated to go into – although this is far from certain and many physicists, including eminent physicists such as Roger Penrose, do not believe that this is a valid solution to the problem. Furthermore, no one has ever advanced convincing reasons as to why this speeding up and slowing down should happen AT ALL, let alone at EXACTLY the right times to produce the universe that we have. I think this is just arguing in desperation to avoid the alternative conclusion – that there was no inflation and this and other initial conditions were exactly and precisely designed and set by a creator designer God.

Even atheist Stephen Hawking had to admit “One possible answer is to say that God chose the initial configuration of the universe for reasons we cannot hope to understand.” (A Brief History of Time p139). Indeed this problem alone, never mind the other unlikely coincidences we’ve mentioned, is so intractable that theorists such as Linde and Guth have been driven to propose that there is a kind of universe generating mechanism. This is a variation of the inflation idea whereby inflation, once started, doesn’t stop but continues for ever. This is supposed to have produced huge numbers of bubbles, bubble universes, of different sizes and with different internal conditions. On this model our universe is just one of the bubbles – a lucky bubble with just the right conditions for life.

The universe generating mechanism of Linde and Guth is supposed to have produced trillions of trillions of trillions of universes – you can see why so many are needed because the improbability of having the right initial conditions and physical constants is so great. Dawkins suggests as an alternative, that perhaps the universe might have expanded and collapsed back to a point and then re-expanded many times – trillions of times – with different values for constants and laws each time, and we just happen to live in a version with the appropriate laws. Unfortunately for Dawkins, Stephen Hawking has recently shown this oscillation process to be theoretically impossible and in any event the observational evidence is that our universe is probably expanding too fast to ever collapse again.

Lee Smolin has put forward a different kind of theory in which he speculates that black holes might give birth to baby universes each slightly different from its parent universe. The idea is that a process of “evolution” could lead to a universe like ours which can support life. As you can imagine Dawkins loves that idea because it uses his favourite concept – natural selection. However, what might drive such evolutionary selection is difficult to imagine. The universes would hardly be in competition with each other, indeed they would be totally isolated from each other.

In my view the idea of multiple universes creates more problems than it solves. Apart from the fact that it has no general explanatory power – it merely addresses the issue of how our universe can have such an unlikely set of rules and initial conditions – it totally begs the question of how such a universe generating mechanism might come into existence and ignores the problem that both it and these supposed other universes remain permanently outside any possibility of observation or verification by ourselves. As Robin Collins states: all things being equal, we should prefer hypotheses that are natural extrapolations from what

we already know about the causal power of various kinds of entities⁵. Furthermore, scenarios in which an infinite set of universes are generated, make conventional science impossible. There all possible events can be ascribed to chance and there can be no presumption of a cause and effect mechanism. Finally, for the universe generator hypothesis to work it needs to produce, or at least be able to produce, an infinite number of universes to be sure that one with the correct properties will arise. Yet neither of the current theories which permit a multi-universe scenario – Everett’s quantum mechanical model or Linde’s inflationary cosmology – justifies such an assumption. Both these models predict a finite and non-random set of universes⁶. Indeed the Everett model only predicts a set of parallel universes each of which has the same physical laws as our own. Clearly this model is of no help at all. Linde’s model does generate universes with different laws, but not an exhaustively random set of such conditions.

As Clifford Longley says, adopting the multiverse model as opposed to the intelligent design hypothesis is like assuming that Shakespeare was not written by a man but by a billion monkeys typing randomly.

John Polkinghorne called the multiverse hypothesis a “pseudo scientific metaphorical guess”. Compare this inelegant hypothesis with the much more elegant hypothesis of a highly intelligent and powerful creator and designer – a hypothesis which also has explanatory power in other areas such as the origin of life as we shall see later.

As we already noted, physicists such as Roger Penrose are opposed to the idea of inflation. In any event the latest observational evidence of the microwave radio background appears to be against inflation having taken place. If inflation did happen then the bubble universe in which we live would most probably be much larger than the observable universe – because it’s very unlikely that inflation would cease at just the size of universe we can observe. If that were true then we would expect the resonant irregularities in the microwave background to be constant as we look at larger and larger scales. However what we actually see is represented by this graph. As you can see at the right hand side of the graph which represents the largest scale we can observe – the scale of the observable universe – the intensity of the resonances diminishes. That indicates that the universe is not much larger than the observable universe and as we have already noted it’s very unlikely that a universe like that could be created by the inflation mechanism.

We’ve already seen that the universe is expanding and indeed has been expanding since its origins. If there were enough matter in the universe then the force of gravity might eventually brake the expansion to a halt. Whereupon the universe would start contracting. Indeed if the force of gravity were stronger it might have collapsed sooner – that’s an important issue I shall be returning to in a minute. The necessary density of matter for this braking to a halt to occur – given the actual strength of the force of gravity, which we call the critical density, is about 6 hydrogen atoms per cubic metre. That’s well above what we actually observe in the universe.

Cosmologists give the symbol ω to the actual density of matter divided by the critical density. Currently it looks like that ratio, ω , is about 0.3. Thus, it appears that the

⁵ Robert Collins, *Reason for Hope Within*, Grand Rapids p61

⁶ W Craig, *Origins & Design 20*, no 2, p24

universe will carry on expanding forever. Indeed some fairly recent observations suggest that the rate of expansion is probably speeding up.

This is important because the universe needed to exist for long enough for generations of stars to be born and die, so that heavy elements, which are an important component of life on earth, would have time to be brought into existence from some of those stars exploding as supernovae as we've already discussed. Even after that our own solar system has existed for some four and a half billion years and it has taken almost all of that time for human life to have developed.

