SIGNS OF A CREATOR?

THE SCIENTIFIC EVIDENCE FOR GOD

By

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The ideas which led to this talk had their beginnings when I began to look at some recent developments in cosmology which were of interest to me. Those of you who know me well will be aware that I was originally a scientist and that my first degree was in theoretical physics – so cosmology was a subject of great interest to me. As I widened my reading and caught up with what had been happening during the last thirty years it struck me that most of these recent developments were pointing to the need for a creator and designer God to explain the results of our observations and experiments. I then started looking at the rest of science to see if the same trend was apparent there. To my amazement and delight, it was – and so towards the end of last year the original idea for this talk was born!

However, I really ought not to have been surprised. Science and Religion should never have been in conflict. The whole of modern scientific thought had its origins in the Christian worldview and Christian theology in the Middle Ages. The ideas that God was the creator and sustainer of the universe led to the concepts of one order throughout the whole of creation and the idea of "natural laws". These are foundations of scientific thought. I submit that conflict between science and Christianity is a historical blip commencing only late in the 19^{th} century and arising out of Darwinism and man's overweaning pride. I trust that this error will be swiftly generally recognised and that science and Christianity can once again develop in harmony

Even today many people feel that God does have a significant role in the natural order. A 1991 Gallup poll showed that over 90% of Americans believed that God created the universe either directly or by intervening in natural processes. However, today we're going to be looking at specific evidence which I believe will give us a much greater certainty than the kind of general feeling expressed in that survey. Nor shall we be looking at a "God of the gaps", a God who fills in the holes of our current scientific understanding. We shall be looking at positive and direct evidence for the existence of a creator and designer God

Of necessity we're going to be looking at a lot of science in many different fields today, but I'm going to make my presentations as simple as possible whilst making my case, but there will be quite a lot of facts and background material to present before I can establish the points I want to make. So you'll just have to be patient and stay with me. I think it will be worth it at the end of the day.

Firstly, this morning we're going to be covering the evidence provided by cosmology and nuclear physics with several breaks for questions and a break for coffee at the end. After coffee, we'll have the last session on the evidence arising out of the Origins of Life with a very brief final closing session to round off the morning. At the end of these sessions we're going to have lunch at the Rado Plage, where you can raise further questions. I'm going to introduce lots of pauses in the sessions to enable you to ask for clarification of any point or to ask questions. Please don't feel embarrassed about that. The material we're going to cover is not at all easy and I'm expecting lots of questions and clarification requests.

There will be very little maths and virtually no equations, but there will be lots of numbers. * Most of these numbers will be either very large or very small so I'm going to be using what we call scientific notation – * that's just expressing numbers as powers of 10, * so that 100 is

10^2 * and 1,000 is 10^3. * In the first case the power is 2 * and in the second case 3. * When we talk of 10 to the power x, then x represents the number of zeroes after the 1 in the number, ** so each increase of 1 in the power makes the number 10 times bigger. * And each decrease of 1 in the power makes the number 10 times smaller. * So, a change of only one in a power is quite a big difference. **This notation is also used for very small numbers, * so that 1/1,000 is represented as 10^{-3}. * We're only going to be looking at very large variations in numbers today so powers of 10, either positive or negative, are accurate enough for our purposes.

We're going to start off by looking at the universe on the largest scale, peering back as close to its origins as we can comfortably and reliably go and at the same time looking at some nuclear physics involved in how matter was created. As I said we're going to start with cosmology – the study of the universe as a whole - and nuclear physics as these two subjects tend to go together.

However, before we start, I'm just going to do a very quick scientific background summary to cover the essential concepts we shall need. * Matter at a very simple level for our talk today consists of neutrons, protons and electrons.

* Neutrons are heavy particles with no electrical charge. * Protons are also heavy, although slightly lighter than a neutron and have a positive electrical charge. * Electrons are light so that it takes 1,836 electrons to make up the mass of a proton. * Electrons have a negative electrical charge equal and opposite to the charge on a proton.

*Matter is made up of atoms. The nuclei of atoms consist of neutrons and protons and the nucleus is surrounded by electrons equal to the number of protons in the nucleus.

