Science and life*

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What is life and where did it come from?

There is no agreement among scientists about the origins of life; there have been many theories and a number of experiments to try and establish how inorganic, that is, lifeless, chemicals might become organic, or living. So far, experiments have suggested what might have been necessary for life to appear but not what happened at the moment of creation itself.[1]

There is, however, agreement that life on earth is improbable; the proportions of a number of chemicals are different from what one would predict, particularly when we look at the proportions on other planets. Also the amount of heat coming from the sun has increased during the earth's life; yet the proportions of carbon dioxide and methane (the global warming chemicals) in the biosphere (the space from the top of the atmosphere to the bottom of the sea-bed) have decreased. This has happened as a result of the combined actions of organisms within the biosphere — bacteria, protists (unicellular organisms), protoctists (multicellular organisms), animals, fungi and plants.

About one percent of the solar energy that hits earth is diverted into living processes via photosynthesis by plants, algae, and green- and purple-bacteria which are then eaten by animals, fungi and most other bacteria.

The first bacteria existed in an oxygen free atmosphere around 3½ thousand million years ago; they are theoretically immortal and the first species survived by fermenting chemicals to obtain energy, much as our muscles do today; later species began to photosynthesise the energy from the sun and also to release a number of chemicals hazardous to life, such as oxygen. Gradually most species developed ways of protecting themselves from the damage oxygen can do to organisms and of using it to sustain bodily processes.. One species discovered how to synthesise light using rhodopsin rather than chlorophyll and members of this species are, as the colour rods, found in the eyes of fish and human beings.

Around 2 million years ago, bacteria began to merge to form unicellular and multicellular organisms complete with mitochondria and DNA. Many of these organisms require a warm environment and so are mostly found in tropical regions where they can cause diseases if they invade other animals, including human beings.

Around 600 million years ago, animals, mostly sea-dwelling, appeared. Animals have to eat other organisms because they cannot photosynthesise whereas most plants can. Around 400

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[1] Whereas scientists have no idea what might have happened before or at the instant of the 'big bang,' they do have some ideas about what might have happened before life was created and what happened after it was but not how it was actually created.

million years ago some of these sea-dwelling animals began to live on land and the fungi began to emerge, some, like the lichens, being a mixture of fungus and primaeval algae. Most fungi live on dead matter but a few, like the fungus that causes athlete's foot, prefer living matter. They are the world's recyclers — there will never be any more coal because this was formed before the fungi had worked out how to break down the cellulose in wood.

Around 300 million years ago plants appeared and, though some use the egg and sperm method of reproduction, most evolved the seed and fruit method engaging other organisms in ensuring their reproduction.

Life has increased organisation, that is, the connections between things, and therefore appears, for varying periods, to counteract entropy or the process by which connections disappear and things die.

Life also relies on organisms making choices; the smallest organisms that create their own shells or housings, when given a choice of particles, will select the ones they want by size and shape; bacteria are able to sense many things including sugar, acid, heat and magnetism and make decisions as a result of sensing them. (Margulis and Sagan, 1995). Moreover, the biosphere as a whole appears to be capable of making collective decisions for its benefit (Lovelock, 1979), one of which could be to reduce the number of human beings on the planet in order to protect itself from the harm being caused to it by human beings!

A warning

Scientists do not agree on a definition of life; Richard Dawkins poured scorn on James Lovelock's *Gaia* hypothesis because he could not see how the earth could have evolved without natural selection but Lovelock was able to demonstrate that it could have (Gribbin and Gribbin, 2009).

Some scientists define life as involving replication and metabolism, the capacity to process energy, but some organisms, like viruses and DNA, can only replicate and need to find a host in order to metabolise while some organisms, like mules and 'sterile female' forms, can only metabolise and not replicate.

We should not be surprised at this; scientists have always disagreed and will continue to disagree because that is one of the ways in which science makes progress (Jones, 1996).

Some implications of the current account for Christians

As with the creation of the universe (Rees, 2000), the creation and maintenance of life on earth is highly improbable; in theory, it should not be possible for such high levels of oxygen and methane to exist simultaneously but it happens on earth because these chemicals go through cyclic processes which hide a proportion of each from the other. Without these processes, our biosphere would not be able to sustain life as we know it.