Of course, apart from the amount of matter, the other critical factor here is gravity. If gravity were stronger the critical density for expansion to halt would be less. If gravity was weaker it would be higher. Gravity is another fundamental quantity, which has been finely tuned in order for life to be possible in our universe. Nuclear forces are about 10^{36} times stronger than gravity, so that number 10^{36} might reasonably be taken to be the possible range for the possible strength of gravity. For the sake of argument though lets assume it's ten billion times less than that – i.e. 10^{26} . Then if we imagine the possible range of the strength of gravity is represented by a ruler 100 million km long (most of the way from here to the sun), then if we moved the strength of gravity on that ruler by the thickness of a human hair, life in our universe would no longer be possible.

If we had moved the indicator on the ruler to increase the force of gravity, then in such a universe a star like the sun would have a mass 10^{15} that of the sun and would have a lifetime 10^{10} times shorter – about one year. All the structures in such a universe would be scaled down. Stars would not be widely dispersed, but packed close together. Thus close encounters would be frequent and planets would not have stable orbits. Even if life could exist on such planets, it could be no larger than small insects on earth.

If we had moved the indicator on the ruler to reduce the force of gravity then in such a universe galaxies would not be able to condense and stars and planets would not be able to form. Even if stars did somehow form gravity would no longer be able to balance the pressure generated by nuclear fusion.

The actual scaling laws are quite complex, but I think we can safely conclude that if someone or something had not set the force of gravity with exquisite precision we wouldn't be here to debate it. Given the precision of the setting on an absolutely enormous scale, I contend that the simplest and most likely explanation for this is a designer and creator God.

Let me finish this section of my talk with what is perhaps the most striking example of a strange and favourable coincidence, the energy density of empty space or the so called cosmological constant.

This could have had any value positive or negative, although theory predicts that it should be large and positive. Fortunately for us it isn't. If it were large and positive, it would act as a strong repulsive force, which would increase with distance. That would have countered the effect of gravity and prevented matter clumping together in the early universe, so there would have been no stars or galaxies. If it were large and negative, it would have acted as an attractive force and would have reversed the expansion of the universe, so that by now it would have recollapsed.

We currently think from observation of the recession of distant galaxies that the cosmological constant has a value of about 0.7, thus gently accelerating the expansion of the universe. It has been estimated that the odds against the cosmological constant being within the range that would permit life in the universe by chance alone are at least 10^{50} to one against!

Roger Penrose an eminent physicist often a collaborator with Stephen Hawking and certainly no Christian has calculated that in order to produce a universe compatible with the second law of thermodynamics (which ours is) and otherwise compatible with observed features of our universe, the phase space volume required had to be accurate to within one part in 10^{123} . That's a number so big that even if we wrote one digit of it one every proton neutron or electron in the entire universe then there would not be enough particles for us to write it down on.

I say that could never happen by chance and many, even most, scientists agree it can't just be chance.

Freeman Dyson said "the more I examine the universe and study the details of its architecture, the more evidence I find that the universe must in some sense have known we were coming."

Cosmologist Edwin Harrison says "The fine tuning of the universe provides prima facie evidence of deistic design."

Sir Fred Hoyle, one of the most famous cosmologists of the 1950's said "I do not believe that any scientist who examined the evidence would fail to draw the inference that the laws of nuclear physics have been deliberately designed with regard to the consequences they produce inside stars."

Even Nobel winning physicist Steven Weinberg (an avowed atheist) said the energy density of space (the cosmological constant referred to previously) "is remarkably well adjusted in our favour".

Astronomer Royal Martin Rees said "[when] the deep forces that shape the universe are taken into consideration, the universe's structure becomes unlikely to an absurd degree."

Just about everything regarding the basic structure of the universe, the forces within it and the numbers which govern those, is balanced on a razor's edge so as to enable life to exist. There are approximately 20 basic constants in particle physics and 15 constants in cosmology all of which are exquisitely finely tuned to permit a universe in which life can exist. As I hope I've already demonstrated, the coincidences are so fantastic that they can't be attributed to mere chance. We can't just say that no explanation is needed. Even a rabid atheist like Dawkins doesn't seek to argue that. Again along with a lot of scientists I say that the most reasonable explanation is a designer creator God – and so far we've only looked at cosmology and nuclear physics.

Life and It's Origins

Let's now turn to the question of life and its origins. Either we need to find a credible way in which life could arise spontaneously and develop into the complex organisms we observe today or we need to admit the need for a creator designer God.

Dawkins and others put much store in Darwin's theory of Evolution by Natural Selection. I have to say that I believe this theory has numerous problems in explaining how life developed from single celled organisms to the complex variety of life forms – including ourselves – that we see today. Let's just look briefly at a few of these.

As a first problem, the fossil record simply does not support Darwinism; we do not find evidence of the numerous intermediate forms of life predicted by Darwin. Instead, new species emerge in the twinkling of an eye, with no evidence of intermediate developmental forms. Darwin himself knew this problem was serious. In the *Origin* he said it was “probably the gravest and most obvious of all the many objections which may be urged against my views.” The gaps still exist today – Stephen J Gould called it “the trade secret of palaeontology”⁷.

The overall character of the fossil record as it stands today was superbly summarised in an article by G G Simpson – a leading palaeontologist who was invited to address the Darwin centenary symposium and whose testimony to the gaps in the fossil record has considerable force. As he points out it is one of the most striking features of the fossil record that most new kinds of organisms appear abruptly and not gradually as Darwin’s theory would have predicted. He says:

“They [new organisms] are not as a rule, led up to by a sequence of almost imperceptibly changing forerunners such as Darwin believed should be usual in evolution. A great many sequences of two or a few temporally inter-grading species are known, but even at this level most species appear without known immediate ancestors, and really long, perfectly complete sequences of numerous species are exceedingly rare.”

In effect, Simpson is admitting that the fossils provide none of the crucial transformational forms predicted by Darwin.