** In addition to these particles there are * very light particles called neutrinos, which are important in radioactivity. * Light is transmitted by particles called photons, which have energy but no mass.

** There are four kinds of force which affect matter:

(i) * the strong nuclear force. This is a very strong and very short range force which holds protons together against their electrical repulsion in the nuclei of atoms. You probably know that like electrical charges repel each other whilst opposite charges attract one another. So protons all having a positive charge couldn't stay close together in the nucleus without the strong nuclear force to overcome the electrical repulsion.

(ii) * the weak nuclear force which is also short range and is weaker than the strong nuclear force. It governs radioactivity.

(iii) ** electromagnetism, which is weaker than the nuclear forces and operates over a longer range. It governs electrical and magnetic phenomena.

(iv) * gravity, which is the weakest of all the forces, but which operates over a very long range. It is an invariably attractive force acting on all matter.

ANY QUESTIONS OR REQUESTS FOR CLARIFICATION SO FAR

Cosmology and Nuclear Physics

Let's start by looking at the history of thinking about the universe we live in. For most of recent history, the majority of scientists and educated people believed that the universe was eternal - that it had always existed and had no beginning. Certainly, that's what the ancient Greeks believed. Only the Jews (and later Christians adopting Jewish ideas) believed that the universe was created by God out of nothing at some particular moment in the past. As we shall see in a moment the Jewish or Christian view is very close to what virtually all scientists believe today.

* What no one knew or guessed until around 80 years ago (when Edwin Hubble started peering at faint objects through the new 100 inch telescope at Mount Wilson and realised they were outside our own galaxy, outside the Milky Way) was the enormously vast scale of the universe. We now know that the universe consists of more than 100 billion galaxies (each similar to our Milky Way) and each containing something like 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 around 100,000 light years across and 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, spiral like this * which contain a mixture of younger and older stars – our own Milky Way is a spiral galaxy. * Spiral Galaxies also exist in a slightly different form known as a barred spiral.

Even within galaxies, distances are vast. The nearest star to the solar system is Proxima Centaurus, about 4.2 light years for 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.

ANY MORE QUESTIONS OR REQUESTS FOR CLARIFICATION

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 galaxies other than the Milky Way, except for 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 at shorter distances, 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 these 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 its 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 was 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. * 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.

** 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.

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.

ANY REQUESTS FOR CLARIFICATION OR QUESTIONS AT THIS POINT

** 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 0.1 atom per cubic metre.

** 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!

** 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 nothing in 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 a way and to a degree that 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.

LETS HAVE ANOTHER PAUSE FOR CLARIFICATION OR QUESTIONS

* 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 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 earthlike 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 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. * 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. * Again, who monkeyed with the physics?

LETS HAVE ANOTHER PAUSE FOR CLARIFICATION OR QUESTIONS

** The properties of the elementary particles are also important. * Neutrons are around 0.14% heavier than a proton – * 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 gives larger molecules the complex chemical properties required for life.

** Furthermore, the exact value of the strong nuclear force 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.

Furthermore, there is more to the universe than meets the eye. We know from measurements of the movements of galaxies within clusters and the gravitational forces which are needed to cause them and also the bending of light by clusters of galaxies, that the average cluster of galaxies has *somewhere* about 9 times more mass than we can see. We call this "dark matter" because we can' see it. This dark matter could be a number of things or combinations of these things (i) brown dwarfs, small stars too small to create enough heat to produce nuclear fusion – this means they wouldn't emit any light (wouldn't shine), (ii) black holes, (iii) exotic elementary particles left over from the Big Bang (often referred to as quark nuggets) or (iv) the total mass of neutrinos (each one having a very small but non-zero mass). Current thoughts favour some combination of (i), (ii) and (iii) as any significant amount of (iv) would result in a universe with a different structure.

Let's return to the question of variations within the universe I mentioned a few moments 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 10^{-5} 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 trillion to one against * (not much chance of willing that lottery!). This factor and this factor alone would be strong evidence for a creator designer God.