Life has only remained possible because of cooperation among organisms, including a sharing out among organisms of the many different processes needed to sustain life; for example, many organisms produce chemicals which other organisms use to sustain their life. Others cooperate by living in symbiosis or spreading seed in exchange for fruit. While competition may have led to the loss of some organisms, it has probably also led to organisms finding new ways of cooperating in order to survive because cooperation, rather than competition, is the 'natural order.'

When Donne (1624) wrote in Meditation 17:

No man is an island,
Entire of itself.
Each is a piece of the continent,
A part of the main.
If a clod be washed away by the sea,
Europe is the less.
As well as if a promontory were.
As well as if a manner of thine own
Or of thine friend's were.
Each man's death diminishes me,
For I am involved in mankind.
Therefore, send not to know
For whom the bell tolls,
It tolls for thee.

he was expressing a view of our place on the earth which twentieth century science has extended to include the whole biosphere. Not only are we a part of God's creation; we are intimately bound up with the fate of the rest of God's creation on earth.

Though we all know that there is life, however we define it, we must be careful about basing our theological arguments on any particular scientific definition of life as there are several and some of these have only emerged as a result of recent research. We could be having a very different discussion in twenty years time because of new research — something James Clerk Maxwell warned Christians about in the nineteenth century (Brooke, 2011).

The role of genes

Forms of life which have a single set of chromosomes are theoretically immortal though most are eaten or destroyed by adverse environments. Some of these forms acquire variability — that is, differences between different members of the species so that, if they come under attack, some will be strong enough to survive — by sharing some of their genes. Others achieve variability by having two sets of chromosomes and sharing half their chromosomes; they make a copy of half their chromosomes to give to each of their offspring. So, unless such an organism has no offspring, a copy of part of it continues to exist in each of its offspring. To that extent genes are theoretically immortal even if the animals or plants that host them are not.

Because we all have two parents, four grandparents, eight great-grandparents and so on, you can soon work out mathematically that most English people are probably related to William the Conqueror; in fact, studies of mitochondrial DNA show that we are all ultimately related as human beings to an African woman who has been called Eve. Though different of her descendants moved into south Asia and Australia, into east Asia and the Americas and into Europe — and we can distinguish these lines by their mitochondrial DNA — we all belong to the same gene pool (Jones, 1996).

There is no evidence that the genes of royalty, the economically successful or the economically depressed come from a different gene pool or have a significant impact on our lives other than in a small number of areas, among them, blood group, eye colour, hair colour and life span.

If your grandparents died natural deaths and you know how old they were when they died, you can get a good idea of how long you will live. The rise in the number of centenarians in the last few decades is not because people's 'normal' lifespans have changed but because fewer

people are dying from accidents or diseases before they reach the end of their natural lifespans. Anyone who reached the age of 80 in 1900 could expect to live nearly as long as anyone who reached the age of 80 in 2000.

The most significant influences on us are our social circumstances — whether we live in a happy family in a decent house in a reasonable area and can go to a good school. All the bad things which some people used to think were associated with genes are associated with these factors in our lives. 'Blue-eyed boys' don't behave any better than brown-eyed boys; they just get let off more often through a northern European social prejudice in favour of blue-eyed boys. Our intelligence, which people once thought was fixed — hence, the 11+ exam, can be affected by the stimulation we get at home, at school, among our friends, at work or during leisure activities throughout our lives so that someone who may have been written off as a 'school failure' can end up more intelligent than the rest of their class. This isn't because 'they had it but weren't using it' but because they have received more stimulation over their lifetimes than others and so have developed it further.

Nothing we do is 'caused' by our genes (Jones, 1996); we may be born dependant on our parents or carers but whether we develop thereafter is a combination of the decisions they take and the decisions we take. Particularly as children and sometimes as adults, we cannot change the circumstances in which we live or the relationships to which we have access; but we are free to choose the ways in which we respond to those circumstances and those relationships. For example, those who forgive those who have harmed them are more likely to be able to lead satisfying lives after the episode of harm (Enright, 2001). (It is important not to blame people for what has happened to them ('victim-blaming') but it is important not to assume that, because someone has had a bad experience, they somehow cannot deal with it — most people can without any counselling, as happened with the survivors of the Aberfan disaster (Morgan et al., 2003), if they are given the space to do so.)