Basically, three explanations have been put forward to explain the gaps in the fossil record: (i) insufficient search, (ii) imperfection of the record, and (iii) punctuated evolution (i.e. that the gaps are real and evolution has proceeded in a series of jumps). The hope of uncovering missing links in unexplored rocks is not completely dead, but it has greatly diminished. As Norman Newell past curator of historical geology at the American Museum of Natural History puts it:

“... experience shows that the gaps which separate the highest categories may never be bridged in the fossil record. Many of the discontinuities tend to be more and more emphasised with increased collecting.”

It is particularly difficult to accept insufficient search as an explanation for the gaps between the major invertebrate phyla. There is a mystifying almost total absence of transitional forms in the pre-Cambrian rocks.

Imperfection of the record has always been the most popular explanation for the gaps. It was Darwin’s explanation. Certainly there is some imperfection, but G G Simpson recently estimated the percentage of living species recovered as fossils in one region of North America and concluded that at least for larger terrestrial forms, the record was almost complete⁸. According to an article by Wyatt Durham in the *Journal of Palaeontology* it is probable that as many as 2% of all marine invertebrate species with hard skeletal components which have ever lived are known as fossils. Most professional palaeontologists have always been sceptical about imperfection as a means of explaining away the absence of transitional forms.

⁷ Eldredge N and Gould S J, *Models in Paleobiology*, Schopf, Freeman, Cooper and Co p181

⁸ Simpson G G, *The Evolution of Life*, University of Chicago Press, Table 8

The fundamental problem in explaining the gaps in terms of insufficient search or in terms of imperfection of the record is the systematic character of the gaps – there are fewer known transitional species between the major divisions than between the minor. Thus, between Eohippus and the modern horse (a minor division) we have dozens of transitional species, while between early land mammals and whales (a major division) we have none. This rule applies fairly universally.

Punctuated evolution – the supposition that new types of organisms arise suddenly – partly solves the problem of the lack of transitional forms. Darwin was opposed to this idea because he was aware of the improbability of evolution by macromutation – an issue we shall deal with in a moment. In 1954 Ernst Mayr initially proposed⁹ (at least in its modern form) an idea later elaborated by Niles Eldredge and Stephen Jay Gould¹⁰ that the gaps in the fossil record should be viewed as real and propose a model of evolution as an episodic process occurring in fits and starts interspaced with long periods of stasis – the punctuated equilibrium. In their model new species arise rapidly in isolated populations. In an isolated population a new species emerges after which it spreads widely and afterwards undergoes little change. Clearly given the small numbers of individuals involved in the transition the chances of finding fossil evidence are remote.

There is considerable evidence from recent genetic studies of isolated populations that this is indeed how new species arise. However, whilst this model is a perfectly reasonable explanation of the gaps between closely related species it is doubtful if it can be extended to explain the larger systematic gaps such as the gap between primitive terrestrial mammals and whales for example. This would require hundreds, probably thousands, of transitional species. Unless we believe in miracles (I do but only when God intervenes), such gaps could not have been crossed in geologically short periods of time with all the transitional forms all contained in isolated areas. Many of the transitional species would surely have spread widely – but no evidence of their existence has been found. Furthermore, unless some of these transitional forms did spread, the chances of further mutation amongst a suitable sub-group would be negligible. Let's be clear on the magnitude of the problem being faced here. The fossil evidence shows that the move from a small land mammal to a whale, or from a small land mammal to a bat, occupied little more than 10 million years – a very short time indeed for the magnitude of change involved.

As a second problem with Darwin's theory, there are numbers of species, which have existed for millions of years with little or no evolutionary change – the so-called "living fossils". One example of these is bowfin fishes. No more than two species of bowfin fishes have existed at any one time. In their history of more than 100 million years, bowfin fishes have displayed virtually no evolution at all. Lungfishes are another example. They evolved quite rapidly at the beginning of their history some 300 million years ago, but since then have again hardly evolved at all for hundreds of millions of years. Other examples are sturgeon fishes, alligators, tapirs and aardvarks. These are difficult, if not impossible, to account for on a strict Darwinistic view. It is, of course, precisely what we would expect on the punctuated equilibrium model. This is one of the reasons why I think the punctuated equilibrium model is probably correct, but we must remember that this does not in any way solve the problem of the larger systematic gaps we just discussed.

⁹ Ernst Mayr, *Change of Genetic Environment and Evolution*, pp157-180

¹⁰ Eldredge N and Gould S J, *Models in Paleobiology*, Schopf, Freeman, Cooper and Co pp82-115.

A third problem with Darwin's theory is the extremely rapid development of huge numbers of new species, indeed numbers of whole new phyla, during the early Cambrian period – the so called Cambrian Explosion. This explosive development cannot be accounted for by a gradualistic evolutionary model and indeed can only be accounted for with great difficulty (if at all) by the punctuated equilibrium model. Within less than 50 million years we see the sudden appearance of all the known animal phyla. A similar and parallel problem exists in the sudden appearance of flowering plants, which Darwin sought to explain away by proposing the existence of an unknown continent in the Southern Hemisphere.

A fourth problem with Darwin's theory is that neither this theory, nor other evolutionary models such as the punctuated equilibrium, have any answer for “irreducibly complex” biological systems (primarily the mechanisms within the cell). Whatever Dawkins says about transitional wing forms advantaging land based animals for example, there is no factual basis for his assertions and they do not satisfactorily address mechanisms like the bacterial flagellum the human immune system or the blood clotting mechanism. He makes an analogy with solving a combination lock which gradually gives out hints. But, like a well designed combination lock, the universe doesn't give out hints. Unless partial constructs are useful, there is no reason why they should be retained. And that's the whole point of irreducible complexity – it's very difficult to see how any intermediate forms could be useful. It's for proponents of evolution as a theory to come up with the answer to this problem. Dawkins doesn't deal with it except to baldly state that he is sure that there are gradualistic mechanisms which can develop these systems. That's not an answer unless you take evolution by natural selection as a given – which Dawkins obviously does. Irreducibly complex biological systems can have no function at all until they are complete and thus cannot have been produced by gradualistic means. Equally, to imagine they could be produced in a single bound of macromutation, strains our credulity given the enormous improbability involved.