LETS HAVE A PAUSE FOR QUESTIONS OR CLARIFICATION HERE AS WE'VE COVERED SOME QUITE DIFFICULT MATERIAL

** 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. * However, 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 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 machine. * This is supposed to have produced trillions upon trillions of universes, none of which we shall be ever able to observe or even detect, * and they then propose that we just happen to live in the lucky one where life is possible. * Polkinghorne called this approach "a pseudo scientific metaphysical guess". I think that was too polite. ** All that unscientific rubbish of universes we can never know or even detect * just to avoid having to introduce the idea of a creator God whom we might be able to see and know - we Christians would say can see and know.

** 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, which we call the critical density, is about 6 atoms per cubic metre – well above what we observe in the universe as we've already said.

Cosmologists give the symbol omega to the actual density of matter divided by the critical density. Currently it looks like that ratio, omega, is about 0.3. Thus, it appears that the universe will carry on expanding forever. Indeed some very recent observations suggest that the rate of expansion may even be 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.

LETS HAVE ANOTHER BREAK THERE FOR QUESTIONS OR CLARIFICATION

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!

** Many, even most, scientists agree this 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 razors edge so as to enable life to 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. * Again along with lot's 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..

LETS HAVE A BREAK THERE FOR ANY FURTHER QUESTIONS OR CLARIFICATIONS

Before we finally leave cosmology though I just want to look at one fairly simple argument that is really more philosophical than scientific. ** The Kalam Cosmological Argument. This was developed by Muslim theologians just after 1,000 AD. This argument has three parts or steps.
* The first is "Whatever begins to exists has a cause".
* The second is "the universe had a beginning"
* and the third is "therefore the universe had a cause".

I think the first principle is sound, things don't suddenly come into existence out of nothing for no reason. I know some scientists talk about the universe originating in a primeval vacuum energy, but that isn't really nothing, it's a rich sea of forces. Such an explanation just pushes the whole question of causation back one level – you then have to explain what brought the vacuum energy into existence. The second principal now has a huge body of scientific observation and evidence in its favour and is generally accepted by almost all scientists. The third statement follows logically from the first two.

I wouldn't want to make too much of this argument compared to the other arguments I've made already today, but I think you will have to admit it does have a certain simplistic force.

COFFEE BREAK

Astronomy

At first sight, there is nothing terribly special about the earth. It's an average unassuming rock spinning around an unremarkable star in a run of the mill galaxy – "a lonely speck in the great enveloping cosmic dark" as Carl Sagan put it.

Nicholas Copernicus started the trend towards regarding the earth as not a special place centuries ago when he established that we revolved around the sun, rather than everything revolving around us.

However, when we take a closer look, we begin to find that the earth is in fact quite special after all! In their book "Rare Earth" Peter Ward and Donald Brownlee from the University of Washington said that the conclusion was inescapable that the earth is a rare place indeed.

Earth's location, its size, the size of the moon, its composition, its structure, its atmosphere, its internal dynamics, the carbon cycle, the oxygen cycle, the nitrogen cycle and so on (and on and on and on) – all testify to the exquisite balance and probable rarity of earth.

Taking location first, it's likely that life is only possible within certain kinds of galaxy and then only within relatively restricted zones within those galaxies. You'll remember we talked about a number of different kinds of galaxies in our cosmology section. Well, irregular galaxies are unsuitable for life because they are generally emitting vast quantities of energy and are thus inhospitable to life. Elliptical galaxies could be suitable, but there is no doubt that spiral galaxies are optimum. Even then, not everywhere in a spiral galaxy is good. Most of them have vast black holes at their centres. You don't want to be near a black hole because they give off lots of radiation as things fall into them. That's why elliptical galaxies are less good than spiral galaxies, because orbits of stars are irregular in elliptical galaxies, and thus stars occasionally visit the dangerous inner regions.

Even within a spiral galaxy, you don't want to be in the spiral arms, because that's where active star formation is going on, and there is a high chance of a supernovae going off nearby during the 3.85 billion years its taken for life to develop on earth. Earth's location, nestled between spiral arms a way out from the centre, is ideal.

Furthermore, our galaxy is relatively large and that helps us to have lots of heavy elements, because there have been more stars to produce those heavy elements (again you'll remember from the cosmology session that all heavy elements are produced in stars).