Genes are much better seen as the 'bootstrap' of life; they set out the initial parameters for a new human being but these can be affected even in the womb if the mother does not have enough food or drinks too much alcohol or takes certain drugs; once the baby is born a whole new set of circumstances can impact on the development of the baby as infant, child, young person, adult and older person — things over which the genes have no control.

The web of life

So, whatever else we may learn about genes, they are not the key to life; they simply pass on to each generation the 'bootstrap' which enables a range of other processes to create and maintain life. Rather life relies on a number of processes or 'systems,' that is, a set of interconnected elements that together produce some output.

Some of these systems are organisms in their own right which either entered the body through the process of conception, like mitochondrial DNA, or after birth, like the 'friendly bacteria' in our gut. In some cases, we are as dependent on these organisms for our continuing survival as we are on the plants that expel oxygen.

About four centuries ago there was a shift to seeing body and mind as separate — the idea had been around for a long time but the philosopher, René Descartes, popularised it. So we ended up with separate branches of medicine for physical and mental health. But by the twentieth century people had become aware that this didn't really work — people who took placebos, pills which look like the real thing but have no curative ingredients, would recover

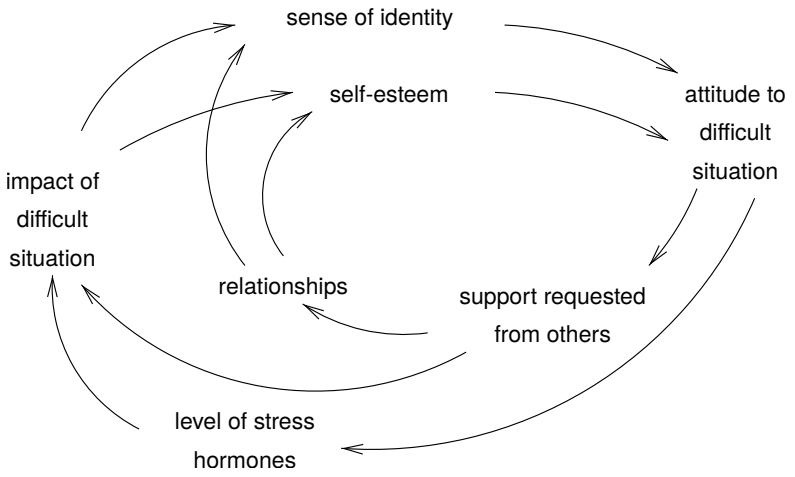

Figure 1: Relationships and identity in a difficult situation

alongside the people who took the real thing and Meyer Friedman and Mike Jordan published research suggesting that people with certain attitudes to life were more likely to suffer from coronary heart disease. Though this research has not been fully supported, it triggered a lot of other research into the connections between mind and body.

In 1984 Osterweis et al. brought together all the research on bereavement in humans and animals and showed that any bereavement causes physiological reactions but that these can be influenced by the ways in which we think about the bereavement.

So it is pointless making distinctions between the different systems within us, other than for theoretical research purposes, or between us as systems and the systems within which we live. Along with the electrical and chemical systems that make up our bodies are the relationship systems that we develop through our interactions with our parents or carers, our peers and other adults. Out of these systems can come what systems thinkers call 'emergent properties' — things which you cannot predict from your knowledge of the system. For example, our sense of identity and self-esteem come from our system of relationships with others (Ladd, 2005); that system of relationships is influenced in turn by the relationships that the people we know have with people we do not know. If we encounter a difficult situation, our sense of identity and our self-esteem will influence the production of the stress hormones and also the ways in which we choose to use those relationships to support us through the situation (figure 1).

A person with high self-esteem will normally deal with a difficult situation better and gain more confidence in dealing with difficult situations in the future; a person who lacks confidence will deal with the situation less well and usually be less confident about dealing with difficult situations in the future (Dziech and Hawkins, 1998) — unless they gain some positive inputs through their relationships that raise their self-esteem. As figure 1 shows, there is only really one source of help to deal with a difficult situation — our relationships, including our relationship with God; everything else just goes round and round in circles.