Thus, I think you can see that the scientific evidence simply does not support Darwin's theory in its classic form of slow gradualistic change. I consider that this theory should be firmly rejected. If Darwinism were not so intellectually satisfying in philosophical terms to so many scientists (because it eliminates the need for God), it is doubtful if it would have survived to this day. Stanley M Stevens, professor of paleobiology at John Hopkins University, says “In fact, the fossil record does not convincingly document a single transition from one species to another”¹¹. He also says “... gradual modification of existing species cannot even account for the origins of most new genera.”¹² And “What happens if we attempt, hypothetically, to form each new genus by gradual modification along one of the well recognised evolutionary pathways? What happens is that we are stymied!”¹³ Now I should emphasise that Stanley Stevens is no friend of Christians or creationists – he roundly attacks these groups later in the book from which I just quoted. So you see just how deficient classical Darwinian theory is.

Here, I should say that I do consider that the punctuated equilibrium model of evolution we discussed a few moments ago has limited validity and does explain some of the development of life as we know it. However, I do not believe it is a complete explanation for all such development because of the problems of rapid major transitions we have looked at and the irreducibly complex systems issue. In my view, the Intelligent Design hypothesis is a better

¹¹ Stanley M Stevens, *The New Evolutionary Timetable*, Harper & Row Ltd p95

¹² Ibid at p97

¹³ Ibid at p99

explanation of the evidence and this is even more strongly supported in the area of the origin of life, which is our next topic.

Whatever its merits in explaining the development of life, I contend that neither Darwinism nor the punctuated equilibrium theory can offer any explanation whatsoever for the *origin* of life. In brief summary my argument is that evolution can only take place by selection amongst naturally self-replicating entities. Until life exists, self-replicating entities do not exist and therefore evolution cannot occur.

It is true that in his book, Darwin himself made no claim that his model of evolution could be extended to explain the origin of life, but the implication was there and was soon taken up by his contemporaries like Thomas Huxley. Today the idea that selection amongst beneficial mutations was responsible for the origin of life is firmly held by most evolutionary biologists.

Now we used to think that life started about 700-800 million years ago, but recently an Australian group has discovered the remains of a simple algae in rocks at least 3,500 million years old. The earth's surface didn't even become solid until 3,900 million years ago, so that leaves at most 400 million years for inorganic compounds to somehow be transformed into living cells.

The formation of life by random processes seems unlikely to the point of impossibility – especially within such a relatively short space of time. Even if earth's primitive seas were (somehow) full of all the right building blocks of life – the right amino acids – (and believe me that in itself is very unlikely – the current evidence from examination of pre-Cambrian rock strata is that they contain none of the residues we would expect to find if a pre-biotic soup had existed), the chances of even the simplest protein self-assembling are less than the chances of randomly selecting a designated atom from all the atoms in the solar system. Here I need to emphasise that proteins are absolutely essential to the existence of living cells. The origins of life's information library – DNA – are even more problematic.

Proteins are each made up of long strings of between 200 to more than 1,000 amino acids. Each amino acid has to be in exactly the right place in the string forming the protein, or the protein won't function – rather like computer code or putting together letters to form a (very long) word. And let me emphasise here that there is absolutely no significant chemical or other similar principle determining the ordering of amino acids in a protein. There are some minor affinities between amino acids, but actual functional proteins tend not to follow that ordering in any event. It is likely that the human body contains more than 1 million different proteins and the simplest functional cell of which we can conceive would contain at least 100 proteins.

Let's assume that earth's primitive ocean somehow had all the right amino acids existing in close proximity to each other within it. Even then the chances of making a complex protein such as collagen (which has 1,055 amino acids) would effectively be nil. The chances of 1,055 amino acids assembling themselves in the right order is 1 in 10^{260} . That's far less than the probability of selecting one particular atom at random from amongst all the atoms of the universe. Furthermore, it's unlikely that all the right amino acids could have been produced by chance from the inorganic chemicals which existed on the early earth, and as we saw the geological evidence is that such a pre-biotic soup never existed.

Haemoglobin is one of the simplest proteins, it contains just 146 amino acids, but even here the chance of it constructing itself by random combinations of amino acids is around 1 in 10^{190} . As Fred Hoyle said, the chances of even one protein being constructed by random combinations of amino acids is less than the chance of a whirlwind passing through a junkyard and leaving behind a fully assembled jumbo jet.

Also, let's not forget that we have been talking about just one protein. As we have already said, we need at least 100 proteins to make a very simple living cell.

And it only gets more complex and unlikely. A protein is not only distinguished by the exact sequence of amino acids which comprise it, but by its shape – the way it is folded. Even then a single protein, or even a million proteins, are of no use unless they are able to be replicated or to replicate themselves. No protein can do that by itself, DNA is required in addition.

Immediately we come to another paradox. Proteins can have no use (even if they somehow came into existence) without DNA – because without DNA they can't reproduce. But DNA has no function or purpose without proteins, so how could it ever arise? We shall be returning to the subject of DNA a little later.

Those who deny a creator God, argue that proteins somehow partially assembled in shorter chains and that such chains somehow developed increasing complexity. However, it is difficult if not impossible to see what functionality such short chains could have had to cause them to be created in the large numbers that would have been necessary for there to be any reasonable chance of further, more complex, development. I believe it is for those advancing such arguments to provide a convincing mechanism. For the moment a designer creator God is, in my view, the only reasonable hypothesis.

It is true that simpler proteins involving fewer amino acids can exist, but such simpler proteins lack the folding structure which is necessary to their function in living organisms until they have at least 75 amino acids. This is still far too many to permit any realistic possibility of a chance origin.