When we look at our solar system its surprising how much the other planets contribute to the habitability of earth. For example, you probably know that scientists believe that an asteroid hitting the earth wiped out the dinosaurs and that there have been a number of other major extinction events in pre-history. Well a few of those may be not too bad, or possibly even good, but if they were happening regularly, life would have found it very difficult to develop. It turns out that Jupiter plays a major role in shielding us from impacts. It deflects many comets and prevents them coming into the inner solar system. Even Saturn and Uranus help in this shielding.

Of course, other solar systems could have large gas giant planets like Jupiter, Saturn and Uranus. Many of the few we have found so far do, but none of them have gas giants with circular orbits distant from the sun - as in our solar system. This leads me to believe that such configurations may well be rarer than we once thought.

Next habitable planets have to be in the Circumstellar Habitable Zone – that's the region around a star where you can have liquid water on the surface of a planet. Also, you want to be on the inner edge of that zone so that you can have relatively low carbon dioxide and relatively high oxygen levels. Earth fits the bill perfectly, but move it 1% out or 5% in from its present orbit around the sun and life would be impossible. Also, habitable planets need to have relatively circular orbits. If they are too elliptical, conditions vary too much during the year.

Our sun is also fairly unusual. It's amongst the 10% most massive stars. That's important because size governs the surface temperature of a star. A smaller star would be much redder, and even if we were closer to it (and so within the CHZ) the whole spectrum of light falling on us would be redder – that's bad for photosynthesis in plants. Also if we were close to a

small star tidal forces would be much stronger and we would end up in a tidally locked state with one face of the planet continually towards the sun. That's before we even think about solar flares which are much more intense in relative terms on red dwarf stars and of course we would be much nearer the star and so closer to all the radiation from the flare. These flares would cause massive temperature spikes on planets within the CHZ and radiation from the flares would very likely reach levels lethal to life as we know it. Finally, scientists now believe that earth needed to be bathed in ultraviolet light to facilitate the break up of water into hydrogen and oxygen to build up oxygen levels – and you don't get much ultraviolet light from a red dwarf!

Yet if the sun were more massive then (again as we saw in the cosmology session) it would have a much shorter life and that wouldn't have given life time to develop on any suitable planets of such a star.

Returning to a point we made earlier, our galaxy is large and thus relatively rich in heavy elements. Our sun is a second or third generation star within this galaxy and thus has a higher abundance of heavy elements than second or first generation stars. It turns out that the level of heavy elements posessed by our sun is close to the golden mean for building earth like habitable planets. Furthermore, our sun is highly stable, much more so than most comparable stars. Its light output fluctuates by less than one tenth of one per cent over the 11 year sunspot cycle, putting it in the lowest 5% of stars as regards variability. Finally, the sun's orbit around our galaxy is highly circular, much more circular than for most other stars of its age. That helps it retain its ideal position between two spiral arms we highlighted earlier.

Near the beginning of this session, I mentioned the earth's large moon as a special factor in enabling life. It turns out that the large moon is an essential component in stabililising the tilt of the earth's axis – which as many of you will know is what gives us the four seasons. The actual tilt of the earth's axis of 23.5 degrees gives us fairly mild seasons. The low variability in that tilt of plus or minus 1.5 degrees keeps it that way. If the moon were not there, or were much less massive, then the tilt would vary over a large range giving major climatic swings - which would not be favourable to the development of life. The large moon also creates large tides. It turns out that these flush nutrients from the land into the sea and also control the circulation of ocean currents which keep the temperatures in the higher lattitudes relatively mild. However, if the moon were even larger then tides would be too violent and the earth's rotation would have been excessively slowed down causing excessive temperature variations between night and day.

This large moon is believed to have originated as a result of a collision between earth and a body approximately the size of mars during an early stage of the earth's formation. That is likley to be a rare event, making earth like planets more unlikely.

