

Christians in Science Lecture at High Cross Church Camberley 16th October 2018
'Bioethics and Genetic Modification' (Professor John Bryant)

'Let everything that has DNA praise the Lord!'

John Bryant is Professor Emeritus of Biosciences at the University of Exeter, a former Chair of Christians in Science (CIS), and an elected member of the International Society for Science and Religion. He writes and lectures regularly on the subject of Bioethics and science and religion. His academic research has focused on DNA, genes and gene expression and the control of DNA replication in plants. In his introductory remarks he explained why bioethics - a set of guidelines for research and practice in the biosciences (including genetics) – had become necessary:

- new scientific knowledge in bioengineering and genetic modification (**GM**) raises ethical questions as to what should/should not be done in future research and in the practical use of such knowledge
- new possibilities in transplant surgery present moral issues
- there are moral issues regarding the use of human embryos for research purposes
- the GM of animals for research purposes raises animal welfare issues
- there are, or there may be, environmental concerns regarding the growing of GM crops.

Professor Bryant (JB) defined some technical terms:

- DNA is the essential self-replicating molecule from which genes are made
- DNA is made up of individual 'bases' (nucleotides), or 'letters' linked in a particular order
- genes are the 'recipes' for running an organism cell by cell and for the synthesis of proteins
- chromosomes contain thousands of genes
- the genome of an organism is the sum total of all its genes
- proteins are the working molecules within a cell and many are enzymes which control biochemical reactions (eg insulin controls sugar metabolism and hence is vital for the control of diabetes).

He emphasised that **every single organism (on our planet) – plants, bacteria, animals – uses the genetic code in the same way, ie it is universal**. All 'life' shares the same basic genetic code structure with huge implications for research in molecular biology. GM is only possible because of the universality of the genetic code. The fundamental issue in bioethics is, therefore, how should scientific knowledge - such as the new developments in genetics - be used in society as a whole. Are there limits to what scientists should do and just because we can do something, should we? For example, JB asked himself, with his motivation as a Christian to serve God, what should **he** do with **his** knowledge of genes and biological structure, and whether **his** faith helped **him** to make correct research decisions - is there a specifically Christian (virtue) approach? JB made a number of points regarding GM:

- it basically involves taking a gene, or a strand of DNA, from one place and putting it somewhere else
- the process is analogous to 'copying and pasting'
- the techniques for doing GM have become easier and easier
- are there ethical objections to the fundamental **process** of GM per se?
- or do the ethical issues (if any) relate to the **application** of GM?
- does the Bible say anything that is relevant?
- all work on GM in the UK is subject to inspection by the Health and Safety Executive (HSE)
- at present, GM of human embryos is **not** allowed except for mitochondrial exchange.

Professor Bryant discussed some of the many **practical applications** of GM such as:

- the insertion of the gene coding for insulin into a bacterium to produce insulin (on an industrial scale)
- the use of genetically modified plants as 'factories' to produce vaccines eg for the Ebola virus
- the complete sequencing of the genomes of many species
- the '100,000' sequencing project (NHS/MRC) to study inherited diseases including cancer
- the growth of genetically modified crops with enhanced properties eg pesticide resistance
- the use of genetically modified animals (mice, rats etc) to research treatments for human diseases.

The applications of GM in **research** are simply vast, such as:

- determining how genes are organised within the chromosomes
- the sequencing of the ‘letters’ within a gene
- studying evolutionary ‘family trees’
- determining the exact mutations involved in genetic disease
- improving organ transplant surgery
- elucidating the function of specific genes
- studying how a plant cell copies its DNA before dividing
- showing that some genes act as ‘dimmer switches’ for the control of protein production.,

The latter two applications formed part of JB’s own research. Genetic research has been greatly facilitated recently by the invention of an extremely versatile new ‘tool’ – the CRISPR-Cas9 system for **Gene Editing**. This enables scientists to ‘cut’ DNA at very specific places and hence to ‘knock out’ or add a specific gene, such as one leading to genetic disease.

JB discussed **human genetics** and what can be done, for example, to alleviate the problems caused by genetic (inherited) disease. In the case of a young couple where one or both parties might be carrying a particular genetic mutation, eg leading to cystic fibrosis, sickle cell anaemia or Huntington’s Disease, IVF can be undertaken and the resulting embryo(s) tested for the particular faulty gene. Faulty embryos would then be discarded, but is there a moral or Christian issue in doing this? 400 inheritable conditions can now be tested for in order to avoid the birth of a child with a life-limiting and often fatal disability. Actually **changing (modifying) human genes is allowed but only** in very specific circumstances, although technically it would be very easy to do. Gene therapy (injection of ‘good genes’) of the bone marrow of young people with immune deficiency has been tried – successfully – but in some cases this has also caused leukaemia necessitating secondary treatment. Despite such problems, gene therapy is becoming established as a **cure** for some inherited diseases. It has to be emphasised that this is somatic (whole body) therapy which only affects existing cells and the results will not be passed on to future generations. A form of GM of human embryos **is** currently permitted in **one** instance only and this is where the mother’s cells have ‘faulty’ mitochondria – these are the parts of the cell, outside the nucleus, which contain a small number of genes, and which control the conversion of sugar-derived energy into ‘useful’ energy. This is sometimes called 3-way (or 3-parent) IVF and involves the removal of the faulty mitochondria from the embryo and replacing them with ‘good’ mitochondria from a donor cell. Failure to do so will lead to very serious problems for the baby which is likely to die at some point. Of course, in theory it would be quite easy to genetically modify a human embryo directly – using techniques which have been successful with animals – and then implant the modified embryo in the mother’s womb and bring the foetus to full term. This could be used as an alternative treatment for the above genetic diseases but it could equally well be used for **enhancement therapy**. This is currently **not** allowed under British law and this might be an ethical/social stance which Christians (like JB) would support. However, some scientists believe in ‘procreative beneficence’ which would involve human GM and selection in the future. After all, why would one not do the best for one’s offspring **before** birth just as we do after birth?