As I've already said I do not believe scientists can validly look towards evolution, Darwinian or otherwise, in seeking a suitable mechanism. Natural selection requires self-replication, but as mathematician Von Neumann has shown¹⁴ any system capable of self replication would need to contain systems or sub-systems that were functionally equivalent to the systems we find in living cells. To put it another way natural selection cannot operate until the level of complexity we find in living cells has been reached, but that level of complexity cannot be arrived at by random fluctuations – chance – because the odds are so immensely against. Thus, pre-biological natural selection is a contradiction in terms. Hence, we can't invoke evolutionary type mechanisms to explain the origins of proteins and DNA.

Nevertheless, both Richard Dawkins and Bernd-Olaf Koppers have attempted to revive the concept of pre-biotic natural selection. Both use a computer model to try and demonstrate the efficiency such selection could have. They select a target sequence of letters to represent a desired functional polymer. After creating a crop of randomly constructed sequences and generating variations amongst them at random, their computers select those sequences that match the target sequence most closely. The computers then amplify the production of these

¹⁴ J von Neumann, *Theory of Self-Reproducing Automata*, University of Illinois Press

sequences (to simulate differential reproduction) and repeat the process. As Koppers puts it “Every mutant sequence that agrees one bit better with the meaningful or reference sequence ... will be allowed to reproduce more rapidly.” After only 35 generations his computer model succeeded in spelling the target sequence “NATURAL SELECTION”. However, there is an obvious flaw in this experiment. Chemical molecules in a pre-biotic ocean do not have a target compound “in mind”. Their different arrangements will not differentially reproduce until they arrive at a functionally advantageous arrangement. The results of both Koppers and Dawkins simulations show early generations full of non-functional gibberish, corresponding to useless chemical compounds in the real world. In Dawkins model, not a single functional word appears until after the tenth generation – and this is with the benefit of the foresight or foreknowledge built into the model. Where would this foreknowledge come from in an unaided material world.

It is precisely the difficulty in arriving at a naturalistic, non-deistic, mechanism that has led some scientists to assume that life developed away from earth, and that earth was later somehow seeded with life. But, of course, that just displaces the problem elsewhere, just pushes it back one stage. Given the extreme improbabilities involved the probabilistic resources of the entire universe are exceeded. To put it another way it’s so unlikely that even if it were happening all over the universe there is no reasonable probability of its happening by chance. In any event, how could any life which was formed, reach us across thousands of millions or even billions of light years of distance. Thus, the approach of moving origins elsewhere solves nothing.

So far, we’ve just looked at the origin of life in terms of its basic chemical components, especially proteins. Most complex life is built up of cells which contain proteins (up to 20,000 different ones in a typical human cell) and many other things as well. For living things to function, the proteins within their cells must be able to reproduce. In order to do that they need both the apparatus of the whole cell and the information contained in a complex chemical compound called DNA. As Richard Lewontin writes “No living molecule is self reproducing. Only whole cells contain all the necessary machinery for self reproduction Not only is DNA incapable of making copies of itself aided or unaided, but it is incapable of ‘making’ anything else The proteins of the cell are made from other proteins, and without that protein forming machinery nothing can be made.” DNA is a pretty common term today and I’m sure you will all have heard of it – in fact it’s an absolutely amazing substance.

DNA is life’s computer programme – its Windows 7 as it were – but much better put together! DNA is the repository of a digital code, a library of information, telling the cell’s machinery how to build specific proteins. This code is written in a four value code (rather than the two value binary code used by computers). These four values are represented by four chemical compounds called bases. These are A (adenine), T (thymine), C (cytosine) and G (guanine). Without this code, without DNA, proteins are unable to reproduce. Thus without DNA living cells cannot function at all. But, where did this digital code, this information contained in DNA, come from. I believe it is best explained on the basis of an intelligent designer and creator.

As I just said, DNA stores information in a four character digital code rather than the two character digital code that computers use. Properly arranged these four characters, or “bases” as they are usually called, instruct cells to build different sequences of amino acids which, as we’ve already seen, are the building blocks of proteins. To build even one protein the

information expressed by between 1,200 and 2,000 bases, that's 1,200 to 2,000 letters in this code, is typically required. This means that there is rather a lot of DNA in the human body. You have more than 2 metres of it, if it were straightened out, squashed into every cell and this 2 metres of DNA contains over 3 billion letters of coding. Altogether within your body you may have as much as 20 million kilometres of DNA – enough to stretch to the moon 50 times over.

DNA is essential to life, but it is not itself alive, indeed it is particularly chemically inert. DNA is like a library of information which is absolutely necessary to the functioning and replication of a cell. But, without the cell, or at least without proteins, the information has no function or purpose – so how could it have originated? Information theorists hold that the creation of new information is generally associated with conscious activity by a thinking being.

Jay Roth, professor of cell and molecular biology at the University of Connecticut, said, “Even reduced to its barest essentials the original template for life must have been very complex indeed. For this template and this template alone, it appears reasonable at present to suggest the possibility of a creator.”

Some scientists have advanced various hypotheses supposing that chemical attractions may have caused DNA's alphabet to self assemble or that natural affinities between amino acids caused them to link up in a particular order. Given the failure of models involving pre-biotic natural selection this seemed to be the only explanation not involving the need for a creator designer. Rather than invoking chance, these theories invoked necessity. Scientists in the late 1960's suggested that the chemicals involved might possess self-ordering properties capable of organising the constituent parts of proteins, and also DNA and RNA into the specific arrangements they now possess¹⁵. Kenyon and Steinman developed the idea that affinities between different amino acids might account for the sequences of amino acids we find in proteins in a book called *Biochemical Predestination* in 1969. They argued that life might have been biochemically predestined by the properties of attraction that exist between different amino acids in proteins. This view has now largely been abandoned. Dean Kenyon has specifically repudiated the notion.

In 1977 Prigogine and Nicolis proposed another self organisational theory based on the idea that systems driven far away from equilibrium often display self-ordering tendencies. For example gravitational energy will produce highly ordered vortices in a draining bathtub or hot air above a radiator will generate distinctive convection currents. They suggested that something similar might apply to the biochemical building blocks of life.