Turning to the earth itself, it needs to be massive enough to retain a breathable atmosphere rich in oxygen and also massive enough to avoid the heat from its interior being lost too quickly. It turns out to be important that the earth has a molten interior. That gives us plate techtonics and an uneven surface. If the earth were perfectly smooth it would all be covered by deep ocean. There might be life in such an ocean, but it wouldn't be human life. Also plate techtonics drives earth's carbon doixide cycle which balances the level of greenhouse gases and regulates temperature. In their book *Rare Earth* Ward and Brownlea state "it may be that plate techtonics is a central requirement for life on a planet".

The molten core also produces the earth's relatively intense magnetic field. This is crucial in regulating the number of low intensity cosmic rays and other radiation which reach earth. Also, it prevents particles from the sun stripping away the upper atmosphere, especially hydrogen and oxygen from water.

So we see that the earth and indeed the whole solar system is a very special place indeed. Much rarer and more unlikely than most people thought during the last 50 years. The universe is so vast that the improbability of earth and the solar system does not entirely rule out a chance explanation, but scientists have calculated that if it originated by chance then it is likely to be the only such habitat in the whole universe. Not nearly such convincing evidence of God as was provided by our cosmology and nuclear physics session, but nevertheless evidence which also points in that direction. We shall see lots of additional and very compelling evidence in our session on life and its origins after lunch.

*** 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.

* Darwin thought that life probably originated in a warm little pond somewhere. This sort of view persisted until quite recently. * In 1953 Stanley Miller mixed together what he thought were fair representations of the ocean and atmosphere of primitive earth and passed some electrical sparks through them – which might have happened in a lightning strike. He managed to produce organic compounds including a few amino acids (which are the building blocks of proteins that are themselves fundamental to life).

However, as we now know it isn't nearly so simple. Scientists are now certain that the early atmosphere of earth was nothing like that used by Miller. When Miller's experiment is repeated with what we now believe to be the correct inputs, few if any organic compounds are created. Furthermore, such organic compounds as are produced are rapidly destroyed by reacting with the other chemicals present. Organic compounds for our purposes today are simply molecules that we find in living organisms.

** In any event, we also now know that the real problem is not forming amino acids (which are quite simple organic compounds), but proteins. * Proteins are each made up of long strings of between 200 and 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 chemical or other similar principle determining the ordering of amino acids in a protein. * It is likely that the human body contains more than 1 million different 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 less than the probability of selecting one particular atom at random * from amongst all the atoms of the universe. Furthermore as we've already seen its unlikely that all the right amino

acids could have been produced by chance from the inorganic chemicals which existed on the early earth.

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, the human body probably contains 1 million different proteins.

** 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 *.

** Immediately we come to another paradox. * Proteins can have no use (even if they somehow came into existence) without DNA, * 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.

LETS TAKE A BREAK FOR QUESTIONS AND CLARIFICATIONS

** 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.

** Furthermore, we now know that primitive life (which involved proteins) * arose very early in earth's history, perhaps 3.85 billion years ago. * The earth's surface didn't even become solid until 3.9 billion years ago. * That didn't give very long for these extremely unlikely assemblages to arise. * Perhaps as little as 100 million years.

* Stephen J Gould said ** "we can only infer from this rapidity that it is not difficult for life of bacterial grade to evolve on planets with appropriate conditions." * With all due respect to Stephen Gould, I don't believe this statement, this reasoning, has any validity at all. * It presumes there is no cause ** and as we've seen its very difficult to imagine a natural mechanism. * We can only make this inference if we are able to dismiss the hypothesis that a creator designer God has intervened – * and so far all the evidence points in the direction of his being very much needed. Scientists such as Gould have to come up with a credible

mechanism for the development of the complex elements of life before we can even think of dismissing God as the most likely mechanism behind life.

** In seeking for a competing mechanism I do not believe scientists can validly look towards evolution, Darwinian or otherwise. * Pre-biological natural selection is essentially a contradiction in terms, because natural selection requires self-replicating organisms in order to function. It is this replication which acts to preserve favourable variations and pass them on to future generations. * But, for reproduction we require proteins and DNA – the very things whose origins we are trying to explain. * So we can't invoke evolutionary type mechanisms to explain the origins of proteins and DNA.

** 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 somehow seeded with life. * But, of course, that just displaces the problem elsewhere, * just pushes it back one stage. That approach 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.