Though scientists often use the tests of metabolism and replication to define life, human, and possibly some animal, life depends not just on metabolising physical energy but also on metabolising emotional or psychological energy. People who are denied relationships can lose the will to live or go mad and suffer harm to their physiological systems (McConville, 1995). People who have few relationships are more likely to suffer mental health problems (Brugha

et al., 1993).

Systems thinkers sometimes talk about 'requisite variety;' unless a system has a sufficient variety of interconnections with other systems, it cannot receive a sufficient variety of inputs to maintain its own systems and to deal with the wide variety of situations it may encounter. This seems to be the case with relationship systems as well as with other kinds of system. Those who have a limited range of relationships develop less over their lifetimes than those who maintain and develop a variety of relationships throughout their lifetimes.

For some scientists, a relationship is no more than a particular configuration of neurons in two people's heads and all that happens as relationships develop is that the configurations change. However, as all metabolisng organisms have relationships, or interconnections, with other organisms as part of metabolising and all those that cannot metabolise have to establish a relationship, wanted or unwanted, with an organism that can, it seems reasonable to conclude that relationships, or interconnections, are essential for life. We may not understand all these relationships, or interconnections, but we can affect any form of life positively and negatively through the relationships, or interconnections, we have with it. So trying to understand how that happens and how we might affect others and life in general is worthwhile.

Our interconnectedness means that

- it is impossible to say when a new organism can become viable outside its parent — technological advances have meant it is possible to mimic many of the functions of the parent's body and keep alive increasingly premature babies
- as all systems are subject to entropy, or the tendency to lose connections, life depends on our ability to develop and maintain the relationships, or interconnections, that are necessary for life
- how our systems relate to other systems varies widely depending on whether or not they are perceived as hostile and our previous experience of them; for example,
  - leprosy succeeds by appearing to be no threat to the immune system much as confidence tricksters succeed by pretending to be no threat to us;
  - we become immune to many diseases as a result of our immune system developing an antibody and we become able to handle many stresses by the experience of handling other stresses well
- 'death' occurs when key relationships, or interconnections, cease to function; these may not be physiological but relational
- though we normally define death in terms of brain function, some of the interconnections between bodily systems cease to operate much later and people continue to be affected by the relationships they have had with someone long after their bodily death.

Part of the success of many organisms is that they are learning systems; at the very minimum they can learn to avoid unpleasant and seek pleasant sensations but in most cases they have more sophisticated learning systems which allow them to generalise and apply their learning in new and different situations producing new and different interactions and interconnections. This helps systems to develop and maintain 'requisite variety.'

Implications for Christians

Very little in the world is 'determined' in the sense that we cannot change it, though in some areas, like our natural lifespan, we can only have a small impact. The universe God created for us has some fixed points but He allowed us, and other living organisms, a lot of discretion in how we use most of what He has given us. At the risk of causing controversy within the Baptist communion, the scientific evidence about the sort of universe God has created is more consistent with the Arminian view that we all have a choice of whether to follow Him and that we face daily choices in whether or not we backslide in our commitment to Him.

God in His wisdom created a world in which we can interact with other organisms, with other human beings and with Him in ways which we choose. But there are always consequences from the choices we make and we can be the victims of the ways in which other people or organisms interact with us or even of circumstances over which we have no control. The question is never whether we will be affected by others — we are — the question is: how will we react to them — including God?

Life depends on a web of interacting systems; some are physically inside us, like our physiological systems and the 'friendly bacteria' which help us to digest food; some are outside us, like the plants which give off oxygen or the people with whom we make relationships. Most systems have systems to protect or to repair them, like our skin, our immune system and the systems to replace our cells periodically or heal those that have been damaged. But all systems can be overwhelmed by the actions of other systems or malfunction because they can no longer be repaired.

Particularly since World War II, we have perfected some wonderful ways of helping our physiological systems through, for example, blood-transfusion, organ transplants or artificial replacements for parts of the body and through drugs that either assist our physiological systems or stop them from becoming overwhelmed.