For many current origin of life scientists, self-organisational models now seem to offer the best approach to explaining the origin of life. Nevertheless there are many critics and huge problems. For example, an early advocate of self-organisation, Dean Kenyon, has now explicitly repudiated such theories as both incompatible with empirical findings and incorrect. Firstly, empirical studies have shown that some differential affinities do exist between various amino acids – that is certain amino acids do form linkages more easily with some other specific amino acids rather than other amino acids. However, it has also been shown that these affinities do not correlate to the ordering of amino acids we find in actual

¹⁵ H J Morowitz, *Energy Flow in Biology*, New York Academic Press, pp5-12

proteins. In short, chemical affinities do not explain the sequential arrangement of amino acids in actual proteins.

In relation to DNA, the point can be made even more strongly. The structure of DNA does, of course, depend on chemical bonds. However, there are no chemical bonds between the bases arranged along the helix structure of the DNA molecule. These are attached to the helix but not to each other. Further, just as you could attach magnetic letters anywhere on your refrigerator, similarly each of the four bases of the digital code (A, T, G and C) can attach anywhere on the backbone of the DNA helix with equal facility. Thus all possible sequences of bases are equally probably (or improbable). Indeed there are no significant differential affinities between any of the four bases and the binding sites on the DNA helix – exactly the same kind of chemical bond attaches each of them. All four bases are acceptable; none is preferred. As Koppers put it “the properties of nucleic acids indicate that all the combinatorially possible nucleotide patterns of DNA are from a chemical point of view equivalent.”¹⁶ Thus it is quite clear that self organising bonding affinities cannot explain the specific sequential arrangement of nucleotide bases in DNA because (i) there are no bonds between the bases themselves and (ii) there are no different kinds of bonds and no differential affinities between the backbone of the DNA helix and the bases which bond to it.

Some scientists have tried to argue that life began in an RNA world rather than a DNA world, but that is not helpful to their case here as the same kind of bonding rules apply to RNA molecules as well. Additionally no RNA molecule which is fully self replicating has yet been discovered or developed. Christian De Duve who, as we’ve already seen, is critical of the idea of an intelligent designer says of an RNA world possibility “Hitching the components together in the right manner raises additional problems of such magnitude that no one has yet attempted to do so in a pre-biotic context.”¹⁷

Some scientists are also unwilling to abandon ‘inevitable ordering’ arguments, in spite of the evidence against that we have just briefly summarised. De Duve says “the processes which generated life were highly deterministic, making life as we know it inevitable given the conditions that existed on the prebiotic earth.” Yet if we imagine the most favourable conditions possible – a pool full of all four DNA bases and all the other components of the DNA molecule – it is clear that it is unlikely that any functional protein or gene would ever arise. To say otherwise is like claiming that the structure of Buckingham Palace is inevitable given the properties of the bricks and stones used to construct it. Bricks don’t care how they are arranged and nor we have discovered do the information carrying bases in DNA.

In fact there is a good reason why this should be so. Information theorists have shown that chemically based ordering would not yield information of a sufficiently complex nature to enable the DNA code to contain the specifications for all the varied components of life. At a simple level this is easy to understand. Suppose there were bonds and affinities such that every time base A occurred it attracted T to follow it and that every time base C occurred, G would likely follow it. As a result, DNA would be full of repetitive sequences AT and CG – rather like the structure of a crystal. In a crystal chemical attractions do determine to a very large extent the arrangement of its molecules. Thus, a crystal is highly structured and regular – ordered and repetitive with little information content. The forces of chemical necessity reduce the capacity to convey novel information. As chemist Michael Polyani notes:

¹⁶ B Koppers, *The Prior Probability of the Existence of Life*, Cambridge MIT Press pp355-369

¹⁷ De Duve, *Vital Dust*, p23

“ ... Whatever may be the origin of the DNA configuration, it can function as a code only if its order is not due to the forces of potential energy. It must be as physically indeterminate as the sequence of words on the printed page.”¹⁸

Chemical affinities do not generate complex sequences. Information is both ‘complex’ and ‘specific’. Thus, chemical affinities cannot be invoked to explain information content. As Yockey says, the accumulation of structural or chemical order does not explain the origin of biological complexity or genetic information¹⁹. He concedes that energy flowing through a system may produce highly ordered patterns, but the information content of DNA is not regularly ordered.

In the face of these difficulties, some, such as Manfred Eigen, have claimed that we must await the discovery of new natural laws to explain the origin of biological information. In my view, this displays confusion on two counts. Firstly, scientific laws do not generally cause or even explain natural phenomena – they describe them. For example, Newton’s law of gravity described but did not explain the attraction between planetary bodies. Secondly, laws describe highly deterministic inherently predictable relationships. Laws describe patterns in which an event becomes inevitable given previous circumstances. Yet, information increases as improbability increases. Thus to say that a scientific law can provide complex information is effectively a contradiction in terms.

Let me just summarise in a couple of sentences what we’ve learnt about the structure of DNA. DNA provides the information that enables the replication of proteins within living cells. This information is represented by the bases attached to the DNA helix. These bases do not interact chemically with each other in DNA. Any base can attach at any point along the DNA helix backbone with equal facility – they are totally interchangeable. That means that chemical affinities could not possibly have produced the ordering we observe. Information requires irregularity of sequencing that bonding affinities between the bases in DNA (which are the information carriers) would not produce. Even if there were any relevant chemical affinities, to hold that they could have produced complex information of the kind we find in DNA is analogous to arguing that a pile of paper and a bottle of ink somehow organised themselves to generate this talk.

If neither chance nor the principles of physical-chemical necessity, nor the two acting in combination, can explain the origin of the information content of DNA, what does. Do we know of anything that has the causal powers to create large amounts of information content. We do. As Henry Quastler, an early pioneer in the application of information theory to molecular biology recognised, the “creation of new information is habitually associated with conscious activity”²⁰.