** You started with a single cell. * That splits to become two, * these divide to become four * and so on. * After just 47 such doublings you have the 10^{16} (that's 10 thousand trillion) cells that a human body contains. Cells are wonderful and amazing things, each one far beyond the limits of human ingenuity. ** A really simple cell, such as a yeast cell, * contains more components than a jumbo jet, * all miniaturised and fitted within a sphere * just 5 thousandths of a millimetre across. * Human cells are far more complicated than yeast cells and come in many different varieties.

** Darwin thought that cells were just simple blobs of protoplasm, * but we now know just how wrong that view was. * The cell is a vast automated chemical factory bustling with violent activity. ** Each cell is encased by an outer membrane, * has a central nucleus which contains all the genetic information to keep it going, * and a cytoplasm or operating space between. The cell is a very lively place. ** The proteins spin, pulsate and fly about, crashing into each other, and * performing up to 1,000 tasks a second – and, when you remember that there are up to 100 million protein molecules in each cell, that gives you some idea of the scale of the activity. All this activity performs many functions, * extracting energy from nutrients, * eliminating waste matter, * making repairs, ** assembling structures, * sending and receiving information * and warding off intruders. Even simple cells are factories of such complexity that they are hundreds of times more complex and indeed more efficient than the largest factories man has yet built.

Every day billions of your cells die. That's normal, they're supposed to die as part of the normal process of renewal and replacement. Indeed when they fail to die on order and instead start dividing wildly, that's cancer. This wild division happens quite often, but your body has many elaborate mechanisms for coping with that. Cancer is fortunately rare and unlucky.

** As we've seen cells are complex machines, * and it seems unlikely to the vanishing point that they could arise by chance or the operation of any evolutionary mechanism, * Darwinian or otherwise. * They, and even small sub-components within them, seem to perfectly fulfil

Darwin's own objection to his theory. * In the *Origin of Species* he said "If it could be demonstrated that any complex organ existed which could not possibly have been formed by successive slight modifications, my theory would absolutely break down."

LETS TAKE ANOTHER BREAK FOR QUESTIONS AND CALRIFICATIONS

** Within the cell are complex sub-systems. * Many scientists have called these sub-systems in cells "irreducibly complex" – * because if you take away any one of their parts * they don't just work less efficiently, they simply don't work at all. It's not that they could evolve or develop from simpler less efficient structures. Unless they're 100% complete they do nothing at all.

* Michael Behe, one of the originators of the notion of irreducible complexity, ** likes to use the analogy of a simple mousetrap. * It has a total of five parts. * It has a wooden platform to which the other parts are attached, a U shaped metal wire which crushes the mouse, a spring which presses against the platform and the U shaped wire when the trap is set, a catch which releases the U shaped wire when the mouse disturbs it and finally a metal bar which holds the U shaped wire back and connects to the catch.

** If you take away any of the parts, it's not that the trap becomes less effective – * it doesn't work at all. * Furthermore, you don't just need any parts for the trap they all have to fit together, be of the right strength, etc. * A designer does that for the mousetrap, * but in the cell who specifies the parts * or tells them how to assemble themselves?

Of course, its possible that some sub-systems within a complex system could have other functions and that the complex system could come to exist by an indirect route. However, the more complex the final system the less likely is that to be possible.

There are many examples of complex molecular machines within the cell and I'm just going to highlight two today - * cilia and the flagellum.

** Cilia are whiplike hairs on the surface of cells. * When the cell is stationary, they move fluids across the surface of the cell. * The cells lining our respiratory tract have cilia in order to sweep mucus down your throat for elimination. * Each of these lining cells has about 200 cilia on its surface. ** These cilia are complex molecular machines and each cilium has about 200 parts.