But we have long had ways of helping our relationship systems in various situations; the Old Testament and the plays produced by the ancient Greeks are full of ideas about how we can manage our interactions with others in a wide range of benign and adverse circumstances. The word 'politics' comes from the Greek word for 'to do with a city' and it was originally intended to help people living in cities, as opposed to villages, to manage their relationships. In the late twentieth century writers like Capra (1982) have drawn attention to how important it is for us to manage our relationships both among ourselves and with the rest of the natural world.

So loving our neighbour as ourselves turns out to be entirely rational because our neighbour is part of the same web of life as we are; by loving our neighbour, we are maintaining the connections in the web of life which will sustain us and our neighbour. If we cannot love our neighbour, we will loosen the connections in the web of life and diminish the resources of creation. By the same token, if we do not love ourselves enough to be able to contribute to the web of life, we become unable to love our neighbour who relies on us for our contribution to the web of life.

But, just as we have to eat other organisms to survive because we cannot photosynthesise the sun's energy, so other organisms may want to make use of us for their survival. In some cases, we have welcomed these organisms into ourselves or made long term relationships with them because they do useful things for us like producing eggs or grain; in other cases, we try to keep them out.

Most of what goes wrong with us physiologically does so because of a malfunction in a system or an invasion by an organism that takes energy from us which we cannot afford to give. Yet we nearly always have a choice in how we respond to these situations and sometimes our response is the difference between life and death; but our response is almost always influenced by the relationships we have. So even our physiological health is affected by the ways in which we think about it and the relationships on which we can call to support it — one possible explanation for why those with a settled belief system generally have better health and live longer than those who do not (Williams and Sternthal, 2007). This does not mean that a religious faith will prevent all malfunctions or invasions by organisms whose actions may lead to our premature physiological death — any more than having a religious faith will prevent us from sinning and possibly our spiritual death. Rather, even when we are facing a life-threatening situation or a temptation to sin, we can choose how to face it and that choice will affect the progress and outcome of the situation. The most dramatic physiological example of this is Stephen Hawking who was originally expected to die in the 1970s but has survived into the 21st century — something which doctors cannot explain; but there are many other less dramatic examples of people surviving apparently impossible threats to their physiological or spiritual lives.

Eternal life

Though bacteria and genes are theoretically immortal, at least until the earth or any alternative planet to which earthly organisms migrate becomes unable to sustain life, science does not give us any answers to the question of what eternal life might be, not least because there is no obvious scientific method which could be used to study it.

Since science has now established time as the fourth dimension in which we live, one way of viewing eternal life is as 'timeless' life, life outside all four dimensions; this is consistent with the Greek word which is normally translated 'eternal' but which also meant 'timeless.'

But, in the discourse with Nicodemus (Jn 3:1–21), Jesus suggests that eternal life comes through a new way of thinking about our relationships. Many scientists were outraged, and a number of religious people were encouraged, by James Lovelock's *Gaia* hypothesis (Gribbin and Gribbin, 2009) because he seemed to be suggesting that things could happen within the biosphere for which it was impossible to show a causal link even though particle physics had predicted a similar unconnected effect for electron spin. (One half of a particle spins one way and the other half the other way without any connection between the two.)

Of course, a number of the disciples saw eternal life in terms of bodily resurrection but Jesus appears to dismiss this in His answer to the Sadducees about the conundrum of the woman who had had seven husbands when He says that the relationships we will have in heaven are quite different from those we have had on earth and that Abraham, Isaac and Jacob are alive (Mt 22:29–32).

In focusing on metabolism and replication as the keys to defining life, scientists may have missed the point that, while our physiological systems are necessary for our earthly life, they are not sufficient; we also need relationships and they may be the real key to understanding both earthly and eternal life.

Conclusion

The apparent support for the existence of the Higgs boson announced recently has served to strengthen support for the 'big bang' theory that the universe was created at a point in time and has expanded at a constant rate ever since. There is nothing equivalent in the science of life; almost anything a scientist says about life can be shown to be a partial explanation. In part this seems to be because life depends on a large number of complex interactions between living organisms and physical systems which is currently beyond full human comprehension. As Paul said, 'For now I look through a mirror puzzled; then I will see face to face. Now I know in part, then I will understand as I too was understood' (1 Cor 13:12).

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