In agriculture, the GM of plants is still a vexed issue and in Europe it is still very highly regulated – beyond what is sensible according to many scientists. In fact, genetically modified crops have been commercially grown since 1995. The main applications have been the development of crop varieties which have enhanced disease and pest resistance, and herbicide and drought tolerance. There have been very large annual increases in the growth of such GM crops particularly in less-developed countries, where in 2016 the amount grown exceeded that in developed countries. But, despite the benefits, opposition to GM crops continues, a stance which JB finds difficult to understand.

And so, can a specifically **Christian bioethical approach to GM** be developed? There is no direct guidance or set of rules in the Bible, nor should we expect there to be. So, should we resort to principles of Christian **virtue** ethics? JB’s view was that Jesus’ ethical approach was largely based on virtue – ‘love God and love your neighbour’ – and we can expand this to a virtue-based ethical approach, which non-Christians and humanists may well be happy to agree to. And so, unless we take the view, as some do, that

GM per se, the very technique itself, is wrong, then we have to look at every application of GM on its own merits (situation ethics) and this may be the only way to proceed, based on questions such as –

- is it a wise and virtuous use of scientific knowledge ?
- does it demonstrate care for other people individually or collectively ?
- does it pose unacceptable risks to the environment ?
- are there animal welfare issues ?

Based on these criteria, we might well decide that some applications of GM **are** wrong. JB's view, for example, was that enhancement (GM) of the human embryo for the future of humankind would be wrong, but on the other hand we might decide that some applications are highly desirable and in his view that would include the GM of crops – providing enhanced yield for the burgeoning world population and a reduced use of pesticides, and thereby a livelihood for poor farmers in less well-developed countries. We should perhaps be beware of talk of 'designer babies' and cultural trends where children become rights (commodities?) that can be purchased according to parental desires and wishes (and not gifts of God – JB).

There were a number of interesting questions and comments in the Q and A discussions following the talk. Some questions related to the possible long-term effects of growing GM crops. Is the increase in less-developed countries due to less opposition there? Are there risky downsides and will genetically modified plants become permanent and irreversible and would the situation in the future be analogous to the use of plastics today – beneficial, but with huge problems of waste and disposal? JB's view was that this is not and would not be the case. He could not understand the continuing opposition of the European Commission and the European Green Movement. In fact, there are many upsides to growing GM crops such as the lower requirement for spraying pesticides which are both expensive and injurious to the health of the workers, and if (unlikely) there were to be unforeseen problems with GM crops 'down the road' we can simply stop growing them! Most countries have their own bio protocols - China, for example, is being very careful about growing GM rice in case there is cross-breeding with the indigenous strain. In fact, the de facto GM of plants and animals has been practised for a very long time by **plant and animal breeders** using traditional cross-breeding (random mixing of whole genomes) to produce new (and improved) varieties and there are no 'crusades' against this. Also plant breeders have been using irradiation of seeds (eg barley) with gamma-rays since the 1920s to increase the variety of crops available – a somewhat crude, but still effective, way of causing random mutations (again acceptable). JB was not impressed with the level of information available to MPs (and legislators globally) and he cited the case of legislation legalising the use of embryonic stem cells for medical repair work being passed in 2002 – a huge bioethical issue - with little opposition compared to that against GM crops. The concern is that 'decision-takers' may not be particularly well-informed and often make decisions based on very short (4/5 years) time horizons. Is there a musical gene?! JB replied that, 'no', there wasn't such a gene, nor one for being 'gay' or intelligent. Such complex traits are coded for by many hundreds of genes. There isn't a (single) gene 'for this and that' but arrays of genes for these complex traits clearly do exist. **Gene-doping**' (a form of gene therapy) is potentially or actually a serious problem, as in the case of the (illegal) use of EPO in athletics to raise the red blood cell count and hence the quantity of oxygen that can be carried. 'Wherever we look in technology there will be those who misuse it'.

The next CIS meeting of the Surrey Heath Group will be on February 12th 2019 at St Paul's Church, Camberley where Professor Paul Ewart will talk about '**Chaos, Chance and the Character of God**'.

John Wood