* A cilium has nine pairs of microtubules encircling two single microtubules. * These microtubules are really just long thin flexible rods. ** The outer microtubules are connected to each other by flexible nexin linkers * and each microtubule has a motor protein called dynein. * The motor protein attaches to one microtubule * and has an arm that reaches over, takes hold of another microtubule ** and pushes it down. * That makes the microtubules slide lengthwise with respect to each other and * as they slide the nexin linkers stretch and become taut. * As the dynein pushes harder it bends the whole structure. Finally it pushes in the opposite direction and bends the structure the other way. ** That's how the cilia create a "rowing" action which enables them to move fluids across the surface of a cell. * Of course that's a really simple basic description, but I think you can already see that * without all the parts we have mentioned fixed together in exactly the right way cilia wouldn't work at all.

* Thus like our mousetrap example cilia are irreducibly complex machines. ** For them to have come into existence by evolutionary means it would be necessary to elucidate a mechanism whereby they could develop gradually – * and its hard to see how that could happen because until they're all there they don't work at all.. So far no-one has done that and indeed it's difficult to see how such a mechanism could exist, * especially bearing in mind that a cilia needs to protrude from the surface of the cell (not exist within it) in order to be functional.

* Before we leave the cilia let's just take another look at its construction.

* Turning now to the flagellum ** this is a kind of propeller that moves bacteria along – * a little bit like the outboard motor of a boat. * The flagellum's propeller is a long whiplike strand of a protein *flagellin*. * This propeller is attached to a drive shaft by a hook protein ** which acts as a universal joint allowing the propeller and drive shaft to rotate freely. * Several different types of proteins act as bearings or bushes where * the drive shaft penetrates the outer cell wall of the bacterium to attach to a rotary motor inside the bacterium itself.

** The flagellum is a really powerful and effective system which can rotate at up to 10,000 rpm. * Not only that but the propeller can stop within one quarter of a revolution and start to rotate in the opposite direction. * It's incredibly efficient and effective, far beyond any motor humans can construct.

Even more amazing the whole system is connected to sensory systems which turn it on and off and govern speed and direction, enabling the bacterium to be guided to food, light or whatever it's seeking.

** At a minimum 30 to 35 proteins are needed to create a functional flagellum and again it's irreducibly complex – * without all these 35 parts it doesn't work at all. * Because it's more complex than a cilia, it's even more difficult to imagine how such a machine could develop by evolutionary means.

* Before we leave the flagellum let's just take another look at its construction.

** More research and more discoveries about how these things work * aren't going to lead us to an evolutionary answer, because as we discover more, * we find that they are even more complex than we previously imagined.

* I believe that irreducibly complex systems such as the two examples we have briefly considered are compelling evidence of purposeful, intelligent design by an intelligent agent. No other theory we currently have or are able to imagine succeeds in explaining them, certainly not Darwinian evolution. * As Allan Sandage an eminently respected scientific authority said "The world is too complicated in all its parts and interconnections to be due to chance alone. I am convinced that the existence of life with all its order in each of its organisms is simply too well put together. …… * The more one learns of biochemistry the more unbelievable it all becomes unless there is some type of organising principle ….."

THAT SEEMS LIKE A GOOD POINT FOR ANOTHER QUESTION AND CLARIFICATION BREAK

* Earlier I said we would return to the question of DNA. DNA is life's computer programme – * its Windows XP 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. * But, where did this digital code, this information, come from. I believe it is best explained on the basis of an intelligent designer and creator.

** DNA stores information in a four character digital code rather than the two character digital code 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 is typically required. ** This means that there is rather a lot of it in the human body. * You have more than 2 metres of it, if it were straightened out, squashed into every cell and this 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. ** However, experiments have shown that amino acids do not have bonding affinities * and worse information theorists have shown that such ordering would not yield information of a sufficiently complex nature. Information requires irregularity of sequencing which bonding affinities would not produce. ** Even more damning to such notions is the discovery that the bases in DNA do not interact chemically at all. * Also, they have been shown to be totally interchangeable. * Any base can be slotted in at any point in the DNA structure. * That means that chemical affinities could not possibly have produced the ordering we observe. 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 lecture.

The information content of DNA is by itself an extremely strong argument for the existence of a creator designer God. Scientists use the principle of uniformity to justify extrapolating from causes we know which we experience in space and time to other events which are distant in space or time or both. Thus, if we currently observe the effects of erosion by running water and see similar effects in ancient rocks scientists use the principle of uniformity to deduce that the cause of the ancient erosion was running water. Scientists even invoked this principle in relation to the canals on the surface of Mars to deduce that there was once liquid water on the surface of Mars. What then of the information content of DNA?