Everyday experience confirms that specified complexity or information content only arises from the activity of intelligent minds. Think of computer code or a newspaper article – these have a mental not a material cause. This holds for specified complexity not only in languages or codes, but other things as well. Think of the carvings of American presidents on Mount Rushmore in the USA – no one would think of suggesting that these had originated by weathering patterns or any activity other than that of an intelligent creator designer.

¹⁸ M Polyani, *Life’s Irreducible Structure*, *Science* 160, pp1308-12

¹⁹ H P Yockey, *Self Organisation, Origin of Life Scenarios and Information Theory*, *Journal of Theoretical Biology* 91

²⁰ H Quastler, *The Emergence of Biological Organisation*, Yale University Press, p7

Indeed we normally hold to this principle so strongly that we make suitable inferences even when the causes themselves cannot be directly observed. Archaeologists assume a mind produced the carvings on the Rosetta stone. Anthropologists argue for the intelligence of early pre-human hominids on the basis of chipped flints which they discover. NASA searches for possible extra-terrestrial intelligence on the basis of searching for patterns (such as the prime number sequence) embedded on electromagnetic signals from space. In all these cases we are unable to observe an intelligent mind at work, but on the basis of what we do observe (or hope to observe) we do not hesitate to infer the existence and operation of such a mind.

We have now observed the information content of DNA. I contend that this information content is by itself an extremely strong argument for the existence of a creator designer God. We know of no other cause besides intelligence that produces complex information. Even the rabid atheist Professor Flew from Cambridge University (who had written more than 25 anti-Christian books) converted to Deism (although not Christianity) a few years ago on the basis of the DNA evidence.

This argument from evidence to design is not an argument from ignorance. Some scientists have said that because we do not yet know how specified complexity in physics and biology could have arisen we are invoking this mysterious and unscientific notion of intelligent design and this is not a scientific explanation but a kind of place holder for ignorance. Yet, as I've just argued, we often infer the activity of intelligent agents as the best explanation for certain events or phenomena. As Dembski has shown²¹ we do so rationally according to clear theoretical criteria. Intelligent agents have unique causal powers that nature and natural forces do not. When we observe effects that we know from experience only intelligent agents can produce, we rightly infer the antecedent presence of a prior intelligence even if we did not observe the action of the particular intelligent agent responsible²². When these criteria are present, as they are in living systems, design constitutes a better explanation than either chance and/or deterministic natural processes.

Yet others have objected that we cannot infer the existence of an intelligent designer for life because we have no knowledge that such a being exists. However, well accepted design inferences elsewhere, do not depend on a prior knowledge of a designing intelligence. Take for example the SETI research by NASA already mentioned. We do not know that any extra terrestrial intelligence exists, but the researchers (in my view rightly) assume that the existence of large amounts of specified complexity in any radiation they might detect would establish the existence of such an intelligence. Closer to home anthropologists have, as we already noted, inferred the intelligence of proto-humans by examination of artefacts these beings produced.

Yes say the objectors but the examples you have given only require intelligence at the human level. The creation of life would require a much greater intelligence than any that we know exists – a superintellect to use Fred Hoyle's words. This is an attempted application of the *vera causa* principle which asserts that we should only postulate (or prefer in our considerations) causes which are sufficient to produce the effect in question and that are

²¹ W Dembski, *The Design Inference: Eliminating Chance through Small Probabilities*, Cambridge University Press pp36-66

²² *Ibid*, pp1-35, 36-66

known to exist by their observation in the present²³. Darwin himself marshalled this argument as a reason for preferring his theory of natural selection over special creation. Scientists, he argued, can observe natural selection whereas they cannot observe God creating new species. Even so, Darwin admitted that he could not observe natural selection creating the kind of large-scale change that his theory required. For this reason, he had to extrapolate beyond the known powers of natural selection to explain the large-scale change during the history of life. But, he knew that natural selection was capable of producing small-scale changes, so he reasoned that this could reasonably be extrapolated to explain large-scale changes over longer times. Historical scientists have long regarded such extrapolations as reasonable and fully in accord with the *vera causa* principle. Consequently the *vera causa* principle cannot reasonably be employed to exclude arguments from intelligent design – it is a reasonable extrapolation to the effect of a greater intellect – God – from the effects of lesser known intellects.

Further, it has been argued that the hypothesis of an intelligent designer is not scientific because it is not testable. However, this allegation is untrue. Advocates of intelligent design have made a number of predictions based on that hypothesis, for example that the long sequences within DNA which do not encode genes and which until recently had no known function, would in fact be shown to have a function. That prediction has recently proved to be correct. These long “junk” sequences within DNA which were until recently thought to be rubbish left over from mutation and undesigned evolutionary processes have been shown to be a part of what might in computer terms be likened to the operating system. They control the application of the gene coding sequences, they turn genes on and off and control their interaction and application. This successful prediction shows that the intelligent design hypothesis is testable.

Finally, others have argued that the intelligent design hypothesis is not science – because it is not naturalistic. If by this, we mean that only materialistic causes can be considered then the intelligent design hypothesis is not scientific on that definition. But what is the rationale for this criteria of materialism? Surely, science should be considering whatever explanations are more probable, not artificially restricting the choices of the kinds of explanations which can be considered. We should be asking what is the most adequate explanation, not choosing from amongst a range of artificially restricted options.

In any event, mainstream physics has for many years accepted that we cannot restrict ourselves to the purely materialistic, mechanical view of nature. Quantum theory requires a mysterious interaction between the observer and the observed. This is an almost mystical phenomenon for which we have no material explanation – we just observe the reality. But, what would have happened before there was any life in the universe to constitute an observer? Perhaps the observer was God!

Of course, the argument to design we have reviewed does not constitute a proof – nothing based upon empirical observation can – but it most emphatically does not amount to an argument from ignorance. Rather it is an inference to best explanation. Causes that can produce the evidence in question are clearly better explanations than those that cannot. We have clearly shown that chance and the blind operation of natural law (or the two in combination) cannot produce life, but we know that an intelligent designer could.

²³ V Kavalovski, *The Vera Causa Principle: A Historico-Philosophical Study of a Meta theoretical Concept from Newton through Darwin*, University of Chicago p104

Origins of Life Conclusion

I think we have demonstrated several things quite convincingly in this part of our day. Firstly we have established that classical Darwinism is effectively a dead outdated theory. Secondly, we have established that alternative theories, such as the punctuated equilibrium, explain some of the development of life following its origins. However, it is doubtful that they offer a complete explanation of such development, as there are too many problems with rapid transitions to highly divergent forms of life (e.g. small land mammals to whales). Thirdly, we have established quite convincingly that neither chance nor the operation of chemical affinities or indeed other natural laws – or even the operation of all of these combined, can explain the origins of life from non-living materials. Finally, we have shown that intelligent design is not an argument from ignorance and that there are no other intellectual grounds for rejecting it. On the basis of this part of our talk alone we have made a very strong case for the existence of a creator/designer of such power that we might as well call him god – although not necessarily the Christian God of course.

Overall Conclusion

When we combine the argument from the evidence about the fine tuning of the universe with our look at Darwinism and the origins of life, then I believe we have an absolutely overwhelming case for the existence of a creator designer god. Furthermore we need to remember the case for the inherent unreliability of purely naturalistic arguments about our evolution advanced in our look at science and religion.

The naturalism that Dawkins and others espouse, in addition to its intrinsic unappealing nature and its dispiriting conclusions about humanity and our place in the cosmos, is in deep intellectual deficit. There is no reason to believe it and excellent reason to reject it. Dawkins worships by faith at the altar of natural selection – and faith it is. It is not Christians who are deluded in relation to the existence of God but Richard Dawkins and his fellows.

Taking all the arguments together, and having have seen the strength of the scientific evidence for a creator designer, Christians must be convinced that we have a winning case and go back “on the attack”, firmly asserting Intelligent Design theories as an intellectually supportable, and indeed preferable, basis for explaining the origins of the universe and the world of biological life we observe.

This means that Christians must rediscover a strong and robust intellectual tradition and cease to emphasise the Christian life and experience *only* in terms of personal metaphysical experience – a felt thing – and reassert its objective reality. The objective reality of a Christ who actually lived and walked on earth 2,000 years ago.

There is the case of a (now) well-known Christian writer, who, shortly after his conversion, asked his pastor about the nature of the Trinity. The reply was “just believe Jesus is God and don’t worry about the details.” That kind of attitude is not going to carry the day in our cynical post-modern world.

Science has stepped beyond its original boundaries and is moving to take over the areas of religion and morality. As Michael Ruse, the famous philosopher of science, says “Evolution came into being as a kind of secular ideology an explicit substitute for Christianity.” Even

today, it “is promulgated as an ideology, a secular religion – a full fledged alternative to Christianity, with meaning and morality.”²⁴ However, science does not have the background to do this, and its basis for so doing – Darwinism – leads directly to amorality and devaluation of humanity.

If we stand by and do nothing, the consequences will probably be very serious. There have already been blatant calls for social engineering of humankind – to “produce quality human beings by means of such consciously engineered processes as society’s best minds can blueprint.”²⁵ Worse we now have the capacity to genetically engineer humanity. As embryologist Brian Goodwin says, “life becomes a set of parts, commodities that can be shifted around.”²⁶

Having been decisively defeated by early Christian apologists, Epicurean materialism modified by Darwinism and modern pragmatism has again reared its head after two thousand years to challenge not only Christianity, but *all* traditional moral and classical philosophical views. This leads logically and inevitably to the elimination of *all* moral values as having any ethical authority and to the devaluation of humanity to the status of experimental animals.

We must take action and give a strong moral lead before the fabric of our society and indeed humanity itself are destroyed. You may think I’m putting the case too strongly, but I leave you with this thought – GM foods today and GM humans next year. I don’t think we have the intelligence or the knowledge to play god today or next year – what do you think?

Finally, I hope I’ve done something today to increase your faith in God and to show that it’s not only possible but reasonable, indeed more reasonable than not, to believe in a designer and creator God. The God hypothesis is the simplest and most consistent we have and all other theories fall short.

However, we mustn’t push our evidence too far. We have demonstrated evidence for an enormously powerful creator and designer God who is clearly favourably disposed towards life, even towards human life. We can know this because he has clearly manipulated the whole of creation to permit it. But, what we have not done is to demonstrate a case for our Christian God – although the designer and creator we have revealed certainly has some of his characteristics and is perfectly consistent with Him. To make the case for a Christian God we need to turn to other revelations – the revelation of scripture and His personal revelation in our lives.

If there are any of you who don’t yet know our Christian God, come to our church, our home groups and our Teaching Days and read his revelation to us – the Bible – to get to know him for yourselves. As it is said – taste and see that He is good.

²⁴ Michael Ruse, *Mystery of Mysteries: Is Evolution a Social Construction?* Harvard University Press 1999

²⁵ Mary Calderone, director of US Sexuality Information and Education Council, cited in *Bible Science Newsletter* May 1990

²⁶ Brian Goodwin cited by Nancy Pearcey *World magazine* 24 February 2001

Cenezoic		now 65 m years ago	
Mesozoic	Cretaceous	65m 146 m years ago	dinosaurs extinct
	Jurassic	146 m years ago 208 m years ago	
	Triassic	208 m years ago 248 m years ago	
Paleozoic	Permian	248 m years ago 290 m years ago	
	Devonian	354 m years ago 417 m years ago	
	Silurian	417 m years ago 443 m years ago	
	Ordovician	443 m years ago 490 m years ago	
	Cambrian	490 m years ago 543 m years ago	all animal phyla formed

Species
Genus
Family
Order
Class
Phylum
Kingdom
Domain