The only thing we know of which produces and organises complex information is intelligence. Thus we can invoke the principle of uniformity to deduce that the most reasonable explanation for the information content of DNA is an intelligent designer. We know of no other cause which produces complex information.

Of course, aside from the problems of life's origins, those who seek to dispense with the need for a creator have to contend with the problem of the development of complex life forms from their primitive ancestors. The problem of evolution.

** One thing we know for certain is that Darwinian evolution by natural selection is not the explanation. It simply faces to many problems. It is not my intention today to discuss the detailed refutation of classical Darwinism – I want to concentrate on positive evidence for a creator rather than refuting particular theories. In fact, the classic version of Darwinism has not been accepted by the majority of scientists working in evolution for more than 40 years now. However, because it still has so much significance in the minds of many laymen, I shall just quickly cover three highly significant reasons why classical Darwinism doesn't work

* Firstly, the fossil record does not support it, we do not find evidence of the numerous intermediate forms 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."

Secondly, there are numbers of species which have existed for millions of years with little or no evolutionary change – the so called "living fossils". These are difficult if not impossible to account for on a strict Darwinistic view.

Thirdly, 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 – cannot be accounted for by a gradualistic evolutionary model and indeed can only be accounted for with great difficulty (if at all) by any kind of evolutionary model. 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.

** The current generally accepted theory of evolution is the punctuational theory. The progress of evolution by the production of new species by mutation in small usually geographically isolated populations – evolution by quantum speciation. * Those who want to know more about it can read popular accounts such as *The New Evolutionary Timetable by Stephen Stanley*.

** It's a pity that so many people have been misled by scientists overselling Darwinism to doubt or even abandon their Christian faith. * It's also positively evil that the theory extended into social and behavioural matters has been used to justify rape and even child abuse, but these are topics for another day. However, if you doubt the seriousness of social Darwinism please read *Total Truth* by *Nancy Pearcey*.

** In spite of the doubts that I have been expressing concerning the ability of a naturalistic non-creationist explanation for the origins of life, * I do believe that the balance of scientific evidence currently favours the development of life by evolutionary means heavily modified

by extinctional and other events. * In my view this does not conflict in any way with a reasonable interpretation of the scriptures or mainstream Christian doctrine, but, once again, an analysis of Genesis Chapter I is a topic for another day!

THAT'S REALLY THE END OF MY ORIGINS OF LIFE SESSION AND IN A MINUTE I'M GING TO DRAW FINAL CONCLUSIONS, BUT BEFORE WE DO THAT ARE THERE ANY FINAL QUESTIONS OR CLARIFICATIONS ON THE LIFE SESSION

Conclusion

Let's bring the material we've covered today to a brief conclusion.

* In the realms of cosmology, we have seen that * the precise degree of uniformity of the universe, and * the precise values required for forces such as gravity and the cosmological constant – all of which needed to have exactly the values they do have in order for our universe to be capable of sustaining life – cannot be explained on a chance basis. ** And these are just a few of the stronger examples we've looked at. There were many others. Indeed, they defy reasonable explanation other than the intervention of a designer and creator.

** In the realms of nuclear physics we have seen that * the precise value of the strong nuclear force, * the precise balance between the size and mass of electrons and protons, ** the precise value of the charge on an electron, * the existence of perfectly tuned resonances in carbon and oxygen atoms are all necessary for life to exist in our universe. * Again, the most reasonable explanation is the existence of a creator and designer.

** In the realms of life we have seen that * it is inconceivably unlikely that life could have originated spontaneously * without the intervention of a designer and creator.

Finally, I have to say that in these and other fields of scientific study, the current trend is towards more and more evidence of design and the necessity for a designer and creator.

** Thus we see that on all scales from the largest to the smallest, * in inert matter and in living organisms, * the universe is full of signs of a creator and designer. There is overwhelming scientific evidence for the existence of * a creator and designer of such power that he is to us simply God.

** 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 musn'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.

ANY FINAL QUESTIONS